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Transparency Associated with the
Process of Eliminating Nuclear Warheads

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Paper 3

The Role of Transparency

Some treatments draw the following distinction between verification and transparency:[1]

- *Transparency*: measures to provide *confidence* that a declared activity is taking place.
- *Verification*: measures to *confirm* that a declared activity is *actually* taking place.

Verification and transparency in the context of nuclear warhead control and elimination encompasses a broad range of measures which are variously designed to:

- demonstrate progress and fairness in ongoing arms reduction processes;
- build confidence that the reductions are significant and unlikely to be reversed;
- reduce the uncertainties in estimates of nuclear weapons and weapon-usable materials;
- assure the international community that significant quantities of weapon-usable fissile materials are not being diverted to unauthorized uses or secretly kept in reserve for future use in nuclear weapons;
- provide independent evidence of whether weapons and weapons-usable fissile material have been diverted;
- provide a verified basis for confidently reducing stockpiles well below current levels;
- provide a coherent record of nuclear warhead elimination that could be relied upon by countries with smaller nuclear arsenals, such as China, India or Pakistan, in reaching a decision to join the nuclear arms reduction process;
- assist in identifying needed improvements needed in the physical security, control and accounting programs for nuclear weapons and weapon-usable fissile materials; and
- enable one to identify the source of stolen or diverted material recovered by law enforcement or customs personnel, by comparing the isotopic profile of the intercepted material with a comprehensive library of such data previously compiled for each distinctive batch of fissile material at storage and production sites.

The international community currently spends approximately US$ 500 million annually on multilateral monitoring and verification of non-proliferation, arms control and disarmament treaties and agreements.[2] Included in this total is the International Atomic Energy Agency (IAEA) verification organization, which has a budget of about US$90 million and includes some 600 staff of which 200 are inspectors.[3] The Organization for the Prohibition of Chemical Weapons, established under the Chemical Weapons Convention of 1993, has a similar budget and a staff of approximately 470 inspectors including about 200 inspectors.[4] The Comprehensive Test Ban Treaty Organization eventually will likely employ between 250 and 400 personnel.[5] Regrettably,

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1 Andrew J. Bieniawski, Jr.(Chairman), et al., "Transparency and Verification Options: An initial Analysis of Approaches for Monitoring Warhead Dismantlement," DOE, Office of Arms Control and Nonproliferation, May 19, 1997, p. 6.

2 R.F. Cleminson, "Multilateral On-going Monitoring and Verification (OMV) of Compliance: Nurturing Cost Effectiveness," The Sixth ISODARCO-Beijing Seminar on Arms Control, October 29-November 1, 1998.

3 Ibid.

4 Ibid.

5 Ibid.

there is no comparable multilateral effort to verify the elimination of nuclear warhead stockpiles, or their reductions.

The elimination of nuclear weapons is unlikely, if not impossible, without achieving either complete trust among nations, or a high degree of transparency over existing nuclear weapon and fissile material inventories and the process of nuclear warhead elimination. History offers little hope that the former will be realized anytime soon; therefore, if nuclear weapons are to be eliminated, it is incumbent upon the weapons states to provide greater transparency over reductions of their respective nuclear weapon arsenals and inventories of fissile materials.

Efforts to Achieve a Global Registry of Nuclear Arms

In the late-1980s, shortly after relations between the United States and the Soviet Union began to thaw, non-government organizations began advocating an exchange of data between the two countries as a means of verifying reductions of nuclear weapon stockpiles in the two countries.[6] The idea of a data exchange was subsequently endorsed by the Russian Foreign Ministry, and on February 12, 1992 Foreign Minister Andrei Kozyrev formerly proposed a reciprocal data exchange among all nuclear nations on inventories of nuclear weapons and fissile materials, and on nuclear weapons production, storage and elimination facilities. None of the other nuclear weapon states responded positively to this initiative, or offered constructive alternative proposals.

On December 16, 1993, the German Foreign Minister Klaus Kinkel proposed the establishment of a nuclear weapon register as a logical extension of the UN registry of conventional arms.[7] This effort was opposed by the United States, United Kingdom (UK) and France, and the proposal was quickly dropped. A 1998 report by Harald Müller of the Peace Research Institute Frankfurt, sets forth the case for why such a registry is still a timely, sensible, and ultimately a necessary step toward achieving nuclear disarmament.[8]

U.S.-Russian Nuclear Warhead and Fissile Material Transparency Negotiations

In 1992, the U.S. Senate adopted the "Biden Condition" to the resolution of ratification of the START I treaty. This condition required that "in connection with any further agreement reducing strategic offensive arms, the President shall seek an appropriate arrangement, including the use of reciprocal inspections, data exchanges, and other cooperative measures, to monitor (A) the number of nuclear weapons on the territory of the parties to this Treaty; and (B) the location and inventory of facilities on the territory of the parties to this treaty capable of producing or processing significant quantities of fissile materials."

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[6] Federation of American Scientists, "Ending the Production of Fissile Material for Weapons and Verifying the Dismantlement of Nuclear Warheads," June 1991.

[7] Harald Müller, "The Nuclear Weapons Register - A Good Idea Whose Time Has Come," Peace Research Institute Frankfurt, PRIF-Report No. 51, June 1998.

[8] Ibid.

Almost two years went by before the Clinton Administration responded to the Biden Condition and approached the Russians. Then in May 1994, a Joint Working Group on "Safeguards, Transparency, and Irreversibility" was established with the mandate to build confidence and promote stability in the two countries' mutual security relationship. At their September 1994 summit meeting Presidents Clinton and Yeltsin agreed to "exchange detailed information at the next Gore-Chernomyrdin Commission on aggregate stockpiles of nuclear warheads, on stocks of fissile materials and on their safety and security." The two Presidents also mandated that the two sides prepare an Agreement for Cooperation—required by U.S. law and similar to agreements the United States has with the United Kingdom and France—that would provide the legal basis for the exchange of classified and sensitive information.

At the December 1994 Gore-Chernomyrdin meeting the United States tabled a draft Agreement for Coperation and element of a "safeguards, transparency, and irreversibility" regime. The key elements of the U.S. proposal included:[9]

- Reciprocal exchanges of detailed information on aggregate stockpiles of nuclear warheads and fissile materials (a stockpile data exchange agreement).
- Mutual reciprocal inspections to confirm excess plutonium and highly-enriched uranium (HEU) removed from nuclear weapons are not being returned to weapons.
- Cooperative measures to confirm the fissile material portion of the Stockpile Data Exchange, i.e., spot checks.
- A cooperative arrangement to monitor warheads declared excess and awaiting dismantlement, to further confirm the dismantlement of these weapons (limited chain-of-custody).

In January 1995, U.S. Ambassador James Goodby tabled a proposed list of warhead and fissile material data to be exchanged. Under the U.S. proposal the number and location of operational warheads would be kept secret.

At the May 9-10, 1995 Summit in Moscow, Presidents Clinton and Yeltsin issued a "Joint Statement on the Transparency and Irreversibility of the Process of Reducing Nuclear Weapons."[10] As we noted in *Nuclear Weapons: The Road to Zero*, at the time this statement represented the fullest description of the intentions of the two countries with regard to transparency of nuclear warhead inventories and dismantlement and fissile material stockpiles.[11] Specifically, they agreed as follows:[12]

- Fissile materials removed from nuclear weapons being eliminated and excess to

[9] Bieniawski, "Transparency and Verification Options: An initial Analysis of Approaches for Monitoring Warhead Dismantlement," p. 22.

[10] The statement is reproduced in Joseph Rotblat, edited by, *Nuclear Weapons: The Road to Zero* (Boulder CO: Westview Press, 1998), pp. 180-181.

[11] Ibid., p. 175.

[12] Bieniawski, "Transparency and Verification Options: An initial Analysis of Approaches for Monitoring Warhead Dismantlement," p. 22.

national security needs will not be used to manufacture nuclear weapons;

- No newly produced fissile materials will be used in nuclear weapons;
- Fissile material from or within the civil nuclear programs will not be used to manufacture nuclear weapons;
- The U.S. and Russian Federation will negotiate agreements to increase transparency and irreversibility of the nuclear arms reduction process that, *inter alia*, established:

  - ♦ an exchange on a regular basis of detailed information on aggregate stockpiles of nuclear weapons, on stocks of fissile materials and on their nuclear security [a stockpile data exchange];
  - ♦ a cooperative arrangement for reciprocal monitoring at storage facilities of fissile material removed from nuclear weapons and declared excess to national security requirements to help confirm the irreversibility of the process of reducing nuclear weapons, recognizing that progress in this area is linked to progress in implementing the joint U.S.-Russian program for the fissile material storage facility at Mayak; and
  - ♦ other cooperative measures, as necessary to enhance confidence in the reciprocal declarations on fissile material stockpiles [spot checks]

In June 1995, the U.S. tabled a Stockpile Data Exchange Agreement with the Russians which proposed that each side not only declare existing inventories of weapons and fissile material but also declare the number of nuclear weapons dismantled each year since 1980 and the quantity of fissile material produced by the Parties each year since 1970 by material type, amount, category of enrichment or grade and production location. The Russian Ministry of Atomic Energy rejected the June 1995 version due to the fact that it was too comprehensive and inconsistent with a "step-by-step" approach to transparency.[13]

By the fall of 1995, the two sides had nearly completed the text of the Agreement for Cooperation providing the legislative basis for exchanging classified nuclear information required to implement these initiatives. However, the Russian government called a halt to the negotiations pending an internal policy review.[14] No substantive negotiations on safeguards, transparency, and irreversibility have taken place since that time. With no sign of progress in sight, U.S. Ambassador James Goodby, a short time, later resigned in disgust. It would be another year and one-half before efforts were made to resume the negotiations, this time as part of the START III negotiations.

In the Joint Statement issued by Presidents Clinton and Yeltsin at their March 21, 1997, Helsinki Summit, the two presidents agreed that:[15]

Once START II enters into force, the U.S. and Russia will immediately

[13] Ibid., p. 23.
[14] Ibid.
[15] Ibid., p. 21.

commence negotiations on a START III agreement which will include *inter alia*:

> Establishment by December 31, 2007, of lower aggregate levels of 2,000-2,500 strategic nuclear warheads for each of the Parties; and
>
> Measures relating to the transparency of strategic nuclear warhead inventories and the destruction of strategic nuclear warheads and any other jointly agreed technical and organizational, measures, to promote the irreversibility of deep reductions including prevention of a rapid increase in the number of warheads.

The Presidents also agreed that in the context of START III negotiations their experts will explore, as separate issues, possible measures relating to nuclear long-range sea-launched cruise missiles and tactical nuclear systems, to include appropriate confidence-building measures; and that the two sides will consider the issues related to transparency in nuclear materials.[16] These negotiations are now bound up by the fate of START II. The United States insists that START III negotiations must await ratification of START II, which the Russian Duma has chosen not to act on, as yet.

The only warhead/fissile material transparency negotiations between the United States and Russia that were successfully concluded, were those related to the February 18, 1993 agreement by the United States to purchase low-enriched uranium from the blending down of up to 500 t of HEU from Russian nuclear weapons. The two sides agreed to transparency measures that would provide confidence that:[17]

- the HEU was extracted from dismantled Russian nuclear weapons;
- the HEU was blended down to LEU in Russia; and
- the LEU shipped to the United States was fabricated into fuel assemblies for use in commercial power reactors.

Through mid-1997 fifteen technical transparency annexes had been signed related to this purchase agreement.[18] As a result of these agreements, at the Siberian Chemical Enterprise at Seversk (Tomsk-7), U.S. technical experts currently have the right to:[19]

- observe HEU components in sealed containers, that are shipped to Seversk from Russian dismantlement facilities, being received and stored;
- request and observe nondestructive assay (NDA) measurements being performed on sealed containers of Russian HEU weapons components to independently confirm the enrichment of uranium;
- request and observe NDA measurements being performed on sealed containers of HEU metal shavings from weapon components;

[16] Ibid.
[17] Ibid., p. 25.
[18] Ibid.
[19] Ibid., p. 26.

- request and observe NDA measurements being performed on HEU oxide containers prior to shipment to the Russian blending facilities at Novouralsk and Zelenogorsk; and
- obtain copies of relevant shipping and material control and accounting documents.

Thus, the U.S. has the right to routinely observe unclassified radiation measurements being performed on HEU components in sealed containers at Seversk.[20]

Lab-to-Lab Technical Discussion

In 1994-1995 technical experts from United States and Russia engaged in a series of reciprocal "familiarization" visits to nuclear material production and storage sites in each country, including Rocky Flats in the United States and Seversk (Tomsk-7) in Russia. In April 1995 the U.S. Department of Energy (USDOE) initiated a "lab-to-lab" program, under which the U.S. and Russian nuclear weapons laboratories could continue these visits and conduct unclassified technical discussions and technology demonstrations related to nuclear warhead dismantlement and fissile material storage and disposition. Since the halt in formal warhead transparency negotiations in 1995, the lab-to lab program has been the principal means of achieving further progress on warhead transparency issues.

As part of the lab-to-lab effort the USDOE's Office of Arms Control and Nonproliferation in 1997 prepared a study of alternative approaches for monitoring warhead dismantlement.[21] The study group identified ten key activities that could be used as part of a warhead dismantlement monitoring regime:[22]

1) Declarations of dismantlement schedules, warheads, and components resulting from the dismantlement process;
2) Spot checks of the weapon receipt and storage areas and component storage areas to confirm the declarations, including the use of radiation signatures of weapons and components (*Zone 4 at Pantex*);

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[20] Ibid.

[21] Ibid. The Bieniawski report reviewed the findings of several previous reports: John B. Brown, Jr., "Nuclear Dismantlement Center (NDC) Alternatives Study (U)" Executive Summary, Volume I and II, Report Classification SRD, prepared by Pacific Northwest Laboratory for Division of Policy and Technical Analysis, Office of Arms Control, US DOE, PNL-X-1837, 1839, November 1990; Report to Congress, "Verification of Nuclear Warhead Dismantlement and Special Nuclear Materials Controls (U)," Report Classification SRD, Department of Energy, DP-5.1-7375, July 1991 (the 3151 Report); "Verifying the dismantlement of nuclear warheads," Federation of American Scientists, Report Unclassified, June 1991; C. Olinger, W.D. Stanbro, D.A. Close, J.T. Markin, M.F. Mullen, and K.E. Apt, "Potential Transparency Elements Associated with Warhead Disassembly Operations at the Pantex Plant," Report Unclassified, Los Alamos National Laboratory, LA-CPO-93-355, December 1992; S. Drell (Chairman) et al., "Verification of Dismantlement of Nuclear Warheads and Control on Nuclear Materials," Report Unclassified, JASON/MITRE, JSR-92-331, January 1993; Rodney K. Wilson (editor), "Analysis of Potential Measures of Monitoring U.S. Nuclear Warhead Dismantlement (U)," Executive Summary, Volume II and Volume III, Report Classification SRD, Sandia National Laboratories Draft Report Numbers VST-049 and VST-050, October 1993; and Rodney K. Wilson and George T. West, "Cooperative Measures for Monitoring U.S. Nuclear Warhead Dismantlement," Report Unclassified, Sandia National Laboratories, VST-051, July 1994.

[22] Ibid., pp. 6-7.

3) Remote monitoring of the weapons receipt and storage areas and component storage areas (*Zone 4 at Pantex*);
4) Chain-of-custody of warheads and components from the storage areas to the dismantlement areas (*from Zone 4 to the gate of Zone 12 at Pantex*);
5) Portal Perimeter Continuous Monitoring (PPCM) to inspect every item that passes in and out of a segregated portion of the dismantlement area (*inside Zone 12 at Pantex*);
6) Chain-of-custody of warheads and components within the dismantlement area (*inside Zone 12 at Pantex*);
7) Sweeping or sanitizing a disassembly bay or dismantlement cell periodically before and after dismantlement (*inside Zone 12 at Pantex*);
8) Remote monitoring or direct observation of the dismantlement process (e.g., during the disassembly of the physics package and during the removal of the high explosive from the pit) (*inside Zone 12 at Pantex*);
9) Chain-of-custody of nuclear components from the dismantlement areas to the component storage areas after dismantlement (*from the gate of Zone 12 back to Zone 4 at Pantex*);
10) Monitoring of the disposition of the nuclear components of the warhead, such as the high explosive and warhead electronics, after dismantlement.

In November 1995 the two sides agreed that "canned sub-assemblies," i.e., thermonuclear warhead secondaries, and classified HEU components could be tracked on an unclassified basis using tags and seals, weighing of the canned sub-assemblies, and "chain-of-custody" techniques.[23] Under the "lab-to lab" program the two sides also have made progress in identifying and demonstrating radiation detection methods for characterizing the mass, isotopic concentration and shape signatures of classified plutonium components stored in sealed storage containers.

A planned visit to Russia to further these joint activities, which was to have taken place in November 1998, was canceled by the Russians. It is unclear whether this was an effort by the Russian security apparatus to curb the lab-to-lab effort, or whether there is a more benign explanation. In any case, joint radiation measurements of nuclear warheads and plutonium pits in sealed storage containers are unlikely to occur until there is an Agreement for Cooperation since both parties agree that the exchange of some currently classified information would be necessary.

Unilateral Declarations Pertaining to Warhead Inventories

As a consequence of the failure to achieve meaningful bilateral or multilateral verification agreements, the community of nations is left with a hodgepodge of unilateral declarations by the United States, Russia and the United Kingdom. As evidenced by the analysis below, these unilateral steps taken to date have been of limited utility in serving the transparency objectives

[23] Ibid., pp. 24-25.

outlined above, and they are no substitute for comprehensive transparency measures needed to achieve nuclear disarmament. The following analysis is limited to unilateral measures taken by the United States, Russia, the United Kingdom and France. The other nuclear weapon states—China, Israel, India and Pakistan—have made no similar declarations and will therefore not be discussed further.

United States. The United States has made the most comprehensive declarations regarding current and historical nuclear warhead stockpile levels. The United States has declassified:

a) the total number of nuclear warheads built annually (by fiscal year) from 1945 through 1961;
b) the total number of nuclear warheads that are now fully retired that were built annually (by fiscal year) from 1962 to the present;
c) the total number of nuclear warheads in the stockpile by fiscal year from 1945 through 1961;
d) a chart of the relative number of warheads in the stockpile from 1945 to present;
e) the total number of nuclear warheads retired from the stockpile annually (by fiscal year) from 1945 through 1989;
f) the total number of nuclear warheads that were disassembled (and not reassembled) annually (by fiscal year) from 1980 to the present;
g) the cumulative yield of all warheads in the stockpile by year from 1945 to 1993;
h the identity (warhead number and mod) of every type of warhead in the stockpile at any time since 1945 and key life-cycle dates (e.g., first production unit, begin quantity production, end of stockpile period, beginning and end of dismantlement period);
i) the total number of warhead pits in storage at Pantex by year from 1988 to present; and
j) the total number of warheads i) disassembled for disposal, ii) disassembled for evaluation and then disposed of, and iii) disassembled for evaluation and then reassembled, at Pantex during each fiscal year from 1988 to present.

Russia. Russia has not declassified any of these categories of data.

United Kingdom and France. In July 1998, the British government, in its *Strategic Defence Review*, revealed the approximate size of its "operational" nuclear weapon holdings: i) during the 1970s; ii) during the 1980s; iii) the previous government's plans for British nuclear forces by the end of 1999; and iv) future stockpile as a consequence of the Strategic Defence Review.[24] These data were presented as bar graphs and excluded United States systems formerly operated by Britain under dual key. The approximate size of the "operational" stockpile as a

[24] British Ministry of Defence, *Strategic Defence Review,* and an accompanying volume of "Supporting Essays;" see particularly, Essay 5, "Deterrence, Arms Control and Proliferation."

consequence of the Strategic Defence Review is given as <200 warheads [See Figure 1, reproduced from the *Strategic Defence Review*, Essay 5].[25] This upper limit is said to exclude "weapons, such as WE177 and Chevaline, which have been withdrawn from service and are waiting final dismantlement," and "missile warheads held as a necessary processing margin or for technical surveillance purposes."[26] Reading from the bar graph in Figure 2 [also reproduced from Essay 5], the total British "operational" warheads, representing "SDR decisions on numbers of operationally available Trident warheads to meet both the strategic and sub-strategic roles," is 250 warheads. Assuming these two totals, <200 and 250 "operational" warheads, are supposed to be the same, the British are somewhat sloppy in their transparency.

The British have three operational *Vanguard* Class Trident submarines and a fourth boat under construction. Only three boats will be deployed with missiles at any time, given that the British have reduced the number of Trident II missiles purchased from 65 to 58. The British have also stated that they plan to put no more than 48 warheads on each boat (3 warheads per missile)—a practice followed with Polaris—which gives an operational stockpile of 144 warheads plus spares. Note 5 in Figure 2 refers to "operationally available Trident warheads to meet strategic and sub-strategic roles." A MOD official described the sub-strategic role as follows: "A sub-strategic strike would be the limited and highly selective use of a sufficient level of violence to convince an aggressor who has already miscalculated our resolve and attacked us that he should halt his aggression and withdraw or face the prospect of a devastating strategic strike."[27] This non-strategic role implies that some missiles will carry only one warhead, instead of three and therefore the British operational nuclear stockpile is actually somewhat less than 144 warheads.

Interestingly, on the one hand, the United States continues to classify the number of currently deployed nuclear warheads, while releasing extensive historical data related to retired weapons and warheads slated for disassembly. On the other hand, the British, at least to a limited extent, have declassified the number of "operational" warheads, and classified the number of spare warheads and those awaiting dismantlement. Actually, declassification by the United States has been so extensive that one can estimate fairly accurately the makeup of the current and future stockpile levels, as we have done in Tables 1 and 2. While there remains some uncertainty in the estimates of the number of deployed warheads by type, the total inventory is known as accurately as one can calibrate, using historical data (1945-1961), the scale of declassified figures presenting the relative size of the stockpile from 1945 to the present. In this regard the relative uncertainty in estimates of the number of U.S. operational warheads is less than the uncertainty in the number of British operational warheads.

By virtue of having announced that they are retaining only two nuclear weapon systems, like the British, the French have revealed indirectly the size of their operational stockpile. The French plan to maintain after 2005 a fleet of four *Triomphant* Class SSBNs, but only three sets of M45 SLBMs will be procured. Thus, the French plan to deploy (3x16x6=) 288 TN75 warheads.

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[25] Ibid.

[26] Ibid.

[27] Quoted in Robert S. Norris and William M. Arkin, "Tables of Nuclear Forces," *SIPRI Yearbook 1998*, Stockholm International Peace Research Institute (Oxford: Oxford University Press, 1998) , p. 440.

In addition, The French will retain 65 ASMP nuclear missiles, 45 for the land-based Mirage 2000N and 20 for the carrier-based Super Étendard and/or the Rafale M. In sum, after 2005 the French plan to have an operational stockpile of 353 warheads plus spares.

Unilateral Declarations Pertaining to Plutonium Inventories

United States. As with warheads, the United States has made the most comprehensive declaration regarding plutonium inventories. In February 1996, the United States revealed:[28]

a) the total U.S. government owned plutonium inventory, 99.5 tonnes (t), as of 30 September 1994, as well as the plutonium inventory by site, chemical and physical form (including plutonium in spent fuel and waste), and isotopic concentration, except the plutonium contained in stockpiled weapons and in pits at Pantex was lumped together; and

b) a history of plutonium production, acquisitions and removals; the respective isotopic concentrations; and a material balance analysis to reconcile the historical data with the current plutonium inventory.

The United States has not updated these data despite the fact that there have been changes in the chemical and physical form and location of some of the plutonium. Since these data are not classified, with considerable effort, that is, by making innumerable inquiries at the Department of Energy, one can piece together a nearly complete picture of the subsequent disposition of the inventory since 1994. From the information published to date, it is not possible in all cases to track the plutonium from its origin (production or acquisition) to its declared end-state. For example, 5.366 t of plutonium were received from the British during the period 1960-1979 (under the 1958 United States-United Kingdom Mutual Defense Agreement). About 4 t of this plutonium is known to have been used for civil reactor research and development. The ultimate disposition by the United States of the remaining 1.4 t of British origin plutonium is not known. As will be discussed further below, this has been a troubling issue since much, if not all, of this plutonium is believed to have derived from civil reactors.

The fact that the United States has not divulged the total mass of plutonium in assembled warheads, but has only revealed only the total amount of plutonium both in warheads and in "pits" storage at Pantex, is apparently an effort to keep secret the mass of plutonium in a warhead "pit" and the number of stockpiled warheads.

In February 1996, the United States also declared that 52.5 t of plutonium were in excess of military needs suggests that the U.S. government is disposing of about one-half of its weapons plutonium. As seen from Table 3, only 38.2 t of the declared excess was weapon-grade plutonium (WGPu), and of this only 22.7 t represents plutonium that was at the time in the form of plutonium warhead components, called plutonium "pits." The 29.8 t of excess plutonium not in pits includes the plutonium that was in "pipeline" and waste materials remaining when pit

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

manufacturing was halted at the Rocky Flats plant in 1989, and in fresh and spent reactor fuel, waste materials and other forms at other Department of Energy sites.

Thus, as summarized in Table 4, 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 3); President Gorbachev made a similar announcement on October 5, 1991. By our estimates, the U.S. stockpile of nuclear weapons was about 10,400 at the end of FY 1998 (September 30, 1998) (Table 1). With START II fully implemented—the date for this has been extended until 2007—the United States plans to retain about the same number of intact nuclear warheads, plus an additional 5000 plutonium pits stored at Pantex to serve as a strategic reserve (Table 2).

Russia. Unlike the United States, Russia has not revealed the size of its plutonium inventory reserves for weapon use, much less the history of plutonium production, acquisitions and removals, the respective isotopic concentrations or a plutonium materials balance analysis to reconcile the historical data with the current inventory.

Russia has declared that 50 t, or up to 50 t of its plutonium is now in excess of 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 adds little in the way of transparency, since others remain unsure of how much plutonium Russia is retaining for weapon purposes. The Russian government has significantly larger inventories of both WGPu and separated reactor-grade plutonium (RGPu) than does the United States. We estimate that Russia has produced about 170 t of WGPu for weapons. There is an additional 30 t or so of mostly RGPu, recovered from processing spent fuel from VVER-440 power reactors and naval reactors and currently stored at Ozersk (formerly Chelyabinsk-65 or "Mayak").

United Kingdom and France. In July 1998, the British declared that the total size of its "stocks of nuclear materials for national security outside international safeguards" was:[29]

7.6 t of plutonium
21.9 t of HEU
15,000 t of other forms of uranium;

and that 4.4 t of plutonium, including 0.3 t of WGPu, and over 9000 t of uranium (not HEU) was no longer required for defense purposes and would be placed under European Atomic Energy Community (EURATOM) safeguards, and be made available to inspection by the International Atomic Energy Agency (IAEA). It is reasonable to assume that all of the plutonium that the UK is retaining for weapons is weapon-grade, as we have done in our summary Table 4.

[29] British Government, "Strategic Defence Review," Essay 5, July 1998.

Because the British have not revealed detailed and comprehensive historical production, acquisition and removal data, these fissile material declarations raise important questions regarding the validity of the plutonium declaration and leave unresolved whether civil plutonium of British origin was used in U.S. nuclear weapons.

The Sellafield plant chemically separated plutonium from the 10 military production reactors[30] and the civil Magnox power reactors. Prior to 1986, the plutonium recovered from the military and civil reactors at Sellafield was co-mingled. Some WGPu produced in civil Magnox reactors was apparently incorporated into military stocks and some fuel-grade plutonium produced at Calder Hall and Chapelcrosss after 1964-1966 may have been substituted.

As noted earlier, under the 1958 United States-United Kingdom Mutual Defense Agreement, the United States received 5.366 t of plutonium from the United Kingdom during the period 1969 -1979. In return the United States gave the United Kingdom 6.7 kilograms of tritium and 7.5 t of HEU.[31] The United States revealed the isotopic content of the 5.4 t of plutonium received from the British:

Pu-240 (%)	Pu Received (t)
2	0.1
10-12	1.2
13-15	1.9
16-20	2.2
Total	5.4

It is unclear how much, if any, of the 5.4 tonnes of British plutonium was produced in military plutonium production reactors, and how much was produced in civil reactors.[32]

The French have not declared the size of their military plutonium stocks.

Unilateral Declarations Pertaining to HEU Inventories

While the United States and Russia have made declarations of HEU in excess of military requirements (See Tables 4 and 5), only the United Kingdom has revealed the size of the HEU inventory being retained for military purposes. As noted above, the United Kingdom has declared that it is retaining 21.9 t of HEU for national security purposes. Since HEU is also used as naval reactor fuel, the British declaration only places an upper limit on the amount of HEU

[30] Two plutonium production reactors were operated at Windscale (renamed Sellafield in the 1970s), four reactors at Calder Hall adjacent to Sellafield, and four Magnox production reactors at Chapelcross in Scotland. The Windscale reactors were shut down following the October 1, 1957 fire at Windscale Pile No. 1.

[31] U.S. Department of Energy, Office of Declassification "Restricted Data Declassification Decisions, 1946-Present," (RDD-4), January 1, 1998, p. II-28.

[32] K.W.J. Burnham, D. Hart, J. Nelson, and R.A. Stevens, *Nature*, **317**, 213-217 (1985); **320**, 9 (1986); **333**, 709-710 (1988); and **395**, 739 (1998).

being reserved for nuclear weapons. Modern two-stage thermonuclear weapons with a yields exceeding 200 kilotons can be made with a primaries each containing about three kilograms of plutonium and secondaries each containing about 20 kilograms of HEU. Consequently, the 21.9 t of HEU declared by the British could support an inventory of over 1000 high-yield nuclear weapons. This is four to five times the declared inventory of "operational" warheads retained by the British.

Nuclear Warhead Dismantlement Transparency

Upon the dissolution of the Soviet Union, Soviet nuclear warheads located in Ukraine were claimed by Ukraine as their property. Subsequently, Ukraine chose to sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as a non-nuclear weapons state. The nuclear warheads on Ukrainian territory were transferred to Russia for dismantlement, and Ukraine received payment for the highly-enriched uranium contained therein. Russia and Ukraine agree that Ukrainian nationals would be permitted to verify the destruction of these warhead at Russian warhead assembly/disassembly facilities. Details associated with this agreement and the method of verification have not been made public.

This transparency arrangement between Russia and Ukraine, which should be viewed as a special case, represents the only transparency of nuclear warhead dismantlement that has transpired since the end of the Cold War. Russia's scuttling in 1995 of the negotiations with the United States of an agreement for cooperation on nuclear matters ended any prospect for bilateral transparency over the dismantlement of U.S. and Russian nuclear warheads.

Summary and Conclusions

In the past seven years, since the dissolution of the Soviet Union and the end of the Cold War, the nuclear weapon states have secured no bilateral or multilateral agreements to provide verification arrangements associated with nuclear warhead stockpiles, fissile material stockpiles for national security purposes, or the dismantlement of nuclear warheads. Alternatively, the United States, Russian and the United Kingdom have each made partial unilateral declarations regarding warhead and fissile material stockpiles. China and other nuclear weapon states have not taken such steps.

The United States has revealed considerable data regarding the size of its nuclear warhead stockpile in years past, but keeps secret the number of warheads currently in its stockpile. Russia has released no nuclear warhead stockpile data. The United Kingdom has released very limited data—in some cases ambiguous or conflicting data—regarding "operational" nuclear warhead stocks.

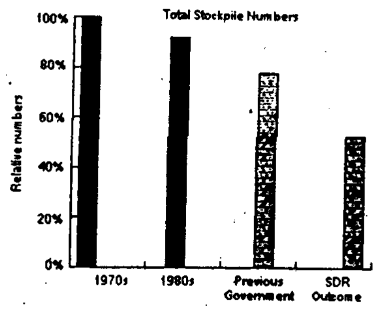
The United States has revealed extensive data regarding its plutonium stocks as of September 1994, but has not updated these data on a periodic basis. Russia and France have made no such declaration. The United Kingdom has revealed its total stock of military plutonium, but not the underlying data needed to confirm the declaration.

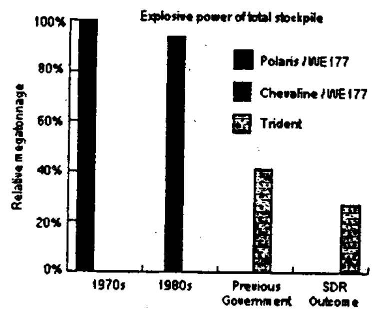
Only the United Kingdom has revealed its total stockpile of military HEU, but not the underlying data to verify it, nor what portion is being reserved for weapons and what portion is reserved for naval fuel.

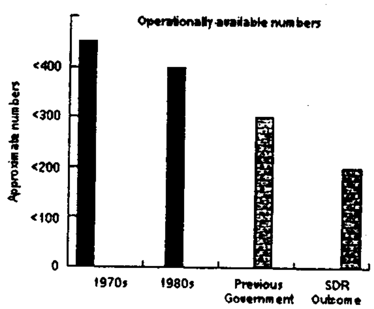
This hodgepodge of unilateral declarations by the weapon states does not meet any of the objectives that verification of nuclear warheads and fissile material is meant to serve. The broad outlines of the types of verification measures that must be put into place to achieve deep reductions in nuclear stockpiles, and their elimination, are known. There is a wide range of verification technologies that can be employed. What is lacking is the implementation of a comprehensive plan acceptable to the weapon states. However, none of the nuclear weapons states, or their weapon laboratories, have published a comprehensive verification plan that it finds acceptable. In preparation for negotiations, the United States reportedly has set forth the elements of a transparency regime associated with START III reductions and the fulfillment of reciprocal unilateral commitments to reduce tactical nuclear weapons. This proposal is being kept secret by the United States pending the Russian State Duma's ratification of START II. Thus, bilateral verification measures that were previously being pursued on a separate track, are now held hostage to the Duma's ratification of START II.

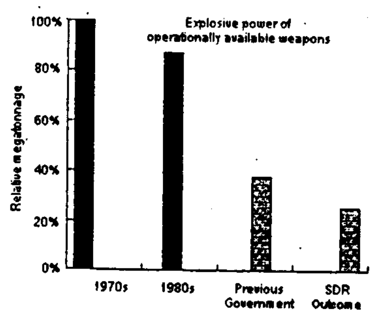
The lack of progress in verification of nuclear warhead reductions to date is evidence that the nuclear weapon states still do not take seriously their NPT obligation to "pursue negotiations in good faith on effective measures related to . . . nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control."

the numbers of operationally available weapons.









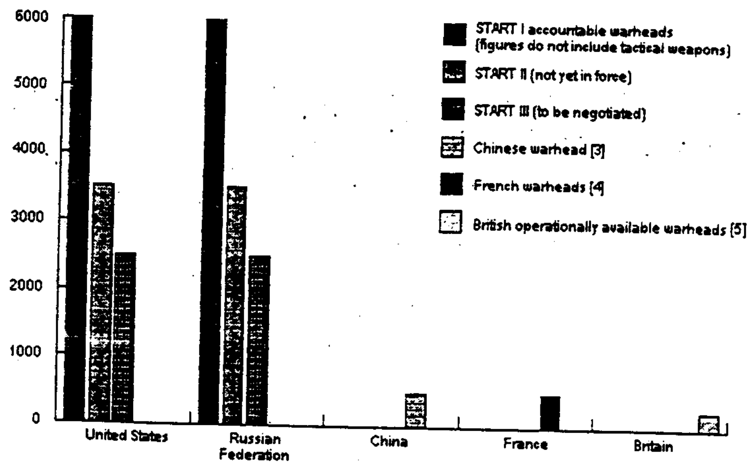
Notes:

1. The charts compare our nuclear weapon holdings during the 1970s and 1980s with the previous government's plans for British nuclear forces by the end of 1999 and SDR decisions. The charts do not include United States systems formerly operated by Britain under dual key arrangements.

2. The figures for total stockpile numbers include all British nuclear weapons, excluding only weapons, such as WE177 and Chevaline, which have been withdrawn from service and are awaiting final dismantlement.

3. The figures for operationally available numbers additionally exclude missile warheads held as a necessary processing margin or for technical surveillance purposes.

Figure 2: A comparison of the United Kingdom's holdings of operational warheads with those of the other four Nuclear Weapon States.



Notes:

1. Table covers the nuclear warhead holdings of the five Nuclear Weapon States, including Britain, under the Nuclear Non-Proliferation Treaty (NPT). Only India, Pakistan, Israel, Cuba and Brazil have not signed the NPT. Brazil has stated its intention to do so.

2. Holdings for the United States and Russia represent the limit on accountable strategic warheads set under START I (to be achieved by 2001), the upper limit set in START II (to be achieved by 2007 once the Treaty has entered into force) and the upper limit discussed by the US and Russia for a START III treaty. The United States additionally holds some stocks of non-strategic nuclear weapons and Russia has a stockpile of several thousand tactical nuclear weapons.

3. Holdings for China represent what is known about the total size of China's nuclear forces, including both strategic and tactical weapons.

4. Holdings for France represent all French nuclear forces, comprising submarine-launched ballistic missile warheads and air-launched weapons.

5. Holdings for Britain represent SDR decisions on numbers of operationally available Trident warheads to meet both the strategic and sub-strategic roles.

Figure 3. U.S. Nuclear Weapon Stockpile

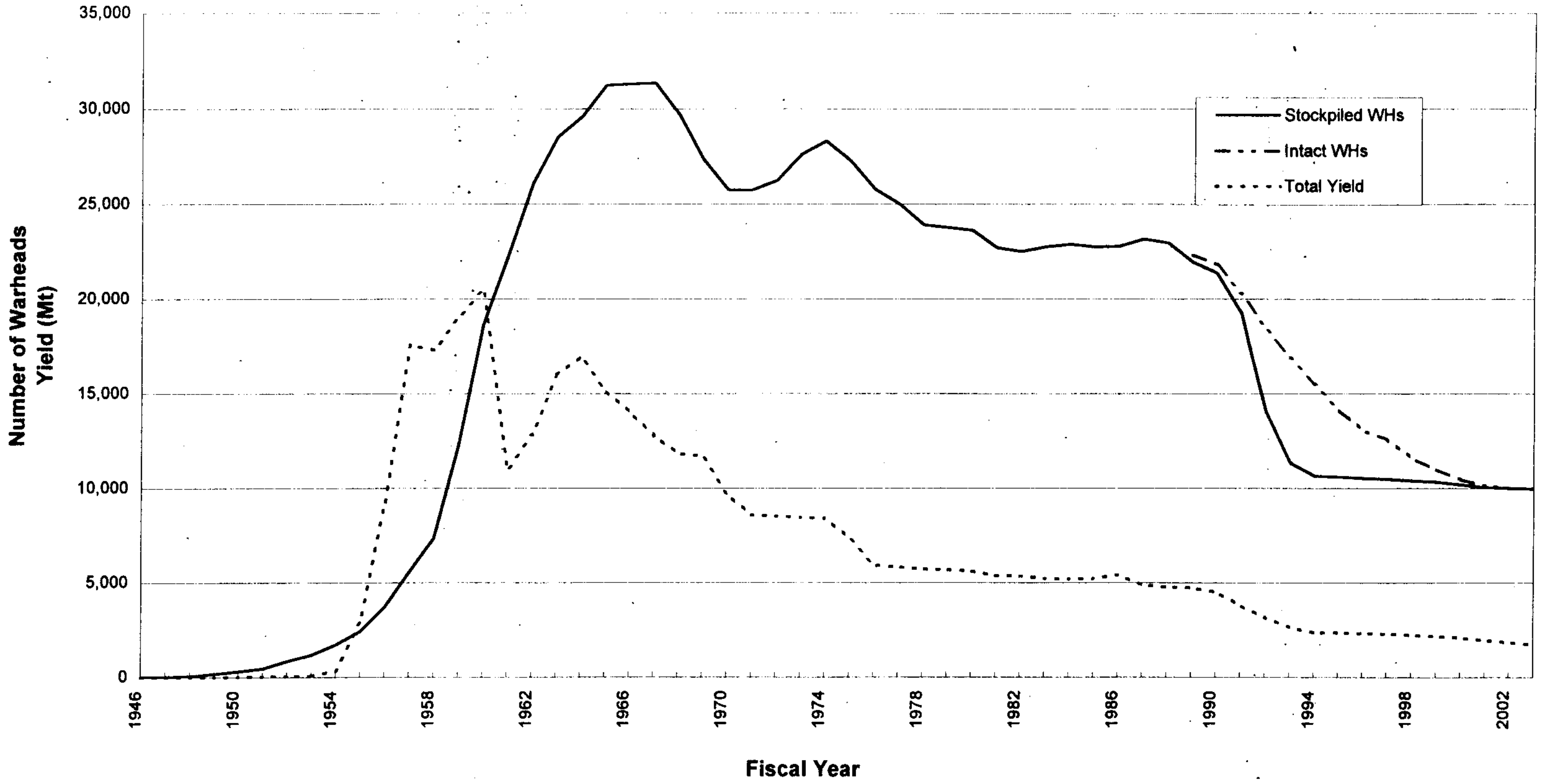


Table 1. U.S. Nuclear Warheads and Pits -- End FY-1998

NRDC -- 9/29/98

		Total WH	Active WHs				Inactive	Total WHs	Awaiting	Total	Pits			WHs+	Total
Warhead	Type	Builds	Deployed	Spares	Hedge	Total	WHs	Stockpiled	Dismantl't.	Intact WHs	Reserve	Excess	Total	Res. Pits	WH+Pits
B53	Strategic bomb	340							37	37	0	0	0	37	37
W56-4	MM II Mk-11	1,000							471	471	11	0	11	482	482
B61-3,4,10	Non-Strategic bomb	1,400	700	50	0	750	0	750		750	109	0	109	859	859
B61-5	Non-Strategic bomb	300									236	0	236	236	236
B61-7	Strategic bomb	700	285	15	0	300	350	650		650	42	0	42	692	692
B61-11	Strategic bomb	50	45	4	0	49	0	49		49	1	0	1	50	50
W62-0	MM III Mk-12	1,700	600	10	0	610		610		610	169	0	169	779	779
W68-0	Poseidon C3 Mk3	5,220									2,468	0	2,468	2,468	2,468
W69-0	SRAM	1,200							186	186	936	0	936	1,122	1,122
W76	T-I C4, T-II D-5 Mk-4	3,400	3,072	128	0	3,200	173	3,373		3373	27	0	27	3,400	3,400
W78	MM III Mk-12A	1,000	900	15	0	915		915		915	42	0	42	957	957
W79-0	8-inch howitzer	250							245	245	0	2	2	247	247
W79-1	8-inch howitzer	300							240	240	0	46	46	240	286
W80-0	SLCM	350	270	20	0	290		290		290	30	0	30	290	320
W80-1	ALCM/ACM	1,850	700	100	0	800	1,000	1,800		1800	43	0	43	1,843	1,843
B83-0,1	Strategic bomb	665	480	120	0	600	55	655		655	8	0	8	663	663
W84	GLCM	400	0	0	0	0	388	388		388	12	0	12	400	400
W87-0	MX Mk-21	560	500	25	0	525	0	525		525	5	0	5	530	530
W88	T-II D-5 Mk-5	400	384	13	0	397	0	397		397	3	0	3	400	400
ICBM		**4,260**	**2,000**	**50**	**0**	**2,050**	**0**	**2,050**	**471**	**2,521**	**227**	**0**	**227**	**2,748**	**2,748**
SLBM		**9,020**	**3,456**	**141**	**0**	**3,597**	**173**	**3,770**	**0**	**3,770**	**2,498**	**0**	**2,498**	**6,268**	**6,268**
Strategic Bomber		**4,805**	**1,510**	**239**	**0**	**1,749**	**1,405**	**3,154**	**223**	**3,377**	**1,030**	**0**	**1,030**	**4,407**	**4,407**
Total Strategic		**18,085**	**6,966**	**430**	**0**	**7,396**	**1,578**	**8,974**	**694**	**9,668**	**3,755**	**0**	**3,755**	**13,423**	**13,423**
Total Non-Strategic		**3,000**	**970**	**70**	**0**	**1,040**	**388**	**1,428**	**485**	**1,913**	**359**	**78**	**437**	**2,272**	**2,350**
Total (Strategic + Non-Strat.)		**21,085**	**7,936**	**500**	**0**	**8,436**	**1,966**	**10,402**	**1,179**	**11,581**	**4,114**	**78**	**4,192**	**15,695**	**15,773**
Other Retired Warhead Pits												**7,081**	**7,081**	**0**	**7,081**
Grand Total			**7,936**	**500**	**0**	**8,436**	**1,966**	**10,402**	**1,179**	**11,581**	**4,114**	**7,159**	**11,273**	**15,695**	**22,854**

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."

Table 2. 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 Intact 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.

Table 3. U.S. Plutonium Inventories Excess to National Security Needs (tonnes).

	Weapon-Grade Plutonium							Fuel and Reactor-Grade Plutonium						Total
Location	**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 4. 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	?	?	?

United Kingdom

Plutonium Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapon Pits	?	?	?	?	?
Other WGPu	?	?	?	?	?
WGPu (total)	3.5	0.3	?	3.1	88.6
FGPu+RGPu	4.1	4.1	100.0	0	0.0
Pu (total)	7.6	4.4	57.9	3.1	40.8

HEU Category	Total (t)	Excess (t)	Excess (%)	Strategic Reserve (t)	Strategic Reserve (%)
Weapons	?	0	0.0	?	?
Other	?	0	0.0	?	?
Total	21.9	0	0.0	21.9	100.0

Table 5. U.S. Excess Highly Enriched Uranium (tonnes).

Location	Metal	Oxides	Unirradiate Fuel	Irradiated Fuel	UF6	Other Forms	Total
Pantex plus planned dismantlements	16.7	-	-	-		-	**16.7**
Oak Ridge Y-12 Plant	63.1	2.7	10.6	0.6		7.9	**84.9**
Idaho National Engineering Lab.	1.6	1.7	2.8	16.6		0.6	**23.4**
Portsmouth GDP	-	7.3	-	-	13.2	2.0	**22.5**
Savannah River Site						22.0	**22.0**
Rocky Flats Site	1.9	<0.1	0.6	-		0.4	**2.8**
Hanford	<0.1	0.1	0.1	0.3		0.1	**0.5**
Los Alamos National Laboratory	<0.1	0.3	0.1	<0.1		0.1	**0.5**
Brookhaven National Laboratory	-	-	-	0.2		<0.1	**0.3**
Sandia National Laboratories	<0.1	0.1	<0.1	0.1		<0.1	**0.2**
Other Sites	<0.1	0.2	0.2	<0.1		<0.1	**0.5**
Total	**83.3**	**12.4**	**14.4**	**17.8**	**13.2**	**33.1**	**174.3**

Source: DOE, Openess Press Confrence, Fact Sheet, Feburary 6, 1996.