Disposition of
Plutonium from Nuclear Weapons

by

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Introduction

The United States and Russia have now both agreed that each country will dispose of 50 tonnes (t) of plutonium (Pu) that have been declared in excess of military needs. Before discussing some of the problems associated with the disposal of this nuclear weapon material, it may be helpful to review the significance of these declarations.

Declarations of Excess Plutonium

United States. In February 1996, the United States declared that the government had an inventory of 99.5 t of plutonium as of September 30, 1994.[1] Not included in this inventory is approximately 350 t of plutonium locked away in some 38,600 t of U.S. commercial reactor spent fuel.[2] The U.S. declaration that 52.5 t is in excess of military needs suggests that the United States government is disposing of about one-half of its weapons plutonium. Actually as seen from Table 1, only 22.7 t of the declared excess represents plutonium that was at the time in the form of plutonium warhead components, called plutonium "pits." The other 29.8 t of plutonium includes the plutonium that was in "pipeline" and waste materials remaining when pit manufacturing was halted at the Rocky Flats plant in 1989, and in fresh and spent reactor fuel, waste materials and other forms scattered around the U.S. Department of Energy (DOE) complex.

Thus, as summarized in Table 2, the United States has declared as excess only about one-third of the plutonium actually contained in intact weapons and stored weapon components. The United States is retaining 47 t of plutonium for weapons. The United States has not significantly reduced the size of its nuclear weapons stockpile since the unilateral nuclear weapon reduction initiative announced by Presidents Bush on September 27, 1991 (Figure 1); President Gorbachev made a similar announcement a week later, on October 5, 1991. By our estimates, with START II fully implemented—the date for this has been extended until 2007—the United States plans to retain some 10,000 intact nuclear warheads plus an additional 5000 plutonium pits stored at Pantex to serve as a strategic reserve (Table 3).

Russia. Russian has also declared that 50 t of its plutonium is now in excess to its military needs. Russia has not revealed the sources of this plutonium—perhaps most or all of it will be from plutonium pits. Since Russia also has declined to declare its total plutonium inventory, Russia's declaration of excess plutonium leaves others unsure of how much plutonium Russia is retaining for weapon purposes. The Russian government has significantly larger inventories of both weapon-grade plutonium (WGPu) and separated reactor-grade plutonium (RGPu) than does the United States. We estimate that Russia has produced about 170 t of plutonium for weapons, and there is about 30 t of mostly reactor-grade plutonium recovered from

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1 U.S. Department of Energy, "Plutonium: The First Fifty Years," February 1996.

2 U.S. Department of Energy, "Integrated Data Base Report—U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics," DOE/RW-0006, Rev. 13, December 1997, p. 1-7; spent fuel inventory projected as of December 31, 1998. The plutonium estimate assumes spent fuel contains on average 0.9% plutonium.

processing spent fuel from VVER-440 power reactors and naval reactors. This 30 t of plutonium is stored at Ozersk (formerly Chelyabinsk-65 or "Mayak"). For the time being, Russia apparently plans to retain more than twice as much plutonium for weapons as the United States. Russia presumably is planning to retain at least as many intact nuclear warheads as the United States, i.e., on the order of 10,000 warheads under START II, and possibly considerably more—perhaps several thousand additional non-strategic warheads. On the other hand, if current trends continue, Russia will likely deploy fewer operational warheads than the United States.

Disposition of Excess Plutonium

United States. The United States is pursuing two approaches to reducing the weapons-usability of the excess plutonium—irradiation of plutonium as mixed-oxide (MOX) fuel in currently operating nuclear power reactors, the so-called "MOX option,"[3] and immobilization of plutonium into stable forms containing fission products as a radiation barrier, the so-called "vitrification option." In the former case the MOX fuel is to be burned in reactors and the spent MOX fuel is to be disposed of as a waste in a geologic repository. In the latter case, the plutonium oxide will be mixed with ceramic material and converted into a crystalline ceramic waste form, called a "puck" (each puck is about the size of a hockey puck). The pucks would then be placed in small cans which in turn would be incorporated into canisters containing vitrified high-level radioactive defense wastes. These so-called "can-in-a-canister" waste packages are to be sent to a geologic repository for permanent disposal. The repository at Yucca Mountain, presently under construction, faces considerable political and licensing hurdles. Even if it survives these hurdles, waste emplacement is not scheduled to begin until 2010 and further delays can be anticipated.

The Department of Energy has estimated the radiological risks associated with implementing the MOX and vitrification options in the United States.[4] Per tonne of plutonium processed, relative to the vitrification option, the MOX option is projected to produce a larger total committed dose to the workers, a larger total population exposure from routine emissions, and it carries a higher radiological risk associated with accidents.[5] Moreover, in the United States the MOX option is expected to take longer, and it is more expensive. The MOX option also encourages non-weapon states to rely on the more dangerous and inherently unsafeguardable closed fuel cycle for their civil power reactors. Despite these drawbacks the DOE is planning to dispose of 33 t of U.S. excess plutonium via the MOX option and 17 t via vitrification. Thirty-three tonnes is the maximum amount of plutonium DOE could dispose of as MOX. The other 17 t is in unsuitable forms, which is why it is being disposed of via the vitrification option.

3 MOX fuel is a mixture of plutonium-oxide and uranium-oxide formed into ceramic pellets. The fuel pellets are inserted into rods which are bundled together to form fuel assemblies.

4 U.S. Department of Energy, Office of Fissile Material Disposition, "Surplus Plutonium Disposition Draft Environmental Impact Statement," DOE/EIS-0283-D, July 1998.

5 Ibid., Volume 1, Part B, pp. 4-53 to 4-59.

DOE proposes to build a pit disassembly and conversion facility which will begin operating in FY 2005.[6] DOE also proposes to build a MOX fuel fabrication plant with a capacity to utilize 3.5 t of surplus plutonium per year, which is to operate for a period of 10 to 15 years beginning in FY 2007.[7] The vitrification plant will be designed to handle up to 5 t of plutonium metal per year. This annual throughput would consist of up to 1.7 t of surplus non-pit plutonium and up to 3.3 t of surplus plutonium derived from pits.[8] Design of the Immobilization and associated Processing Facility is scheduled to begin in FY 2000.[9]

The U.S. government's argument for implementing the dual track approach in the United States is that the MOX option is the only option acceptable to Russia, and its implementation in the United States will enhance the probability of success of the Russian program. The United States and Russia completed a "Joint United States/Russian Plutonium Disposition Study" in September 1996. In this study Russia is on record as agreeing that, "The United States and Russia need not use the same [plutonium] disposition technology."[10] Thus, there is no compelling argument for allocating most of the U.S. excess plutonium to the MOX alternative. The U.S. and Russian disposition options are not so inextricably linked to require the maximum possible amount of U.S. excess plutonium to be converted into MOX. In my view both the United States and Russia should placed a much higher priority on implementing the vitrification option. And neither of these options is as important as verifiably dismantling nuclear weapon stockpiles and securing current inventories of weapon-usable nuclear materials.

Russia. On September 2, 1998, Presidents Yeltsin and Clinton agreed to begin negotiations of a bilateral agreement that will lay out concrete steps for plutonium disposition and cooperation in this area. The U.S. already has detailed plans, so this agreement effectively applies only to Russia.

Russia faces several major difficulties in disposing of its plutonium. Russia has opposed use of the vitrification option, and Russia does not have a MOX fabrication plant with adequate capacity, nor funds to construct one. Various proposals for constructing a MOX fabrication plant in Russia have been floated by U.S. and Russian officials and European nuclear industry officials, but none nail down the financing. One proposal is for the U.S to build in Russia a plant for converting WGPu, currently in the form of weapon components (i.e., "pits"), into a different chemical and physical structure, so that the plutonium can be safeguarded without the risk of revealing sensitive weapon design data; and for Russia to finance the construction of a pilot MOX fabrication plant

6 DOE FY 1999 Congressional Budget Request, February 1998, Volume 1, p. 724. The preliminary total estimated cost of the pit disassembly and conversion plant is $346 million and the total project cost is $586 million.

7 Ibid., p. 731. The preliminary total estimated cost of the MOX fabrication plant is $384 million, and the total project cost is $575 million.

8 U.S. Department of Energy, Office of Fissile Material Disposition, "Surplus Plutonium Disposition Draft Environmental Impact Statement," DOE/EIS-0283-D, July 1998, Summary, p.S-18.

9 DOE FY 1999 Congressional Budget Request, February 1998, Volume 1, p. 702.

10 "Joint U.S./Russian Plutonium Disposition Study," September 1996, Executive Summary, p. ExSum-2.

with money saved by borrowing against the money saved by displacing low-enriched uranium fuel. Russia, France and Germany have a joint proposal for constructing a pilot MOX plant with a capacity of 1.3 t of plutonium annually, sufficient capacity to supply fuel for four VVER-1000 plants operating on ~1/3 MOX cores (0.25 t Pu/reactor-y) and the BN-600 with a partial MOX core loading (0.3 t Pu/y). France and Germany are interested in constructing the Russian MOX pilot plant provided that someone else pays for it. To date neither U.S. commercial nor government entities has offered to finance the Russian plant and they appear unlikely to do so.

The 1.3 t Pu/y pilot MOX fabrication plant has a capacity of only 37 percent of the proposed U.S. MOX fabrication plant, and only 15 percent of the combined capacity of the U.S. MOX and vitrification facilities. Clearly, the Russian program is not keeping pace with the U.S. program even on paper. Moreover, the rate of conversion of plutonium using the proposed 1.3 t Pu/y pilot MOX fabrication plant is too slow in light of the fact that Russia is currently, and plans to continue, separating plutonium from VVER-440 power reactors and three plutonium production reactors. In recent years about 2 t of plutonium were being separated annually from VVER-440 spent fuel processed at Chelyabinsk-65, and about 1.4 t of plutonium is being recovered annually by processing spent fuel from the three remaining plutonium production reactors—two reactors at Tomsk-7 and one at Krasnoyarsk-26. Consequently, even if the proposed pilot MOX fabrication plant were to be constructed in Russia, its 1.3 t Pu/y capacity is less than 40 percent of the rate at which Russia continues to separate plutonium. Russia plans to stop processing production reactor fuel in the year 2000, when the reactors are scheduled to shift over to a different fuel type. Even so, under current plans Russia would still be separating plutonium as fast as it is converted to MOX.

The current DOE policy is not to construct the U.S. MOX fabrication plant unless there is "significant progress with Russia on plans for plutonium disposition" by the end-FY 2000 [September 30, 2000].[11] Since it is highly probable that there will be little progress on plutonium disposition in Russia over the next several years, there may be little or no U.S. plutonium converted into MOX for years to come.

Probably underlying much of the negative Russian reaction to the vitrification disposal option is a valuation of plutonium derived from production costs to the State and from the substantial health and environmental consequences of its production. "We got it with blood and sweat, and that would be incorrect to just push it away." Minister of Atomic Energy Yegeny Adamov stated at the U.S.-Russian talks held earlier last month in Moscow.[12] The Minister may not appreciate that no weight should be given to sunk costs in decisions related to future investments.

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11 Statement of Howard Cantor, Acting Director, Office of Fissile Material Disposition, at the Council on Foreign Relations "The Management and Disposition of Excess Nuclear Weapons Material," March 9, 1998.

12 "Russian-American Talks on War Plutonium to be Held in Sept," Veronika Romanenkova, ITAR-TASS News Agency, September 4, 1998.

Economics of Plutonium Use as a Reactor Fuel

The U.S. National Academy of Sciences (NAS) prepared a comprehensive comparison of the relative cost of fresh low-enriched uranium (LEU) and MOX fuel.[13] The NAS took as its baseline fuel characteristics:

	LEU fuel	MOX fuel
Fuel enrichment	4.4% U-235	4.8% WGPu; 95.2% DU (0.25% U-235)
Fuel burnup	40,000 MWd/tHM	40,000 MWd/tHM
capacity factor	75 percent	75 percent

typical of fuel for pressurized water reactors, including fuel for the Russian VVER-1000 reactor. The NAS estimate for the cost of LEU fuel was \$1400 ± 200 per kilogram of heavy metal (kgHM),[14] and for MOX fuel was \$2100 ± 300 per kgHM,[15] or about 50 percent greater. Thus it is uneconomical to use plutonium as a fuel for commercial power reactors, even if the plutonium is provided at no cost, as is the case when one attempting to dispose of excess plutonium from weapons.

Many European and Asian reactor owners are contracting with BNFL in the United Kingdom and Cogema in France to reprocess spent fuel to recover and recycle the plutonium and the unused uranium as MOX fuel. This is referred to as the "closed fuel cycle," as opposed to the "open cycle" where the spent LEU fuel is disposed of directly as waste. The economics of a closed fuel cycle relative to the open cycle is even worse than the case outlined above where the plutonium is already separated.

To obtain the plutonium needed to fabricate one tonne of MOX fuel, one must reprocess some five to seven tonnes of spent LEU fuel, at a cost of more than \$1000 per kgHM in the spent fuel. While some credit is received for the extra unused uranium recovered, even so, the life cycle cost of fuel under the closed cycle is about twice the life cycle cost of fuel when operating an open fuel cycle.

Risks Associated With the Commercial Use of Plutonium

Many nuclear engineers who do not understand or appreciate economics, argue that one must use the plutonium to get the maximum energy value out of the uranium fuel. If this logic had merit we should be collecting all the energy from sunlight and storing it in batteries rather than letting it go to waste. We don't do this because it is uneconomical to do so. As with solar energy,

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13 National Academy of Sciences, Committee on International Security and Arms Control, " Management and Disposition of Excess Weapons Plutonium" (Washington, D.C.: National Academy Press, 1995), pp. 280-329.

14 Ibid., p. 290.

15 Ibid., p. 294. Without property tax and insurance the cost was estimated to be \$1900 ± 300 per kgHM.

one can always introduce plutonium recycling and fast breeder reactors, and thus achieve a practically inexhaustible supply of nuclear energy, but it makes no sense whatsoever to do this before the closed fuel cycle is economically competitive with the open fuel cycle.

Another bogus argument is that plutonium recycling is needed for waste management purposes. Actually, the closed cycle results in larger volumes of low-level and transuranic wastes and a smaller volumes of uranium mining and milling wastes and high level waste. Moreover, the high-level mixed waste from reprocessing represents a dangerous and difficult-to-manage waste form in comparison to encapsulating spent fuel. In terms of health effects from routine operations and the risks to future generations, it is difficult to conclude that either cycle is preferred.

The overriding argument for not reprocessing and recycling plutonium, even if it were economical to do so, derives from the fact that separated plutonium is usable in nuclear weapons and it requires very little plutonium to make a weapon. A pure fission nuclear weapon with a yield of one kiloton can be made with as little as one to three kilograms of weapon-grade plutonium, depending on the sophistication of the implosion technique employed. A weapon of the same yield, but made with reactor-grade plutonium would require about 20-30 percent more plutonium. Modern thermonuclear primaries with yields of several kilotons are made with about three kilograms of plutonium.

Given the small quantity of fissile material need to make a nuclear weapon, highly accurate material accounting and control measures are essential to determine whether a theft has taken place, and to provide timely warning to prevent the material from being used for illicit purposes. It is well established—from experience at existing civil and military chemical separation (reprocessing) plants, naval fuel facilities, and mixed-oxide fuel facilities—that it is extremely difficult (we would argue impossible) to provide in practice adequate material control and accounting, at bulk handling facilities where large amounts of nuclear weapons-usable material are processed in the form of liquids, gases and/or powders. At present there is no way to determine through inventory procedures whether weapon quantities of plutonium are being diverted from these military and civil bulk handling facilities.

Currently, Iraq, Iran, North Korea and probably Libya are pursuing nuclear weapons. Iraq and North Korea have been caught violating their Nuclear Nonproliferation Treaty (NPT) and IAEA obligations. According to a recent press report, U.N. arms inspectors reported twice to the United States, in 1996 and 1997, that they had credible intelligence indicating that Iraq built and has maintained three or four implosion devices that lack only the cores of enriched uranium to make 2 kiloton nuclear weapons.[16] The North Korean "Agreed Framework" to limit this state's nuclear program is stalled, for reasons which include recent satellite imagery of construction activities which may be associated with clandestine nuclear weapons activity, and the test firing of a three-stage missile (and partially successful satellite launch) which passed over a portion of Japan. Less than one year into what many thought would be a long-term global moratorium on nuclear testing, India and then Pakistan successfully demonstrated—at a

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16 Barton Gellman, "Iraqi Work Toward A-Bomb Reported, *The Washington Post*, September 30, 1998, p. A1.

minimum—fission weapon technological capability, and India claims to have tested a hybrid two-stage thermonuclear device. Terrorists attacks represent a growing threat, both in the frequency of attacks and kinds of explosives devices that are being used. Clearly, this is not the time to be promoting technologies that require the stockpiling of nuclear weapon-usable materials, or promoting the commercial use of inherently unsafeguardable facilities.

The United Kingdom, France, Russia, and Japan are reprocessing spent civil reactor fuel for waste management and to separate plutonium for recycle as a nuclear fuel in light water reactors and breeders. While France, Russia and Japan claim a continued interest in developing plutonium breeder reactors, their breeder programs are all moribund. Not only is there no adequate means of safeguarding large bulk handling facilities to prevent weapon-usable plutonium from being stolen, but also reprocessing of spent fuel and the recycling of plutonium[17] into fresh fuel for reactors permit non-nuclear weapons states to justify the acquisition and stockpiling of nuclear weapons-usable material—ostensibly for peaceful purposes. At the same time, without violating any international safeguards agreements, these countries can design and fabricate non-nuclear weapon components. By moving to a point of being within hours of having nuclear weapons—perhaps needing only to introduce the fissile material into the weapons—a nascent weapons state would have all of its options open. Under these conditions, international safeguards agreements can serve as a cover by concealing the signs of critical change until it is too late for diplomacy to reverse a decision to "go nuclear." India recovered the plutonium for its first nuclear device in a reprocessing plant that was ostensibly developed as part of its "peaceful" breeder program.

An enormous surplus of plutonium has been separated from civil nuclear power reactor spent fuel in Europe and Asia despite, and to some extent because of, the unfavorable economics of the closed fuel cycle. France, the United Kingdom, Japan and Russia continue to separate plutonium at a far greater rate than it is being burned in existing reactors. France and the United Kingdom are separating about 20 t of plutonium per year, but only 9 t were recycled into fuel in 1997.[18] The U.K stockpile of separated civil plutonium (i.e., not fabricated into fuel or in use in reactors), including that owned by Japanese and other foreign utilities, now stands at 50 t and is projected to grow to 100 t by 2010.[19] As of the end of 1997, Japan had accumulated 24 t of separated plutonium, of which 5 t was stored in Japan and 19 t was stored in France and the United Kingdom.[20] The global inventory of separated civil plutonium is now an estimated 170 t—some 3.6 times the 47 t of plutonium reserved by the United States for weapons and comparable to stocks of plutonium reserved for weapons by all nuclear powers.

The accumulation of large stockpiles of separated plutonium and weapon-usable expertise in nominally civil programs will act as a barrier to deep reductions and eventual elimination of

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17 Or any other weapons material, such as highly enriched uranium or uranium-233.

18 Frank von Hippel, "How to Simplify the Plutonium Problem, *Nature*, July 30, 1998, p. 415.

19 Ibid.

20 *Nuke Info Tokyo*, July/Aug. 1998, p. 5.

nuclear weapons held by declared and undeclared weapon states. One need only ask how far China, for example, might be willing to go in accepting limits on, or reductions in its nuclear weapons stockpile if Japan is poised to accumulate an even larger inventory of weapons-usable fissile materials in pursuit of a civil plutonium program with no clear commercial rationale. Similarly, Russia's continued operation of three reprocessing plants and Russia's committed to the deployment of BN-800 type breeder reactor and a closed fuel cycle fuel, could abort U.S. political support for continuing toward very deep reductions and ultimate abolition of nuclear weapons stockpiles. The lack of such a commitment by the United States and other nuclear weapons states, could, in turn, lead to continued erosion of the nonproliferation regime. Hence, there is a need to forthrightly address the mistaken legitimacy afforded civil plutonium programs under the current system of international controls. In any case, nations having civil nuclear energy programs with closed fuel cycles can make an important contribution to the disarmament process by deferring further separation of plutonium until the global inventories of plutonium are substantially reduced.

In sum, the current surplus of separated plutonium represents a threat to the national security of the United States and other nations and is an impediment to the abolition of nuclear weapons. It is ironic that the United Kingdom, France, and Japan are compounding security risks by commercially separating plutonium from spent fuel while the United States and Russia seek to put excess plutonium back into spent fuel to reduce the national security threat to all nations. Meanwhile, the more important tasks involved in the business of getting on with nuclear warhead reductions—such as verifying nuclear warhead elimination and nuclear warhead and fissile material stockpile inventories—remain stalled while additional nations announce their accession to the nuclear club and others openly flout the mandates of the international community.

Table 1. U.S. Plutonium Inventories Excess to National Security Needs (Metric Tons).

Location	Weapon-Grade Plutonium							Fuel and Reactor-Grade Plutonium						Total
	Pits	Other Metal	Oxides	Reactor Fuel	Irradiated Fuel	Other Forms	Total	Metal	Oxides	Reactor Fuel	Irradiated Fuel	Other Forms	Total	Plutonium Inventory
Pantex /future dismantlements	21.3		-	-	-	-	**21.3**	-	-	-	-	-	**0.0**	**21.3**
Rocky Flats	1.4	4.3	1.6	-	-	3.2	**10.5**	-	-	-	-	-	**0.0**	**10.5**
Hanford Site		<0.1	1.0	-	0.2	0.5	**1.7**	0.8	1.1	0.8	6.4	0.2	**9.3**	**11.0**
Los Alamos		0.5	<0.1	<0.1	-	1.0	**1.5**	0.1	-	<0.1	-	0.3	**0.4**	**1.9**
Savannah River		0.4	0.5	-	0.2	0.2	**1.3**	0.1	0.2	<0.1	0.1	0.2	**0.6**	**1.9**
INEL		<0.1	-	0.2	0.2	<0.1	**0.4**	-	-	-	0.3	<0.1	**0.3**	**0.7**
ANL-West							**0.0**	<0.1	-	3.6	<0.1	-	**3.6**	**3.6**
Other Sites		<0.1	-	-	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	0.1	<0.1	**0.1**	**0.2**
Total	**22.7**	**5.1**	**3.1**	**0.2**	**0.6**	**6.4**	**38.2**	**1.0**	**1.3**	**4.4**	**6.9**	**0.7**	**14.3**	**52.5**

Totals may not add due to rounding to the nearest tenth of a metric ton.

Sources: U.S. Department of Energy, "Plutonium: The First Fifty Years," February 1996, p. 76.
U.S. Department of Energy, "Taking Stock: A Look at the Opportunities and Challenges Posed by Inventories from the Cold War Era," DOE/EM-0275, January 1996, p. 45.

Table 2. Fissile Material Disposition

United States

Plutonium Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapon Pits	69.7	22.7	32.6	47	67.4
Other WGPu	15.5	15.5	100.0	0	0.0
WGPu (total)	85.2	38.2	44.8	47	55.2
FGPu+RGPu	14.3	14.3	100.0	0	0.0
Pu (total)	99.5	52.5	52.8	47	47.2

HEU Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapons	?	81.7	?	?	?
Other	?	92.6	?	?	?
Total	?	174.3	?	?	?

Russia

Plutonium Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapon Pits	?	50	?	?	?
Other WGPu	?	0	?	?	?
WGPu (total)	170	50	29.4	120	70.6
FGPu+RGPu	30	30	100.0	0	0.0
Pu (total)	200	80	40.0	120	60.0

HEU Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapons	?	500	?	?	?
Other	?	0	?	?	?
Total	?	500	?	?	?

Abbreviations:

WGPu -- weapon-grade plutonium (Pu-240 < 7%)

FGPu -- fuel-grade plutonium (7%<Pu-240<19%)

RGPu -- reactor-grade plutonium (Pu-240>19%)

HEU -- highly-enriched uranium (U-235>20%)

Table 3. U.S. Nuclear Warheads and Pits --START II

NRDC -- 9/29/98

Warhead	Type	Total WH Builds	Active WHs Deployed	Spares	Hedge	Total	Inactive WHs	Total WHs Stockpiled	Awaiting Dismantl't.	Total tact WHs	Pits Reserve	Excess	Total	WHs+ Res. Pits	Total WH+Pits
W56-4	MM II Mk-11	1,000								0	482		482	482	482
B61-3,4,10	Non-Strategic bomb	1,400	600	30		630	73	703		703	156		156	859	859
B61-5	Non-Strategic bomb	300								0	236		236	236	236
B61-7	Strategic bomb	700	230	20		250	395	645		645	47		47	692	692
B61-11	Strategic bomb	50	45	5		49	0	49		49	1		1	50	50
W62-0	MM III Mk-12	1,700					491	491		491	288		288	779	779
W68-0	Poseidon C3 Mk3	5,220								0	2,468		2,468	2,468	2,468
W69-0	SRAM	1,200								0	1,122		1,122	1,122	1,122
W76	T-I C4, T-II D-5 Mk-4	3,400	1,296	128	1,235	2,659	624	3,283		3283	117		117	3,400	3,400
W78	MM III Mk-12A	1,000			794	794		794		794	163		163	957	957
W80-0	SLCM	350	250	12		262		262		262	58		58	320	320
W80-1	ALCM/ACM	1,850	370	30	400	800	958	1,758		1758	85		85	1,843	1,843
B83-0,1	Strategic bomb	665	430	20	100	550	99	649		649	14		14	663	663
W84	GLCM	400					388	388		388	12		12	400	400
W87-0	MX Mk-21	525	500	20		520		520		520	10		10	530	530
W88	T-II D-5 Mk-5	400	384	10		394		394		394	6		6	400	400
ICBM		**4,225**	**500**	**20**	**794**	**1,314**	**491**	**1,805**	**0**	**1,805**	**943**	**0**	**943**	**2,748**	**2,748**
SLBM		**9,020**	**1,680**	**138**	**1,235**	**3,053**	**624**	**3,677**	**0**	**3,677**	**2,591**	**0**	**2,591**	**6,268**	**6,268**
Strategic Bomber		**4,465**	**1,075**	**75**	**500**	**1,650**	**1,452**	**3,102**	**0**	**3,102**	**1,269**	**0**	**1,269**	**4,371**	**4,371**
Total Strategic		**17,710**	**3,255**	**233**	**2,529**	**6,017**	**2,567**	**8,584**	**0**	**8,584**	**4,803**	**0**	**4,803**	**13,387**	**13,387**
Total Non-Strategic		**2,450**	**850**	**42**	**0**	**892**	**461**	**1,353**	**0**	**1,353**	**462**	**0**	**462**	**1,815**	**1,815**
Total (Strategic + Non-Strat.)		**20,160**	**4,105**	**275**	**2,529**	**6,909**	**3,028**	**9,937**	**0**	**9,937**	**5,265**	**0**	**5,265**	**15,202**	**15,202**
Other Retired Warhead Pits												**7,614**	**7,614**	**0**	**7,614**
Grand Total			**4,105**	**275**	**2,529**	**6,909**	**3,028**	**9,937**	**0**	**9,937**	**5,265**	**7,614**	**12,879**	**15,202**	**22,816**

The fraction of active B61 bombs and W80 ALCM/ALM warheads that are spares is unknown.
700 B61-7 were built; 50 of these were converted to B61-11.
The B53 bombs are assumed to have no associated plutonium pits.
Inactive warheads are also referred to as "reliability replacement warheads."
It is assumed that the limited-life components, e.g., tritium reservoirs, of inactive warheads are not maintained.

Figure 1. U.S. Nuclear Weapon Stockpile