Dismantlement of Nuclear Weapons and Disposal of Fissile Material from Weapons

by

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I. Introduction.

As we move into the twenty-first century, one of the highest priorities of every nation should be the construction of a truly universal, comprehensive and non-discriminatory regime for safeguarding and permanently disposing of nuclear weapon-usable fissile materials, thereby creating a genuine opportunity for the abolition of nuclear weapons. Important steps toward achieving this goal include:

(a) further deep reductions in the deployed arsenals of all nuclear-weapon states, declared and undeclared;

(b) declarations, data exchanges, and cooperative verification measures to confirm the progressive elimination of both operational and reserve nuclear weapon stockpiles, including the permanent disassembly of nuclear warheads and bombs, the destruction of non-fissile components, and the status of fissile material components withdrawn from weapons;

(c) secure storage of all plutonium and HEU components withdrawn from weapons under bilateral or five-power verification pending implementation of arrangements for conversion/dilution to reactor fuel or direct disposal as vitrified waste;

(d) application in the weapon states of IAEA or comparable multilateral safeguards to all fissile material inventories not stored in weapon-component form, and to all facilities with the capacity to use, produce, separate, enrich, or otherwise process fissile material.

(e) a global, verified cutoff in the production of fissile materials for weapons purposes;

(f) capping and drawing down the world inventories of weapon-usable fissile materials, including a moratorium on programs for the civil production and use of separated plutonium and highly-enriched uranium (HEU), with particular emphasis on programs in Russia, Japan, U.K, and France.

Our objective should not only be the abolition of nuclear weapons, but a complete ban on the civil production, stockpiling and use of weapons-usable fissile materials, with verified declarations and reductions of existing stocks. Plutonium should not be used as a civil reactor fuel until such time as world energy market conditions justify the added security risk of using it for this purpose, and stronger international security arrangements are available to mitigate this risk.

The current policies of the United States and Russian fall far short of these objectives. Moreover, the U.S. and Russian initiatives to declare, safeguard and dispose of excess stocks of weapon fissile materials are progressing at a painfully slow pace. On the U.S. side progress has been slowed by the enormity of the problem, the reluctance of the Department of Defense

(DOD) to relinquish militarily useful fissile materials and open U.S. weapon facilities to bilateral safeguards, and by the slow pace at which the DOE is implementing the National Environmental Policy Act (NEPA) process for deciding how to dispose of the plutonium. On the Russian side there are the added problems of a lack of money and opposition by hard-liners to U.S.-Russian cooperative efforts. Both sides are engaged in negotiations on the full range of fissile material control issues, including an exchange of weapon stockpile and fissile material data, a plutonium production reactor cut-off, and the purchase of Russian weapon highly-enriched uranium (HEU) by the U.S., but these negotiations are now bogged down and the previous atmosphere of good will is eroding.

II. Reductions in the U.S. and Russian Warhead Stockpiles.

A. The U.S. Nuclear Stockpile. The U.S. nuclear weapons stockpile peaked in 1967 at about 32,000 warheads.[1] According to estimates by my colleague Dr. Robert S. Norris today there are about 8,750 warheads in the operational (deployed) stockpile.[2] Another 5,000 warheads in Air Force, Navy and Department of Energy (DOE) depots are in a queue, awaiting their turn on the Pantex disassembly line (Table 1). The U.S. dismantled 1,556 warheads in 1993, and 1,369 warheads in 1994. The dismantlement goal for fiscal year 1995 was 2,002 warheads, but by May 8 only 986 warheads had been dismantled--a rate that will result in about 1,600 warheads dismantled in FY 1995 (ending September 30). As of May 8, 1995 there were 7,239 pits in storage at Pantex,[3] so we assume there are about 7,500 in storage today.

While the general public perception is that the U.S. and Russian nuclear weapon stockpiles will be reduced to about 3,500 warheads by 2003 under the START II treaty, the truth is that the stockpile the Clinton Administration is planning will be more than twice as large--closer to 7,500 warheads (Table 1). In addition to the 3,500 operational strategic warheads in the U.S. arsenal in 2003, the Pentagon plans to retain another 950 warheads for non-strategic forces , i.e., the ''strategic reserve'' and presumably additional spares. The strategic reserve, originally created for use after a nuclear war with Russia, now is conceived as a force allowing the U.S. to resist potential coercion by such nations as China, North Korea, and Iran who might attempt to take advantage of the United States following a nuclear war. The reserve force could also be directed towards these or other countries irrespective of the Russian context, should the national officials so decide.

Finally, another 2,500 warheads are destined for what the Pentagon calls the ''hedge.'' When fully implemented in 2003, the hedge will be a contingency stockpile made up of

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[1] Thomas B. Cochran, William M. Arkin, and Milton M. Hoenig, *Nuclear Weapons Databook, Volume I: U.S. Nuclear Forces and Capabilities*, (Cambridge, MA: Ballinger Publ. Co., 1984), p. 15.

[2] Robert S. Norris and William M. Arkin, ''NRDC Nuclear Notebook,'' *The Bulletin of the Atomic Scientists*, July/August 1995, pp. 77-79.

[3] Pantex Public Affairs Office to Robert S. Norris, private communication, May 1995.

warheads removed from active forces, but not dismantled. The purpose of retaining them intact is so that they can be rapidly "reconstituted," to use the Pentagon's word. By redeploying them on bombers and missiles the Pentagon could return to START I force levels if the need should arise. Thus, the real size of the future U.S. stockpile will be approximately 7,500 warheads. In addition, of the plutonium that the U.S. has declared excess to date, we estimate that only about 6 tonnes (t) will come from intact pits, so as many as 12,000 intact plutonium pits will remain in storage at the DOE Pantex facility after the year 2002.

B. The Russian Nuclear Stockpile. The Soviet stockpile is believed to have peaked at about 45,000 warheads in the mid-1980s,[4] and has probably been reduced to about 25,000 warheads today, with approximately one-half operational and the other half scheduled for dismantlement. Since the warhead retirement rate is probably not much greater than that in the U.S., the Russian arsenal will exceed the U.S. arsenal into the next century.

The future size of the Russian nuclear weapon stockpile, as well as the precise past and current size, is still cloaked in secrecy. No doubt Russia will match the U.S. in the arsenal it retains and create a hedge of its own. Therefore, we can anticipate that the Russians likely will retain at least 7,500 warheads after 2003.

Russian arms control experts view START II as giving the United States a nuclear advantage with respect to deployed strategic warheads, and as being too costly to implement. It is an open question whether it will be ratified by the Russian Duma. Even if ratified we should by mindful that START II has more to do with lowering the alert status of the superpower arsenals than it has to do with nuclear disarmament. The Superpowers have shown no tangible interest in going beyond START II to achieve the verified elimination of the bulk of their nuclear weapon stockpiles.

III. Nuclear Weapons and Fissile Material Data Exchange.

My organization, the Natural Resources Defense Council (NRDC), and the Federation of American Scientists (FAS) have been advocating an exchange of data on nuclear weapons and weapon-usable fissile material since 1989. Last year the Clinton Administration finally endorsed the idea. In the National Defense Authorization Act for FY 1995 (Section 3155), Congress amended Section 144 of the Atomic Energy Act of 1954, to allow DOE and DOD to release restricted data and formerly restricted data, as necessary, to further fissile material and other weapons material control and accountability programs.

In September 1994, Presidents Clinton and Yeltsin agreed to "exchange detailed information at the next Gore-Chernomyrdin Commission on aggregate stockpiles of nuclear

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[4] Thomas B. Cochran, Robert S. Norris and Oleg A. Bukharin, *Making the Russian Bomb: From Stalin to Yeltsin*, (Boulder, CO: Westview Press, 1995, p. 31.

warheads, and stocks of fissile materials and on their safety and security." Congress required that the data exchange be made through an agreement for cooperation similar to agreements the U.S. has with the U.K. and France.

At the December 1994 Gore-Chernomyrdin meeting the U.S. tabled a draft Agreement for Cooperation and a draft list of warhead stockpile information the U.S. was willing to exchange. In January of this year Ambassador James Goodby tabled a proposed list of fissile material data to be exchanged. The Russian response was to say that they needed more time to organize themselves. Further talks on this issue were to have occurred during the week of June 26; otherwise to date no significant progress has taken place with respect to the data exchange.

It is unclear whether the data exchange will require approval by the Russian parliament. Getting parliament's approval for such an agreement may be difficult. While the U.S. Congress provided a grace period through calendar 1995 during which the agreement for cooperation would not have to be submitted to the Senate, if the Agreement is not negotiated and signed before December 31, the new Republican controlled Senate will have an opportunity to reject it.

Even if these political issues are resolved, the U.S. DOD and the Russian Ministries of Defense (MOD) and Atomic Energy (Minatom) intend to keep the data exchange secret and available only to the two governments. The U.S. DOD wants to classify the data to avoid public disclosure of the large number of nuclear weapons it plans to retain in "inactive reserve." Similarly, the Russian MOD and Minatom do not want the Russian public to know the size of their nuclear weapon arsenal and fissile material inventories. Since accounting for the latter is uncertain, Russian authorities seek to avoid a situation in which public disclosure now becomes the source for latter embarrassment, as inadequacies in the data are revealed by inevitable scrutiny that follows public disclosure.

On a separate and slower track, the U.S. is proposing to follow the data exchange with a transparency agreement that would permit visits to any facility possessing fissile material other than weapons or naval fuel. Negotiations regarding this transparency proposal will likely await approval of the data exchange.

IV. Fissile Material Inventories.

In Table 2 we provide our estimates of the makeup of the current U.S. government plutonium and highly-enriched uranium (HEU) inventories exclusive of HEU for naval reactor fuel.[5] The total plutonium inventory is fairly accurately known to be about 100 t. Of this

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[5] These estimates represent an update of estimates made in Thomas B. Cochran, et al., *Nuclear Weapons Databook, Volume II, U.S. Nuclear Warhead Production*, (Cambridge, MA: Ballinger Publishing Co, 1987), taking into consideration new plutonium and highly-enriched uranium production and inventory data released by the Department of Energy in 1994, as a result of declassification initiatives of Secretary Hazel O'Leary.

amount about 86 t is weapon-grade plutonium. Only about 67 t is estimated to have ever been in weapons or intact plutonium pits at any one time.

According to DOE, the U.S. produced 994 t of HEU ($\geq$20% U-235), including naval reactor fuel, between 1945 and 1992. Relative to our knowledge of the plutonium inventories, we are much less certain of the total amount of HEU in weapons and available for weapons. Especially uncertain is the total amount of intermediate-enriched uranium produced for thermonuclear secondaries. Keeping in mind these large uncertainties, we estimate that some 725 t of HEU were in the weapon stockpile in the mid-1980s, of which 500 t was oralloy ($\sim$93% U-235) and perhaps 225 t of intermediate enrichment (averaging $\sim$40% U-235).

We estimate that Russia has produced about 170 t of plutonium for weapons and has recovered an additional 25-30 t of reactor-grade plutonium from processing civil and naval fuel. The Russian HEU stockpile, including what is in weapons, is believed to be on the order of 1200 t.

IV. Declarations of Excess Materials.

In the fall of 1994 the Clinton Administration declared as excess and agreed to place under IAEA safeguards one tonne of plutonium in the Z vault at Hanford and ten tonnes of HEU at Vault 16 at the Y-12 Plant in Oak Ridge. On March 1, 1995, President Clinton announced that "200 tons of [additional] fissile material" had been "permanently withdrawn from the U.S. nuclear stockpile." While this material by definition is no longer needed for national security purposes, the makeup of this additional 200 t, from whence it came and where it resides remains classified due to DOD's opposition to efforts by the DOE to declassify the breakdown. Our estimate of the breakdown of the "permanently withdrawn" fissile material is given in Table 3.

We are told that on the order of 165 t of the 200 t will be HEU and some 35 t will be plutonium. Thus, to date, out of a total plutonium inventory of 100 t, about 36 t has been declared excess. An estimated 4 t of plutonium were obtained from the U.K under assurances that it would not be used in weapons.[6] Although we do not believe this 4 t is included in the Clinton Administration declarations of excess fissile material, we include it as part of our estimate of the fissile material permanently withdrawn from U.S. weapon use.

The public has been led to believe that the U.S. government will be removing at least 50 t plutonium from weapons and placing it under IAEA safeguards pending final disposal.[7] However, as noted above, only about 67 t of the 100 t plutonium inventory was ever in weapons

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[6] Obtained from the U.K. under a U.S/UK Defense Agreement signed in 1958.

[7] See, for example, National Academy of Sciences, *Management and Disposition of Excess Weapons*, (Washington, D.C.: National Academy Press, 1994), pp. 1, 19.

at any one time, and by our estimates only about 6 t of plutonium that is in pits (9% of the 67 t) are being declared excess. Even this small amount will be stored as intact pits for some years. Most of the plutonium that has been declared excess is either reactor-grade plutonium (10.5 t), or is leftover solutions and residues from the weapon manufacturing process (19 t).

Most of the plutonium that will be removed from weapons has yet to be declared excess. Under current Administration plans it will be retained as intact pits--eventually some 12,000. Presently, the U.S. DOD has no intention of declaring these pits as surplus, thereby permanently withdrawing them from the stockpile. Instead, these 12,000 pits will be retained as part of the fissile material reserve.

From Table 3, we see that about 175 t of HEU has now been declared excess. This includes about 40 t that was never part of the weapons program. An additional ten tonnes has been placed under IAEA safeguards; and the remaining 125 t is intermediate enriched uranium from thermonuclear weapon secondaries.

By our estimates about 30 percent of the plutonium (10.5 t out of 36.5 t), and 23 percent of the HEU (~40 t out of 175 t) that has been declared excess is not fissile material removed from weapons, but comes from other DOE stocks.

With respect to the most recent declaration, the Administration has stated, "The 200 tons of excess fissile material will be considered for IAEA safeguards according to a step-by-step approach that will take into account the need to protect sensitive information and satisfy budgetary, environmental, safety, and health requirements." This may take an extremely long time since the Administration is storing 6 t of the plutonium as intact plutonium pits and tens of tonnes of the HEU as intact secondaries.

We estimate that some 60 t of plutonium and 380 t of HEU will be retained for weapon purposes under current Pentagon plans for implementing START I and START II (Table 4). Thus, until there is a START III, a similar agreement, or a shift in Administration policy, we estimate that the Administration is unlikely to declare as excess any additional plutonium beyond the estimated 36 t already declared and the 4 t received from the U.K. under the condition it not be used for weapons. Beyond what it has already declared as excess, the Administration could make an additional 100 t of HEU available for civil use, bring the total amount of HEU made available for civil use to about 270 t (Table 5). This additional 100 t could also be reserved for naval reactor fuel.

Russia declared its willingness to sell 500 t of HEU (≥90% U-235) from weapons to the United States in 1993. Since the U.S.-Russian agreement defines the amount and price of the uranium in terms of the 4.4%-enriched LEU equivalent of 90% enriched HEU, Russia has in effect declared as excess 3-4 times the amount of weapon-grade equivalent fissile material as the United States. But then Russia has produced considerably more fissile material for weapons than the United States.

V. Disposition of Excess HEU.

A. Disposition of HEU from U.S. Weapons. The U.S. DOE is preparing an Environmental Impact Statement on Fissile Material Disposition, covering excess plutonium, HEU and U-233 stocks. In its pre-decisional draft, DOE has retained as reasonable alternatives: a) direct sale of HEU, b) sale after blending to LEU (19% U-235 or 5% U-235), and c) discard as waste after blending to 19% U-235. Blending to LEU for subsequent sale as power reactor fuel is the obvious preferred option.

Of the HEU already declared excess, 63.2 t has been committed to the United States Enrichment Corporation (USEC) to be converted into reactor fuel. This includes 13.2 t (about 97.3% U-235) that was produced for naval reactor fuel, but did not meet Navy specs, and 50 t from thermonuclear weapon secondaries, of which 5 t is 70%-enriched and the remaining 45 t is 37.5%-enriched. Blending of the 13.2 t has already begun.

B. Disposition of HEU from Russian Weapons. On February 18, 1993 the United States and the Russian Federation agreed to the sale of approximately 500 t of HEU (>90% U-235) from dismantled Russian weapons for use as civil power-reactor fuel in the United States. The full 500 t of HEU could be converted into 15,260 t of LEU (4.4% U-235). An implementing contract was signed on January 14, 1994 by the USEC, serving as the Executive Agent for the United States. USEC agreed to purchase the LEU, blended from the HEU in Russia, over 20 years at a rate of up to 10 t of HEU-equivalent per year for the first five years and up to 30 t per year for the remaining 15 years. Until the United States and Russia consummate the data exchange we will not know the true significance of the U.S.-Russian HEU deal in terms of its impact on Russia 's nuclear weapon stockpile and reserve.

To date, 6 t of blended HEU-equivalent were sold in 1995, and several tonnes in sixteen canisters have already been shipped.[8] USEC has ordered 12 t of HEU-equivalent for 1996, but the parties have not yet agreed on the price and/or payment schedule.

The U.S-Russian HEU deal is on shaky ground, if not unraveling altogether. The U.S. government established USEC in order to move the DOE uranium enrichment enterprise off budget, and is in the process of privatizing USEC. USEC's primary interest is in making its balance sheet look attractive to investors as it prepares to ''privatize'' via a stock offering to the public. Although USEC is the sole executive agent for the United States for implementing the HEU Agreement, the national security objective of the HEU Agreement is of secondary concern to USEC. Consequently, USEC has no incentive to offer Minatom a fair market value for its enriched uranium.

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[8] *The Washington Post*, June 25, 1995, p. A21.

About two-thirds of the gross revenues of $11.9 billion (unadjusted 1993 dollars) that Minatom can expect from the sale of the material will come from the value of the separative work (90 million SWU), and one-third from the value of the uranium feed (430 million lb U_3O_8). The initial price of the material is $780 per kilogram of LEU, based upon $82.10 per SWU and $28.50 per kg of UF_6. DOE extracted as part of the agreement a concession that Russia will not be paid for the feed until the uranium is sold, used to overfeed U.S. enrichment plants, or until the contract expires in 2013, whichever occurs first. The issue of reimbursement for the uranium feed component of the sale has not been resolved. USEC is telling the Russians they will not be paid for the feed for several years. The problem is that the Russian government expects Minatom to pay for the feed up front, which represent one-third of the contract value, or one-half of Minatom's revenues from the SWU component. Minatom must also pay for the blending. In order to meet LEU specifications for U-232, U-234 and U-236 content spelled out under the agreement, Minatom must enrich the blend feed to about 1.5% U-235. In the end there is little, if any, profit left for Minatom. Minatom is accusing the USEC of failing to resolve the timetable for compensation, and accusing the U.S. Department of Commerce of tying up the deal through its attempts to penalize former Soviet republics for the Soviet Union having dumped uranium in the U.S. market at prices below "fair market prices."

The Clinton Administration, the Congress, USEC and various private interests are attempting to get the HEU deal back on track, but to date no consensus solution has been found.

VI. Disposition of Plutonium.

A. U.S. Plutonium. In its pre-decisional draft environmental impact statement on fissile material disposition, DOE has retained three categories of plutonium disposal options: 1) direct deep borehole disposal, 2) immobilization in glass, ceramic, or metal for subsequent geologic disposal, and 3) conversion to mixed-oxide (MOX) fuel for burning in reactors on a once through basis followed by permanent geologic disposal. The deep borehole options, including direct emplacement or with immobilization prior to disposal, are probably not serious contenders, but are carried because they were not ruled out by the National Academy of Sciences (*Management and Disposition of Excess Weapons*, NAS, 1994).

DOE's excess plutonium is found in a wide variety of forms, including solutions, oxide, residues, and metal. Much of it is not suitable for conversion into MOX fuel, or at least it would be costly to do so. The Department, therefore, may have to utilize multiple disposal options.

All of the plutonium immobilization options that DOE is considering involve building a new vitrification facility. DOE plans to start operating the Defense Waste Processing Facility (DWPF) at the Savannah River Site (SRS) in mid-1996. DWPF is designed to vitrify the 34 million gallons (129 million liters) of high-level waste (HLW) at SRS over a 24 year period. DOE claims that modifying DWPF to mix plutonium with the HLW prior to vitrification, or fuse together concentric cylinders of fission product glass and plutonium glass, would be too expensive. We are not convinced that this is the case.

Environmentalists are also concerned that DOE is not moving ahead now with research and development on the plutonium vitrification option which could be done relatively cheaply. The Institute for Energy and Environmental Research, in its recent report *Fissile Materials in Glass, Darkly*, has recommended that DOE build three pilot vitrification plants within the next two years to test various vitrification options.

I believe an attractive option for Hanford would be to hire a commercial firm to build and operate a vitrification plant at Hanford and for DOE to modify the Fuel and Material Examination Facility (FMEF) to mix plutonium with defense waste prior to delivery to the commercial firm for vitrification. Last year a development team comprised of the Environmental Corporation of America, Raytheon Company, and SGN/Numatec, Inc. submitted a proposal to DOE whereby they would construct a copy of the vitrification plant at La Hague that was designed by SGN and is operated by Cogema. DOE rejected the proposal on the basis that it would not accept a sole source bid for this undertaking.

If the deep borehole option is excluded, regardless of whether the plutonium disposition option is vitrification or MOX, it will ultimately be destined for a geologic repository. The nuclear industry in the United States is embarked on a reckless gutting of the licensing criteria for assessing the adequacy of the proposed U.S. repository at Yucca Mountain in Nevada.

As early as 1957 the National Academy of Sciences recommended that the preferred method of permanent disposal would be in a stable geologic formation (they suggested salt deposits) deep within the earth. In the late-1970s the Department of Energy began a process of systematically selecting the best candidate geologic medium to be followed by selection of the best site. First, DOE and then Senator Bennett Johnston (D-LA) and his colleagues in the Congress coopted that process and forced the decision to locate the first repository at Yucca Mountain. Also, in the late 1970s the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC) began developing licensing criteria for the repository. Concerned that Yucca Mountain may have difficulty meeting the EPA standards, the nuclear industry is now asking the Congress to gut the licensing criteria. EPA published its high-level waste criteria in 1993, but the industry persuaded Congress to exempt Yucca Mountain and write a new rule only after receiving recommendations from the National Academy of Sciences.

The latest incarnation of the nuclear industry's preferred licensing approach is found in two bills introduced this year. First, on January 5 of this year Senator Johnston introduced S.167, to amend the Nuclear Waste Policy Act of 1982. Among other things, Senator Johnston's bill replaces EPA's high level nuclear waste disposal criteria by a single standard requiring that the annual dose to an average individual not exceed one-third of the annual dose from natural background radiation. This translates into an individual risk limit of 100 mrem annually, a factor of seven higher than the individual risk limit in the EPA rule. On February

23 Congressman Fred Upton (R-MI) introduced a similar bill in the House that exempts Yucca Mountain from EPA regulations and substitutes the 100 mrem individual risk limit.

More importantly, these two egregious bills tossed out two basic tenets of the now more than 60 year old health physics profession--the ALARA principle and the need to establish a limit on the collective dose to populations when population groups are exposed to low doses of radiation over long periods. They also tossed out fifteen years of carefully developed, scientifically based, and peer reviewed nuclear waste regulations. The Johnston and Upton bills replace these by an ill conceived, cynical and arrogant standard presented by the nuclear industry--a standard that is based on bald politics rather than science and that could dramatically endanger public health for centuries to come.

The latest blow came just two weeks ago. Responding to utility criticism, on June 20 the House of Representatives voted to terminate funds for the DOE Yucca Mountain project in favor of funding an interim storage facility for spent fuel. Thus, in the United States it appears as if the direct disposal option may mean long term interim storage.

With respect to the MOX option, DOE has eliminated all proposals other than burning the MOX in existing LWR and/or Candu reactors. Atomic Energy of Canada Limited's (AECL) proposal to burn excess U.S. weapon plutonium at Ontario Hydro's Bruce Nuclear Generating Station now appears to be among the most attractive of the MOX options. The Bruce station has eight Candu reactors (four 769 MWe and four 860 MWe) that could be dedicated for this purpose. Each reactor could burn annually fuel containing about one tonne of plutonium to about 9,700 MWd/t, or 17,700 MWd/t depending upon the fuel design. The MOX fuel would be fabricated in the U.S.--it has been suggested at the FMEF--before shipment to Canada. A parallel option for burning excess Russian plutonium has been proposed, but the details and economics are less well developed.

While NRDC favors the vitrification option, last November we suggested an alternative MOX option for consideration, whereby the U.S. Government would offer to supply fresh MOX fuel to foreign reactor operators in exchange for an equivalent quantity of spent fuel, at a price equivalent to, or below, the sum of the current market prices for reprocessing and MOX fuel fabrication. This offer would be directed primarily at Japanese and European utilities that are likely to contract with Cogema and BNFL for a second round of spent fuel reprocessing.

In effect, the U.S. would compete directly with BNFL and Cogema for spent fuel management services, but would provide these services at an equivalent or reduced price without actually reprocessing any spent fuel. Under this option, DOE in theory at least could actually make money disposing of its excess plutonium. A potential ''show stopper'' with respect to this proposal is the need to import and store foreign spent fuel. This problem might be avoided, or at least postponed, by deferring the return of the spent fuel until the repository is available.

B. Russian Plutonium. The situation on the Russian side with respect to disposal of excess plutonium looks bleak. As noted above, by our estimates Russia has about 200 t of plutonium, excluding that in spent fuel. About 170 t was produced for weapons and is now in weapons, dismantled pits, and in storage at various manufacturing plants, while about 30 t came from processing civil reactor fuel and is now mostly in storage at Chelyabinsk-65. Thus, Russia has about twice as much separated plutonium in weapons and in storage as does the United States. Moreover, despite having a plutonium surplus under inadequate physical security and material control and accounting, Russia continues to separate two to three tonnes of plutonium per year at three sites. As former Secretary of Energy Herrington once remarked about the United States, Russia is simply "awash" in plutonium.

This past January the United States and Russia agreed to study the following options for disposing of Russian plutonium from dismantled weapons: burial in deep boreholes or geologic repositories, burning as MOX in LWRs, stabilization, immobilization, and accelerator transmutation. Minatom steadfastly maintains that it should close its civil fuel cycle and use its excess plutonium as start-up cores for a breeder reactor fuel cycle. While we would not necessarily oppose every MOX option for Russia, NRDC will oppose any U.S. or Western assistance to dispose of excess Russian plutonium in a manner that would assist significantly Minatom's efforts to close its civil fuel cycle. Given that Russia's excess plutonium is also found in a wide variety of forms, including forms that are unsuitable for conversion to MOX, Minatom would be well served by developing a direct disposal option even if its priority is for MOX.

After spending 1.2 billion DM, Seimens recently indicated that it intends to abandon its 120 t/y MOX plant (95% complete) at Hanau, Germany, due to opposition by the Hesse SPD-Green government. Seimens is now trying to get political support for using the plant to make MOX from Russian weapons plutonium, or to transfer the plant hardware to Russia, or elsewhere for the same purpose. There does not appear to be any political support for such a move in the U.S.

Table 1. U.S. Nuclear Weapons Stockpile.
(NRDC Estimates--Revised 1 August 1995)

	July 1995	2003
Warheads:		
Operational:		
Strategic		
ICBM	2050	450/500
SLBM	2900	1,680
Bomber Weapons	2650	1,320
Subtotal	**7,600**	**3,450/3,500**
Non-Strategic		
SLCM	350	350
Tactical Bombs	800	600
Subtotal	**1,150**	**950**
Subtotal (Operational) (includes ~10% spares)	**8,750**	**5,000**
Hedge:		
ICBM	0	900
SLBM	0	450
Bomber Weapons	0	800
Subtotal	**0**	**2,150**
Inactive GLCM	350	350
Subtotal	**9,100**	**7,500**
Awaiting Dismantlement	**5,000**	**0**
Total:	**~14,000**	**7,500**
Plutonium Pits:		
Stored Intact Pits:		
Strategic Reserve	2,200	8,700
Declared Excess, (Stored pits or converted to metal)	5,300	5,300

Table 2. Inventory of U.S. Plutonium and Highly-Enriched Uranium (July 1995).
(NRDC Estimates--Revised 31 July 1995)

	tonne
Plutonium:	
Weapon-grade Pu (WGPu):	
In Weapons (Active and Reserve Stockpile)	42
Removed From Weapons	
Strategic Reserve Pits	7
Excess Pits	16
Subtotal (Removed from Weapons)	**23**
Solutions, fuel, scrap, etc.	19
Subtotal (WGPu)	**84**
Reactor-Grade Pu (RGPu):	14.5
Total Pu	**98.5**
Highly-Enriched Uranium:	
In Weapons (Active and Reserve Stockpile)	
Oralloy (93% U-235)	235
EU (Avg. ~40% U-235)	100
Removed from Weapons:	
Oralloy (93% U-235)	
From Gun-Type Fission Warheads	80
Intact Secondaries	140
EU (Avg. ~40% U-235), Intact Secondaries	140
Oralloy (93% U-235) at Y-12	45
Subtotals (Weapon components):	
Oralloy (93% U-235)	**500**
EU (Avg. ~40% U-235)	**225**
Recovered from Spent Savannah Reactor Fuel	24.4
HEU Oxide Under IAEA (Vault 16 at Y-12)	10
UF_6 (≥92% U-235), not to Navy Specs	13.2
HEU (≥92% U-235), not to Navy specs	2-3
HEU Total (exclusive of Fresh Navy fuel)	**775**
HEU (Fresh Navy Fuel)	?

Table 3. Fissile Material Permanently Withdrawn From the U.S. Nuclear Weapons Use (July 1995). (NRDC Estimates--Revised 31 July 1995)

	tonne
Plutonium:	
Weapon-Grade Plutonium (WGPu):	
Solutions, fuel, scrap, etc.	19
Intact pits	16
Subtotal (WGPu):	**35**
Reactor-Grade Pu (WGPu):	
Pu Oxide (Z Vault at Hanford under IAEA)	1
Other	9.5
Pu from UK (ZPPR and FFTF fuel)-not declared excess[9]	4
Subtotal (RGPu)	**14.5**
Total Plutonium	**49.5**
Highly-Enriched Uranium:	
Committed to be Placed Under IAEA Safeguards:	
Non-weapon ≥92% U-235 oxide in Vault 16 at Y-12	10
Committed to USEC for conversion to LEU:	
UF_6 (≥92% U-235) at Portsmouth, not to Navy specs	13.2
EU Metal from Thermonuclear Secondaries:	
70% U-235	5
37.5% U-235	45
Subtotal to USEC for LEU fuel	**63.2**
Other:	
HEU (≥92% U-235), not to Navy specs	2-3
From Savannah River Reactor Fuel (~35% U-234)	24.4
Intact Weapon Secondaries (Avg. 40% U-235)	~75
Subtotal (Other)	**101.8**
Total HEU	**175**

[9] Obtained from the U.K. under a U.S/UK Defense Agreement signed in 1958. The UK claims it received assurances from the U.S. that the plutonium would not be used for weapon purposes.

Table 4. U.S. Fissile Material In Weapons and Reserved for Weapons (2003).
(NRDC Estimates--Revised 31 July 1995)

	tonne
Weapon-Grade Plutonium:	
In Weapons:	23
Strategic Reserve Pits:	26
Total Plutonium in Weapons and Reserved for Weapons	**49**
Highly-Enriched Uranium:	
In Weapons:	
Oralloy (93% U-235)	140
EU (Avg. ~40% U-235)	60
Fissile Material Strategic Reserve (Intact Weapon Components):	
Oralloy (93% U-235)	140
EU (Avg. ~40% U-235)	40
HEU Subtotals (In Weapons and Reserved for Weapons):	
Oralloy (93% U-235)	**280**
EU (Avg. ~40% U-235)	**100**
Total HEU In Weapons and Reserved for Weapons	**380**

Table 5. U.S. Fissile Material Available For Reactor Fuel or Disposal.
(NRDC Estimates--Revised 31 July 1995)

	tonne
Plutonium Available for MOX or Disposal	
Weapon-grade Plutonium (WGPu):	
Excess Pits	16
Solutions, fuel, scrap, etc.	19
Subtotal (WGPu)	**35**
Reactor-Grade Pu (WGPu):	
Pu Oxide (Z Vault at Hanford under IAEA)	1
Pu from UK (ZPPR and FFTF fuel)-not declares excess	4
Other	9.5
Subtotal (RGPu)	**14.5**
Total Plutonium available for MOX of disposal	**49.5**
Highly-Enriched Uranium Available for Reactor Fuel:	
Retained for Naval Fuel:	
Oralloy (93% U-235) From Gun-Type Fission Warheads	80
Oralloy (93% U-235) at Y-12	45
Subtotal	**125**
Available for Conversion to Civil LEU fuel:	
Oralloy (≥92% U-235):	
Non-weapon Oxide (Vault 16 at Y-12) under IAEA	10
UF_6 at Portsmouth to USEC for LEU	13.2
Metal, not to Navy specs	2-3
Intact Secondaries	95
EU Metal From Secondaries Committed to USEC	
70% U-235	5
37.5% U-235	45
EU (Avg. ~40% U-235) in Intact Secondaries	~75
From Savannah River Reactor Fuel (~35% U-234)	24.4
Subtotals Available for Civil LEU:	
Oralloy (≥92% U-235)	**~120**
EU (Avg. 35-40% U-235)	**~150**
Total HEU	**~395**