Princeton University
Woodrow Wilson School of Public and International Affairs
Graduate Program

TOPICS IN INTERNATIONAL RELATIONS

Protection Against Weapons of Mass Destruction (WMD)

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Sessions: Mondays, 1-4 PM
Program on Science and Global Security Conference Room, 221 Nassau St, 2nd floor

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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

Date D=Draft PM F= Final PM	**Unit**/Topic (Possible guest lecturers)
Feb. 5	1. Overview
Discuss and agree on course paper topic with one of us during the first four weeks	
Feb. 12	2. Nuclear weapons and their effects
Feb. 19, D1	3. Legacies of the Cold War: Deterrence, arms control and cooperative threat reduction
Feb. 26	4. Nuclear proliferation, Atoms for Peace and the NPT
Mar. 5, F1	5 Libya, North Korea and Iran
Mar. 12, D2	6. Multilateral arms control beyond the NPT: CTBT and the Fissile Material (Cutoff) Treaty (Nelson)
Break	
March 26	7. The India-Pakistan nuclear arms race and its byproducts (Mian)
April 2, F2	8. Missile proliferation and defense (Postol?)
April 9	9. The future of biological weapons (Chyba) (and a little about chemical weapons)
	Submit draft papers and begin presentations during ninth week
April 16	10. WMD terrorism, UNSCR 1540 and Homeland Security
April 23	11. The goal of nuclear-weapon policy: abolition or not?
April 30	12. Student paper presentations and a debate on how to deal with Iran

Nuclear and potential 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 therefore not a major focus of this course. The consequence of biological weapons use ranges from the trivial to the pandemic -- which can also happen naturally. They must therefore be considered.

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

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 (which turned out to have scrapped its WMD programs after the 1991 Gulf War). The U.K. and U.S. successfully pressed Libya to reveal and scrap its nuclear program. North Korea was persuaded to halt its plutonium program for 8 years but started an HEU program and, after being confronted by the Bush Administration, re-started its plutonium program and tested a nuclear weapon. Iran is pursuing, at the least, a nuclear-weapons *option* in defiance of demands from the U.N. Security Council that it suspend its enrichment and heavy-water reactor programs.

The greatest threat, however, may still be from the Cold War arsenals. Eighteen years after the fall of the Berlin Wall and sixteen after the disintegration of the Soviet Union, 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. The security of U.S. nuclear weapons and materials may be better but it is far from impregnable.

The US response to these security threats has included arms control and nonproliferation treaties, cooperative threat reduction programs 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.

The purpose of this course is to provide students with the information to be able to assess the effectiveness and the limits of these various ways of dealing with WMD and also to provide some orders of magnitude and simple back-of-the-envelope (BoE) approaches to assessing the threats and alternative defenses.

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 memos (PMs) are due in draft February 19 and March 12. Feedback will be provided within a week and the memos are due in final form March 5 and April 2. 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 week of April 9. Written and oral reactions to the readings by volunteers each week. No final.

Reading Materials. Read the week's section in the syllabus first as an overview. For those readings for which URLs are not supplied, copies are available on Blackboard. *Deadly Arsenals: Nuclear, Biological, and Chemical Threats, 2nd edition, by* Joseph Cirincione *et al* (Carnegie Endowment for International Peace, 2005) is recommended for purchase and also on reserve in the WWS Stokes Library in the basement of Wallace Hall and. It can be purchased at http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=16650&prog=zgp&proj=znpp. Students can pick up free copies of *Global Fissile Material Report 2006* at the Program on Science and Global Security, 221 Nassau St, 2nd floor.

Useful web sites:

Arms Control Association/Arms Control Today: www.armscontrol.org
Armscontrolwonk: www.armscontrolwonk.com
Bulletin of the Atomic Scientists: www.thebulletin.org. See especially the NRDC nuclear notebook: http://www.thebulletin.org/nuclear_weapons_data/index.htm
Carnegie Endowment for Peace Nonproliferation Program: www.carnegieendowment.org/npp
Disarmament Diplomacy: www.acronym.org.uk
Federation of American Scientists: www.fas.org
Global Security: http://www.globalsecurity.org/wmd/index.html
Institute for Science and International Security: http://www.isis-online.org
International Atomic Energy Agency: http://www.iaea.org
International Panel on Fissile Materials: www.fissilematerials.org
Monterey Institute for International Studies, Center for Nonproliferation Studies: www.cns.miis.edu;
Nonproliferation Review: www.cns.miis.edu/pubs/npr
Nuclear Information Project: www.nukestrat.com
Nuclear Threat Initiative: www.nti.org
RANSAC Nuclear Security Advisory Council: www.ransac.org
Science and Global Security: www.princeton.edu/~globsec/publications/SciGloSec.shtml

I. OVERVIEW

1. Overview of the different approaches to protection from WMD

The U.S. has spent enormous sums acquiring nuclear weapons and on defenses against them: as of 1996, about $5 trillion on the weapons and the means to deliver them, $1 trillion on bomber and missile defense, and $20 billion on civil defense.[1] **[Footnotes are references not readings.]** Smaller amounts have been spent on chemical and biological weapons in the past and defenses against them more recently. Efforts to control the spread of WMD include nonproliferation treaties, export controls and preemption. Where weapons exist, means to limit and reduce them include arms control and cooperative threat reduction.

Deterrence. 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, the U.S., France and U.K. also used nuclear threats to deter a perceived threat of massive Soviet conventional attack and, since the Cold War, a weakened Russia has similarly invoked nuclear deterrence against the possibility of 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 used the threat of nuclear retaliation to deter chemical and biological as well as nuclear attacks. This policy appears to contradict U.S. commitments made in support of the Nonproliferation Treaty that the U.S. 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-armed state.

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

Treaties. Major attempts have also been made to deal with WMD through international treaties.[2] These include:

- The [Nuclear-weapons] Nonproliferation Treaty of 1970 under which all non-nuclear weapon states have committed not to acquire nuclear weapons and to accept International Atomic Energy Agency monitoring of their nuclear activities in

[1] *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940,* Stephen Schwartz, ed. (Brookings, 1998).
[2] For the texts of the treaties see http://www.state.gov/www/global/arms/bureau_ac/treaties_ac.html

exchange for commitments by the U.S., Russia, Britain, France and China to eventual nuclear disarmament. (Israel, India, Pakistan and North Korea are outside the treaty);

- The Biological Weapons Convention (BWC) of 1972, under which, as of Oct. 2006, 155 out of 192 countries have agreed to ban biological weapons but without any arrangements for verification.[3]

- The Chemical Weapons Convention (CWC) of 1993, under which, as of the end of 2006, 181 countries have agreed to eliminate their chemical weapons by specified dates and to accept inspections by the Organization for the Prohibition of Chemical Weapons of facilities that could produce or are suspected of producing CW. [4]

Compliance with these commitments has been impressive but far from perfect. The State Department's most recent (August 2005) report, *Adherence to and Compliance With Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* gives the U.S. Government's view on these issues. [5]

Export controls. Attempts have been made to reinforce the WMD regimes with agreements between countries possessing relevant technologies not to export technologies that could facilitate WMD or long-range missile programs in suspect countries: the Nuclear Suppliers Group,[6] the Australia Group (BW and CW technologies and materials),[7] and the Missile Technology Control Regime.[8]

Preemption. 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 Osirak reactor before it could be 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.[9] Iraq expelled these inspectors in 1998 and five years later U.S. and allied forces invaded Iraq out of concern that Iraq had reconstituted its WMD programs.[10]

The U.S. almost mounted an attack on North Korea's plutonium-production facilities in 1994. The crisis was defused after Jimmy Carter mediated an agreement under which North Korea shut down these facilities in exchange for heavy oil for its power-plant boilers and the construction of two nuclear power reactors. This agreement broke down in early 2003 because of the DPRK's clandestine uranium-enrichment program.

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[3] http://www.armscontrol.org/factsheets/bwcataglance.asp
[4] http://www.opcw.org/factsandfigures/index.html#participation
[5] *http://www.state.gov/t/vci/rls/rpt/51977.htm.*
[6] http://www.nsg-online.org/
[7] http://www.australiagroup.net/index_en.htm
[8] http://www.mtcr.info/english/index.html
[9] International Atomic Energy Agency <http://www.iaea.org/worldatom/Programmes/ActionTeam/nwp2.html > and UN Special Commission http://www.un.org/Depts/unscom.
[10] For the U.S. post-war reassessment of the basis of that concern, see *Comprehnsive Report of the Special Advisor to the DCI on Iraq's WMD,* 30 Sept. 2004, http://www.cia.gov/cia/reports/iraq_wmd_2004/

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."[11]

Arms control. In addition to the WMD 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 Strategic Offensive Reductions Treaty (2002). A Comprehensive [nuclear] Test Ban Treaty has been ratified by 132 countries but will only come into force when all the 44 countries that had nuclear reactors in 1996 have all ratified it. Ten, including the U.S., have not.

Arms control and weapon-ban agreements have always been 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 could do. With the end of the Cold War, concerns about what other countries might do if unconstrained have declined. 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 because it would bring unwelcome inspections to the U.S. pharmaceutical industry and DoD biodefense programs. In 2002 the Bush Administration withdrew from the 1972 ABM Treaty that limited U.S. and Soviet/Russian missile defenses. The Moscow Treaty of 2003, which mandates further cuts in Russian and U.S. deployed nuclear warheads has no verification arrangements and will be in force for only one day (December 31, 2012). In 2004, the Bush Administration announced that a Fissile Material Cutoff Treaty with "effective verification is not achievable." (The FMCT would end the production of plutonium and highly enriched uranium for weapons.) Future Administrations may, however, see more merit in arms control.

Cooperative Threat Reduction. 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 provide civilian jobs for their excess WMD experts to prevent them from becoming sources of materials and expertise for

[11] http://www.fas.org/irp/offdocs/nspd/nspd-17.html

terrorists or would-be WMD states. More recently, CTR programs have been established in Iraq and Libya.

Presentations: Overview and history (FvH). Perspectives (AG, and SK).

Read

- "Global Trends" (pp. 3-25) in *Deadly Arsenals: Nuclear, Biological, and Chemical Threats* by Joseph Cirincione *et al* (Carnegie Endowment for International Peace, 2005. (The chapter is also at http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=16650&prog=zgp&proj=znpp) Students are advised to buy a copy of *Deadly Arsenals*.

- "Apocalypse Soon," Robert McNamara, *Foreign Policy*, May/June 2005, pp. 29-35 (on Blackboard)

- "Restraints Fray and Risks Grow as Nuclear Club Gains Members," by William J. Broad And David E. Sanger, *New York Times*, October 15, 2006, (on Blackboard)

- *Americans on WMD Proliferation* (poll) April 2004, http://www.pipa.org/OnlineReports/WMDProliferation/WMD_Prolif_Apr04/WMDProlif_Apr04_rpt.pdf. Summary (pages 2&3) and browse through the rest of the report

- Mohamed ElBaradei – Nobel Lecture, Oslo, December 10, 2005, http://nobelprize.org/peace/laureates/2005/elbaradei-lecture-en.html

Related material of interest (aka "References")

- "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 weapons and their effects**

Fissile materials. 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% in chain-reacting U-235 (from the natural level of 0.7%) and the artificial element, plutonium.

Uranium is enriched by technologies that use the 1-percent weight difference between U-235 and the chemically virtually identical isotope U-238 that makes up the remainder of natural uranium. Enrichment technology is still beyond the practical reach of subnational groups.

To produce a nuclear explosion, one must assemble a super-critical mass of fissile material so that about two of the approximately three neutrons produced by each fission will cause follow-on fissions, 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 thermonuclear 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. Most secondaries are believed to also include fissile material.

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).[12] At slow speeds, neutrons develop a strong preference for absorption by U-235. Some "slow-neutron" reactors can maintain a chain reaction even if they are 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 that do not absorb neutrons – in practice, very pure graphite or heavy water.

Fissile material is detected through its weak emissions of penetrating gamma rays associated with the continuous very slow radioactive decay of its atoms and, especially in the case of plutonium, neutrons emitted by spontaneous fissions. 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.

Nuclear-weapon effects. The major effects of nuclear explosions are direct neutron and gamma radiation at short range, 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 particles that can carry the radioactivity back to the ground. 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).

Tutorials: Design of the Hiroshima and Nagasaki bombs (Kemp); Nuclear-weapon effects (AG); Nuclear winter (FvH).

Read

- *Global Fissile Material 2006*, chapters 1-2, pp. 6-18. (Copies available as PS&GS.)
- "City of Doom" in *Hiroshima: Three Witnesses* by Richard H. Minear (Princeton University Press, 1990), pp. 178-197 (on Blackboard).
- *The U.S. Nuclear War Plan: A Time for Change* (NRDC, 2001) Slide show, http://www.nrdc.org/nuclear/planphoto/planphoto.asp

[12] Other artificial fissile materials can be made in this way -- notably U-233 by neutron capture on Th-232.

- "Nuclear winter revisited with a modern climate model and current nuclear arsenals: Still catastrophic consequences," Alan Robock, Luke Oman, and Georgiy Stenchikov, submitted to *J. Geophys. Research, 2006,* http://climate.envsci.rutgers.edu/pdf/nw4.pdf

References

- Nuclear weapons effect applet, *http://www.fas.org/main/content.jsp?formAction=297&contentId=367*
- Recommendation of the General Advisory Committee to the Atomic Energy Commission against the development of the H-bomb, October 30, 1949, reprinted in *The Advisors: Oppenheimer, Teller, and the Superbomb* by Herbert York, Stanford University Press, pp. 159-162.
- "Nuclear weapons" (pp. 58-65) in *Megawatts and Megatons* by Richard Garwin and Georges Charpak (Alfred A. Knopf, 2001).
- 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. Scanned version at http://www.princeton.edu/~globsec/publications/effects/effects.shtml
- 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).
- 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 that 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 cancer risk 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

3. Legacies of the Cold War: Deterrence, arms control and cooperative threat reduction

Nuclear deterrence. After the first Soviet nuclear test in 1949, the U.S. built up in a decade from a few hundred Nagaski-type bombs with yields of a few tens of kilotons to tens of thousands of hydrogen bombs with yields of megatons (a thousand kilotons).

In the 1950s, the U.S. threatened "massive [nuclear] retaliation" in response to fears of a Soviet invasion of Western Europe. By 1963, this would have meant the deaths of several hundred million people in the Soviet Union and China plus perhaps one hundred million in allied countries killed by the radioactive fallout.

Many attempts were made by nuclear theorists to devise ways in which mutual deterrence might be circumvented by the U.S. or the Soviet Union. One idea was that one side might disarm the other with a first strike. The arms race turned on the offensive side toward more accurate missile warheads and on the defensive side toward more survivable basing modes: missile silos, submarines, land-mobile missiles and early warning systems to allow launch before the attacking weapons arrived.

Another idea was that it might be possible in some sense to win a "limited" nuclear war – either with battlefield nuclear weapons or with strategic nuclear weapons launched against each other. But calculations of the "collateral" deaths from such limited nuclear wars ran into the tens of millions and no one could guarantee that the "losing" side would not "escalate" to all-out nuclear war.

The Cold War ended without nuclear weapons being used, which some saw as a testimony to the robustness of deterrence but others worried about the near misses – most notably, the Cuban Missile crisis.

Despite the fact that the Washington and Moscow are no longer see each other as existential threats, a large fraction of both countries' missiles remain ready to launch at the other. Paradoxically, the nuclear confrontation, with its dangers of accidental or unauthorized launch, has outlived its political origin.

U.S. –Soviet/Russian nuclear arms control. In1946, the U.S. offered to eliminate its nuclear weapons if other countries first opened themselves to international inspections that would verify that they were not pursuing nuclear weapons. Negotiations quickly reached an impasse with the Soviet Union 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 nuclear buildups and later to reduce their nuclear weapons.

The first U.S-Soviet agreement limiting nuclear weapons was the 1972 U.S.-Soviet SALT I Interim Agreement with Respect to Limitation of Strategic Offensive Arms. This was paired with the Anti-Ballistic Missile (ABM) Treaty under which the U.S. and Soviet Union agreed not to add to the offense-offense arms race an offense-defense arms

race. The SALT I agreement was followed by the un-ratified but complied with 1979 SALT II Treaty that limited numbers of warheads per missile as well as missile launchers. The SALT Treaties were verified only by "national technical means:" imaging satellites and long-range radars for tracking missile tests.

The ending of the Cold War was heralded by agreements under which the U.S. and Soviet Union agreed to reduce their huge offensive nuclear arsenals. The 1987 Intermediate-range Nuclear Forces Treaty eliminated land-based missiles with ranges between 500 and 5500 km. And the 1994 Strategic Arms Reduction Treaty (START), which limits Russia and the U.S. each to a total of 4900 warheads deployed on the ballistic missiles and a total of 1600 intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and heavy bombers.[13] START implementation was completed on Dec. 5, 2001. As a result of Gorbachev's exchange of Soviet paranoia for "glasnost," (transparency) the INF and START Treaties include inspections at missile, ballistic-missile submarine and heavy-bomber bases and even the removal of the nose cones from randomly selected ballistic missiles to enable inspectors from the other country to check that the number of warheads carried is in agreement with the number declared.

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. However, in 1991, Presidents Bush I 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 store 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 tens of thousands to the low thousands.

Presidents Clinton and Yeltsin wanted to follow up the START Treaty with START II and START III Treaties that would have reduced the strategic offensive forces to less than 2500 warheads on each side. But the growing pressure for ballistic missile defense from the Republicans after they took over the Congress in 1994 and Russian concerns that U.S. deployment of such defenses might bring their deterrent into question resulted in START II not being ratified and START III being aborted.

In 2001, President Bush announced U.S. withdrawal from the ABM Treaty. Under pressure from President Putin and alarmed U.S. and European arms control advocates, in 2002, Presidents Bush and Putin signed the Strategic Offensive Reductions Treaty (SORT), according to which the U.S. and Russia will limit the number of their deployed strategic warheads to less than 2200 on Dec. 31, 2012. At the Bush Administration's

[13] http://www.armscontrol.org/factsheets/start1.asp

insistence, however, the treaty has no requirements to destroy warheads taken off deployment or weapon-delivery systems, and is to remain in force only for one day. The Treaty has no verification arrangements of its own but could be verified by the detailed verification arrangements in the START Treaty -- if START is extended beyond 2009. SORT can be extended by "subsequent agreement"[14] but the Bush Administration made clear that, as far as it was concerned, this was the end of U.S.-Soviet/Russian arms control.

In 2004, under pressure from Congress to reduce the number of non-deployed U.S. nuclear warheads to reflect reductions in deployed warheads, the Bush Administration announced a reduction by "almost half." Based on non-governmental estimates, this would correspond to a reduction from about 11,000 to about 6,000 total U.S. strategic and tactical nuclear warheads.[15] Western estimates of the number of intact warheads that Russia has are very uncertain. Typically, it is assumed that Russia has the same number as the U.S. with an uncertainty of a factor of two.

Cooperative Threat Reduction. With the end of the Cold War, a new danger emerged: that the oversized WMD complexes that Russia could no longer support might become sources of nuclear or biological weapons materials or expertise for terrorists or states. The U.S. therefore launched a number of programs to assist Russia in downsizing its production complexes, converting excess WMD personnel and disposing of the materials.

The name of one of these programs, the DoD's "Nunn-Lugar" or "Cooperative Threat Reduction" program, is often used loosely as a label for all these programs. However, the largest nuclear assistance programs are located within the DoE's National Nuclear Security Administration (NNSA). U.S. involvement in the International Science and Technology Centers (ISTC), which provide R&D contracts to needy former Soviet Union scientists, is managed by the State Department. In fiscal year 2006, the total annual cooperative Threat Reduction budget for NNSA was about $800 million, for DOD about $400 million, and for State about $150 million.[16]

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 for resale for nuclear-power-reactor fuel after it is blended down to low-enriched uranium (LEU). The annual income of Russia's nuclear complex from this deal is about $500 million and the Russian weapon uranium fuels about one half of U.S. nuclear-power capacity generating about 10 percent of U.S. electricity.

The largest NNSA program is the Materials Protection, Control and Accounting program (over $400 M in FY06). This program works to strengthen the security of Russian warheads, and fissile and radiological materials, provides radiation detectors at border crossings and megaports, and works to eliminate excess Russian civilian HEU. Other

[14] http://www.state.gov/p/eur/rls/or/2002/10471.htm
[15] "What's behind Bush's Nuclear Cuts" by Robert Norris and Hans Kristensen, Arms Control Today, October 2004, pp. 6-12, http://www.armscontrol.org/act/2004_10/NRDC.asp.
[16] www.ransac.org

programs include conversion of U.S. and Soviet-designed HEU-fueled reactors ($25 M) and return to Russia of HEU fuel exported by the Soviet Union ($15 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 for the local populations ($174 M), and assistance in the disposal of excess Russian weapons plutonium ($35 M).

The DoD programs[17] include: chemical-weapon destruction ($100 M), elimination of strategic delivery vehicles (missile submarines, etc., $80 M), warhead security upgrades ($100 M), and WMD & BW proliferation prevention ($100 M).

The State Dept. programs include: non-weapons R&D for Russian WMD scientists ($60 M), and training of border-control personnel ($10 M). The major conduit of funding to support non-weapons R&D by Russian WMD experts is the International Science and Technology Center in Moscow, which is co-funded with a consortium of other nations.[18]

Cooperative efforts to upgrade fissile-material security have been attempted with other countries as well. The collaboration with China was suspended after the unproven Wen Ho Lee spy accusations.[19] During the Afghanistan war, the U.S. offered to help Pakistan to upgrade the security of its nuclear weapons and materials. Pakistan refused out of fear that the U.S. might try to seize or destroy these strategic assets if it knew where they were. Limited investments have been made in providing new employment for former Iraqi and Libyan WMD experts.

Tutorials: Satellite imaging (A.G.). The successes and limitations of Cooperative Threat Reduction (FvH). Deterrence (R.S.K.)

Film (FvH has a copy if you haven't seen and want to borrow): *Dr Strangelove; 13 Days* (2000, 147 minutes).

Read:

- "JFK's first-strike plan" by Fred Kaplan, *Atlantic Monthly*, October 2001, p. 81 (on Blackboard).

- "The Rise of U.S. Nuclear Primacy by Keir A. Lieber and Daryl G. Press, *Foreign Affairs,* March/April 2006, p. 42 (on Blackboard). [For U.S., Chinese and Russian critiques of this simplistic analysis, see Bruce Blair and Chen Yali, "The Fallacy of Nuclear Primarcy;" Li Bin, "Paper Tiger with Whitened Teeth;" and Ivan Safanchuk, "Beyond MAD" in *China Security,* Fall 2006, http://www.wsichina.org/]

[17] http://www.defenselink.mil/pubs/ctr/
[18] http://www.istc.ru/
[19] "Scientist, fisherman, gardener, spy" by Stephen Schwartz in *The Bulletin of the Atomic Scientists,* November/December 2000, p. 31.

- "Taking nuclear weapons off hair-trigger alert" by Bruce Blair, Harold Feiveson and Frank von Hippel, *Scientific American,* November 1997, pp. 74-81 (on Blackboard).

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

- "ReSTART: The Need for a New U.S.-Russian Strategic Arms Agreement," by Anatoli Diakov and Eugene Miasnikov, *Arms Control Today,* September 2006 (on Blackboard).

- "Potatoes were guarded better…" by Oleg Bukharin and William Potter, *Bulletin of the Atomic Scientists,* May-June 1995 (on BlackBoard)

- "Nuclear Roulette" (pp. 231-279) in *Hang Separately: Cooperative Security between the United States and Russia, 1985-1994* by Leon V. Sigal (New York: The Century Foundation Press, 2000)(on Blackboard).

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- *Beyond Nuclear Deterrence: Transforming the U.S.-Russian Equation* by Alexei Arbatov and Vladimir Dvorkin (Carnegie Endowment for International Peace, 2006)

- 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.

- "The false god of nuclear deterrence" by Lee Butler, Global Dialogue, Autumn 1999, p. 74.

- "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*.

- "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

- *Monitoring Nuclear Weapons and Nuclear-Explosive Materials: An Assessment of Methods and Capabilities* (National Academy Press, 2005).

- *Controlling Nuclear Warheads and Materials* by Matthew Bunn and Anthony Wier (Nuclear Threat Initiative) http://www.nti.org/e_research/cnwm/overview/cnwm_home.asp

4. **Nuclear proliferation, "Atoms for Peace" and the NPT**

The Non-proliferation Treaty. 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, amounts to a bargain between five "nuclear-weapon states" (U.S., Soviet Union/Russsia, U.K., France, China) that conducted nuclear explosions prior to 1967 and the non-nuclear-weapon states. The non-weapon states commit not to acquire nuclear weapons and to allow the IAEA to verify their compliance. The weapon states commit to: i) "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."

Today Israel, India, North Korea and Pakistan are the only states outside the treaty and are *de facto* nuclear-weapon states. (North Korea joined the NPT in 1985 but never allowed full IAEA inspections to verify its compliance and, after a long series of crises, withdrew from the Treaty in 2003.)

Thus far, the NPT has been amazingly successful in establishing an international norm against the spread of nuclear weapons. South Africa stayed outside and 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 military juntas ruled them 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. Iraq and Libya had clandestine nuclear-weapon development programs but gave them up as a result of international pressure.

On the proliferation side, the struggle over the future of the NPT is focused on the Iran's nuclear program. On the disarmament side, the crisis has been caused by the Bush Administration's rejection of arms control. The high-water mark in a shared vision of steps toward nuclear disarmament occurred at the NPT Review Conference of 2000 and was expressed in the "13 steps" agreed to by the original five nuclear-weapon states. The Bush Administration has repudiated most of the items in this agreement and blocked it even being mentioned in the documents of the NPT Review Conference of 2005, contributing to that conference not even being able to agree on an agenda.

Atoms for Peace. 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."[20]

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."[21]

During the 20 years following President Eisenhower's speech, the U.S. and Soviet Union exported to approximately 50 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.

Article IV of the 1970 Nonproliferation Treaty assured the non-weapon states of their "inalienable right…to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with articles I and II of this Treaty [which contain the basic commitment not to acquire nuclear weapons]." Today, Iran frequently cites this inalienable right and the U.S. and other countries express skepticism about Iran's commitment to not acquire nuclear weapons.

Export controls. The period of lack of concern about the spread of reactor fuel-cycle facilities that gave so many countries 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 used in its "peaceful nuclear explosion."[22]

The U.S. changed its export policy dramatically after the Indian nuclear explosion but the export policies of other countries changed more gradually. In 1976, France supplied Iraq with the high-powered HEU-fueled research reactor that Israel bombed in 1981.

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-

[20] http://www.eisenhower.utexas.edu/atoms.htm
[21] http://www.learnworld.com/ZNW/LWText.Acheson-Lilienthal.html#text
[22] Israel received similar assistance from France, which had full knowledge of Israel's interest in nuclear weapons. Pakistan obtained the uranium centrifuge technology that it used to make highly-enriched uranium for weapons clandestinely from a Dutch civilian uranium enrichment company.

separation technologies. Following the 1991 Gulf War, export controls were extended to "dual-use" equipment and components as well. In addition the NSG agreed not to export nuclear technologies or materials at all to countries outside of the NPT.[23] The Bush Administration recently obtained an exemption for India for reactor technology and nuclear fuel but this exemption still has to be approved by the Nuclear Suppliers Group.

The system is only as strong as its weakest element however. Pakistan, not a member of the Nuclear Supplier's Group supplied Iran, Libya and North Korea with centrifuge-enrichment technology.

IAEA safeguards. 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 that requires signatories to declare the locations of nuclear-fuel-cycle related research and development activities even when they do not involve the use of nuclear material (e.g. centrifuge development and manufacture). The Additional Protocol also 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.[24] As of November 26, 2006, the Additional Protocol had been ratified and brought into force in 77 countries. Iran has not ratified by complied on a voluntary basis until its case was referred to the U.N. Security Council.[25]

Tutorials: Making plutonium (FvH), highly-enriched uranium (AG), IAEA safeguards (SK)

Read:

- Nonproliferation Treaty, http://www.un.org/events/npt2005/npttreaty.html and the "13 Steps" excerpts from the NPT 2000 Review Final Document, http://www.reachingcriticalwill.org/legal/npt/13point.html

- "Nuclear supplier organizations" (pp. 443-450) in *Deadly Arsenals*.

- *Global Fissile Material Report 2006*, chapters 3-4, pp. 21-37.

- "Why do states build nuclear weapons? Three models in search of a bomb" by Scott Sagan, *International Security 21,* Winter 1996/97, pp. 54-86 (on Blackboard).

- "Half Full or Half Empty? Realizing the promise of the Nonproliferation Treaty" by Jean du Preez, *Arms Control Today,* December 2006 (on Blackboard).

[23] http://www.nsg-online.org/
[24] www.iaea.org/Publications/Documents/ Infcircs/1998/infcirc540corrected.pdf
[25] http://www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html

- "The Thinkable" by Bill Keller, New York Times Magazine, May 4, 2003 (on Blackboard).

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

- "Politics and protection: Why the 2005 NPT Review Conference failed" by Rebecca Johnson, Disarmament Diplomacy 80 Autumn 2005, http://www.acronym.org.uk/dd/dd80/80npt.htm

- "Turning a Blind Eye Again? The Khan Network's History and Lessons for U.S. Policy" by Leonard Weiss, Arms Control Today, March 2005, http://www.armscontrol.org/act/2005_03/Weiss.asp

- "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).

- "South Africa and the affordable bomb" by David Albright, *Bulletin of the Atomic Scientists,* July/August 1994, pp. 37-47.

- "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),

- 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).

5. **Iraq, DPRK, Libya and Iran**

Since the end of the Cold War, secret nuclear-weapon programs have been discovered in at least four countries that had signed up to the NPT: Iraq, the DPRK, Libya and Iran. We know now that Iraq's program was shut down after its defeat in the 1991 Gulf War and the imposition of unprecedented international inspections. The DPRK went all the way and even carried out a nuclear test in 2006. Libya decided "to come in from the Cold." Iran certainly wants at least a nuclear-weapon option – like Japan but has not yet overtly committed to actually acquiring nuclear weapons.

Preemption. A Princeton PhD thesis by Lyle Goldstein (2001), now published,[26] provides compelling evidence that nascent nuclear programs 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, U.S.-Iran and perhaps, in case of a confrontation over Taiwan, still U.S.-China.

Read:

- "North Korea" (pp. 279-293); "Iran (pp. 294-313); and "Libya" (pp. 316-327) in *Deadly Arsenals.*

- Robert S. Norris and Hans M. Kristensen, "U.S. nuclear threats: Then and now," *Bulletin of the Atomic Scientists,* September/October 2006, pp. 69-71 (on Blackboard).

- "The new calculus of pre-emption" by Robert Litwak, *Survival 44,* Winter 2002-2003, pp. 53-80 (on Blackboard).

- "Uncooperative America" (pp. 1-10) in *Hang Separately: Cooperative Security between the United States and Russia, 1985-1994* by Leon V. Sigal (Century Foundation Press, 2000) (on Blackboard).

- "Who "won" Libya? The force-diplomacy debate and its implications for theory and policy," by Bruce W. Jentleson and Christopher Whytock, *International Security*, Winter 2005/2006 (on Blackboard). [skim]

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- "In Focus: IAEA and Iran," http://www.iaea.org/NewsCenter/Focus/IaeaIran/index.shtml

- Nuclear Posture Review (leaked excerpts from a classified document submitted to Congress, December 31, 2001), http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm

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

6. **Multilateral nuclear arms control beyond the NPT: the Comprehensive Test Ban and the Fissile Material (Cutoff) Treaty**

[26] Lyle J. Goldstein, *Preventative Attack and Weapons of Mass Destruction: A Comparative Historical Analysis* (Stanford University Press, 2006).

Starting with the Nonproliferation Treaty, there have been a series of treaties proposed to deal with WMD on multilateral basis. The objective – as with the NPT – has been to get all countries to join.

The Biological Weapons Convention came into force in 1975 and bans the acquisition of any biological or toxin weapons. This treaty will be discussed in a later week.

The Chemical Weapons Convention (CWC) which came into force in 1997, similarly bans the possession of chemical weapons. Unlike the BWC and like the NPT, the CWC has associated with it a verification organization, the Organization for the Prohibition of Chemical Weapons.

With regard to the nonproliferation and elimination nuclear weapons, since 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 Material Cutoff Treaty that would ban the production of more fissile materials for nuclear weapons.

The Comprehensive Nuclear Test Ban (CTB). 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, *The Lucky Dragon,* causing the death of one of its crew. In 1963, after the Cuban Missile Crisis scared the leaderships of the USSR and U.S. as well as the world public, 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 nuclear-weapon states joined.[27] In 1974, 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 unilateral testing moratoria announced by Gorbachev and Yeltsin, Congress forced an end to U.S. nuclear testing. In 1996, after prolonged negotiations in the Geneva-based U.N. Conference on Disarmament, most countries signed a Comprehensive Test Ban Treaty (CTBT). However, in 1999, in a party-line vote (with the Republicans voting against and the Democrats voting for) the U.S. Senate refused to ratify the treaty. Although the CTBT has been ratified by 132 countries it will not come into force until all the 44 countries that had nuclear reactors in 1996 have all ratified it. Ten, including the U.S., have not.[28]

Central issues in the U.S. debate over the CTBT were (and are) whether:

- The U.S. can maintain the reliability of its nuclear weapons without testing;
- The U.S. needs new types of nuclear weapons that would have to be tested;

[27] *SIPRI Yearbook 2006: Armaments, Disarmament and International Security* (Oxford University Press), p. 805.
[28] http://www.armscontrol.org/factsheets/ctbtsig.asp

- Other countries could gain significant advantage by cheating below the detection threshold.[29]

Three years after the Senate voted the CTBT down, the National Academy of Sciences published an analysis of these issues.[30]

Despite the Senate rejection of the CTB Treaty, there has been a global testing moratorium since 1996 except for the Indian and Pakistani nuclear tests of May 1998

The G.W. Bush Administration opposes ratification of the CTBT but says that it sees no current need to test. However, the leaderships of both the Department of Defense and Energy have called into question U.S. capability to maintain its nuclear stockpile without testing and have promoted new nuclear weapons – especially a nuclear earth penetrating "bunker buster." There was a major debate in the Senate on May 20-21, 2003 over the earth-penetrator and the repeal of a 1993 law[31] 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. After two more years of debate, the bunker buster proposal was zeroed out by the Congress in 2005. It has been replaced, however, by a program to develop a new "Reliable Replacement Warhead" that is supposed to be developed and deployed without testing. Thus, a consensus appears to have developed that the end of testing is desirable but a two-thirds Senate majority does not exist to ratify the CTBT.

Ending the production of fissile materials for weapons. During the 1950s and '60s, when the U.S. was far ahead of the Soviet Union in its nuclear-weapons buildup, it repeatedly proposed a bilateral halt of the production fissile materials for weapons. After the end of the Cold War, with the Cold War arsenals being downsized and a resulting surplus of fissile material, an international consensus developed that a global Fissile Material Cutoff Treaty (FMCT) should be negotiated in the UN standing Conference on Disarmament (CD) in Geneva. Negotiations have been blocked since 1994, however, by linkage requirements by various countries of FMCT negotiations to talks on nuclear disarmament and the non-weaponization of space (the latter by China and Russia) and by the U.S. refusal to agree to such linkages. In 2004, the Bush Administration announced in addition that it did not think that an FMCT would be effectively verifiable and, in 2006, submitted to the CD a declaratory treaty similar to the Biological Weapons Convention. This upset many non-weapon states that have accepted strict IAEA verification of the peaceful nature of their nuclear programs.

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[29] The Senate debate, including much information submitted for the record, may be found in the *Congressional Record* of Oct. 8, 1999, pp. S12257-316; Oct, 12, pp. S12329-405; Oct. 13, pp. S12505-550, http://thomas.loc.gov.

[30] *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

[31] Spratt-Furse amend: http://www.ucsusa.org/global_security/nuclear_weapons/page.cfm?pageID=1182

Many non-weapon states prefer to call the proposed treaty a Fissile Material Treaty because they would like to see it go beyond a simple cutoff of future production and include as well a ban on the weapons use of civilian fissile material and also the placement of fissile materials removed from excess warheads under IAEA monitoring. A complication that must be confronted by any verification proposal is U.S., Russian and U.K. use of highly enriched uranium for naval-reactor fuel as well as weapons.

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 and China also let it be known that it had stopped producing. This would leave only Israel, India, Pakistan and North Korea still producing fissile material for weapons.

Tutorials: The rise and fall of the robust nuclear bunker buster and the rise of the reliable replacement warhead (RN). Verifying a ban on fissile-material production for weapons (FvH & SK).

Read

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

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

- Linton F. Brooks, Administrator, National Nuclear Security Administration, *The Future Of The U.S. Nuclear Weapons Stockpile*, 25 January 2006, pp. 1-4 (on Blackboard).

- *If it ain't broke: The already reliable U.S. nuclear arsenal* by Robert Nelson, *Arms Control Today,* April 2006, http://www.armscontrol.org/act/2006_04/reliablefeature.asp

- *Global Fissile Material Report 2006,* Chapter 5, "A Fissile Material Cutoff Treaty," pp. 40-50.

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- "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;

- *Nuclear weapons: The reliable replacement warhead program and the life extension program* by Jonathan Medalia, Congressional Research Service, December 13, 2006, http://fas.org/sgp/crs/nuke/RL33748.pdf.

- *Nuclear warheads: The reliable replacement warhead program and the life extension program* by Jonathan Medalia, Congressional Research Service, 2006, http://www.fas.org/sgp/crs/nuke/RL33748.pdf

- Draft "Treaty Banning the Production of Fissile Material for Use in Nuclear Weapons or Other Nuclear Explosives" by Tom Shea, 13 November 2003, http://www.fissilematerials.org/ipfm/site_down/fmct-shea.pdf

7. The India-Pakistan Nuclear Arms Race and Its Byproducts

The South Asian nuclear arms race is often characterized as currently the most dangerous in the world because of the periodic Pakistani-Indian crises over the divided state of Kashmir and attacks by Pakistan-based Islamic fundamentalists, including the December 2001 attack on India's Parliament which led to massive mobilizations and nuclear threats from both sides.

India's nuclear weapons program grew out of Atoms for Peace programs sponsored by the U.S. and Canada. Pakistan's nuclear-weapons program grew from A.Q. Khan's theft from the Netherlands of centrifuge designs and supplier lists. Pakistan has also received assistance from China.

The U.S. cut off relations with India's nuclear program after India's first nuclear test in 1974 and persuaded the Nuclear Suppliers Group (NSG) to do likewise for India and other non-NPT states (Israel and Pakistan). Recently, however, the U.S. reversed its position on India and is attempting to persuade the NSG to do so as well. China has proposed that nuclear trade be allowed with Pakistan as well.

If the U.S. succeeds in persuading the NSG and IAEA to go along with its proposal, India's nuclear-energy program would be divided into two parts: a civilian program with which international cooperation would be allowed and that would be under IAEA safeguards, and another part which could be used to produce plutonium and HEU for weapons as well as nuclear power. Both India and Pakistan are building facilities that could accelerate their nuclear-weapon buildups.

Tutorials: Stable/unstable nuclear balances; early-warning systems

Read:

- "The nuclear confrontation in South Asia" by M.V. Ramana and Zia Mian, *SIPRI Yearbook 2003*, Oxford University Press, 2003, pp. 195-212 (on Blackboard).

- "Against Nuclear Apartheid" by Jaswant Singh, *Foreign Affairs,* Sept.-Oct. 1998, p. 41 (on Blackboard).

- "The Wrath of Khan" by William Langewiesche, *Atlantic Monthly*, November 2005, pp. 62-85 (on Blackboard).

- "Wrong Ends, Means, and Needs: Behind the U.S. Nuclear Deal with India" by Zia Mian and M. V. Ramana , *Arms Control Today*, January/February 2006, pp. 11-17, http://www.armscontrol.org/act/2006_01-02/JANFEB-IndiaFeature.asp

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- "India, Pakistan and the Bomb" by M. V. Ramana and A. H. Nayyar, *Scientific American*, December 2001, pp.72-83.
- *Deadly Arsenals*: Chapter 11: India (pp. 220-237); and Chapter 12: Pakistan (pp. 238-258).
- *Fissile Materials in South Asia: The implication of the U.S.-India nuclear deal* by Zia Mian, A.H. Nayyar, R. Rajaraman and M.V. Ramana (International Panel on Fissile Materials) Sept. 2006.

8. **Missile Proliferation and Defense**

Aerial warfare in World War II was dominated by mass bombings and efforts to shoot down the bombers. 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 the forebearers of modern cruise and ballistic missiles. Indeed, the V-2 is still with us in the form of the Scud missiles that the Soviet Union produced and exported in great numbers and that North Korea, Iraq, Iran and other countries learned how to produce.

Ballistic missiles. Staging, i.e. jettisoning structural weight as fuel is consumed, made it possible to develop ballistic missiles of intercontinental range. During the Cold War, U.S. and Soviet Union ultimately each deployed about 2000 long-range land- and submarine-based ballistic missiles, equipped with an average of 3-4 warheads each.

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 with ranges beyond about 1500 km. Since the 1980s, however, a number of additional countries mastered staging and deployed 2-stage intermediate-range missiles with ranges up to about 3,000 km: India (Agni, 1989), Israel (Jericho II, 1990), North Korea (Taepo Dong I, one test in 1998, could reach part of the U.S. with a very small payload – "the golf ball of death"), and Pakistan (Shaheen II, 2005). Iran is reportedly working on a multi-stage Shahab-4.[32]

The G-7 countries (Canada, France, Germany, Italy, Japan, U.K., and U.S.) established the Missile Technology Control Regime in 1987 to restrict the export of ballistic and cruise-missiles and associated technologies. In 2006, the MTCR had 34 member states.[33] It focuses especially on controlling the proliferation of missiles that could carry a 500-kg

[32] http://www.globalsecurity.org/wmd/world/iran/shahab-4.htm
[33] http://www.mtcr.info/english/

payload (less than 10 percent of the weight of the Hiroshima or Nagasaki warheads but the estimated weight of a first-generation nuclear warhead today) more than 300 kilometers.

Ballistic missile defense. 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. In 1967, in the runup to the 1968 elections, despite the skepticism of his technical advisors, President Johnson decided 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 interceptor missiles were supposed to be deployed and the Senate turned against the idea after President Nixon was elected. Although Nixon had originally forced Johnson's decision, Nixon was forced to agree to the ABM Treaty of 1972, which banned national missile defenses.[34]

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, however, 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.[35] North Korea gave this possibility 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, the Bush 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 presidential election of 2004. This commitment was fulfilled but, in the rush to deploy, requirements for successful intercept tests of the system before deployment were suspended.

The Bush Administration argued – unconvincingly to some – that the "Axis of Evil" countries could not be deterred from launching nuclear 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. feared that, if these countries acquired nuclear weapons, U.S. threats of "regime change" would no longer be credible.

Technical critics remain convinced that a missile-defense system would be incapable of discriminating decoys and other "penetration aids," deployable by even unsophisticated attackers, from the real warheads that could be hidden among them.

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[34] "Stopping Sentinel" (pp. 178-195) in *Advice and Dissent: Scientists in the Political Arena* by Joel Primack and Frank von Hippel (Basic Books, 1974). For a discussion of the role of the discussions between U.S. and Soviet scientists in reversing the Soviet conventional wisdom that "defense is good" see "'Not a Fool': Brezhnev and the ABM Treaty" (pp. 193-232) in *Unarmed Forces: The Transnational Movement to End the Cold War* by Matthew Evangelista (Cornell University Press, 1999).

[35] "Executive Summary," *Report of the Commission to Assess the Ballistic Missile Threat to the United States* (Donald Rumsfeld, Chairman), July 15, 1998, www.fas.org/irp/threat/bm-threat.htm

In recent years – especially since Iraq's launch of conventionally armed Scud missiles against Saudi Arabia and Israel during the 1991 Gulf War[36] -- increasing efforts have been devoted to defenses against short-range missiles. U.S. Patriot missiles were ineffective against the Scuds in 1991 but upgraded Patriots and other systems have been deployed by the U.S. and Israel and Japan and Taiwan have bought them to defend against DPRK and Chinese missiles respectively.

Tutorials: Rocket range/payload. Radar and infrared detection, decoys and discrimination.

Read

- "Missile proliferation" (pp. 83-118) in *Deadly Arsenals*.

- "Anti-ballistic-missile systems" by Richard Garwin and Hans Bethe, *Scientific American,* March 1968 (the original and classic public discussion of decoys, on Blackboard).

- Executive Summary, "Technical Realities: An Analysis of the 2004 Deployment of a U.S. National Missile Defense System", Union of Concerned Scientists, 2004: http://www.ucsusa.org/global_security/missile_defense/technical-realities-national-missile-defense-deployment-in-2004.html

- Dennis Gormley, "Cruise Control," *Bulletin of the Atomic Scientists,* March/April 2006, p. 26 (on Blackboard).

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- *The physics of space security* by David Wright, Laura Grego and Lisbeth Gronlund, American Academy of Arts and Sciences, 2005, http://www.ucsusa.org/assets/documents/global_security/Space_Security.pdf

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

- "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

[36] "Video Evidence on the Effectiveness of Patriot During the 1991 Gulf War" by George Lewis and Theodore Postol, *Science & Global Security* Vol. 4, 1, 1993, pp. 1-63.

- Letter from MIT Prof. Theodore Postol to White House Chief of Staff, John Podesta, May11, 2000 alleging fraud in the DoD's one test of an interceptor against decoys, http://www.fas.org/spp/starwars/program/news00/postol_051100.html

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

9. **The Future of Biological Weapons**

(and a little about chemical 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 (antibiotics, anti-virals and vaccines for BW).

Because of the durability of its spore form, anthrax 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.[37] Iraq produced a considerable amount before the 1991 Gulf War. But, thus far, the 2001 anthrax letters have been the most lethal use of anthrax.

The Biological Weapons Convention. 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.

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. Negotiations on a protocol were launched in 1994 and produced a final draft but, in August 2001, the Bush Administration insisted that the negotiations be abandoned because it considered verification hopeless and also potentially too intrusive for the U.S. biodefense program and U.S. pharmaceutical companies.[38] In November 2001, President Bush proposed an alternative approach to strengthening the BWC that focused on the encouragement of national initiatives to strengthen controls on pathogens and criminalize BW activities.[39] With the U.S. vetoing any alternative, that approach was accepted by the other parties to the BWC.

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[37] For popular accounts, see: J. Miller, S. Engelberg and W. Broad, *Germs: Biological Weapons and America's Secret War* (Simon and Schuster, 2001); *The Biology of Doom: The History of America's Secret Germ Warfare Project* by Ed Regis, (Henry Holt, 1999); and *Biohazard: The chilling true story of the largest covert biological weapons program in the world* [*the Soviet Union's*] *told from inside by the man who ran it* by Ken Alibek with Stephen Handelman (Random House, 1999).
[38] http://www.state.gov/t/ac/rls/rm/2001/index.cfm?docid=5497
[39] http://www.whitehouse.gov/news/releases/2001/11/20011101.html

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. The casualties, while horrific, were comparable to the number that might have been caused by a similar weight of conventional shells or bombs. More powerful nerve gases were developed after WW I but chemical weapons are still orders of magnitude less lethal on a weight basis than nuclear and biological weapons.

Chemical weapons were not used in World War II. In the 1960s, Egypt used chemical weapons against Yemen, and in the 1980s Saddam used them against Iran as well as against Iraq's own Kurds. During the Cold War, the U.S. and Soviet Union built up huge stockpiles of chemical weapons and agents that they are now struggling to destroy. Iraq built up a considerable chemical-weapons stockpile that was destroyed by UNSCOM. In 1995, the Japanese terrorist group, Aum Shinrikyo produced and used sarin nerve gas in an attack on the Tokyo subway system.[40]

WW I 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 states suspected of interest in manufacturing chemical or biological weapons.

After 20 years of negotiations in the Geneva-based Conference on Disarmament, the Chemical Weapons Convention (CWC) was signed in 1993. It came into force in 1997. The CWC requires countries to declare their stockpiles and production facilities and to destroy them. Six countries (the U.S., Russia, India, South Korea, Libya and Albania) declared stockpiles and five more declared production facilities. The CWC also requires countries to declare data on the production sites, processing, consumption, acquisition, and import or export of above-threshold quantities of chemical-weapon precursor chemicals. It subjects facilities that could produce agents or their precursors to international inspections and also contains elaborate arrangements for challenge inspections in case accusations of violations are found credible by the compliance-monitoring Organization for the Prohibition of Chemical Weapons (OPCW), headquartered in the Netherlands at the Hague.[41] However, the U.S. and OPCW governing board subsequently have weakened the abilities of the inspectors to do their jobs and, despite U.S. accusations of various countries of cheating, there have been no challenge inspections.

Despite delays due to technical problems and public concerns about safety, the U.S. is 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 was

[40] "A case study of the Aum Shinrikyo" in *Global proliferation of weapons of mass destruction,* Hearings before the Permanent Subcommittee on Investigations of the U.S. Senate Committee on Governmental Affairs, Oct. 31, Nov. 1, 1995, pp. 47-102.
[41] http://www.opcw.org

stalled by both public concerns about safety and lack of funds. However, destruction of mustard gas began in 2002, a mustard-gas destruction plant went into operation at a second site in 2006 and Russia, the U.S. and EU nations are funding construction of a nerve-gas destruction facility.

Defense against Biological Weapons. The response to the anthrax letters demonstrated how poorly prepared the U.S. was for even a small biological attack. The "first responders" to a biological attack were and would be doctors and hospitals.

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

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

- "Threat assessment" R&D to assess methods that could be used to enhance pathogen virulence or reduce their susceptibility to antibiotics vaccines and other countermeasures.

The threat-assessment research is often secret and is controversial, since the U.S. might inadvertently release a new more virulent pathogen through this research (as in the *Andromeda Strain*) or be suspected by other countries of an offensive BW program. Certainly, the U.S. is concerned that potential offensive agents might be developed in Russia's still secret military bio-defense 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 life-sciences community is concerned that government restrictions on publication would damage essential processes of information sharing and peer review and has urged that community be allowed to deal with the problem itself. The first proposals for how to do this were contained in the National Academy of Sciences report, *Biotechnology Research in an age of terrorism: Confronting the dual use dilemma* (2004). In 2004, a National Science Advisory Board for Biosecurity was established to advise the federal government on these issues.[42]

Tutorial. Determinants of disease spread (A.G.).

Read

[42] www.biosecurityboard.gov

- "Biological and chemical weapons, agents and proliferation" (pp. 57-68), *Deadly Arsenals*

- "Bioterror: What Can Be Done?" by Matthew Meselson in *The New York Review of Books*, December 20, 2001 (on Blackboard and at http://www.nybooks.com/articles/14971).

- "Biotechnology and the Challenge to Arms Control" by Christopher F. Chyba, *Arms Control Today*, October 2006, http://www.armscontrol.org/act/2006_10/BioTechFeature.asp

- "Executive Summary," *Biotechnology Research in an Age of Terrorism (*on BlackBoard or at http://www.nap.edu/books/0309089778/html/)

- "Biodefense crossing the line" by Milton Leitenberg, Ambassador James Leonard and Richard Spertzel, *Politics and the Life Sciences 22 #2* (2004), p. 1 (on Blackboard or at http://www.politicsandthelifesciences.org/Contents/Contents-2003-9/PLS2003-9-22-02-0002.pdf)

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- Jonathan Tucker and Raymond A. Zilinskas, "Assessing U.S. proposals to strengthen the Biological Weapons Convention, " *Arms Control Today,* April 2002, pp. 10-14, http://www.armscontrol.org/act/2002_04/tuczilapril02.asp

- 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). (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* (World Health Organization, 2004) http://www.who.int/csr/delibepidemics/biochemguide/en/index.html

- "A chemical weapons atlas" by E.J. Hogendoorn, *Bulletin of the Atomic Scientists,* Sept./Oct. 1997

- "Recharging the Chemical Weapons Convention" by Amy Smithson, *Arms Control Today,* March 2004, p. 6, http://www.armscontrol.org/act/2004_03/Smithson.asp?print

- "A genealogy of the chemical weapons taboo" by Richard Price, *International Organization 49, No. 1* (1995), pp. 73-103.

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

10. **WMD Terrorism, UNSCR 1540 and Homeland Defense**

The Sept. 11, 2001 attacks against the World Trade Center, the subsequent anthrax letter attacks and the discovery of the A.Q. Khan uranium-enrichment and nuclear weapon design supply network served to ring the alarm about the possibility of WMD terrorism in a way that the Aum Shinrikyo activities in Japan in 1995 had not.

On the international level in 2004 the U.N. Security Council agreed on resolution 1540 which

> "decides…that all States…shall adopt and enforce appropriate effective laws which prohibit any non-State actor to manufacture, acquire, possess, develop, transport, transfer or use nuclear, chemical or biological weapons [and] establish domestic controls to prevent the proliferation of nuclear, chemical, or biological weapons and their means of delivery, including by establishing appropriate controls over related materials..."

In 2002, Congress created the Department of Homeland Security with about 180,000 employees and a budget of about $30 billion to protect against and respond to terrorist attacks. The DHS was created out of a number of existing agencies, including the Customs Service, Immigration and Naturalization Service, Coast Guard, Transportation Security Administration, Federal Emergency Management Agency, Animal and Health Inspection Service, National BW Defense Analysis Center, and Secret Service.[43]

[43] http://www.dhs.gov

The greatest concerns are nuclear and biological terrorism. In the nuclear area, the DHS has focused on detecting fissile materials coming across borders but this is a daunting task, especially for highly enriched uranium (HEU), which is the easiest material for terrorists to use to make a nuclear explosive (gun-type design). HEU emits very little radiation and can be easily shielded. Far more effective would be to eliminate as much HEU as possible, consolidate the remainder at as few locations as possible and maximize the security at those locations.

In the biological area too more can be done to limit the number of locations where pathogens can be found and to secure those locations more effectively. Major preparations are required also to deal with both natural and man-made outbreaks of disease. In the case of anthrax, which is not communicable from human to human, a major outbreak would have to be man-made – most likely by the dispersal of spores into the atmosphere of a city. In the case of communicable diseases, a small outbreak could spread rapidly unless effectively contained by quarantine, antibiotics, vaccines, etc. Preparations for containing outbreaks such as avian flu should be helpful for man-made outbreaks as well.

Tutorial. How to estimate casualties from airborne chemicals, radioactive materials and pathogens, based on quantities released, toxicity, weather conditions and population density (FvH). Detecting nuclear materials (AG)

Read

- "The ongoing failure of imagination" by Graham Allison, *Bulletin of the Atomic Scientists,* Sept.-Oct. 2006, pp. 36-41 (on Blackboard).

- "Global Cleanout: Reducing the Threat of HEU-fueled Nuclear Terrorism" by Alexander Glaser and Frank von Hippel, *Arms Control Today,* January 2006 (on Blackboard).

- "Anthrax powder: state of the art?" by Gary Matsumoto, *Science 302,* November 28, 2003, pp. 1492-7 (on Blackboard).

- UN Security Council Resolution 1540; http://www.un.org/News/Press/docs/2004/sc8076.doc.htm

- *Implementing United Nations Security Council Resolution 1540*, WWS Policy Workshop Report, 2006, Executive Summary (on Blackboard).

- "The Cult" (pp. 151-164) in *Germs: biological weapons and America's secret war* by Judith Miller, Stephen Engelberg, and William Broad (Simon & Schuster, 2001) [TO SCAN]

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Seema Gahlaut, "UN Security Council Resolution 1540: A Principled Necessity"
Daniel Joyner, "UN Security Council Resolution 1540: A Legal Travesty"
Center International Trade and Security, University of Georgia, August 2006

Film available: *Last Best Chance* (Nuclear Threat Initiative, 2006).

11. **The goal of U.S. nuclear-weapons Policy: Abolition or not?**

U.S. nuclear-weapons policy has two main elements:

- Deterring with nuclear threats of major attacks by other countries on the U.S., its military forces and its allies, and

- Persuading other countries not to acquire nuclear weapons.

Obviously, there is some tension between these two objectives. How much is a matter of much debate. Some argue that the degree to which other countries are willing to stay non-nuclear is influenced by the U.S. example. Others argue that nations are driven to acquire nuclear weapons primarily by security threats in their neighborhoods. There is no doubt, however, that the legitimacy of the nonproliferation regime is a major determinant in making it possible to mobilize countries to prevent a country from going nuclear. The U.S. approach of "do as I say, not as I do" and the recent U.S. abandonment of even rhetorical support of the ultimate goal of nuclear disarmament have undercut the legitimacy of the nuclear nonproliferation regime.

During the Cold War, most countries that had capabilies to acquire nuclear weapons were under either the Soviet or the U.S. nuclear "umbrella." This required that they give up their own nuclear ambitions. Today, few countries ally themselves with Russia and a number feel the need to have a deterrent against U.S. threats of "regime change." The proliferation situation has therefore become more volatile.

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

Some are profoundly skeptical, 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.

Others do not see how nations can remain indefinitely divided between a few nuclear-weapon haves and the rest have-nots. But most have postponed engaging in the debate about nuclear disarmament. They think that, whether one is aiming for small or zero

stockpiles makes little difference today. A few worry about fudging what they see as a profoundly moral issue.

With regard to actually achieving nuclear disarmament, some believe that it will require the resolution of major regional confrontations that are considered as threatening the existence of certain countries, in particular: Israel in the Middle East, Pakistan in South Asia and the DPRK on the Korean Peninsula.

Others feel that nuclear disarmament will only be achieved when all the potential nuclear-weapon states have become democratic and transparent. Solingen has replaced the requirement of democracy in this theory with a requirement of economic liberalism, which he takes as more reliably requiring international transparency.

Read

- "A world free of nuclear weapons" by George Shultz, William Perry, Henry Kissinger and Sam Nunn, *Wall Street Journal*, Jan. 4, 2007, A15 (on Blackboard).

- "Nuclear Deterrence for the Future" by Thomas C. Schelling, *Issues of Science and Technology*, Fall 2006 (on Blackboard).

- "Is there a role for nuclear weapons today?" by Frank Miller, *Arms Control Today,* July-August 2005 (on Blackboard or http://www.armscontrol.org/act/2005_07-08/Miller.asp).

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

- *What Are Nuclear Weapons For? Recommendations For Restructuring U.S. Strategic Nuclear Forces* by Sidney D. Drell and James E. Goodby, Arms Control Association, April 2005, pp. 1-32 (on Blackboard or http://www.armscontrol.org/pdf/USNW_2005_Drell-Goodby.pdf) skim.

- "The political economy of nuclear restraint" by Etel Solingen, *International Security 19,* Autumn 1994, pp. 126-169 (on Blackboard) skim.

Questions

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- "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/article.php?art_ofn=jf00butler

- Kofi Annan on Nuclear disarmament and non-proliferation, Princeton University, 28 November 2006, http://www.un.org/News/Press/docs/2006/sgsm10767.doc.htm

12. **Student paper presentations and a debate on how to deal with Iran**