Safety and Control of Nuclear Materials and Nuclear Weapons

by

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I. Introduction.

This paper provides an assessment of the security threat associated with weapon-usable fissile materials in Russia, and a progress report on U.S.-Russian cooperation to improve fissile material protection, control and accounting (MPC&A) in Russia, which inherited more than 90 percent of the Soviet Union's weapon-usable fissile material.[1]

II. Diversions of Weapon-Usable Materials from Russian Facilities.

We estimate that about 25,000 intact nuclear weapons remain in the former Soviet Union (FSU), and that about 1200 tonnes (t) of weapon-usable highly-enriched uranium (HEU) and 170 t of separated plutonium are in weapons or available for weapons, and an additional 30 t of separated civil plutonium are stored in Russia. Most, if not all, of these inventories are stored under inadequate conditions of physical security and of material control and accounting. According to the CIA, "the Russians have taken a number of steps over the last 2 years to increase security [of nuclear warheads]. For example, weapon storage sites are being consolidated from over 600 throughout the former U.S.S.R. in 1989 to approximately 100 today."[2]

Weapon-usable fissile materials are also scattered among an estimated 80 to 100 sites in the former Soviet Union, mostly in Russia. I have compiled from open sources a list of Russian sites that have, or may have, significant quantities of weapon-usable fissile material (Table 1). The isotopic concentration of uranium-235 in Russian naval reactors varies, so some fraction of the marine reactor bases in Table 1 probably should be excluded. Some of the other sites are quite large and have numerous individual facilities possessing significant quantities of fissile materials. Chelyabinsk-65, for example, has two operating production reactors, two chemical separation plants, an analytical laboratory, a plutonium storage facility, and a cluster of facilities similar to the Rocky Flats Plant in the U.S, that is devoted to plutonium pit manufacturing.

Russian President Boris Yeltsin has said that 40 percent of individual private businessmen and 60 percent of all Russian companies have been corrupted by organized crime. The CIA estimates that there are 200 large, sophisticated criminal organizations that conduct extensive criminal operations throughout Russia and around the world.[3] Corruption is rife in the Russian Army; approximately 3,000 officers have been disciplined for engaging in questionable business practices, and 46 generals and other officers face trial on criminal charges, according to a recent

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[1] This paper represents an update of an earlier paper presented at the Carnegie Endowment for International Peace Conference on Nuclear Non-Proliferation in 1995, Washington, D.C., 31 January 1995.

[2] Dr. Gordon Oehler, Director, Non-Proliferation Center, Central Intelligence Agency, Testimony before the Senate Armed Services Committee, January 31, 1995, S. Hrg. 104-35, p. 4.

[3] Oehler, CIA, Testimony before the Senate Armed Services Committee, January 31, 1995, p. 6.

Department of Energy (DOE) report.[4] In 1992, some 40,000 charges of corruption were brought against members of the Russian armed forces. In the same year, the Russian defense ministry reported 4,000 cases of conventional weapons missing from military depots and nearly 6,500 cases in 1993.[5]

Reports of illegal activities in Russia associated with nuclear materials--offers to sell and successful and unsuccessful attempts to steal nuclear materials--appear in the Russian and European press at a rate of several per week. Low-enriched uranium fuel has been stolen. On 24 Febuary 1995 *The Washington Post* quoted Interior Minister Viktor Yerin as saying that his ministry was investigating 30 cases in which radioactive materials were stolen from nuclear facilities; and on 25 March 1995, Moscow Radio quoted GOSATOMNADZOR as saying that as of 1 January 1995 there had been 19 thefts of uranium from Minatom enterprises. Early this year, I was told that the U.S. has been informed that a larger amount of weapon-usable material was stolen, and that a substantial fraction remains unaccounted for. I do not know the details of any of these cases and am not in a position to judge the extent to which these cases are serious.

Since the fall of 1992, five serious cases of diversion of weapon-usable fissile material have occurred--three involving 1.5 to 3 kilograms (kg) of HEU, and the other two involved over 100 grams of HEU or plutonium (Table 2). Most, if not all, of the materials were stolen from Russian nuclear facilities, and in two cases the materials were intercepted outside of Russia.

Several conclusions can be drawn from these five most serious known cases:

1) kilogram quantities of weapon-usable fissile materials are being stolen from institutes in Russia;

2) some fraction of these materials are not being intercepted before leaving the Russian borders; and

3) organized crime elements were involved in one known case to date (Vilnius), although it is not clear they knew they were shipping fissile material.

4) All known cases involved diversions from civil, space, and naval reactor research and fuel manufacturing facilities. No known diversions have occurred that involved nuclear weapons or weapon components.

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[4] U.S. Department of Energy, Office of Intelligence and National Security, Office of Threat Assessment, "The Russian Mafia," 15 November 1993.

[5] "The High Price of Freeing Markets," *The Economist*, 19 February 1994, as cited by Jonathan Dean in "The Final Stage of Arms Control," Union of Concerned Scientists, 21 May 1994.

5) We don't know what we don't know. Given the lack of adequate inventory controls, there may well have been successful diversions that have not been detected.

There have been no cases of rogue states or terrorists using nuclear weapons. The sarin gas attack in Tokyo comes the closest to a terrorist attack using a weapon of mass destruction. This case may have relevance to nuclear terrorism to the extent that the cult had developed the capability to manufacture and stockpile a sizable quantity of poison gas, and members of the cult included a few highly educated chemists and engineers.

If one assumes that the significance of a given risk to national security is a function of its lethality and likelihood of occurrence, then the prospect of thousands of people dying in a nuclear terrorist attack should rank very high on the list of threats. In fact, two attacks of the requisite *potential* lethality have recently occurred in the U.S. -- the bombing of the World Trade Center in New York City and the Federal Building in Oklahoma City. In the World Trade Center case all that was lacking was the requisite explosive power. Even the fissile yield of a crude nuclear device made with a few kilograms of plutonium would have been enough to bring down the building, killing 40,000 or more people.

In my view, however, the most serious threat is represented by the diversion of kilogram quantities of weapon-usable materials from Russia to Iran, Iraq or Libya, where the design and construction of nuclear weapons would receive government support. It is universally agreed among arms control experts that the pacing item in acquiring nuclear weapons is the availability of weapon-usable material. This time period can be cut from years to weeks should the requisite material be diverted from Russia to a rogue state. Unlike the North Korean case, there would be little, if any, time to slow or stop the program through diplomacy.

So there would appear to be a very high priority -- at least as high if not exceeding that attached to theater ballistic missile defense -- to preventing terrorist organizations and hostile states from gaining access to weapon-usable fissile materials. Yet in the United States the Pentagon is spending $3 billion annually on missile defense, but only $45 million this year to assist Russia in improving the security and control over its fissile materials. To upgrade to Western standards the MPC&A at the 80 to 100 sites in Russian is an enormous undertaking that will require a huge capital investment well beyond the funding levels being contemplated by the U.S. Government.

III. U.S. MPC&A assistance to Russia.

For discussion purposes I break down the MPC&A assistance effort into the following components:

* The Department of Defense's (DOD's) Cooperative Threat Reduction (CTR) program responsible for administering funding provided under the Soviet Threat Reduction Act of 1991 (P.L. 102-228, also known as the "Nunn-Lugar Act"),

and subsequent congressional appropriations. This program is referred to as the "Nunn-Lugar," or "Government-to-Government" effort.

* A program of cooperation among U.S. and Russian nuclear laboratories, administered by the DOE and called the Laboratory-to-Laboratory Nuclear Materials Protection, Control, and Accounting Program. This program is often referred to as the DOE administered "Lab-to-Lab" program.

* Nuclear Regulatory Commission (NRC) cooperation with Gosatomnadzor (GAN) on development of a safeguards infrastructure for Russia.

* International Science and Technology Center (ISTC) administered MPC&A activities funded under Nunn-Lugar, including "Project 40," a GAN led project with Ministry of Atomic Energy (Minatom) cooperation to develop safeguards for plutonium processing at Tomsk-7.

The first two programs, the Gov-to-Gov and Lab-to-Lab efforts, have received the greatest attention and funding. The NRC program is a rather small effort, and the objective of the ISTC program is to provide alternative employment for weapon scientists, not to improve MPC&A.

The Cooperative Threat Reduction Program (Nunn-Lugar) had as its fundamental purpose assistance to (1) **destroy nuclear**, chemical and other **weapons** and (2) transport, store, disable, and **safeguard** weapons in connection with **their destruction**, and (3) **establish verifiable safeguards** against the proliferation of such weapons. Following passage of the Nunn-Lugar, the U.S. Congress has approved $400 million for Nunn-Lugar in the FY 1992, and each of the following three years and expanded its scope. DOD lost $218 million of the original $400 million authorized in FY 1992, due to failure by DOD to obligate the funds in a timely manner. To date Congress has decided not to renew $350 million in unobligated Nunn-Lugar funds, leaving DOD with only $1.25 billion available for obligations through FY 1995 (Table 3). Of this the Pentagon has proposed obligating $1.191 billion, but as of 22 May 1995, it had actually obligated $623 million, and as of 8 May 1995, it had dispersed only $177 million, plus there was an additional $205 million worth of unpaid work that contractors had already performed.

There are two recent good reviews of the Nunn-Lugar program, one by Dunbar Lockwood and the other by the General Accounting Office.[6] Lockwood notes that the Nunn-Lugar program has made important contributions in facilitating the elimination of former Soviet strategic weapons outside of Russia, particularly in the Ukraine; and was instrumental in paving

[6] Dunbar Lockwood, "The Nunn-Lugar Program: No Time To Pull the Plug," *Arms Control Today*, June 1995, pp. 8-13; and U.S. General Accounting Office, "Weapons of Mass Destruction--Reducing the Threat From the Former Soviet Union: An Update,"GAO/NSIAD-95-165, 9 June 1995. Lockwood has just departed the Arms Control Association and now works at the Arms Control and Disarmament Agency.

the way for Kiev's accession to the Non-Proliferation Treaty (NPT).[7] Nunn-Lugar has also contributed considerable equipment to states of the former Soviet Union to accelerate the dismantlement and destruction of strategic nuclear delivery vehicles (SNVD) under START I.[8]

On the other hand, Nunn-Lugar efforts directed toward improving the security of nuclear warheads and weapon-usable fissile materials in the FSU have accomplished very little. In fact, there have been no significant Nunn-Lugar generated improvements in MPC&A at fixed facilities in Russia.

One of the Nunn-Lugar success stories was Project Sapphire, which took place last year. Although paid with Nunn-Lugar funding, Project Saphire was a response to an offer by the Kazakh Republic. United States, in cooperation with the Kazakh Republic, moved 600 kg of HEU (of various enrichments) from the Ulbinsky Metallurgical Plant in Ust-Kamenogorsk, Kazakhstan to the Y-12 Plant at Oak Ridge, Tennessee for safe keeping. This was Soviet naval fuel and scrap which the Kazakh Republic had no interest in retaining. While a marked success, it should be noted that there are an estimated 1,200 tonnes of separated HEU in the FSU, mostly in Russia. Thus, Project Sapphire remedied only 0.05 percent of the problem represented by inadequate physical security and fissile material control.

Following passage of the Nunn-Lugar, exclusive of Operation Sapphire, DOD allocated approximately $226 million for nuclear warhead transport and dismantlement, and fissile material security (Table 4). The status of these Nunn-Lugar efforts is as follows:

A. Warhead Transport and Emergency Response ($55 million):

DOD allocated $5 million for armored blankets to protect warheads, $ 21.5 million for rail car security, and $30 million for emergency response training ($15 million to Russia and $5 million each to Ukraine, Kazakhstan, and Belarus). The Kevlar blankets to protect the warheads in transport from small arms fire were successfully delivered under budget (for $3.3 M) by June 1993, but this was after the tactical warheads had been transported back to Russia from dispersed deployment sites. Likewise, the first U.S.-made rail car modification kits were not shipped until April 1994. By August 1994, 80 percent of the emergency response equipment and training task had been completed. It is interesting to note that DOD allocated more funding to emergency planning than it originally set aside for improving MPC&A at existing facilities. Also, DOD was willing to spend $30 million to show the FSU how to respond to the next nuclear accident, but nothing to assist in the cleanup of the nuclear accidents that had already occurred.

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[7] Lockwood, *Arms Control Today*, June 1995, pp. 8-13.

[8] Ibid.

B. Fissile Material Storage Facilities and Containers ($140 million):

Russia plans to build two fissile material storage facilities, each capable of holding 50,000 containers--an estimated two to five containers are required per warhead--and each built in two 25,000 container phases. The first facility will be sited at Chelyabinsk-65 and the second probably at Tomsk-7.

The United States obligated $16 million to help design the first storage facility. Of this $12.8 million in Nunn-Lugar funds was spent in the United States by the U.S. Army Corp of Engineers to review the Russian design proposals. The remaining $1 million was contributed by DOE (not from Nunn-Lugar funds) to Russia for final engineering drawings.

DOD has agreed to provide an additional $75 million in equipment to help construct the facility. The DOD had spent $27 million of this by 8 May 1995. This included the purchase from U.S. contractors of some $18 million worth of heavy equipment (bulldozers and road graders). There is no shortage of such equipment in Russia. In fact, there is a bulldozer factory in the city of Chelyabinsk a few kilometers from the site. The U.S.-supplied equipment was placed in storage in the United States, awaiting shipment to Russia, and remained there while the storage facility site was cleared.

DOD has included an additional $6 million for design and $75 million for construction of the Chelyabinsk-65 facility in its FY 1996-97 budget estimate. If approved by Congress the total Nunn-Lugar obligation for the facility would increase from $90 million to $171 million.

In addition, DOD has allocated $50 million to U.S. contractors to construct storage containers for Russian plutonium pits and other fissile material. Of this amount the DOD has obligated $45 million and dispersed $10 million. Problems in construction experienced by the U.S. contractor have delayed shipment of containers to Russia.

C. Improving MPC&A at Existing Facilities ($30 million):

The U.S. initially offered to provide $10 million in assistance to demonstrate state-of-the-art MPC&A at two facilities. Russia responded by offering the LEU line at the Elektrostal fuel fabrication plant. The U.S. declined, requesting access to the HEU line at Elektrostal. Russia said this line was used to manufacture naval fuel, and consequently, the U.S. could not be given access to this line (the Russians are not permitted access to U.S. naval fuel facilities). To date $1 million had been spent with no results. Subsequently the U.S. offered to spend $20 million to upgrade the MPC&A at the facility that would be used to blend the 500 t of HEU down into LEU prior to shipment to the U.S. Minatom constructed its own MPC&A at the blending facility and claimed that U.S. assistance was not needed.

After failure to make progress by demonstrating state-of-the art MPC&A at two facilities, the U.S. asked Russia to identify the MPC&A improvements that were most needed. The U.S. would allocate an additional $20 million in assistance to provide "quick fixes." Russia did not respond to the U.S. request to identify the quick fix sites. Funding for all three projects ($30 million less $1 million already spent) has been reprogrammed for a new Gov-to-Gov initiative approved by the Russians to upgrade MPC&A at four major risk sites (Mayak, Obninsk, Elektrostal [breeder line], and Dimitrovgrad). Two other sites, Novosibirsk and Podolsk, have been tabled by the U.S. but not agreed to by the Russians. The U.S.-Russian agreement to upgrade MPC&A at four high risk facilities was reached in December 1994. **To date, there has not been any significant improvement in MPC&A in Russia under the DOD administered Nunn-Lugar program, primarily, for the following reasons.**

Because of the initial success of a DOE initiated Lab-to-Lab cooperative effort (described below), and the failure of the Nunn-Lugar MPC&A effort, management of the Gov-to-Gov program, and the $30 million allocated by DOD under Nunn-Lugar, have been transferred to DOE. The Clinton Administration has decided that in the future the Gov-to-Gov and Lab-to-Lab efforts will be managed by DOE and funded out of the DOE budget, and not by Nunn-Lugar.

IV. U.S. DOE Administered Lab-to-Lab Effort.

In response to the difficulties experienced by Nunn-Lugar and Congressional direction in the Conference Report on the FY 1995 Defense Authorization Act to move ahead on improving fissile material control in Russia[9], the Under Secretary of Energy initiated the Lab-to-Lab MPC&A program. The current objective of this effort is "to make rapid improvements in the protection, control, and accounting of nuclear materials, especially weapon-usable materials (separated plutonium and highly enriched uranium), by working directly and cooperatively with Russian laboratories and institutes. Implementation at operating nuclear facilities in Russia, many of which are highly sensitive and inaccessible to foreigners, are to be carried out by the Russian laboratories, with technical cooperation from U.S. laboratories."[10]

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[9] In April 19, 1994 testimony before the Military Application of Nuclear Material Panel of the House Armed Services Committee, NRDC cited the failure of the Nunn-Lugar effort with regard to improving physical security and MC&A in Russia, and the need for a joint lab-to-lab R&D effort related to the verification of the nuclear warhead dismantlement process. We recommended, among other proposals, that DOE (as opposed to DOD) be given primary responsibility for policy development and implementation of safeguards over warhead dismantlement and fissile material control--areas of responsibility that traditionally have been the purview of DOE and Minatom. We also recommended that Congress provide DOE with $100 M to conduct a much expanded and accelerated effort to implement its international fissile material control responsibilities.

[10] "Integrated Action Plan for the US-Russian Laboratory-to-Laboratory Program on Nuclear Materials Protection, Control, and Accounting," Revision 1, Prepared by the Multi-Laboratory Steering Group, September 30, 1994.

Under this DOE administered program, U.S. national laboratories are currently working with the two Russian weapon labs (Arzamas-16 and Chelyabinsk-70), the Kurchatov and Eleron Institutes in Moscow, and the Institute of Physics and Power Engineering (IPE) in Obninsk, along with three other Russian institutes that provide a small amount of technical support.

In contrast to the DOD-administered Nunn-Lugar effort, the DOE Lab-to-Lab effort quickly began to show results. Starting from scratch in mid-April 1994, the Lab-to-Lab cooperative effort was already installing MPC&A improvements at the Kurchatov Institute by November-December. This was followed by the initiation of an Arzamas-16 proposal permitting the cooperative program to expand to other facilities. The U.S. and Russian scientists have begun integrating their different MPC&A systems at a demonstration facility to certify equipment for implementation ''throughout the Russian nuclear weapons complex.'' In addition, U.S. labs have recently shipped a portal monitoring system to Chelyabinsk-70 and an MPC&A system is being designed for the Russian weapon complex there. MPC&A equipment is also being installed at the civil reactor research site at Obninsk.[11]

Through FY 1995 the U.S. Government will spend just under $48 million on MPC&A in Russia--$45 million in FY 1995 (Table 5). DOE has requested $70 million for cooperative MPC&A in FY 1996. Scientists at Sandia are already complaining privately that good Russian proposals are not being accepted because of limitations on funding. Thus, the rate of progress in Russia is already budget-limited.

Despite showing remarkable progress to date, the DOE administered Lab-to-Lab effort will not succeed unless there are significant changes made in the scope of its mission and the level of funding. The funding level must be increased if the MPC&A is to be brought up to Western standards at all 80 to 100 sites in Russia where weapon-usable material is thought to be used or stored. Moreover, as presently defined, the mission has no ultimate goal, and no quantitative means of measuring progress or success. This will result in the program becoming budget-limited. The available budget will define what can be accomplished, instead of the objective defining the budget.

The mission must be changed in order to make the program comprehensive and effective. This will require access by Western experts to the more sensitive Russian facilities on a reciprocal basis. To appreciate this difficulty, it is useful to recall that shortly after the passage of Nunn-Lugar, Minatom Minister Mikhailov was attacked by Russian hard-liners for giving the Americans access to Russia's defense secrets. They were referring to conditions contained in the Act and in the subsequent U.S.-Russian framework agreement, which states that the United States ''shall have the right to examine the use of any material, training, or other services'' that it might provide under the Nunn-Lugar assistance program. In December 1992, Minister Mikhailov publicly defended himself by noting that the Nunn-Lugar provisions provided no real

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[11] Lockwood, *Arms Control Today*, June 1995, pp. 8-13.

access to, or information on, Russia's nuclear weapon activities.[12] Ever since, Mikhailov has had to make sure the cooperative effort carried no national security disadvantage to Russia.

Consequently, to gain access to sensitive Russian nuclear weapon facilities, the cooperative MPC&A program must be viewed by Russia as completely reciprocal both in its mission and its implementation.

V. Proposed New Direction.

I believe these major deficiencies in the cooperative MPC&A effort can only be overcome by revising the mission of the Lab-to-Lab program to have the weapon laboratories of the two countries jointly research, develop, and demonstrate, on a bilateral basis, a monitoring and safeguards regime that covers *all nuclear weapons and weapon-usable fissile materials* in the weapon states. Only then will the parties be forced to address methods for adequately safeguarding the most sensitive facilities and materials in both countries. This RD&D effort could be done without making a political commitment to adopt the bilateral, or multilateral, safeguards program once demonstrated. Do the RD&D first; then have the political debate over whether the program should take on treaty status.

The following are a few observations concerning this proposed expanded mission:

a) This expanded mission should have complete reciprocity. U.S. and Russian specialists would have equal access to each other's facilities.

b) The directive for this expanded mission should come from the two presidents in order to give needed political cover to Russian ministry and institute officials, and to obtain the cooperation of the U.S. Navy.

c) By covering *all weapon-usable fissile materials and nuclear weapons*, special interests, e.g., Minatom, and the U.S. Navy, cannot exclude coverage on the basis that their materials or facilities are too sensitive.

d) Given the substantial nuclear proliferation risks today, building toward a comprehensive non-discriminatory safeguards regime that covers the weapon states should be a high priority in its own right. As shown in Figures 1 and 2 most of the weapon-usable materials in the world are not covered by any international safeguards. The recent weapon-usable material thefts occurred in a weapon-state (Russia), not facilities now under IAEA safeguards.

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[12] Christopher E. Paine and Thomas B. Cochran, "Strengthening International Controls on the Military Applications of Nuclear Technology," in *Controlling the Atom in the 21st Century*, edited by David P. O'Very, Christopher E. Paine, and Dan W. Reicher, (Boulder: Westview Press, 1994), p. 45.

e) RD&D on safeguards applicable to the weapon states should begin initially on a bilateral basis with Russia in order to move more quickly to improve MPC&A in Russia, and because the Russians do not want the IAEA at their weapon facilities at this time.

f) If we are to achieve deep reductions in the global nuclear weapon arsenals, a safeguards regime covering the weapon states is essential (Figure 3). We should initiate the RD&D for such a regime now. To convince other weapon states to reduce their own arsenals significantly, they must be convinced that weapons retired under current and future arms agreements have been dismantled and all weapon-usable materials are accounted for. If we fail to implement today a comprehensive verification regime over the nuclear stockpile reduction process and fissile material inventories in the U.S. and Russia, this failure may constrain in the future how far we can go in reducing global arsenals and ending further proliferation of nuclear weapons.

Table 1. Sites in Russia Likely to Have Weapon-Usable Fissile Material.

Weapon Laboratories:
1. Institute of Experimental Physics (VNIIEF, Arzamas-16)
2. Institute of Theoretical Physics (Chelyabinsk-70)

Warhead Production Facilities:
3. Sverdlovsk-45
4. Zlatoust-36
   Penza-19 (probably no Pu or HEU)
   Arzamas-16 (counted above)

Plutonium Production Sites:
5. Chelyabinsk-65
6. Tomsk-7
7. Krasnoyarsk-26

Uranium Enrichment Plants:
8. Sverdlovsk-44
   Tomsk-7 (counted above)
   Krasnoyarsk-26 (LEU only?)
   Angarsk (LEU only)

Research on Pu Fuels:
9. Bochvar Institute of In-organic Materials (VNIINM, Moscow)
10. Institute of Power Engineering (IFE, Minatom, Obninsk)
11. Institute of Nuclear Reactors (NIIAR, Minatom, Dimitrovgrad)
12. Khoplin Radium Institute (Minatom, St. Petersburg)
    Chelyabinsk-65 (Mayak) (counted above)

Fuel Fabrication Facilities:
    Ulbinsky Metallurgical Plant (Ust-Kamenogorsk, Kazakhstan) (now LEU only)
13. State Scientific Production Enterprize Politekh (Elektrostal)
    Machine-Building Factory (Elektrostal, near Moscow) (LEU)
14. Factory of Chemical Concentrates (NZKhK, Novisibirsk)
    Chepetsk Mechanical Plant (ChMZ, Glazov) (LEU)

Research Reactors, Critical and Subcritical Assemblies:
15. Kurcahtov Institute (Moscow)
    Institute of Power Engineering (IFE, Minatom, Obninsk) (counted above)
    Institute of Nuclear Reactors (NIIAR, Minatom, Dimitrovgrad) (counted above)
16. Institute of Power Engineering (Zarechny, Yekaterinburg)
17. NIIP (Minatom, Moscow) ?
18. Machine-Building Factory (Elektrostal, near Moscow)
19. Experimental Design Bureau for Machine Building (OKBM, Nizhny Novgorod)
20. Institute of Theoretical and Exp. Physics (ITEF, Minatom, Moscow)

21. Institute of Chemical Technologies (VNIIKhT, Minatom, Moscow)
22. Gidropress (Minatom, Moscow)
    Arzamas-16 (counted above)
23. Institute of Nuclear Physics (Ministry of Science, Tomsk)
24. Moscow Power Institute (Ministry of Science, Moscow)
25. Institute of Physics and Engineering (MIFI, Ministry of Science, Moscow)
26. Machinstitute (Ministry of Science) ?
27. Krylov Institute, Roscomkhimnefteprom (St. Petersburg)
28. Physical-Chemical Institute, Roscomkhimnefteprom (NIFKhI, Obninsk)
29. Centrgeologia, Roscomnedra (Belgorod)
30. Medical-Biological Institute, Minzdrav (Moscow) Petersburg
31. Institute of Nuclear Physics, Rosacademnauki (Gatchina)
32. Joint Research Institute (Dubna)

Marine Reactor bases:
Northern Fleet:
33. Andreva Guba
34. Malaya Lopatka Guba
35. Bolshaya Guba
36. Zapadnaya Complex
37. Nerpichya Guba
38. Ara Guba
39. Sayda Guba
40. Yagelnaya Guba
41. Olenya Guba
42. Pala Guba
43. Polyamy
44. Atomflot
45. Rosta
46. Gremikha (aka Ostrovnoy and Yokanga)
47. Severodvinsk
48. ''Baltic Plant'' Admirality Production Association (St. Petersburg)
49. Production Association ''Krasnoe Sormovo'' (Nizhniy Novgorod)
Pacific Fleet:
50. Zavety Ilyicha
51. Ladmir Bay
52. Chazma Bay
53. Pavlovsk (large naval base)
54. Abrek Bay
55. Bolshoi Kamen
56. Installation 927-III
57. Gomyak
58. Rybachi

Table 2. Diversions of Significant Quantities of Weapon-Usable Fissile Material from Institutes in Russia.

Oct. 1992:	an employee of the Luch Production Association, which manufactures nuclear space reactors, in Podolsk was apprehended at the Podolsk train station with 1.5 kilograms of HEU in his suitcase.
May 1993:	27 crates containing 4 tonnes (t) of beryllium (Be) metal and a small quantity of HEU were discovered in a bank vault in Vilnius, Lithuania. The DOE claims there were 2 kg of U-235 mechanically implanted in the beryllium. The Lithuanian Nuclear Power Authority (VATESI) claims there were 3860 kg of pure Be and 140 kg of a Be alloy containing 150 g of uranium enriched to 50 percent. The CIA account is consistent with that of claim of VATESI, and differs from DOE's. Apparently, the beryllium was intercepted as it was being shipped from the Minatom Institute of Physics and Power Engineering (IPE) in Obninsk, by a company called AMI (two mobsters) in Zarechny, Sverdlovsk region (Yekaterinburg), to an organized crime group in Lithuania.
Feb. 9, 1994:	3 kg (90% U-235) HEU stolen from the Elektrostal plant near Moscow. A St. Petersburg butcher was apprehended in an attempt to sell it.
Aug. 10, 1994:	German authorities intercepted 0.5 kg of material in a suitcase at the Munich airport after arrival by plane from Moscow. Of this, 0.3-0.35 kg were Pu-239 (87.5% Pu-239). The Pu was a peculiar mixture of oxide powders similar to mixed-oxide (MOX) fuel. The suspected couriers, two Spaniards and a Columbian were arrested. Also in 1994 (on May 10, June 13, and August 14) German authorities intercepted smaller samples of plutonium and HEU.
Dec. 14, 1994;	2.7 kg of HEU (87.7% U-235) were seized by Czech authorities in Prague.

Table 3. Annual Nunn-Lugar Funding Levels.

FY 1992	$ 182 M
FY 1993	288 M
FY 1994	400 M
FY 1995	380 M
Total	$1,250 M

Table 4. Allocation of Nunn-Lugar Funds for Fissile Material and Nuclear Warhead Security.

A. Warhead Transport and Emergency Response:

1)	$ 5 M	for delivery of 2,500 Kevlar armored blankets;
2)	$ 20 M	to improve the security of rail cars for nuclear weapons transport;
3)	$ 30 M	for emergency response equipment and training
Subtotal	$ 55 M	

B. Fissile Material Storage:

1)	$ 15 M	for the design, and
	$ 75 M	for the construction, of one or two fissile material storage facilities in Russia;
2)	$ 50 M	worth of fissile material storage containers;
Subtotal	$140 M	

C. Improvement in MPC&A at Existing Facilities

1)	$ 10 M	to assist Russia in improving MPC&A (originally for improvements at Elektrostal);
2)	$ 10 M	for MC&A associated with blending HEU to LEU for sale to the U.S.; and
3)	$ 10 M	for MPC&A quick fixes at selected facilities
Subtotal	$ 30 M	
Total:	$210 M	

Table 5. Annual U.S. Funding Levels for the Government-to-Government and Lab-to-Lab MPC&A Efforts for Existing Facilities in Russia.

	Gov-to-Gov	Lab-to-Lab	Total
FY-1994	$ 1 M	$ 2 M	$ 3 M
FY-1995	$29 M	$15 M	$45 M
FY-1996 (proposed by DOE)	$30 M	$40 M	$70 M
Total	$60 M	$57 M	

FIGURE 1. CURRENT SAFEGUARDS

	WEAPON STATES		NON-WEAPON STATES
	DECLARED	UNDECLARED	
MILITARY:			
Warheads:			
Operational			
Reserve			
Retired			
Fissile Material:			
In Warheads			
Reserved for Warheads			
Declared Excess			
Facilities:			
Weapon Production			
Material Production			
Excess Material Storage			
NAVAL FUEL CYCLE:			
Facilities			
Fuel			
CIVIL NUCLEAR:			
Reactors		IAEA	IAEA
Fuel Cycle Facilities		IAEA	IAEA
HEU/Pu		IAEA	IAEA
LEU		IAEA	IAEA
Spent Fuel		IAEA	IAEA

FIGURE 2. FISSILE CUTOFF FOR WEAPONS AND EXCESS STOCKS UNDER IAEA SAFEGUARDS

	WEAPON STATES		NON-WEAPON STATES
	DECLARED	UNDECLARED	
MILITARY:			
Warheads:			
Operational			
Reserve			
Retired			
Fissile Material:			
In Warheads			
Reserved for Warheads			
Declared Excess	IAEA		
Facilities:			
Weapon Production			
Material Production	IAEA	IAEA	
Excess Material Storage	IAEA		
NAVAL FUEL CYCLE:			
Facilities			
Fuel			
CIVIL NUCLEAR:			
Reactors		IAEA	IAEA
Fuel Cycle Facilities	IAEA	IAEA	IAEA
HEU/Pu	IAEA	IAEA	IAEA
LEU		IAEA	IAEA
Spent Fuel		IAEA	IAEA

FIGURE 3. A COMPRESENSIVE SAFEGUARDS REGIME FOR THE 21ST CENTURY

	WEAPON STATES		NON-WEAPON STATES
	DECLARED	UNDECLARED	
MILITARY:			
Warheads:			
Operational	MONITORED		
Reserve	MONITORED		
Retired	MONITORED		
Fissile Material:			
In Warheads	MONITORED		
Reserved for Warheads	MONITORED		
Declared Excess	IAEA	IAEA	
Facilities:			
Weapon Production	MONITORED		
Material Production	IAEA	IAEA	
Excess Material Storage	IAEA		
NAVAL FUEL CYCLE:			
Facilities	MONITORED	MONITORED	MONITORED
Fuel	MONITORED	MONITORED	MONITORED
CIVIL NUCLEAR:			
Reactors	IAEA	IAEA	IAEA
Fuel Cycle Facilities	IAEA	IAEA	IAEA
HEU/Pu	IAEA	IAEA	IAEA
LEU	IAEA	IAEA	IAEA
Spent Fuel	IAEA	IAEA	IAEA