# Protection Against
# Weapons of Mass Destruction (WMD)

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**Sessions:** Tuesdays, 1:00-4:00 PM
Room 11, Robertson Hall
Draft: 1/29/04

This course surveys and assesses the threats and the different approaches to protection against WMD. It provides essential technical, historical and organizational background for students interested in getting involved in WMD policy.

**Schedule**

D=Draft PM
F= Final PM Unit/Topic (guest lecturer)

Feb. 3 1. History of the different approaches to protection against WMD
Discuss proposed paper with one of us during second week

Feb. 10 2. 2. Nuclear proliferation, Atoms for Peace, export controls & the NPT (Ellsberg)

The Weapons

Feb. 17, D1 3. 3. Nuclear weapons

Feb. 24 4. 4. Biological weapons

Defenses

Mar. 2, F1 5. 5. Defense against biological weapons

Mar. 9, D2 6. 6. Deterrence and/or preemption
break

Mar. 23 7. 7. Missile proliferation and defense

Diplomacy

Mar. 30, F2 8. 8. Multilateral arms control: CTBT and the Fissile Cutoff, export controls
Submit draft papers and begin presentations

Apr. 6 9. 9. Dealing with the legacy of the Cold War: arms reduction agreement

Apr. 13 110. The future of U.S. nonproliferation policy (discussion/Perkovich)

Apr. 20 11. Cooperative threat reduction (Bukharin, Luongo, Weiner)

Apr. 27 112. The goal of WMD policy: abolition or not? (discussion, visitor?)
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Nuclear and biological weapons represent the only large-scale threats to U.S. security. Chemical weapons are often described as WMD. However, they fall in a lesser range of threats shared by attacks on chemical and nuclear-power plants, dispersal of radioactivity (dirty bombs) and aircraft crashes into buildings and are not a major focus of this course.

Since September 11, 2001 attacks and the fall-2001 anthrax letters, the world, especially the U.S., has become preoccupied with the dangers of acquisition and use of nuclear or biological weapons by terrorist groups.

In his January 2002 State of the Union speech, President Bush threatened preemptive attacks against hostile states with WMD programs - naming Iran, Iraq and North Korea in particular, and actually carried out the threat in the case of Iraq. The international community has successfully pressed Iran and Libya to reveal their nuclear programs and to agree to the "Additional Protocol" to the Nonproliferation Treaty, which allows the International Atomic Energy Agency to carry out intrusive inspections. A shipment of centrifuge components to Libya was intercepted on the high seas. However, North Korea

re-started its nuclear-weapons program, while expressing a willingness to scrap it if it receives assurances against attack and economic assistance.

The greatest threat, however, may still be from the Cold War arsenals. Fifteen years after the end of the Cold War, Russia and the U.S. keep missiles carrying thousands of thermonuclear warheads on alert ready to launch at each other within 15 minutes. Furthermore, many thousands of surplus warheads and surplus fissile materials sufficient to make many thousands more; millions of artillery shells filled with nerve gas, and seed stocks for biological-weapon agents are scattered across Russia in many locations with varying levels of security. U.S. security is better but far from impregnable.

The US response to these security threats has included arms control and nonproliferation treaties, financial assistance for securing and destroying nuclear materials and biological-weapons facilities; and unilateral defensive measures ranging from anti-missile and civil defenses to threats of preemptive attacks.

Course requirements and deliverables. No prerequisites other than a serious interest in arms control. Undergraduates may enroll with permission from the instructor. Two short (less than1000 word) policy memoranda (PMs) due in draft February 17 and March 9. Feedback will be provided within a week and the memos are due in final form two weeks later. One policy memo, at least, should include some BoE quantitative analysis (advice will be provided as needed). One 4000-6000 word research paper on an agreed topic to be presented in draft and oral as well as in final written form. The draft paper is due during the weeks of March 30 or April 6. Two volunteer student presentations on the readings each week. No final.

Reading Materials. For those readings for which URLs are not supplied, multiple copies will be available on e-reserve and/or on reserve in the WWS library in the basement of Wallace Hall. Deadly Arsenals: Tracking Weapons of Mass Destruction by Joseph Cirincione et al (Carnegie Endowment for International Peace, 2002) is recommended for purchase and will be available at the U-store.

Web sites:
Arms Control Association/Arms Control Today: www.armscontrol.org
Bulletin of the Atomic Scientists: www.thebulletin.org
Carnegie Endowment for Peace Nonproliferation Program:
www.ceip.org/files/nonprolif/default.asp
Disarmament Diplomacy: www.acronym.org.uk
Global Security: www.globalsecurity.org
Institute for Science and Global Security: http://www.isis-online.org/
International Atomic Energy Agency: http://www.iaea.org/
Nuclear Threat Initiative: www.nti.org
Nonproliferation Review: http://cns.miis.edu/pubs/npr/

**I. OVERVIEW**

1. **History of the different approaches to protection from WMD**

The U.S. has spent enormous sums acquiring nuclear weapons for "deterrence" and on defenses against them: about $5 trillion on deterrence, $1 trillion on bomber and missile defense, and $20 billion on civil defense as of 1996. [Footnotes are references not readings.] Smaller but still huge amounts have been spent on chemical and biological weapons in the past and defenses against them more recently.

In the case of nuclear weapons, the primary emphasis has been on the threat of nuclear retaliation to deter nuclear attack because, for most of the nuclear era, effective defense has been seen as infeasible. During the Cold War, however, the U.S., France and U.K. used nuclear threats to deter massive Soviet conventional attack and, since the Cold War, a weakened Russia has similarly invoked nuclear deterrence against massive conventional attack by NATO, China, Turkey and other neighbors.

Since the U.S. decided to eliminate its chemical and biological weapons, the U.S. DoD has also used the threat of nuclear retaliation to deter chemical and biological as well as nuclear attacks. This policy contradicts U.S. commitments that the it will not use nuclear weapons against non-nuclear-weapon states unless they attack the U.S., its forces or its allies in concert with a nuclear-weapon state.
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There have been periodic debates about the possibility of carrying out "preemptive" attacks to prevent the development of WMD threats - and occasional decisions to do so. In 1981, Israel bombed Iraq's Osirik reactor before it could by used to produce plutonium. Following Iraq's expulsion from Kuwait in 1991, the U.N. required it to accept IAEA and UNSCOM inspectors who rooted out its WMD production programs. In 2003, five years after Iraq expelled these inspectors in 1998, U.S. and allied forces invaded Iraq out of concern that Iraq had reconstituted its WMD programs.

The U.S. almost mounted an attack on North Korea's plutonium production facilities in 1994. The crisis was defused, however, after Jimmy Carter mediated an agreement under which North Korea shut down these facilities in exchange for heavy oil and the construction of two nuclear power reactors by the multinational Korean Peninsula Energy Development Organization. (This agreement was officially put on hold on Dec. 1, 2003.)

In December 2002, the Bush Administration issued an unclassified version of its report, "National Strategy to Combat Weapons of Mass Destruction," which asserts that "U.S. military forces and appropriate civilian agencies must have the capability to defend against WMD-armed adversaries, including in appropriate cases through preemptive measures." Leaked excerpts of the DoD's 2001 Nuclear Posture Review discuss the possibility of using nuclear weapons in such preemptive attacks.

There have also been periodic major debates in the U.S. over the feasibility of defense against nuclear weapons. Einstein wrote in 1947, "there is no secret and there is no defense." However, the U.S. Government has periodically mounted major and often

controversial efforts: in the 1950s, defense against bombers; in 1968-72, 1983-88, and since 2002, defense against ballistic missiles; and, in the 1960s and 1980s civil defense. Today, a major effort is being mounted to prepare civil defenses against biological attack.

Major attempts have also been made to stem proliferation through international treaties under which countries renounced WMD. These include:

" The Nonproliferation Treaty of 1970, under which more than 180 countries have committed not to acquire nuclear weapons and to accept International Atomic Energy Agency monitoring of their nuclear activities in exchange for commitments to eventual nuclear disarmament by the U.S., Russia, Britain, France and China;

" The Chemical Weapons Convention (CWC) of 1993, under which all signatories have agreed to verified elimination of their chemical weapons by specified dates and to accept inspections of facilities which could produce or are suspected of producing CW; and

" The Biological Weapons Convention (BWC) of 1972, which bans biological weapons but without any arrangements for verification.

Compliance with these commitments has been impressive but far from perfect. According to the DoD, in addition to the 8 known nuclear weapon states, an additional 4 (all parties to the NPT) "have nuclear weapons programs," 13 "have biological weapons," and 16 "have chemical weapons." Attempts have therefore been made to reinforce the WMD regimes with agreements between the industrialized and some other countries possessing relevant technologies not to export technologies that could facilitate WMD or long-range missile programs in suspect countries.

In addition to the nonproliferation regimes, a number of U.S.-Soviet/Russian treaties were negotiated in attempts to limit the nuclear arms race during the Cold War and reduce nuclear arsenals afterwards: the Strategic Arms Limitation Treaty and the Treaty on the Limitation of Anti-Ballistic Missile (ABM) Systems (1972); the Intermediate Nuclear Forces Treaty (1987); the Strategic Arms Reduction Treaty (1994) and the Moscow Treaty (2002). A Comprehensive [nuclear] Test Ban Treaty has been ratified by 106 countries but will only come into force if and when the 44 countries with nuclear reactors in 1996 have all ratified it. Twelve, including the U.S., have not.

Arms control and weapon-ban agreements have always controversial in the U.S. Critics worry about constraining U.S. options and lulling the U.S. with a false sense of security. They also discount the values of constraints on U.S. opponents by arguing that that they will cheat. During the Cold War these arguments were balanced by concerns about what an unconstrained Soviet Union would do. With the end of the Cold War, however, concerns about what other countries might do if unconstrained have largely disappeared. The Chemical Weapons Convention received the two thirds Senate vote required for ratification in 1993 only in exchange for the elimination of the U.S. Arms Control and Disarmament Agency and special limitations on international inspections in the U.S. The Senate refused to ratify the Comprehensive Test Ban Treaty in 1999. In 2001, the Bush

Administration rejected the proposed Verification Protocol for the Biological Weapons Convention that would bring unwelcome inspections to the U.S. pharmaceutical industry and DoD biodefense programs. In 2002 it withdrew from the ABM Treaty. The dates agreed to for the reductions in deployed strategic warheads in the Moscow Treaty are such that it will be in force for only a day (December 31, 2002) unless it is extended. Many of the same activist Congressmen and political appointees who campaigned for the abrogation of the ABM Treaty are now campaigning for a resumption of U.S. nuclear testing.

After the end of the Cold War, a number and of "cooperative threat reduction" (CTR) programs were organized to help Russia downsize and the other fSU countries eliminate the WMD arsenals and production facilities that they had inherited from the Soviet Union and to employ their excess WMD experts to prevent them from becoming sources of materials and expertise for terrorists or would-be WMD states.

**Read:**

" "Pakistan Chief Says It Appears Scientists Sold Nuclear Data" by Mark Landler and David E. Sanger, New York Times, January 24, 2004, p. A-1

" "Global Trends" (pp. 3-23) on the web at http://www.ceip.org/files/Publications/DeadlyArsenals.asp?from=pubauthor) in Deadly Arsenals: Tracking Weapons of Mass Destruction by Joseph Cirincione et al (Carnegie Endowment for International Peace, 2002)

" The Spread of Nuclear Weapons: A Debate Renewed by Scott Sagan and Kenneth Waltz (W.W. Norton, 2002). Read at least the first two chapters: "More may be better" by Waltz, and "More will be worse" by Sagan.

" "National Strategy to Combat Weapons of Mass Destruction," http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf.

" "Uncooperative America" (pp. 3-14) in Disarming Strangers: Nuclear Diplomacy with North Korea by Leon V. Sigal (Princeton University Press, 1998)

Related material of interest (aka [below] "References")

" Arms Control: The New Guide to Negotiations and Agreements by Josef Goldblat (Sage, 2002).

" "Dismantling the Concept Of 'Weapons of Mass Destruction'" by Wolfgang K. H. Panofsky, Arms Control Today, April 1998, http://www.armscontrol.org/act/1998_04/wkhp98.asp

" Nuclear Posture Review (excerpts), January 8, 2002,
http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm

" "Working in the White House on nuclear nonproliferation and arms control" by Frank von Hippel, Federation of American Scientists Public Interest Report, March/April 1995, (http://www.fas.org/faspir/archive/1990-2000/March-April1995.pdf).

**2. Nuclear Proliferation, "Atoms for Peace, " and the NPT**
(guest lecture by Daniel Ellsberg )

The U.S. conducted its first nuclear test in 1945, Russia in 1949, the U.K. in 1952, France in 1960 and China in 1964. After China's test, the U.S. and Soviet Union discovered a joint interest in nuclear nonproliferation. The Nonproliferation Treaty (NPT) which came into force in 1970, divides countries into two classes: five "nuclear-weapon states" (U.S., Soviet Union, U.K., France, China) that carried out nuclear explosions prior to 1967 and "non-nuclear-weapon states" that committed to carry out their nuclear activities under International Atomic Energy Agency (IAEA) safeguards designed to provide international assurance that no fissile material was being diverted to weapons use. A number of other states stayed outside the treaty because they had nuclear ambitions.

The NPT constitutes a bargain between the nuclear-weapon and non-weapon states. The non-weapon states commit not to acquire nuclear weapons and to allow the IAEA to inspect their nuclear programs in order to verify their compliance. The weapon states commit: i) to "cessation of the nuclear arms race at an early date and to nuclear disarmament," and ii) "exchange…equipment, materials and scientific and technological information for the peaceful uses of nuclear energy…without discrimination."
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Today Israel, India and Pakistan are the only states remaining outside the treaty and are de facto nuclear-weapon states. South Africa acquired nuclear weapons in 1979 but then gave them up and joined the NPT in 1991. Argentina and Brazil both had clandestine nuclear-weapons programs when they had military governments but the successor civilian governments jointly renounced these programs in 1991. Belarus, Kazakhstan and Ukraine inherited nuclear weapons when the Soviet Union disintegrated in 1991 but renounced them in 1993 and 1994.

The idea of exchanging nuclear-energy technology for commitments to nonproliferation and acceptance of IAEA inspection was first put forward officially in 1953 in President Eisenhower's "Atoms for Peace" speech, where he proposed to

"encourage world-wide investigation into the most effective peacetime uses of fissionable material, and with the certainty that they had all the material needed for the conduct of all experiments that were appropriate…The Atomic Energy Agency could be made responsible for the impounding, storage, and protection of the contributed fissionable and other materials. The ingenuity of our scientists will provide special safe conditions under

which such a bank of fissionable material can be made essentially immune to surprise seizure."

This was a drastic departure from the view put forward in the first analysis of the problem of preventing weapons use of fissile materials, the 1946 Acheson-Lillienthal Report (p. 4):

"We have concluded unanimously that there is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons controlled only by a system which relies on inspection and similar police-like methods."

During the 20 years following President Eisenhower's speech, the U.S. and Soviet Union exported to approximately 40 countries research reactors fueled by weapon-grade highly-enriched uranium (HEU) and the U.S. promoted the development of plutonium-breeder reactors and plutonium recycle worldwide.

This period of lack of concern about the spread of reactor fuel cycle facilities that give direct access to weapon-useable highly-enriched uranium and plutonium came to an end in 1974 after India used nuclear training and technology provided by the U.S. and Canada to produce and separate the plutonium that it used for its "peaceful nuclear explosion."

The U.S. changed its export policy dramatically after the Indian nuclear explosion but the export policies of other countries developed more gradually. In 1976, France supplied Iraq with the high-powered HEU-fueled research reactor that Israel bombed in 1981. More recently, Pakistan appears to have supplied Iran, Libya and North Korea with centrifuge-enrichment technology.

In the early 1970s, the Non-Proliferation Treaty Exporters Committee (Zangger Committee) was formed to coordinate the export policies of supplier countries. In 1976, following India's test, the unofficial Nuclear Suppliers Group (NSG) was established to develop stronger limitations on the export of uranium-enrichment and plutonium-extraction technologies. Following the Gulf War, export controls were extended to "dual-use" technologies as well. In addition the NSG agreed not to export nuclear technologies at all to countries outside of the NPT.

The purpose of the original IAEA safeguard system was to verify that nuclear materials were not diverted from declared nuclear programs. Following the discovery of Iraq's massive clandestine program in 1991, an "Additional Protocol" to the NPT was developed, which requires signatories to "declare the location of nuclear fuel cycle related research and development activities, not involving the use of nuclear material" and authorizes the IAEA to perform environmental sampling to detect clandestine reprocessing and enrichment facilities and conduct surprise inspections with as little as two hours notice. As of the end of 2003, the Additional Protocol had been ratified and brought into force in 38 countries. Both Iran and Libya have recently signed the protocol and it is in force in Iran on a provisional basis.

**Read:**

" "Pakistan (pp. 207-219), "North Korea" (pp. 241-254), "Iran" (pp.255-269); and "Nuclear supplier organizations" (pp. 413-420) in Deadly Arsenals.

" "Argentina and Brazil: rivals, not enemies" (pp. 45-71); and "The former Soviet Union: managing the inheritance;" (pp. 89-128) in Bridled ambition: why countries constrain their nuclear capabilities by Mitchell Reiss (Johns Hopkins University Press, 1995).

" "The nuclear nonproliferation treaty: history and current problems" by George Bunn, Arms Control Today, December 2003, pp. 4-10, http://www.armscontrol.org/act/2003_12/Bunn.asp

" "Nuclear-weapon states and the grand bargain" by Leonard Weiss, Arms Control Today, December 2003, http://www.armscontrol.org/act/2003_12/Weiss.asp

" "North Korea and Iran: Test cases for an improved nonproliferation regime?" by Joseph Cirincione and Jon. B. Wolfshtal, Arms Control Today, December 2003, http://www.armscontrol.org/act/2003_12/CirincioneandWolfsthal.asp

**References:**

" "Implementation of the NPT safeguards agreement in the Islamic Republic of Iran" (IAEA, Nov. 10, 2003), http://www.iaea.org/Publications/Documents/Board/2003/gov2003-75.pdf

" "Introduction" (pp. 23-35) in Nuclear Safeguards and the International Atomic Energy Agency (U.S. Congressional Office of Technology Assessment, 1995), http://www.wws.princeton.edu/~ota/ns20/alpha_f.html

" "Uranium enrichment technologies" in Technology and the Proliferation of Nuclear Weapons by Richard Kokoski (Oxford University Press, 1995), pp. 9-54. [An alternative treatment which discusses some of the physics and the difficulties in more detail can be found in "Uranium Enrichment" in The Politics and Technology of Nuclear Proliferation by Robert F. Mozley (University of Washington Press, 1998), pp. 77-125).

## II. THE WEAPONS

### 3. Nuclear weapons

The essential material for the production of nuclear weapons is fissile material (material that can sustain an explosive fission chain reaction). The two fissile materials that have been used in the production of nuclear weapons thus far are uranium enriched to about 90% U-235 (from the natural level of 0.7%) and the artificial element, plutonium.

Uranium is enriched by technologies that use the weight difference of the chemically identical isotopes.

To produce a nuclear explosion, one must assemble a super-critical mass of fissile material so that a large enough fraction of the approximately 3 neutrons produced by each fission is absorbed by fissile material that each fission will cause more than one fission, resulting in an exponentially growing fission chain-reaction. All nuclear weapons contain fission triggers ("primaries"). In advanced designs, the yield of these fission triggers is "boosted" by neutrons from the fusion of deuterium-tritium gas inside the fission "primary." There may also be a thermonuclear "secondary" compressed and heated to fusion temperatures by X-rays from the primary.
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Plutonium is produced in nuclear reactors by neutron capture on the abundant, non-chain-reacting isotope, U-238 (the remaining 99.3% of natural uranium). At slow speeds, neutrons develop a strong preference for absorption by U-235. "Slow neutron" reactors therefore can be fueled with natural uranium. In order for a large enough fraction of the neutrons to be absorbed by the 0.7% U-235 to sustain the chain reaction, however, the neutrons have to be slowed by collisions with materials which do not absorb neutrons - in practice, very pure graphite or heavy water,.

The major effects of nuclear explosions are direct neutron and gamma radiation at short range and blast and heat out to distances that depend upon yield, and radioactive fallout downwind if the explosion's fireball touches the ground and sucks up and contaminates dirt and debris. The protective value of the concrete and dirt around a fallout shelter stems from the fact that these materials attenuate the penetrating gamma radiation emitted by the fission products in fallout (about a factor of ten per foot).

Fissile material is detected through its weak emissions of penetrating gamma rays and neutrons associated with the continuous radioactive decay of an infinitesimal fraction of its atoms. In the absence of effective shielding, this radiation can be detected outside containers or vehicles or even from a low-flying helicopter by a Nuclear Emergency Search Team.

Tutorial: N. Korea's plutonium-production reactors and the gas-centrifuge technology acquired by Pakistan to produce highly-enriched uranium. Design of the Hiroshima and Nagasaki bombs.

[Film: "Trinity And Beyond: The Atomic Bomb Movie"

**Read:**

" Hiroshima by John Hersey (1946).

" The U.S. Nuclear War Plan: A Time for Change (NRDC, 2001) (scan) http://www.nrdc.org/nuclear/warplan.

**References**

" "South Africa and the affordable bomb" by David Albright, Bulletin of the Atomic Scientists, July/August 1994, pp. 37-47. http://www.thebulletin.org/issues/1994/ja94/ja94Albright.html.

" "Plutonium and reprocessing of spent nuclear fuel" by Frank von Hippel in Science 293, September 28, 2001, pp. 2397-8.

" "Nuclear physics" (pp. 25-39) and "Plutonium production in nuclear reactors" (pp. 43-64) and "Bomb assembly" (pp. 126-133) in The Politics and Technology of Nuclear Proliferation by Robert F. Mozley (University of Washington Press, 1998),

" "Nuclear weapons" (pp. 58-65) in Megawatts and Megatons by Richard Garwin and Georges Charpak (Alfred A. Knopf, 2001).

" "The Effects of Nuclear Explosions" (pp. 25-34) in Chapter 3; "The NRDC Nuclear War Simulation Model," in

" The USG's basic reference on nuclear-weapons effects is The Effects of Nuclear Weapons, Samuel Glasstone and Philip J. Dolan, eds, (U.S. Government Printing Office, 1977) - comes complete with Dr. Strangelove bomb-effects computer.

" The basic reference on fission-weapon design is The Los Alamos primer: the first lectures on how to build an atomic bomb by Robert Serber (University of California Press, 1992).

" The basic reference on the nuclear fuel cycle is Nuclear Chemical Engineering, 2nd edition by Manson Benedict, Thomas H. Pigford and Hans Wolfgang Levi (McGraw Hill, 1981).

" If you want to understand some of the issues relating to the effect of the isotopic difference between weapon-grade and reactor-grade plutonium on the yield of a fission explosive, see J. Carson Mark, "Explosive properties of reactor-grade plutonium" in Science & Global Security 4 (1993), pp. 111-128, http://www.princeton.edu/~globsec/publications/pdf/4_1Mark.pdf

" For a primer on the detection of nuclear warheads, see "Detecting Nuclear Warheads" by Steve Fetter et al, Science & Global Security 1 (1990), pp. 225-302), http://www.princeton.edu/~globsec/publications/pdf/1_3-4FetterB.pdf.

Radiological weapons. Radiological weapons are weapons which disperse radioactive materials in order to inflict radiation doses. This might be done by dispersal of a radioisotope source or by precipitating an accident in a nuclear power plant or spent-fuel storage pool. As the Chernobyl accident illustrates, such an event would be unlikely to kill many people by high radiation doses. However, it could contaminate large areas and slightly increase the risk of cancer in a very large population.

**Reference:**
" "Exposures and effects of the Chernobyl accident," Annex J in Sources and Effects of Ionizing Radiation (UN, 2000) http://www.unscear.org/pdffiles/annexj.pdf

**4. Biological and chemical weapons**
(mostly biological weapons)
Approaches to defense against both chemical and biological weapons are generally well known: gas masks and suits, filters on the air intakes of buildings, and antidotes.

Biological weapons. We have recently learned more than we wanted to about anthrax. Because of the durability of its spore form, this has been the prototypical BW agent since WWII. Both the U.S. and Russia developed huge production capacities for anthrax and several other biological agents during the Cold War. Iraq produced a considerable amount.

In 1969, President Nixon decided to unilaterally end the U.S. BW program. This led to the negotiation of the Biological Weapons Convention. Unlike other arms control treaties, however, the BWC has no arrangements for verification.
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In 1991, after the revelation of cheating on a massive scale by both Russia and Iraq, the Third Review Conference of the BWC set up an Ad Hoc Group of Experts to develop the basis for a verification protocol and, in 1994, on the basis of this group's report, negotiations on a Protocol were launched. These negotiations led to a consensus on a protocol by essentially all parties but, in August 2001, the Bush Administration rejected the draft protocol and insisted that the negotiations be abandoned as hopeless. In November 2001, President Bush proposed an alternative approach to strengthening the BWC based on the encouragement of unilateral national initiatives.

Tutorials. Biological agents (Kahn). How to estimate casualties, based on quantities released, toxicity, weather conditions and population density (von Hippel).

**Read:**

" "Biological and chemical weapons, agents and proliferation" (pp. 45-68), Deadly Arsenals

" "The Cult" (pp. 151-164) and "Evil Empire" (pp. 165-182) in Germs: biological weapons and America's secret war by Judith Miller, Stephen Engelberg, and William Broad (Simon & Schuster, 2001).

" "A farewell to germs: the U.S. renunciation of biological and toxin warfare, 1969-70" by Jonathan B. Tucker, International Security 27, Summer 2002, pp. 107-148; http://thesius.ingentaselect.com/vl=25061372/cl=73/nw=1/fm=docpdf/rpsv/cw/mitpress/01622889/v27n1/s5/p107

" "Anthrax powder: state of the art?" by Gary Matsurmoto, Science 302, November 28, 2003, pp. 1492-7.

" "The Great Terror: In northern Iraq, there is new evidence of Saddam Hussein's genocidal war on the Kurds-and of his possible ties to Al Qaeda" by Jeffrey Goldberg, New Yorker, March 25, 2002 http://newyorker.com/fact/content/?020325fa_FACT1

References

" "The growing threat of biological weapons," Steven Block American Scientist, Jan-Feb. 2001, http://www.sigmaxi.org/amsci/articles/01articles/Block.html

" "Nuclear Blindness: An overview of the biological programs of the former Soviet Union and Iraq" by Christopher Davis, http://www.cdc.gov/ncidod/EID/vol5no4/davis.htm

" The 1972 Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxic Weapons (BWC) http://www.state.gov/www/global/arms/treaties/bwc1.html

" "Technical Aspects of Biological Weapon Proliferation" in Technologies Underlying Weapons of Mass Destruction (Congressional Office of Technology Assessment, 1993), pp. 71-117, http://www.wws.princeton.edu/~ota/ns20/alpha_f.html

" Jonathan Tucker and Raymond A. Zilinskas, "Assessing U.S. proposals to strengthen the Biological Weapons Convention, " Arms Control Today, April 2002, pp. 10-14.

" "Bare-bones multilateralism at the BWC review conference," Arms Control Today, Dec. 2002, p. 19.

" For a history of the evolution of the U.S. BW program and policy until 1990, see Barton Berstein, "Origins of the U.S. biological warfare program (pp. 9-25); and Susan Wright, "Evolution of Biological Warfare Policy, 1945-1990" (pp. 26-48) in Preventing a Biological Arms Race, Susan Wright, ed. (MIT Press, 1990).

" "The Sverdlovsk Anthrax Outbreak of 1979" by M. Meselson, J. Guillemin, M. Hugh-Jones, A. Langmuir, I. Popova, A. Shelokov, and O. Yampolskaya in Biological Weapons: Limiting the Threat, Joshua Lederberg, ed. (MIT Press, 2000) pp. 193-209. In 1979, an accidental release of perhaps less than a gram of anthrax spores in the Soviet city of Sverlovsk (now Nizhni Novgorod) caused a reported 64 deaths downwind out to the edge of the city (4 km). (This reading is being introduce early because, although the agent was a BW agent, the dispersal pattern is a classic example of a down-wind plume which will be used to illustrate the calculation of plumes for both chemical and biological agents.)

" Chapter 3, "Biological and chemical agents" and Annex 3: "Chemical agents" in Public health response to biological and chemical weapons: WHO guidance, 2nd edition, (World

Health Organization, prepublication edition, November 2001)
http://www.who.int/emc/book_2nd_edition.htm

Chemical weapons. 124,000 tons of chemical agents were dispersed in World War I (resulting in over a million casualties and over 90,000 deaths). In the 1960s Egypt used chemical weapons against Yemen, and in the 1980s they were used in the Iraq-Iran War. During the Cold War, the U.S. and Soviet Union built up huge stockpiles of weapons and of nerve gas and other chemical-weapons agents, which they are now struggling to destroy. Iraq built up a considerable chemical-weapons stockpile. In 1995, the Japanese terrorist group, Aum Shinrikyo produced and used sarin nerve gas in an attack on the Tokyo subway system.

Mustard gas is not very difficult to make -especially given supplies of the industrial chemical thiodiglycol. Nerve gases such as sarin are related to organophosphorus pesticides. The production processes of these agents and their difficulties are well known. Their degradation products are also well known and can be detected at extremely low levels. The Australia group of industrialized countries has attempted to block the export of dual-use technologies that could be useful to would-be CW or BW states.

After 20 years of negotiations in the Geneva-based Conference on Disarmament, the Chemical Weapons Convention was signed in 1993. The Convention requires countries to declare their stockpiles and production facilities and to destroy them. As of 2001, four countries (U.S., Russia, India, and South Korea) had declared stockpiles. It also requires countries to declare data on the production sites, processing, consumption, acquisition, import or export of above-threshold quantities of chemical-weapon precursor chemicals. It subjects production facilities to international inspections and also contains elaborate arrangements for challenge inspections in case accusations of violations are found credible by the compliance-monitoring inter-governmental Organization for the Prohibition of Chemical Weapons OPCW), headquartered in the Netherlands at the Hague. However, the U.S. and other countries have been dissatisfied with the performance of the OPCW, it has not been adequately funded, the U.S. has accused Iran of violating the CWC but has refused to call for a challenge inspection, and many countries have not complied with the CWC's reporting requirements.

Despite delays due to technical problems and public concerns about safety, the U.S. is now well underway in an $18+ billion program to destroy its 31,000 -tons stockpile of chemical-weapons agents. Russia's program to destroy its stockpile of 40,000 tons has been stalled by public concerns about safety and lack of funds, however, the U.S. and EU have begun to supply funds for a nerve-gas destruction facility.

References:
" "A chemical weapons atlas" by E.J. Hogendoorn, Bulletin of the Atomic Scientists, Sept./Oct. 1997, http://www.thebulletin.org/issues/1997/so97/so97hogendoom.html.

" "Technical Aspects of Chemical Weapon Proliferation" in Technologies Underlying Weapons of Mass Destruction (Congressional Office of Technology Assessment, 1993), pp. 15-69, http://www.wws.princeton.edu/~ota/ns20/alpha_f.html.

" Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, http://www.opcw.org/.

" Website of the Australia Group, http://www.australiagroup.net.

" "Study assesses risk of attack on chemical plant," Washington Post, March 12, 2002, p. A8.

" "The Bhopal accident" in "Chemical accidents," http://www.opcw.nl/chemhaz/chemacci.htm#pagetop. In this accident, an estimated 20-30 tons of toxic chemical was released into the atmosphere from an industrial facility in an urban area, causing 2500 deaths and 100,000 injuries.

## III. DEFENSE

### 5. Defense against biological weapons

(Nelson, Kahn and von Hippel)

The response to the anthrax letters demonstrated how poorly prepared the U.S. was for a even a small biological attack. One reason was that the "first responders" to a biological attack would be doctors, hospitals and public health departments, not the police, fire departments, national guard, and the military.

Since the fall of 2001, the U.S. Government has begun to pour billions of dollars into biodefense and biodefense R&D.

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These investments include:

" Computers and communications systems for public health departments to facilitate early detection of unusual patterns of illnesses;

" Sensors in subways to detect biological agents;

" Regional stockpiles of antibiotics and vaccines;

" Programs to develop better detectors and vaccines for viruses that might be used by bioterrorists; and

" "Threat assessment" R&D to assess possible tactics that bioterrorists might use to disperse BW agents, and engineer them to enhance their virulence and to eliminate their susceptibility to vaccines and countermeasures to these tactics. These activities tend to be

secret and are controversial, since the U.S. might create new threats in this way and/or be seen by other countries as developing an offensive BW program.

The concern that published life-sciences research might be used by bio-terrorists to create enhanced agents has created a great deal of debate about the appropriate response. The leadership of the life-sciences community is concerned that government restrictions on publication would damage essential processes of information sharing and peer review within the community and has urged that it be allowed to deal with the problem itself. The first proposals for how to do this is contained in the recent National Academy of Sciences report, Biotechnology Research in an age of terrorism: Confronting the dual use dilemma.

Tutorials. The determinants of disease spread (R. Nelson). Public health approaches to preventing disease spread using smallpox as an example (Kahn).

**Read:**

" "Bioterror: What Can Be Done?" by Matthew Meselson in The New York Review of Books, December 20, 2001, http://www.nybooks.com/articles/14971

" "The Looming Threat of Bioterrorism" by Donald A. Henderson, Science 283, 5406, Feb 26 1999: 1279-1282.

" "The Future" (pp. 287-314) in Germs: biological weapons and America's secret war by Judith Miller, Stephen Engelberg, and William Broad (Simon & Schuster, 2001).

" "Executive Summary," Biotechnology Research in an Age of Terrorism, http://www.nap.edu/books/0309089778/html/

**References:**

" "Strengthening The Nation's Public Health Infrastructure: Historic Challenge, Unprecedented Opportunity," by Baker, E.L. and Koplan J.P., Health Affairs, Nov/Dec. 2002. Vol. 21/No. 6. Pages 15-27.

" "The Public Health Infrastructure: Rebuild or Redesign?" by Lurie, N. Health Affairs, Nov/Dec. 2002. Vol. 21/No. 6, pp. 28-30.

" "Governmental Public Health in the United States: The Implications of Federalism," by Turnock BJ and Atchison C., Health Affairs, Nov/Dec. 2002. Vol. 21/No. 6, pp. 68-78.

" Annex 5, "Mathematical Theory of Epidemics" in Public health response to biological and chemical weapons: WHO guidance, 2nd edition, (WHO, 2002) http://www.who.int/emc/book_2nd_edition.htm

" Testimony of Tara O'Toole, Hearing on "FEMA's Role in Managing Bioterrorist Attacks and the Impact of Public Health Concerns on Bioterrorism Preparedness," U.S. Senate Government Affairs Subcommittee on International Security, Proliferation &

Federal Services, July 23, 2001, http://www.hopkins-biodefense.org/pages/library/fema.html.

**6. Deterrence and/or Preemption?**

In the 1950s, the U.S. threatened "massive [nuclear] retaliation" in response to fears of a Soviet invasion of Western Europe. This would have meant the total destruction of Soviet and Chinese cities and the deaths of hundreds of millions. However, as U.S. intelligence concerning Soviet military-related facilities improved and the number of U.S. nuclear weapons multiplied, the emphasis shifted to "counterforce" and counter-industrial targeting. Many tens of millions of civilians would still have been killed as a result of "collateral damage" but total destruction of Soviet cities would have been a threat held in reserve as long as U.S. cities were spared. As missile warheads became more accurate, the land-based missiles became each-others' highest priority targets, which made them "time-urgent" targets and put them in a hair trigger, launch-on-warning status.
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Despite their rapprochement, India and Pakistan seem to be moving slowly but steadily toward a similar missile confrontation - but in a situation where the two countries have a history of war, a continuing conflict over Kashmir, and much shorter missile flight times.

A recent Princeton PhD thesis provides compelling evidence that nascent nuclear powers often provoke thoughts of preemptive strikes by established nuclear powers with which they have confrontational relationships. Historical case studies include U.S. considerations of preemptive attacks on the Soviet Union and China, Soviet consideration of a preemptive attack on China, and Israel's actual preemptive attack on Iraq. Contemporary cases are: U.S.-North Korea, India-Pakistan and perhaps still U.S.-China.

Tutorials:; Stable/unstable nuclear balances (von Hippel); early-warning systems (Nelson)

Films (optional): Dr Strangelove; 13 Days (2000, 147 minutes);

**Read:**
" "Taking nuclear weapons off hair-trigger alert" by Bruce Blair, Harold Feiveson and Frank von Hippel, Scientific American, November 1997, pp. 74-81. For the reaction of the then Commander in Chief of the U.S. Strategic Command, see "General Eugene E. Habiger, Commander in Chief, US Strategic Command, Interview with Defense Writer's Group, Wash DC 31 March 1998, fourth question:
http://www.fas.org/news/usa/1998/03/980331-dwg.htm

" "The next Nuclear Posture Review?" (pp. 243-283) in The Nuclear Turning Point, Harold Feiveson, ed. (Brookings, 1999).

**" TO BE ADDED":**

" A.H. Nayyar and M.V. Ramana, "India, Pakistan and the Bomb," Scientific American, December 2001.

" "Indian and Pakistani nuclear weapons: for better or worse?" (pp. 88-124) in The Spread of Nuclear Weapons: A Debate Renewed by Scott Sagan and Kenneth Waltz (W.W. Norton, 2003).

" "Preemptive posturing: What happened to deterrence?" by Hans Kristensen, Bulletin of the Atomic Scientists, Sept.-Oct. 2002, http://www.thebulletin.org/issues/2002/so02/so02kristensen.html

" "Contemporary cases" in Valleys of vulnerability: Instability in asymmetric nuclear rivalries" by Lyle J. Goldstein (PhD thesis, 2001), pp. 196-219.

References:
" "Intercontinental ballistic missiles" and "Nuclear missile submarines" (pp. 137-193) in Science, Technology and the Nuclear Arms Race by Dietrich Schroeer (John Wiley & Sons, 1984)

" For updates on current Russian, U.S. and other-country nuclear forces, see the "Nuclear notebook" of the Bulletin of the Atomic Scientists, http://www.thebulletin.org/issues/nukenotes/nukenote.html

" Chapter 2, "The single integrated operational plan and U.S. nuclear forces;" Chapter 4, "Attacking Russia's nuclear forces," and Chapter 5, "Attacking Russian Cities" in The U.S. Nuclear War Plan: A Time for Change (NRDC, 2001) http://www.nrdc.org/nuclear/warplan.

**7. Missile Proliferation and Defense**

Aerial warfare in World War II was dominated by mass-bomber attacks. After the Allies won dominance of the air in the Battle of Britain, however, Germany began to attack Britain with unmanned V-1 and V-2 missiles. These missiles were respectively the forbearers of modern cruise and ballistic missiles. Indeed, the V-2 is still with us in the form of the Scud missile which the Soviet Union produced and exported in great numbers and which North Korea, Iraq, Iran and other countries have learned how to produce.

Staging, i.e. jettisoning structural weight as fuel is consumed, made it possible to develop ballistic missiles of intercontinental range. The U.S. and Soviet Union ultimately each deployed about 2000 long-range land-based ballistic missiles, equipped with an average of 3-4 warheads each.
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Prior to the late 1980s, a large number of countries had 300-500 km Scud missiles but only the five NPT nuclear-weapon states had long-range multistage ballistic missiles. During the 1990's, however, a number of additional countries mastered staging and deployed 2-stage intermediate-range missiles: India (Agni, 1989), Israel (1990), North Korea (Taepo Dong I, one test in 1998), In addition, North Korea has developed a large single stage missile, the No Dong (1993, 1300 km) which is probably the basis for similar Pakistani (Ghauri, tested 1998) and Iranian (Shahab III, untested) missiles. Iran is reportedly building a somewhat longer single-stage missile (Shahab IV) based on the Russian SS-4.

The Missile Technology Control Regime was established in 1987 by the G-7 countries (Canada, France, Germany, Italy, Japan, U.K., and U.S.) to establish agreed export controls on ballistic-missile technologies. In 2002 it had 33 member states.

Both the U.S. and Soviet Union had missile-defense R&D programs from the time of Russia's launch of the first earth satellite "Sputnik" in 1957. In the 1960s, systems were actually deployed. Russia started with a system to defend Moscow and, despite the skepticism of his technical advisors, President Johnson decided in 1967 it was politically necessary for him to deploy a national defense for the U.S. However, opposition developed in the suburbs where the nuclear-tipped missiles were supposed to be deployed, the Democratic Senate turned against the idea after a Republican President (Nixon) was elected, and Nixon was forced to agree to the ABM Treaty (1972) which banned national missile defenses.

President Reagan rebelled against the ABM Treaty and launched his Strategic Defense Initiative in 1983 but the Democratic Senate refused to go along. In 1996, a Republican Congress established a Commission to Assess the Ballistic Missile Threat to the United States chaired by Donald Rumsfeld. The Commission reported back in 1998 that North Korea, Iran and/or Iraq might, with foreign assistance, secretly and rapidly develop missiles that could reach the U.S. North Korea appeared to give this threat credibility by attempting to launch a satellite a few months later. After G.W. Bush was elected President, Rumsfeld became Secretary of Defense. In 2002, their Administration took the U.S. out of the ABM Treaty, ramped up missile-defense expenditures to $9 billion/year - more than any other military R&D program -- and committed the nation to deploy at least a few interceptor missiles by the end of 2004.

The Administration argued - unconvincingly to some - that the "Axis of Evil" countries could not be deterred from launching nuclear or biological-tipped missiles at the U.S., even though they would know that such an attack would be suicidal. Others suggested that the real concern was that the U.S. might be deterred from using its conventional military superiority against these countries if they could attack the U.S. with nuclear missiles.

Many technical critics remain unconvinced that a missile-defense system will be capable of discriminating potential decoys and "penetration aids," deployable by even unsophisticated attackers, from the real warheads that could be hidden among them.

Tutorials: Rocket range/payload (FvH) Radar and infrared detection and discrimination (Nelson)

**Read:**

" "Missile proliferation" (pp. 69-99) and "The Missile Technology Control Regime" (pp. 403-409) in Deadly Arsenals.

" "Missile defense: The untold story" by Bill Keller, New York Times, Dec. 29, 2001, A33.

" "The Continuing Debate on National Missile Defenses," Lisbeth Gronlund, George N. Lewis, and David C. Wright, Physics Today, December 2000, p. 36, www.physicstoday.com/pt/vol-53/iss-12/p36.html.

References:

" "U.S. Policy on Ballistic Missile Proliferation: The MTCR's First Decade (1987-1997)" by Wyn Q. Bowen in Nonproliferation Review, Fall 1997, p. 21, http://cns.miis.edu/pubs/npr/vol05/51/bowen51.pdf

" "Free flight of a ballistic missile" by Albert D. Wheelon, ARS Journal, Dec. 1959, pp. 915-926

" Lisbeth Gronlund and David Wright, "Depressed trajectory SLBMs," Science & Global Security 3 (1992), pp. 101-159.

" "Long-range nuclear cruise missiles and stability" by George Lewis and Theodore Postol, Science &Global Security 3 (1992), pp. 49-99.

" "Rhetoric or reality? Missile defense under Bush" by Philip Coyle, Arms Control Today, May 2002, pp. 3-8.

" Foreign Missile Developments and the Ballistic Missile Threat Through 2015, Unclassified Summary of a National Intelligence Estimate, National Foreign Intelligence Board, December 2001, http://www.cia.gov/nic/pubs/other_products/Unclassifiedballisticmissilefinal.htm

" Countermeasures, Andrew Sessler et al (April 2000), http://www.ucsusa.org/index.html

" "Decoy rejection gains Pentagon's attention," Aviation Week, Sept. 16, 2002, p. 31.

## IV. DIPLOMACY

### 8. Multilateral nuclear arms control
(Nelson, von Hippel)

Aside from the 1970 Nonproliferation Treaty, multilateral negotiations on nuclear weapons control have focused on steps toward a Comprehensive [nuclear weapons] Test Ban Treaty and a Fissile Cutoff Treaty that would ban the production of more fissile materials for nuclear weapons.
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The Comprehensive Nuclear Test Ban (CTBT). The international test-ban movement began in 1954, after the radioactive fallout from the U.S. 10-megaton "Bravo" test blanketed a Japanese fishing boat, causing the death of one of its crew. In 1963, after the frightening Cuban Missile Crisis and under pressure from international concern about the worldwide radioactive fallout from atmospheric testing, the U.S., Soviet Union and U.K. signed the Partial Test Ban Treaty ending their nuclear testing everywhere but underground. Subsequently, all other potential nuclear-weapon states joined. In 1974, during the Watergate hearings, President Nixon signed the Threshold Test Ban Treaty, which limits U.S. and Russian underground nuclear tests to less than 150 kilotons. In 1992, following a series of testing moratoria called by Gorbachev and Yeltsin, a Democratic Congress forced an end to U.S. nuclear testing by 1996 as long as no other country tested. In 1996, after prolonged negotiations in the Geneva-based U.N. Conference on Disarmament, most countries signed a Comprehensive Test Ban. However, in 1999, the U.S. Senate refused to ratify the treaty. Central issues in the debate were whether:

" The U.S. can maintain the reliability of its nuclear weapons without testing;

" The U.S. needs new types of nuclear weapons, which would have to be tested;

" Other countries could gain significant advantage by cheating below the detection threshold.

The G.W. Bush Administration has announced that it opposes ratification of the CTBT but that it sees no current need to test. However, elements within both the DoD and Congressional Republican leadership have called into question U.S. capability to maintain its nuclear stockpile without testing and are promoting new nuclear weapons - especially the nuclear earth penetrator. There was a great debate in the Senate on May 20-21, 2003 over the earth-penetrator and the repeal of a 1993 law banning the development of new nuclear weapons with yields less than 5,000 tons of TNT equivalent ("mini-nukes"). The focus of the opponents was on the implication that nuclear weapons could be used for any other purpose than deterrence.
Tutorial: The nuclear earth-penetrating warhead (Nelson).

**Read:**

" "The Comprehensive Test Ban Treaty" by Jeremiah D. Sullivan, Physics Today, March 1998 http://www.aip.org/pt/vol-51/iss-3/vol51no3p24-29part1.pdf; http://www.aip.org/pt/vol-51/iss-3/vol51no3p24-29part2.pdf

" "The Death of a Treaty" by Terry L.Deibel, Foreign Affairs, Sept.-Oct. 2002, 142-161.

" "Nuclear weapons in the 21st Century" by Stephen Younger, Associate Lab Director for Nuclear Weapons, Los Alamos National Laboratory, LAUR-002850, June 27, 2000, http://www.fcnl.org/issues/arm/sup/nukwpns21stcent.pdf

" "Nuclear Bunker Busters, Mini-Nukes, and the US Nuclear Stockpile," Robert Nelson, Physics Today, November 2003, http://www.physicstoday.org/vol-56/iss-11/p32.html

**References:**

" Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty (National Academy of Sciences, 2002), Executive Summary at http://www.armscontrol.org/act/2002_09/nassept02.asp; full text at http://www.nap.edu/catalog/10471.html.

" "Statement of C. Paul Robinson, Director, Sandia National Laboratories, Senate Committee on Armed Services, Oct. 7, 1999, http://www.fas.org/spp/starwars/congress/1999_h/991007pr.pdf

" "That old designing fever" by Greg Mello, Bulletin of the Atomic Scientists, January/February 2000, http://www.thebulletin.org/issues/2000/jf00/jf00mello.html;

" Findings and Recommendations Concerning the Comprehensive Nuclear Test Ban Treaty by General John M. Shalikashvili, Special Advisor to the President and Secretary of State, January 2001, http://www.usun-vienna.usia.co.at/ctbt_report.html

Ending the production of fissile materials for weapons. During the 1950s and '60s, while the U.S. was ahead, it attempted to negotiate a bilateral halt with the Soviet Union of the production fissile materials for weapons. During the 1990s, this effort resumed as an international effort to negotiate in the UN Conference on Disarmament, a global ban on the production of fissile material for nuclear weapons, a. k. a. as the "Fissile Cutoff." However, negotiations have been blocked since 1994 by linkages by various countries of the negotiations to the negotiation of other arms-control agreements that they were interested in - and by U.S. refusal to agree to such linkage. Most recently the impasse has been with China, which has scaled back its demand to discussion (not negotiation) of a treaty on space non-weaponization. A number of countries - especially Pakistan - also requested that reductions of existing stocks be included in the negotiations. They settled for an agreement from the other weapons states to discuss this possibility.

Despite the lack of negotiations, in the early 90s, the U.S., Russia, Britain and France all announced that they had ended production of fissile material for weapons. China also let it be known that it had embarked on a moratorium. This left only Israel, India and Pakistan still producing fissile material for weapons.

Tutorial: Verifying a the moratorium on fissile-material production (FvH)

Read: "Nuclear disarmament, nuclear terrorism and fissile materials, Frank von Hippel, Briefing to the Latin American and Caribbean Delegates to the Preparatory Meeting for the 2005 NPT Review Conference, U.N., March 14, 2002

**References:**

" "The FMCT and Cuts in Fissile Material Stockpiles by Frank von Hippel, Disarmament Forum 2 (1999), pp. 35-44, http://www.unog.ch/UNIDIR/2E-HIPP.PDF

9. Dealing with the legacy of Cold War: Arms control

In1946, the U.S. offered to eliminate its nuclear weapons if other countries first opened themselves to international verification that they were not pursuing nuclear weapons. Negotiations quickly reached an impasse with the USSR insisting that the U.S. eliminate its nuclear stockpile before the Soviet Union opened itself to international inspection. However, starting in 1972, the two countries did begin to sign treaties to at first limit their arms buildup and then later to reduce their nuclear weapons.

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The first U.S-Soviet agreement limiting nuclear weapons was the 1972 U.S.-Soviet Strategic Arms Limitation Treaty [SALT] I Interim Agreement with Respect to Limitation of Strategic Offensive Arms. This agreement was followed by the un-ratified but complied with 1979 SALT II Treaty; the 1987 INF Treaty on elimination of Intermediate-range Nuclear Forces (land-based missiles with ranges between 500 and 5500 km); and the 1994 Strategic Arms Reduction Treaty [START I]. START I, whose implementation was completed on Dec. 5, 2001, limits Russia and the U.S. each to a total of1600 intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and heavy bombers, and a total of 4900 warheads deployed on the ballistic missiles.

In May 2002, Presidents Bush and Putin signed the Strategic Offensive Reductions Treaty, according to which the U.S. and Russia will limit the number of their deployed strategic warheads to less than 2200 by Dec. 31, 2012. The Treaty has no requirements to destroy warheads taken off deployment or weapon-delivery systems and is to remain in force only through the end of 2012 but can be extended by "subsequent agreement." The Treaty has no verification arrangements of its own but could be verified by the detailed verification arrangements in the START I Treaty if it is extended beyond 2009.

The SALT Treaties were verified only by "national technical means:" imaging satellites and long-range radars for tracking missile tests. The INF and START I Treaty include

inspections at missile, ballistic-missile submarine and heavy-bomber bases. Beginning with the INF Treaty, proposals were made that nondeployed as well as deployed nuclear warheads should be limited. Such proposals have been the subject of nongovernmental and official U.S.-Russian technical studies but no negotiations have been launched.

Only about half the nuclear weapons produced during the Cold War were long-range. The other half were short-range, "tactical" or "battlefield" nuclear weapons: nuclear artillery shells; short-range land-based, ship-based and aircraft-based missiles; bombs for fighter-bombers; nuclear-armed anti-aircraft missiles, torpedoes, and depth charges; atomic demolition mines, etc. These weapons have never been subject to verified limitations. Such limitations would be similar to limitations on non-deployed strategic warheads. However, in 1991, Presidents Bush and Gorbachev issued parallel unilateral statements in which they pledged to eliminate the nuclear weapons that had been assigned to the U.S. and Soviet armies; to reduce and keep nondeployed the tactical nuclear weapons that had been assigned to the surface navies and attack submarines, and to reduce the numbers of tactical nuclear weapons that had been assigned to aircraft. As a result, it is generally believed that the number of Russian and U.S. tactical weapons has been reduced from the tens of thousands to low thousands.

**Tutorials:** Using satellite images for verification, Josh Handler?
Dismantling the Doomsday Machine, Frank von Hippel

**Read:**
" Alan Krass, "Cold War Arms Control" (pp. 9-25) and "The Arms Control Revolution" (pp. 29-64) in The United States and Arms Control: The Challenge of Leadership (Praeger, 1997).

" "Nuclear arms control at a crossroads" (pp. 3-14) and "A strategy of staged reductions and de-alerting of nuclear forces" (pp. 15-27) in The Nuclear Turning Point, Harold Feiveson, ed. (Brookings, 1999).

" "The Moscow Treaty: making matters worse" by Christopher Paine, Bulletin of the Atomic Scientists, November/December 2002, p. 19.

" "The 1991-1992 [Presidential Nuclear Initiatives] and the elimination, storage, and security of tactical nuclear weapons" by Joshua Handler (pp. 20-41) in Tatical Nuclear Weapons, Brian Alexander and Alistair Millar, eds, (Brasseys, 2003).

**References:**
" "A Comprehensive Transparency Regime For Warheads and Fissile Materials" by Steve Fetter, Arms Control Today, January/February 1999, http://www.armscontrol.org/act/1999_01-02/sfjf99.asp

" "Advanced KH-11 Broadens U.S. Recon Capability," Aviation Week, January 6, 1997, 24.

" "Secret NRO Recons Eye Iraqi Threats," Aviation Week. Sept. 16, 2002, p. 23.

" "START I at a Glance," Arms Control Association, http://www.armscontrol.org/factsheets/start1.asp

" "The Unruly Hedge: Cold War Thinking at the Crawford Summit" by Hans M. Kristensen, Arms Control Today, December 2001, http://www.armscontrol.org/act/2001_12/kristensennov01.asp

10. The Future of U.S. Nonproliferation Policy
(discussion with George Perkovich, Vice President for Research, Carnegie Endowment for Peace)

**Read:**

"Bush's Nuclear Revolution" by George Perkovich, Foreign Affairs 82, March/April 2003, pp. 2-8.

**11. Cooperative Threat Reduction**
(Oleg Bukharin, Ken Luongo, Sharon Weiner )

With the end of the Cold War, a new danger emerged: that the oversized WMD complexes that Russia could no longer support could potentially become a sources of weapons materials or expertise for terrorists or radical states. The U.S. therefore launched a number of programs to assist Russia in downsizing its production complexes and, converting excess personnel and disposing of the materials.
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The name of one of these programs, the DoD "Nunn-Lugar" or Cooperative Threat Reduction program, is often used loosely as a label for all these programs. However, most of the nuclear assistance programs are located within the DoE's National Nuclear Security Administration (NNSA) and U.S. involvement in the International Science and Technology Center (ISTC), which provides R&D contracts to needy fSU WMD scientists, is managed by the State Department. The total budget for the NNSA and DoD programs in FY04 is about $500 million each and for State about $100 million.

The U.S. and Russia also made a commercially-based agreement in 1994 under which the U.S. Enrichment Corporation is purchasing 30 tons of excess Russian weapon-grade uranium per year after it is blended down to low-enriched uranium for resale for nuclear-power-reactor fuel. The annual income of Russia's nuclear complex from this deal is about $500 million and it fuels about one half of U.S. nuclear capacity.

The largest NNSA program is the Materials Protection, Control and Accounting program ($260 M in FY04). This includes strengthened security for Russian warheads and fissile and radiological materials, radiation monitoring at border crossings and megaports, and

consolidation and conversion of excess Russian civilian HEU. Other programs include conversion of U.S. and Soviet-designed HEU-fueled reactors ($9 M) and return to Russia of HEU fuel exported by the Soviet Union ($10 M); non-weapons R&D for Russian nuclear scientists ($40 M), shutting down Russia's last 3 plutonium-production reactors by providing alternative sources of heat and electricity ($50 M), and assistance for the dispostion of excess Russian weapons plutonium ($47 M).

The DoD programs include: chemical-weapon destruction ($200 M), elimination of strategic delivery vehicles (missile submarines, etc., $60 M), warhead security upgrades ($48 M), BW proliferation prevention ($54 M).

The State Dept. programs include: nonweapons R&D for Russian WMD scientists ($73 M), and export control assistance ($30 M).

Cooperative efforts to upgrade fissile-material security have been launched with other countries as well. The collaboration with China has been suspended since the Wen Ho Lee debacle. During the Afghanistan war, the U.S. made an offer, which was refused, to assist Pakistan to upgrade the security of its nuclear weapons and materials.

Tutorial: Corralling highly-enriched uranium, the nuclear terrorist's choice (FvH)

**Read:**
" "Potatoes were guarded better…" by Oleg Bukharin and William Potter, Bulletin of the Atomic Scientists, May-June 1995
http://www.thebulletin.org/issues/1995/mj95/mj95.bukharin.html

" "The Mystery of the Sunken Gyros" by Vladimir Orlov and William Potter, Bulletin of the Atomic Scientists, November-December 1998,
http://www.thebulletin.org/issues/1998/nd98/nd98orlovpotter.html

" "U.S. Nonproliferation Assistance Programs" (chapter 3) in Nuclear Status Report: Nuclear Weapons, Fissile Material, and Export Controls in the Former Soviet Union (Carnegie Endowment for International Peace, 2001),
http://www.ceip.org/files/Publications/StatusReport.asp

" "The Next Steps in U.S. Nonproliferation Policy" by Senator Richard Lugar, Arms Control Today, December 2002, pp. 3-7,
http://www.armscontrol.org/act/2002_12/lugar_dec02.asp

" "Reform and expansion of coopertive threat reduction" by Ken Luongo and William Hoehn III, Arms Control Today June 2003,
http://www.armscontrol.org/act/2003_06/luongohoehn_june03.asp

**References:**
" "Preventing nuclear entrepreneurship in Russia's nuclear cities" by Sharon Weiner, International Security 27, Fall 2002, pp. 126-158.

" "Science in the Pursuit of Peace: The Success and Future of the ISTC" by Victor Alessi and Ronald Lehman, Arms Control Today, June/July 1998.

" "Illicit nuclear trafficking in the NIS: What's new? What's true?" by W.C. Potter and Elena Sokova, Nonprolifration Review, Summer 2002, p. 112.

" "Bioweapons from Russia: stemming the flow" by Jonathan Tucker, Issues in Science and Technology, Spring 1999.

" DoD CTR web page: http://www.dtra.mil/ctr/ctr_index.html

" ISTC web site: http://www.istc.ru/

**12. The goal of WMD policy: abolition or not?**
(Guest lecture?)

The Chemical Weapons Convention attempts to ban chemical weapons. The Biological Weapons Convention attempts to ban biological weapons. The Nonproliferation Treaty commits the nuclear-weapon states to pursue nuclear disarmament in good faith.

Some are profoundly sceptical, however, about the goal of eliminating WMD. They believe that the existence of nuclear weapons prevented World War III. They do not believe that the elimination of WMD is verifiable or that a zero-WMD world would be stable to a breakout. In short, they believe that WMD abolition is neither feasible nor desirable.

Some who are not comfortable with the idea of living with WMD indefinitely and who do not see how nations can remain indefinitely divided between a few WMD haves and the rest WMD have-not countries have postponed engaging in the debate because they think that, whether we are aiming for small or zero stockpiles makes little difference today. Others worry about fudging what they see as a profoundly moral issue.

Tutorial (FvH). Can we verify zero?

**Read:**
" "Statement on nuclear weapons by international generals and admirals." http://prop1.org/2000/genint.htm

" "Its dangerous to disarm" by Richard Haas (subsequently head of the State Department's Policy Planning office and now President of the Council on Foreign Relations), New York Times, Dec. 11, 1996.

" " The Gift of Time" by Jonathan Schell, (Metropolitan Books, 1998), pages to be selected

" "The road to abolition: how far can we go?" (pp. 287-301) in The Nuclear Turning Point.

" "Why Do We Have to Keep the Bomb?" by Kathleen Bailey, Bulletin of the Atomic Scientists, January/February 1995, http://www.thebulletin.org/issues/1995/jf95/jf95Bailey.html

" "Zero Tolerance" by Lee Butler (former Commander in Chief of the U.S. Strategic Command), Bulletin of the Atomic Scientists, January/February 2000, pp. 20-21, http://www.thebulletin.org/issues/2000/jf00/jf00butler.html

" "Remember your Humanity," Nobel Prize acceptance speech by Joseph Rotblat, Bulletin of the Atomic Scientists, March/April 1996, http://www.thebulletin.org/issues/1996/ma96/ma96rotblat.html

**Reference:**
" "13 Steps" excerpts from the NPT 2000 Review Final Document.