THE POTENTIAL THREAT DUE TO INADEQUATE CONTROL OVER FISSILE MATERIAL IN RUSSIA

TESTIMONY

OF

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BEFORE THE

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OF THE

SENATE COMMITTEE ON FOREIGN RELATIONS

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I. Introduction.

Mr. Chairman, my name is Thomas B. Cochran. I am a physicist and director of the Nuclear Program of the Natural Resources Defense Council (NRDC). NRDC has been engaged since 1986 in a series of joint demonstration projects and site visits and studies related to the verification of a nuclear test ban, verification of nuclear warhead disposition, and fissile material control. We have worked with various institutions in the Soviet Union and Russia, including the Soviet/Russian Academy of Sciences, Foreign Ministry and Ministry of Atomic Energy. NRDC has just completed a book, *Making the Russian Bomb, From Stalin to Yeltsin*,[1] that provides a detailed account of the Russian nuclear weapons program, its facilities, and its production history.

I welcome this opportunity to present NRDC's views with regard to the threat represented by the inadequate physical security and material control and accounting over weapon-usable materials in Russia. Mr. Chairman, first I want to thank you and Senator Nunn for your personal efforts and leadership in securing funds to permit the U.S. Government to assist republics of the former Soviet Union in improving the control over these materials. This is one of the most important national security initiatives of the United States. I understand that you and Senator Nunn plan to hold additional hearings where you will be addressing new policy initiatives that could improve the Administration's program to assist Russia and other republics of the former Soviet Union in improving their control over these weapon-usable materials; therefore, my testimony today will focus on defining the threat.

II. The Russian Stockpile of Nuclear Weapons and Fissile Materials.

We estimate that Russia, during the Soviet era, produced about 170 metric tons (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 highly-enriched uranium (HEU) stockpile, including what is in weapons, is believed to be on the order of 1200 t. The Russian nuclear weapon production complex closely parallels that of the United States. Therefore, it is reasonable to assume that about 35-50 t of weapon-grade plutonium is "pipeline" material, in the form of solutions, scrap, and residues, and the remaining 120-135 t is in finished weapon components, i.e., pits in weapons or removed from weapons and now in storage. We do not have accurate estimates with respect to the Russian HEU stockpile, but it would not be unreasonable to assume that several hundred tons are in excess of what is in weapon components. As you know, the United States has agreed to purchase 500 t of HEU, which will be blended into LEU, and it is reasonable to assume that Russia will retain a stockpile comparable to that of the United States.

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

The Soviet nuclear warhead stockpile is believed to have peaked at about 45,000 warheads in 1986[2] and has probably been reduced to about 25,000 warheads today. We estimate that approximately one-half of the 25,000 warheads are 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. Today upwards of 60 t of plutonium is probably still in weapons, and perhaps as much as 75 t is stored as intact weapon pits. These are just ball park figures.

The principal nuclear weapon research, test and production facilities in Russia are listed in Table 1. In addition to these, there are numerous other sites associated with production and use of weapon-usable naval, space, and civil reactor fuel. Many of the weapon and civil nuclear sites are large multi-purpose complexes. For example, Mayak (Chelyabinsk-65) has currently operating two HEU-fueled tritium production reactors, two chemical separation plants, several pilot plutonium fuel fabrication facilities, a pit manufacturing complex similar to our Rocky Flats Plant, and one or more plutonium storage facilities. Tomsk-7 has two operating plutonium production reactors, a chemical separation plant, pit manufacturing, and a uranium enrichment plant. In all there are an estimated 80 to 100 facilities supporting nuclear weapon production, naval fuel production, and civil nuclear fuel research and development that store or use significant quantities of weapon-usable fissile material, primarily plutonium and HEU.

In addition, there are numerous nuclear weapon storage depots under the control of the Ministry of Defense. According to the CIA, weapon storage sites have been consolidated from over 600 throughout the former U.S.S.R. in 1989, to approximately 100 as of January 1995.[3] All, or nearly all, of these remaining storage sites are in Russia.

Other than the warhead storage sites, most if not all of these facilities have inadequate physical security and material control and accounting when judged against U.S. regulatory requirements. U.S. government officials and support contractors who have visited some of these facilities can give you hair raising accounts of the lack of adequate physical security at some of these places. Given the lack of security it is not surprising that kilogram quantities of weapon-usable fissile materials have already been stolen.

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

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.[4] The CIA

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[2] *Making the Russian Bomb: From Stalin to Yeltsin*, p. 31.

[3] 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.

[4] U.S. Department of Energy, Office of Intelligence and National Security, Office of Threat Assessment, "The Russian Mafia," 15 November 1993, pp. 2-3.

estimates that there are 200 large, sophisticated criminal organizations that conduct extensive criminal operations throughout Russia and around the world.[5] 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 Department of Energy (DOE) report.[6] 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.[7]

Reports of illegal activities in Russia associated with nuclear materials--offers to sell as well as successful and unsuccessful attempts to steal nuclear materials--have appeared with high frequency in the Russian and European press. Low-enriched uranium fuel has been stolen. On 24 February 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, at least 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 involving 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 have been stolen from institutes in Russia since the breakup of the Soviet Union.

2) Some fraction of these materials was not intercepted before leaving the Russian borders.

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.

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

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

[7] "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.

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.

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 acquired a sophisticated laboratory and 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.

The cases that involve the largest quantities of weapon-usable materials, i.e., 1.5 to 3 kg of HEU, appear to be the work of one, or at most a few, individuals with access to the material but lacking the knowledge or contacts to successfully market it. The case that gives me the greatest concern is the interception in Vilnius, Lithuania in 1993 of four tonnes of beryllium that were diverted from a nuclear research institute at Obninsk in Russia. There is some ambiguity regarding the amount of HEU that was included with the beryllium.

The significance of the Vilnius case is not the amount of weapon-usable fissile material that was involved; rather it is that it had all the elements associated with the most worrisome scenario that potentially could involve the successful diversion of very large quantities of fissile material from Russia to the Middle East. Involved in this single case were a) at least one senior regional Russian government official, b) a senior official of a nuclear institute where tonne quantities of weapon-usable fissile materials are stored under inadequate physical security, c) an organization believed to be linked to the KGB and organized crime (mob) groups in Russia and Lithuania, and d) very likely an arms merchant with a history of dealings with Middle East states and terrorist organizations.

One other aspect of the Vilnius case is noteworthy. This case involved the shipment of four tonnes (2 cubic meters) of beryllium metal in 33 shipping crates. Each shipping crate was about 0.13 cubic meters (about five cubic feet) in volume. It would be very easy to hide a few kilograms of plutonium or HEU in such a shipment. Much larger shipments of metals are routinely exported from Russia legally. The Vilnius case demonstrates how easy it would be to divert enough plutonium or HEU for an arsenal of several nuclear weapons by hiding the fissile material among several tons of metal shipped in the course of a normal commercial transaction.

I believe we should be more concerned regarding diversion scenarios where the recipient is a rogue state, rather than diversions to individuals or terrorist organizations that do not have state support. As demonstrated by the program in Iraq, a state can provide the financial and technical support needed to develop sophisticated nuclear weapons. It is generally agreed by all experts within the arms control community that the pacing item in terms of a state's ability to obtain nuclear weapons is the acquisition of the fissile material. Purchasing the fissile material illicitly would reduce by years the time needed to acquire nuclear weapons. There would be little, if any, time available to bring diplomatic pressure, as in the case of North Korea, or for military intervention, as in the case of Iraq, if a rogue state secretly acquired kilogram quantities of fissile material from Russia by illicit means.

IV. How Significant are the Quantities of Weapon-Usable Materials Intercepted to Date?

There is considerable misinformation regarding the amount of fissile material needed to make a nuclear weapon. There is no precise value. The actual amount required depends strongly on the desired yield and the sophistication of the design.[8] This is demonstrated in Figures 1 and 2, which provide my very rough estimates of the yield of a pure fission single stage weapon versus the amount of weapon-grade plutonium (Figure 1) and HEU (Figure 2), for three levels of technical sophistication. The so-called low technology curve in each figure is meant to represent 1945 technology--the technology of the *Fat Man* bomb dropped on Nagasaki. The high technology curve in each figure is believed to be within the capability of the United States and Russia today. The three tests of Operation *Sandstone*, conducted by the United States in 1948, explored a technique for achieving higher yields than were obtained with the *Fat Man* design; and at least four of the five tests in Operation *Ranger*, conducted in 1951, explored the use of much smaller quantities of fissile material than used in the *Fat Man* design. These tests--1950s technology--fall somewhere between the high and low technology curves in Figures 1 and 2. The medium technology curves in the two figures can be considered as very rough approximations of this U.S. capability in the late-1940s and early 1950s.

The Medium Technology curves in Figures 1 and 2 are certainly within the capability of several Middle East states for a first weapon. Experts in these countries have the benefit of nuclear data and weapon related design information published during the past 50 years, high speed desk top computers, and sophisticated generic and nuclear related software.

Two of the significant cases of Russian nuclear materials diversion since 1992 (identified in Table 2) each involve the theft of about 3 kg of weapon-grade HEU. From Figure 2, we see that three to five kilograms of HEU is sufficient to construct a nuclear device with a yield on the order of one kiloton of TNT equivalent using technology that was available to the United States in the early 1950s. One of the two 1 kiloton shots during the 1951 *Ranger* test series may have used an amount of HEU in this range. With a similar amount of plutonium, or if two or three

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[8] The mass of fissile material used will also depend other factors, such as how much high explosive is used to compress the fissile material. For a given basic design, one can reduce the fissile material required to achieve a given yield (or alternatively increase the yield for a given amount of fissile material) by increasing the amount of chemical high explosive. But since overall weight, yield-to-weight and yield-to-volume are important design considerations, pure fission weapons in the arsenals of the weapon states will, more likely than not, contain more than the minimum fissile material needed to obtain a given yield.

times as much HEU were available, a state could fabricate a weapon with a yield exceeding 10 kilotons based on the same 1950s technology.

We are all familiar with the destructive power of the Hiroshima and Nagasaki weapons; but as shown in Table 3, even a one kiloton nuclear device is a formidable weapon. Several types of tactical nuclear warheads that were until recently in the U.S. stockpile had yields in this range. The Oklahoma bomb had an estimated weight of about 2.4 to 5 tons.[9] Thus, a one kiloton nuclear device would be about 200-400 times more powerful, and have a destructive potential about 34-54 times greater.[10]

V. Conclusion.

There are currently several hundred tons of weapon-usable fissile material under inadequate physical security and material control in Russia. Kilogram quantities of weapon-usable fissile materials have been stolen from institutes in Russia since the breakup of the Soviet Union. Some fraction of these materials was not intercepted before leaving the Russian borders. The quantities that have already been stolen (and fortunately intercepted) are sufficient to make small nuclear weapons. Bases on one unsuccessful attempt, it is reasonable to conclude that sufficient fissile material can be diverted from Russian stockpiles--with a high probability of success--to provide a sub-national group with one or two nuclear weapons, or even a rogue state with a sizable arsenal.

[9] The lower limit assumes the Oklahoma bomb was made by mixing fertilizer with diesel fuel. The upper limit assumes it was made using a high grade auto racing fuel.

[10] Here we assume the destructive area scales as the two-thirds power of the yield.

Table 1
Principal Nuclear Weapon Research, Test and Production Facilities

DESIGN LABORATORIES

All-Russian Scientific Research Institute of Experimental Physics (2VNIIEF)
Arzamas-16 (*Kremlev*) 55° 23'N 43° 50'E
at Sarova, Nizhni Novgorod Oblast

All-Russian Scientific Research Institute of Technical Physics (VNIITF)
Chelyabinsk-70 (*Snezhinsk*) 56° 05'N 60° 44'E
20 km north of Kasli, Urals region

TEST SITES

Central Test Site
Novaya Zemlya
Northern and Southern Test Areas
two islands north of the Arctic Circle

Semipalatinsk (or Kazakh) Test Site (permanently closed in 1991)
Semipalatinsk-21
Shagan River, Degelen Mountain, and Konyastan test areas
south of Semipalatinsk, Kazakhstan

WARHEAD PRODUCTION (ASSEMBLY) FACILITIES

Final Assembly
Sverdlovsk-45 (*Lesnoy*) 58° 40'N 59° 48'E
at Nizhnyaya Tura, 200 km north of Yekaterinburg, Urals region

Zlatoust-36 (*Trekhgornyy*) 54° 42'N 58° 25'E
at Yuryuzan, 85 km southeast of Zlatoust, Urals region

Arzamas-16 (*Kremlev*) Avangard see above
at Sarova, Nizhniy Novgorod Oblast

Components
Penza-19 (*Zarechnyy*) 53° 08'N 46° 35'E
at Kuznetsk, 115 km east of Penza

PLUTONIUM AND TRITIUM PRODUCTION REACTORS

Mayak Chemical Combine
Chelyabinsk-65 (formerly **Chelyabinsk-40**) (*Ozersk*) 55° 44'N 60° 54'E
at Lake Kyzyltash, near Kasli and Kyshtym, Chelyabinsk Oblast, Urals region

Siberian Chemical Combine (SKhK)
Tomsk-7 (*Seversk*) 56° 37'N 84° 47'E
on the Tom River 15 km northwest of Tomsk in Siberia

Mining-Chemical Combine (GKhK)
Krasnoyarsk-26 (*Zheleznogorsk*) 56° 20'N 93° 36'E
on the Yenisey River 10 km north of Dodonovo near Krasnoyarsk in Siberia

URANIUM ENRICHMENT FACILITIES

Ural Electrochemical Combine (UEKhK)
Sverdlovsk-44 (*Novouralsk*) 57° 15'N 59° 48'E
near Verkh-Neyvinsk, near Yekaterinburg, Urals region

Siberian Chemical Combine
Tomsk-7 (*Seversk*) see above
on the Tom River 15 km northwest of Tomsk in Siberia

Electrochemistry Combine
Krasnoyarsk-45 (*Zelenogorsk*) 56° 08'N 94° 29'E
on the Kan River between Krasnoyarsk and Kansk, Siberia

Electrolyzing Chemical Combine (AEKhK) 52° 31'N 103° 55'E
at Angarsk, 30 km northwest of Irkutsk in Siberia

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:	33 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 Lithuanian Nuclear Power Authority (VATESI) claims there were 3,860 kg of pure Be and 140 kg of a Be alloy containing 150 g of uranium enriched to 50 percent. 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. Effects of a One Kiloton Fission Weapon Detonation.

Underground Detonation

Depth of Burial (ft)	Crater Dimensions Depth (ft)	Diameter (ft)
surface	17-30	90-160[11]
67	96	290[12]
120	90-110	300-400[13]

Surface Detonation

Over Pressure (psi)	Distance[14] (ft)	Effects
30	590	675 mph winds
20	690	Almost all structures destroyed except exteriors of some steel reinforced concrete buildings--500 mph wind.
7	1,250	Complete destruction of all brick buildings two stories or higher; moderate damage to reinforced concrete buildings--220 mph wind.
4	1,740	Collapse of all wooden buildings--135 mph wind
2	2,790	Moderate damage to houses (wooden building usable only after repair--70 mph wind.
Radiation Dose[15] (rads)		
8,000	600-800	Immediate incapacitation followed by death
650	900-1,300	50% of the exposed (unshielded) people die within 60 days despite heroic medicine

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[11] Samuel Glasstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, U.S. DOD and ERDA, Third Edition, pp. 255-256. Shot *Sugar*, a 1.2 kt surface explosion, produced a crater 17 ft deep and 90 ft in diameter.

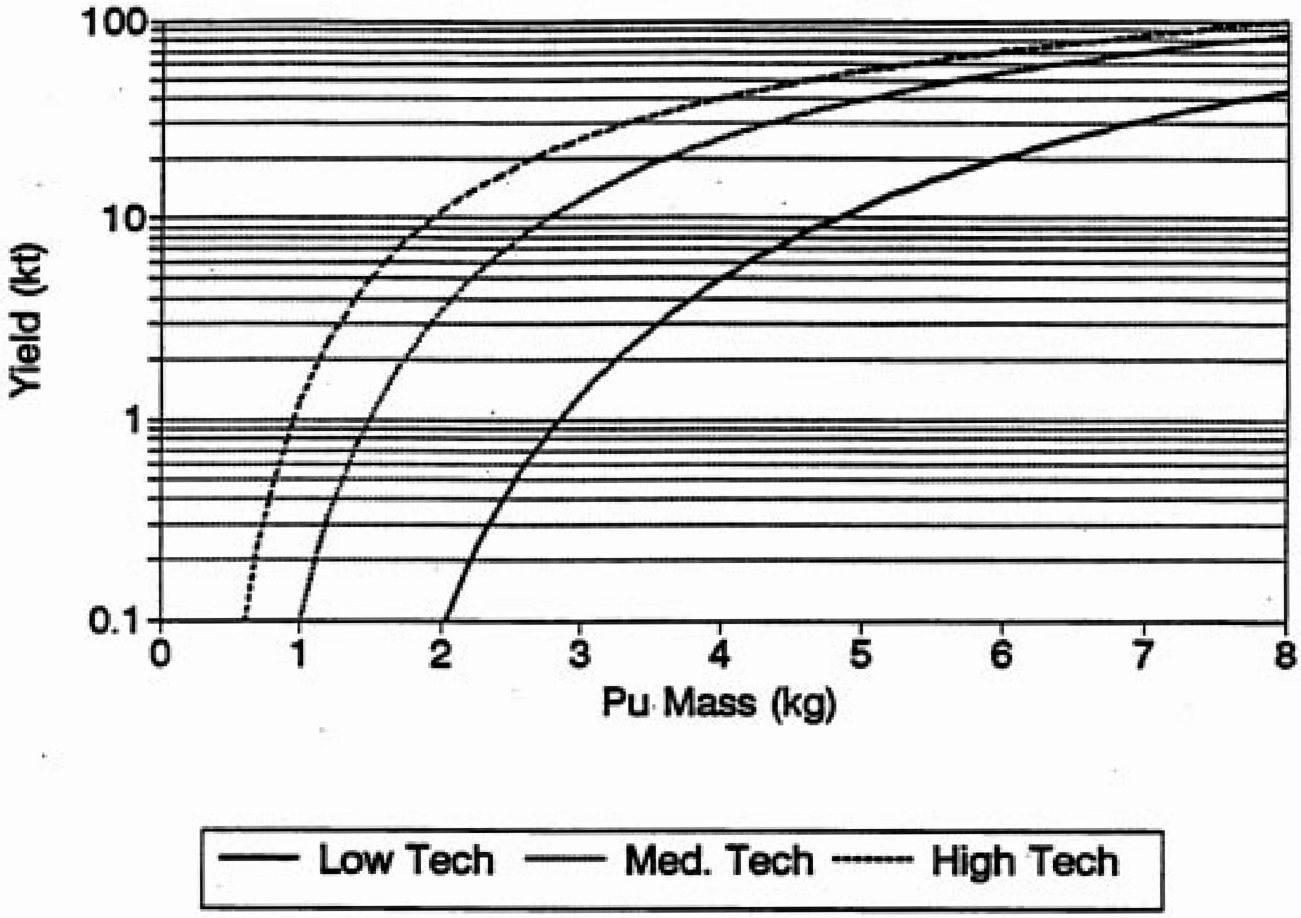
[12] Shot Ess, Nevada Test Site, 23 March 1955.

[13] *The Effects of Nuclear Weapons*, Third Edition, pp. 255-256.

[14] Ibid., pp. 113 and 115; and Department of the Army, *Nuclear Weapons Employment*, Pamphlet No. 39-1, p. 42.

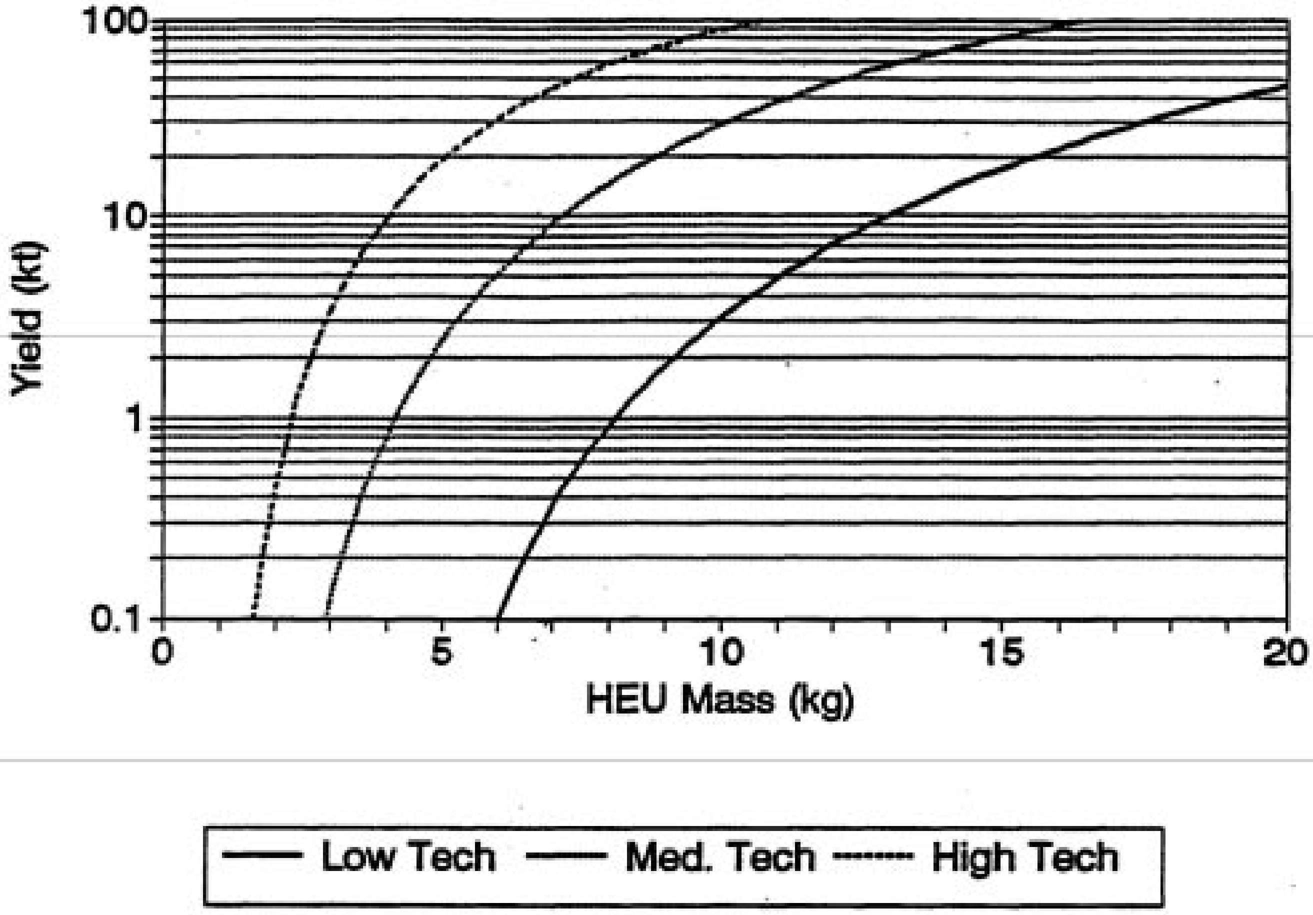
[15] *The Effects of Nuclear Weapons*, Third Edition, pp. 369 and 371. These neutron doses are for a contact surface burst; the doses for an air burst would be twice the values given here.

Figure 1[1]
Yield vs. Pu Mass
(as a function of technical capability)



[1] T.B. Cochran and C.E. Paine, "The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons," *Nuclear Weapons Databook* monograph series, Natural Resources Defense Council, Washington, D.C., 13 April 1995.

Figure 2[1]
Yield vs. HEU Mass
(as a function of technical capability)



[1] T.B. Cochran and C.E. Paine, "The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons," *Nuclear Weapons Databook* monograph series, Natural Resources Defense Council, Washington, D.C., 13 April 1995.