

The Status Report of Plutonium Management in Japan - 2016 -

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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 “Guidelines for the Management of Plutonium.”

(2) Overview of the status of separated plutonium management

As of the end of 2016, the total amount of separated plutonium both managed within and outside of Japan was approximately 46.9 tons, approximately 9.8 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 2016. ②As for the reprocessing of spent fuel contracted out to the U.K., approximately 20.8 tons of separated plutonium is held in the U.K. There was no plutonium newly separated and added to the stock in 2016. Approximately 1 ton of 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 2015	As of the end of the year 2016
Total			47.9	46.9
Held in Japan			10.8	9.8
(Total)			37.1	37.1
Held abroad	Breakdown	U.K.	20.9	20.8
		France	16.2	16.2

(3) Conclusion of the safeguards in 2016

The IAEA's Board of Governors held in June 2017 has affirmatively concluded that the safeguards conducted by the IAEA in 2016 determined that all the nuclear material remain in peaceful activities (Broader Conclusion) on the ground that there are no indications of the declared nuclear materials deviating from peaceful nuclear activities and there are no indications of undeclared nuclear materials nor activities.

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 2016 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 but has not been irradiated. Such plutonium is held in the following facilities :

- 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 assemblies..

“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.

“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 fresh mixed oxide fuels loaded into the reactors and irradiated.

4. Additional reference information

In response to the revision of the definition of plutonium to be reported under the IAEA’s “Guidelines for the Management of Plutonium”, unirradiated plutonium contained in unirradiated new fuel (251kg Pu) that was loaded into Monju in August 2010, is now counted as part of “separated plutonium” in the report of the year 2016. (See details in Reference 5 “Clarification of Definitions based on the Amendment to the Plutonium Management Guidelines”)

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 2016.
- Reference 2 The balance of separated plutonium held in Japan at the end of the year 2016.
- Reference 3 The Status of Separated Plutonium in Japan (2016) (illustration)
- Reference 4 The amount of plutonium held in Japan at the end of the year 2016 to be published by the IAEA under *the Guidelines for the Management of Plutonium*.
- Reference 5 The amount of plutonium held in each country at the end of the year 2015 published by the IAEA under *the Guidelines for the Management of Plutonium*.

Attachment

The Status of Separated Plutonium Management in Japan as of the End of the Year 2016

1. Separated plutonium in storage

Figures in brackets are the data published last year for the end of year 2015

(1) Separated plutonium held in Japan

<Unit: kg Pu>

Reprocessing Facilities			Japan Atomic Energy Agency (JAEA) Tokai Reprocessing Plant	Japan Nuclear Fuel Limited (JNFL) Rokkasho Reprocessing Plant	Total
	Breakdown (Note 1)	Plutonium nitrate, etc. (Dissolved into nitric acid for reprocessing)		27(266)	276(285)
Plutonium oxide (held as mixed oxide in containers)		281(246)	3,329(3,329)	3,610(3,575)	
Total			309(512)	3,604(3,614)	3,913(4,126)
		Fissile Plutonium	202(336)	2,342(2,348)	2,544(2,684)

Fuel fabrication Facilities			JAEA Plutonium Fuel Fabrication Facilities
	Breakdown (Note 2)	Plutonium oxide (held in plutonium oxide containers)	
Plutonium in the stage of testing or fabrication		936(999)	
New fuel, etc. (held as finished fuel assemblies, etc.)		446(446)	
Total			3,805(3,596)
		Fissile Plutonium	2,627(2,490)

Reactors and Other Facilities			Joyo	Monju	Commercial Reactors	R&D Facilities (Note 3)
	Unirradiated new fuel held at nuclear reactor sites, etc.		134 (134)	282 (31) (Note 4)	1,597 (2,501)	113 (444)
Total			2,126(3,110)			
		Fissile Plutonium	1,434(2,134)			

Total			9,844(10,832)			
		Fissile Plutonium	6,605(7,307)			

(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) In response to the revision of the definition of plutonium to be reported under IAEA's "Guidelines for the Management of Plutonium" (September 2016), unirradiated fuels (251 kg Pu) loaded in Monju in August 2010 was added.

(2) Separated plutonium held abroad (Note 5)

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.

<Unit: kg Pu>

	Separated plutonium	
		Fissile Plutonium
U.K.	20,839(20,868)	14,003(14,032)
France	16,217(16,248)	10,513(10,542)
Total	37,056(37,115)	24,516(24,574)

(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., 2016

Figures in brackets are the data for the end of the year 2015

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

Amount of plutonium-oxide recovered (Note 6)	JAEA Tokai Reprocessing Plant	JNFL Rokkasho Reprocessing Plant	Total
		244 (308)	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.

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

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

(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.

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

Amount of MOX fuel loaded and irradiated in nuclear reactors (Note 8)	Nuclear Reactors
	904 (0)

(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.

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

The amount of separated plutonium held in nuclear reactors and other facilities in Japan at the end of the year 2016.

			Plutonium held(Note 1) (Unirradiated separated plutonium)		Plutonium loaded into the reactors out of the "Plutonium held" in the left column (Note 2) (Unirradiated separated plutonium)		(Reference Data)"Total amount of unirradiated separated plutonium loaded into the reactor cores by the end of 2016 " minus "Total amount of irradiated plutonium unloaded from the reactor cores" (Note 3)		
			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	282 ^(Note 4)	193 ^(Note 4)	251 ^(Note 4)	171 ^(Note 4)	1,533*	1,069
Commercial Reactors	Tokyo Electric Power Company Holdings	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	181	117	-	-	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 Developmen t Facilities	Japan Atomic Energy Agency	Fast Critical Assembly in Tokai R&D Center(Note 5)	-	-					
		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) Unirradiated separated plutonium held at the end of 2016

(Note 2) Plutonium loaded into the reactors out of the unirradiated separated plutonium held at the end of 2016

During the year 2016, unirradiated separated plutonium equivalent to 720kgPU was irradiated at Takahama Unit 3 and 184kgPu at Takahama Unit 4

(Note 3) The figures represent the total amount of unirradiated separated plutonium loaded into reactor cores by the end of 2016 subtracted by the total amount of irradiated plutonium unloaded from reactor cores by the end of 2016. It is equivalent to the weight of plutonium of the unirradiated MOX fuel staying in the reactor cores at the end of 2016, For commercial reactors, some irradiated fuels may be removed to spent fuel pools temporarily for periodic inspection.

(Note 4) In response to the revision of the definition of plutonium to be reported under IAEA's "Guidelines for the Management of Plutonium" (September, 2016), unirradiated fuels (251 kg Pu) loaded in Monju in August 2010 was added. * : Total of the 1,533kg Pu includes 251kg Pu unirradiated separated plutonium loaded in Monju

(Note 5) No inventory registered as plutonium was shipped out in 2016.

Additional information for reference (as of the end of 2016):

Irradiated plutonium contained in spent fuel in the storage facilities at reactor sites: 137,392kg Pu

Irradiated plutonium contained in spent fuel in the storage facilities at reprocessing plants: 26,734kg Pu

Small amount of plutonium contained in radioactive waste and recognized as irrecoverable for the time being: 144kg Pu

The Balance of Separated Plutonium held in Japan at the end of the year 2016.

Unit: kg Pu

< Variations during the year 2016 > ^(Note 1)		
Total amount of plutonium newly separated at reprocessing facilities		0
Total amount of plutonium newly loaded in reactors and irradiated		△904
Total amount of plutonium exported in Japan		△325
Variance in processes at facilities		△10
Balance		△1,239

[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, 2016 (the end of the year 2015)		512	
increase and decrease	Separation of plutonium (in 2016)		0
	Plutonium shipped out (in 2016)		△209
	Variance in processes at reprocessing facility ^(Note 2)		5
	Breakdown	Transfer to retained waste	△0.1
		Retransfer from retained waste	4.4
		Nuclear loss	△0.1
Measured discard		△1.7	
Material unaccounted for (MUF)		2.5	
Inventory as of the end of Dec. 2016		309	

[JAEA Plutonium Fabrication Facility]

From raw material of MOX to fuel assembly products ^(Note 1)			
Inventory as of Jan. 1, 2016 (the end of the year 2015) ^(Note 3)		3,596	
increase and decrease	Plutonium received (in 2016)		209
	Plutonium shipped out (in 2016)		△0
	Variance in processes at fuel fabrication facilities ^(Note 2)		0
	Breakdown	Shipper/receiver difference	0.0
		Retransfer from retained waste	0.0
		Nuclear loss	△0.3
Material unaccounted for (MUF)		0.4	
Inventory as of the end of Dec. 2016		3,805	

[Nuclear Reactors and Other Facilities]

"Joyo", "Monju", "Commercial Reactors", and "R&D Facilities" ^(Note 1)			
Inventory as of Jan. 1, 2016 (the end of the year 2015)		3,361	
increase and decrease	Decrease by loading in reactors and irradiation (in 2016)		△904
	Plutonium shipped out (in 2016)		△325
	Variance at reactor sites		△6
	Breakdown	Nuclear loss	△5.7
		Transfer to retained waste, etc.	△0.0
Inventory as of the end of Dec. 2016		2,126	

[JNFL Reprocessing Plant]			
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, 2016 (the end of the year 2015)		3,614	
increase and decrease	Separation of plutonium (in 2016)	0	
	Plutonium shipped in (in 2016): material for analysis	0	
	Plutonium shipped out (in 2016): material for analysis	△0	
	Variance in processes at reprocessing facility ^(Note 2)	△10	
	Breakdown	Transfer to retained waste	△0.0
		Retransfer from retained waste	0.0
		Nuclear loss	△0.8
Measured discard		0.0	
Material unaccounted for (MUF)		△8.9	
Inventory as of the end of Dec. 2016		3,604	

(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 book 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 book 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 book 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 3) In response to the revision of the definition of plutonium to be reported under IAEA’s “Guidelines for the Management of Plutonium” (September 2016), unirradiated fuels (251 kg Pu) which were loaded in Monju in August 2010 was added in the report of the year 2016.

- The Status of Separated Plutonium in Japan (2016) -

Unit: kg Pu

[Separated plutonium held abroad]

Total amount abroad	37,056
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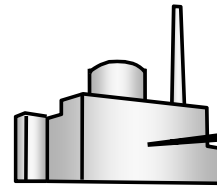
[Separated plutonium shipped abroad]

(JAEA) Fast Critical Assembly	325
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Transferred amount from Japan	325
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[Amount of Holdings]

New fuel and for R&D	2,126
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Nuclear Reactors and Other Facilities

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

[Total amount unirradiated] Amount of plutonium loaded into reactors and irradiated	Δ904
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Variations in Nuclear Reactors	Δ6
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Total amount shipped out	0
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Total amount in Japan	9,844
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Spent Fuels

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

[Total amount separated] Amount of reprocessed spent fuel	0
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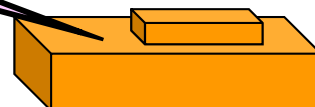
[Amount recovered] Amounts converted from plutonium nitrate to plutonium oxide	244
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Variations in processes	Δ5
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(Transferred amount in a facility and variation in processes at a facility)

[Used amount] Amount of plutonium in fuel fabrication processes	0
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Variations in processes	0
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Fuel Fabrication Facilities

[Amount of Holdings]

Plutonium oxide	2,423
Plutonium in the stage of testing or fabrication	936
New fuel, etc.	446
Total	3,805

Total amount shipped out	209
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Reprocessing Facilities

[Amount of Holdings]

Plutonium nitrate, etc.	303
Plutonium oxide	3,610
Total	3,913

(Note 1) "Amount of Holdings" is the figure as of the end of the year 2016.
 (Note 2) "Transferred amount in a facility and variances in processes at facility" shows the figure for one year in 2016.
 (Note 3) "Δ" indicates decrease.

The Amount of Plutonium Held in Japan to be published by the IAEA
under *the Guidelines for the Management of Plutonium*
(as of the end of the year 2016. 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	3.9	(4.1)
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	3.4	(3.1)
3. Plutonium contained in unirradiated MOX fuel, including that loaded into a reactor core prior to use, or other unirradiated plutonium in fabricated products at reactor sites or elsewhere	2.5	(3.1)
4. Unirradiated separated plutonium held elsewhere	0.1	(0.4)
[Sum of lines 1-4 above]*2	[9.8	(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.	37.1*3	(37.1*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.	137	(136)
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	[164	(163)]
(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 under 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.

*6: The amount at the end of 2016 is revised based on the change of definition in accordance with the amendment to the Guidelines.

[Reference 5]

The Amount of Plutonium Held in Each Country at the End of the Year 2015 Published by the IAEA under *the Guidelines for the Management of Plutonium*

(Unit:t Pu)

	Unirradiated plutonium * ¹	Plutonium contained in spent fuel * ²
U.S	49.0	656
Russia	55.4	151
U.K.	129.4	29
France	79.7	281.7
China * ³	25.4kg	-
Japan	10.8	163
Germany	1.8	116.3
Belgium	< 50kg	40
Switzerland	< 50kg	20

*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 decided on *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 of each country about plutonium utilization reported to the IAEA under the Guidelines.

[Clarification of Definitions based on the Amendment to the *Plutonium Management Guidelines*”]

In September, 2016, for the purpose of clarifying the description of line 3 of Annex B “Annual Figures for Holdings Civil Unirradiated Plutonium” in *the Guidelines for the Management of Plutonium* of the IAEA, line 3 was revised to “Plutonium contained in unirradiated MOX fuel, including that loaded into a reactor core prior to use, or other unirradiated plutonium in fabricated products at reactor sites or elsewhere (note: underlined part is added),” and based on this revision, the description of line 3 of Annual Figures for Holdings Civil Unirradiated Plutonium, in Reference 4 “The amount of plutonium held in Japan as of the end of 2016 to be published by the IAEA under the Guidelines for the Management of Plutonium,” was accordingly revised.

Japan has also revised the definition of “Separated plutonium held in Japan” to “unirradiated separated plutonium that has been separated at reprocessing facilities but has not been irradiated.” (note: underlined part is revised)