


Putting the Genie Back in the Bottle: Nuclear Non-Proliferation in an Era of Great Power Competition

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- Outline:
1. Nuclear Weapons 101.
 2. Nuclear Arsenals and Their Impact.
 2. The Comprehensive Test Ban Treaty.
 3. Monitoring Nuclear Tests - Science in the Public Interest.
 4. Why should you care?
 6. Some Conclusions.

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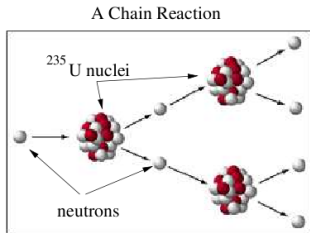
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- Return to Great Power competition \approx 2014 (US, China, Russia).

Nuclear Weapons 101

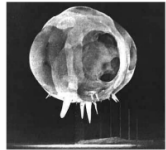
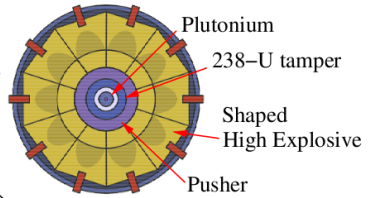
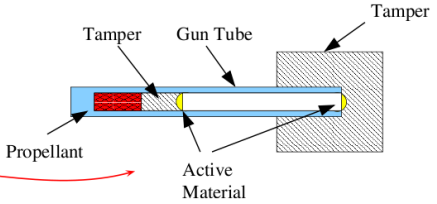
- Fissile materials (^{235}U , ^{239}Pu) release enormous energies.
- As each nucleus splits, it emits 2 or so neutrons plus lots of energy ($\approx 180\text{ MeV}$).
- If density is high, a 'chain reaction' will cause other fissions in a self-propagating process.



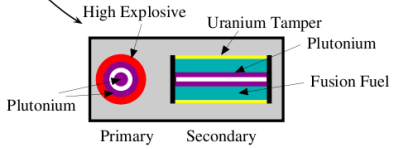
- Only about 8 kg of plutonium or 25 kg of highly-enriched uranium (HEU) is needed to produce a weapon.

Nuclear Weapons 101

- Uranium, gun-type weapon - High explosive fires highly-enriched uranium slug down the gun tube and into the uranium target. The density increases enough to sustain the chain reaction.
- Plutonium implosion device - High explosive crushes the plutonium primary to a density where fission can occur.
- Two-stage, thermonuclear weapon - Fission weapon crushes secondary containing deuterium and tritium gas and/or a fissionable 'spark plug'.

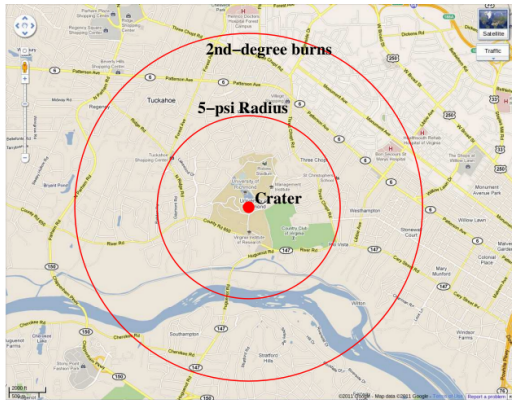


Nuclear fireball 1 ms after detonation (Tumbler Snapper); it is about 20 m across.



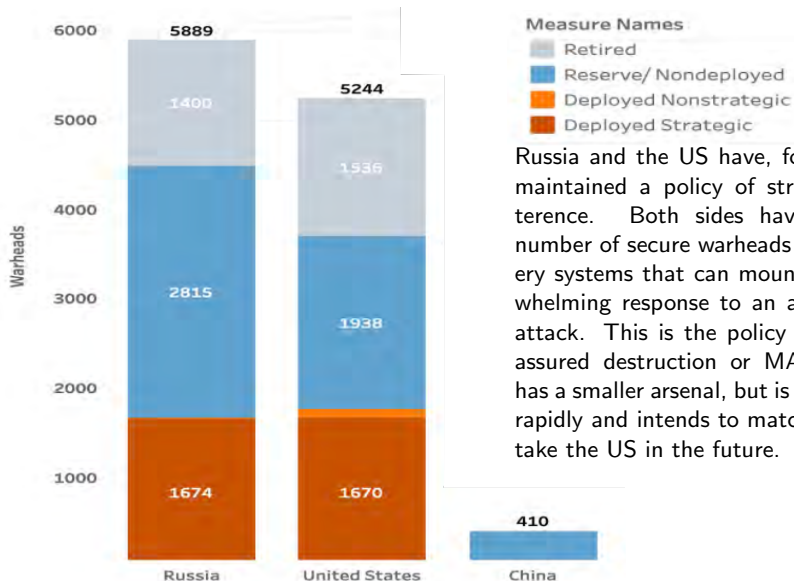
Nuclear Weapons 101

- Energy released in the form of light, heat and blast.
- Blast $\approx 40\text{-}50\%$ of total energy.
- Thermal radiation $\approx 30\text{-}50\%$ of total energy.
- Ionizing radiation $\approx 5\%$ of total energy.
- Residual radiation $\approx 5\text{-}10\%$ of total energy.
- Figure shows effect of a 15 kiloton bomb (about the size of the Hiroshima bomb) exploded over the Gottwald Science Center.



▶ Play

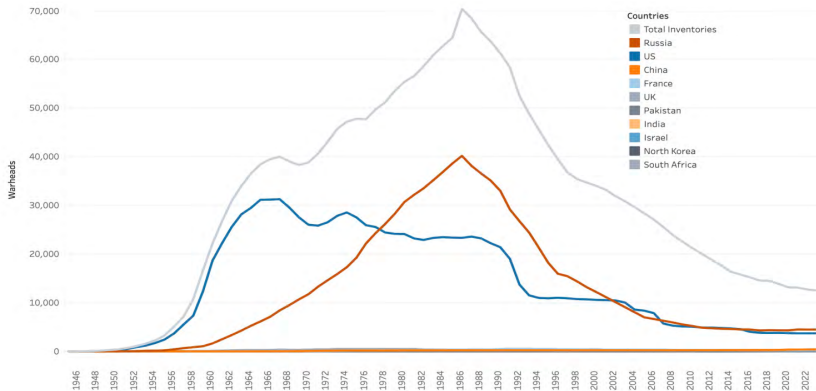
The Strategic Balance



Russia and the US have, for decades maintained a policy of strategic deterrence. Both sides have a large number of secure warheads and delivery systems that can mount an overwhelming response to an adversary's attack. This is the policy of mutual assured destruction or MAD. China has a smaller arsenal, but is expanding rapidly and intends to match or overtake the US in the future.

The Nuclear Arms Race

Six Decades of a Global Nuclear Arms Race



Source: Hans M. Kristensen, Matt Korda, and Robert Norris, "Status of World Nuclear Forces," 2023, Federation of American Scientists (FAS), March 29, 2023, <https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/>.

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Who Has Nukes?

SIPRI Estimate of Global Nuclear Forces in 2022



Note: The boundaries used in this map do not imply any endorsement or acceptance by SIPRI.

Who Has Nukes?

SIPRI Estimate of World Nuclear Forces in 2022 - I

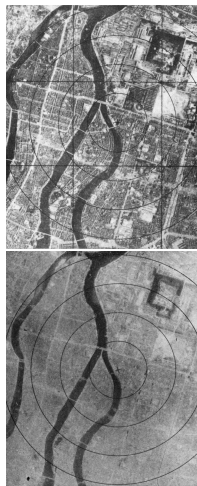
State	Year of first nuclear test	Deployed warheads ^a	Stored warheads ^b	Total stockpile ^c	Retired warheads	Total inventory
United States	1945	1 744 ^d	1 964 ^e	3 708	1 720 ^f	5 428
Russia	1949	1 588 ^g	2 889 ^h	4 477	1 500 ^f	5 977
United Kingdom	1952	120	60	180	45 ⁱ	225 ^j
France	1960	280	10 ^k	290	..	290
China	1964	-	350	350	-	350
India	1974	-	160	160	..	160
Pakistan	1998	-	165	165	..	165
Israel	..	-	90	90	..	90
North Korea	2006	-	20	20	..	20 ^l
Total		3 732	5 708	9 440	3 265	12 705

.. = not applicable or not available; - = nil or a negligible value.

Source: SIPRI, "10. World Nuclear Forces," *SIPRI Yearbook 2022*, p 342, <https://www.sipri.org/yearbook/2022/10>

Why We Don't Want To Use Them.

- Little Boy dropped on Hiroshima (Aug 6, 1945)¹
 - ① 66,000 -140,000 prompt deaths.
 - ② radiation-induced cancer and leukemia started appearing about 5 years later.
 - ③ number of birth defects not significantly higher.
 - ④ Severe mental retardation from prenatal exposure.
- India-Pakistan Regional Exchange Simulation²
 - ① Regional nuclear war.
 - ② Involve about 100 15-kiloton nuclear weapons.
 - ③ Launched at heavily populated urban areas.
 - ④ 27 million prompt deaths.
- Full US-Russia Exchange Simulation²
 - ① Over 4,000 100-kT nuclear warheads.
 - ② 360 million prompts deaths.
 - ③ Societal collapse.
 - ④ Global climatic changes, widespread radioactive contamination.
 - ⑤ Famine could cause more than 10 times as many deaths.

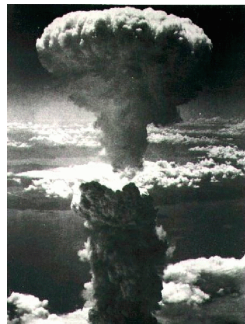


¹ "Atomic bombings of Hiroshima and Nagasaki", https://en.wikipedia.org/wiki/Main_Page.

² "Nowhere To Hide", François Diaz-Maurin, Bulletin of the Atomic Scientists, October 20, 2022.

How Do We Prevent Their Use?








- Arms control agreements and confidence building measures manage strategic competition.
- Testing bans reduce the proliferation of nuclear weapons to other countries.
- The Comprehensive Test Ban Treaty (CTBT) prohibits all nuclear explosions.
- An array of seismological, hydroacoustic, infrasound, and radionuclide sensors will monitor compliance.
- On-site inspection to check compliance.

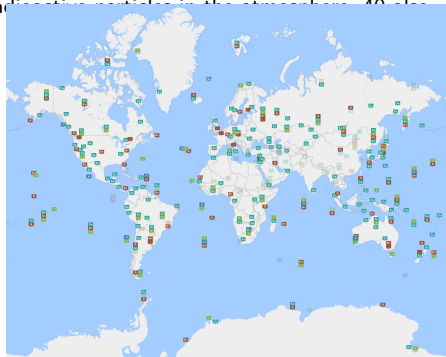


Green - ratified
Blue - signed
Red - outside treaty

The CTBT Verification Regime

- The International Monitoring System (IMS), consists of 337 facilities that constantly monitor for signs of nuclear explosions. Over 90% are already collecting data.
- Detection technologies:
 - Seismic: 50 primary and 120 auxiliary seismic stations monitor shock waves.
 - Hydroacoustic: 11 hydrophone stations 'listen' for sound waves in the oceans.
 - Infrasound: 60 stations on the surface can detect ultra-low frequency sound waves (inaudible to the human ear) that are emitted by large explosions.
 - Radionuclide: 80 stations measure radioactive particles in the atmosphere; 40 also pick up noble gases.
- On-site-Inspection: If IMS data show a nuclear test has occurred, a Member State can request an on-site-inspection subject to a vote.

	Primary Seismic
	Auxiliary Seismic
	Infrasound
	Hydroacoustic
	Radionuclide
	Radionuclide with Noble Gas *
	Radionuclide Laboratories



Status of the CTBT in the Biden Administration

- 1 Biden supported the CTBT while in the Senate in the 1990's.
- 2 Key priority that serves the national security interests of the United States.¹
- 3 Part of an array of arms control initiatives including negotiations with China and Russia while maintaining the viability of the US arsenal without nuclear weapons testing.²
- 4 International Monitoring System (IMS) can detect even relatively low-yield nuclear explosions in any environment on Earth.¹
- 5 Resuming U.S. nuclear testing 'would be 'as reckless as it is dangerous,' - Candidate Joe Biden.³
- 6 "Consistent with the goals of the CTBT, the United States continues to observe a moratorium on nuclear explosive testing and calls on all states possessing nuclear weapons to declare or maintain such a moratorium." - NNSA Administrator Jill Hruby, June 19, 2023.

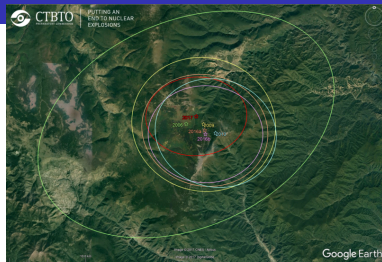
¹ Ambassador B.D. Jenkins, Under Secretary for Arms Control and International Security, UN Headquarters, September 23, 2021

² National Security Advisor Jake Sullivan, Arms Control Association (ACA) Annual Forum, June 02, 2023

³ The Nevada Independent, May 28th, 2020.

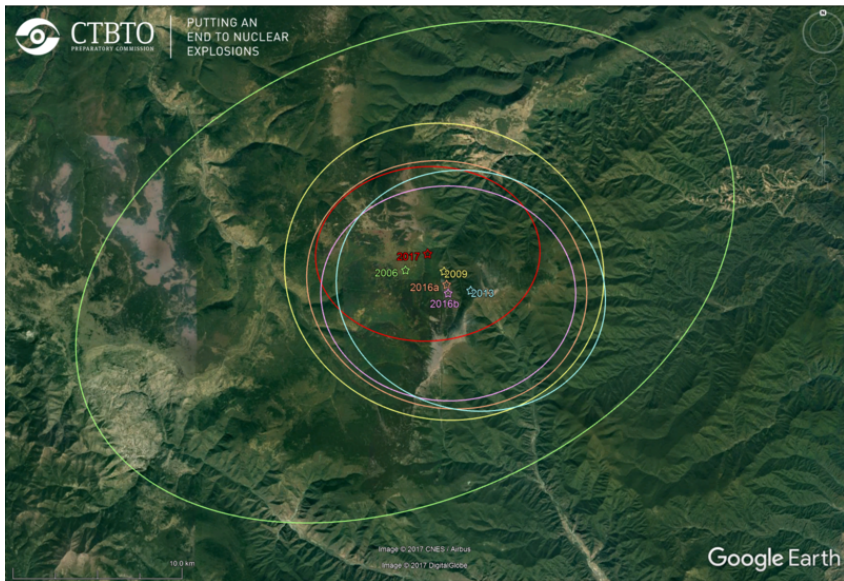
Testing the Testers

- North Korean tests a nuclear bomb October 9, 2006.
 - Over 20 CTBTO seismic stations detect it.
 - Radionuclides detected two weeks and 4700 miles away (!) in the Yukon.
 - Yield: **0.7 - 2.0 kt.**
- They do it again on May 25, 2009
 - 61 CTBTO seismic stations detect blast.
 - No radionuclides are found!!?? Epic fail?
 - Yield: **2 - 5.4 kt.**
- February 12, 2013 Test
 - 94 seismic, 2 infrasound stations.
 - Radionuclides found again!
 - Yield: **6 - 16 kt.**
- January 6, 2016 Test
 - NK claims a hydrogen bomb, but data consistent with previous test.
 - Yield: **7 - 10 kt.**
 - Radionuclide evidence inconclusive due to background.



- September 9, 2016 Test
 - Yield: **20-30 kt.**
 - No radionuclides detected.
- September 3, 2017 Test.
 - Yield is large - **70-280 kt.**
 - Hydrogen bomb or boosted fission.
 - error ellipse = ± 6.7 km.

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What is Happening?

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- A few days later, the atmosphere is filled with a cloud of inert and radioactive particles. Calculations of the weather enables meteorologists to predict the spread of the plume from the blast (**meteorology, physics, computer science**).
- Air is sampled and analyzed for the presence of the xenon isotopes. Nuclear physics detectors make the final identification of the decay of the xenon nuclei (**nuclear physics**).
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International response is driven by the scientific results - scientists have to get it right!

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The American Geophysical Union and the Seismological Society of America have stated the IMS will detect all explosions down to 1 kiloton (and much less in some areas) and within a radius of 35 km (October, 2009).

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Why Should You Care?

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- The worst-case scenario under a no-CTBT regime poses far bigger threats to U.S. security - sophisticated nuclear weapons in the hands of many more adversaries - than the worst-case scenario of clandestine testing in a CTBT regime, within the constraints posed by the monitoring system.

National Academy of Sciences (NAS), *Technical Issues Related to the Comprehensive Nuclear-Test-Ban Treaty*, Washington, D.C., National Academy Press, 2002, pp. 10.

Conclusions

- Do we live in a safer world than during the Cold War? **Yes, sort of.**
 - The threat of nuclear Armageddon has receded by managing the strategic competition with Russia - arms agreements and testing moratorium.
- Has the threat of a nuclear conflict increased? **Yes.**
 - The war in the Ukraine, the positioning of tactical nuclear weapons by Russia in Belarus, the actions of North Korea, and other nations have raised the possibility of a limited nuclear exchange.
- What can be done? **Lots, but it will take time, money (Opps! There goes my tax cut!) and leadership from the US (CTBT, NPT, ABM, BWC, CTR).**
- What can I do?
 - Learn! Think! Cut through the hype.
 - Vote! Write to Congress!
 - The US and other countries are in desperate need of technical expertise.



Additional Slides

Risk of a Nuclear War in Ukraine

- Russia has long-held a significant number of tactical nuclear weapons (≈ 2000) for use on the battlefield or “smaller” targets. Their yield ranges from a few tons to 100 kT. The Hiroshima bomb was 15 kT.
- Threats by Putin have raised the possibility of the Ukraine war going nuclear. There are many scenarios for how this would happen and many experts claim this is the most dangerous time for a nuclear war since the Cuban Missile Crisis.
- Many war game simulations in the past have shown that it is difficult NOT for a war to escalate after first-use. This is called climbing the escalation ladder. It is hard to climb down.
- It is likely a first-use of nuclear weapons by Putin would be met with a conventional response by NATO on military targets, e.g the site that launched the attack. It could also lead to strikes on other sites including ones in Russia.

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- 4 Production of trained scientists, engineers, technicians. all from basic science research.
About 250 doctoral theses have come out of JLab.



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Ben Franklin's answer: Sir, what's the use of a newborn baby?

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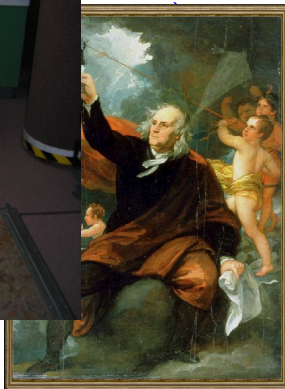


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Another Reason To Care - Timeline of North Korean Nuclear Program

- 1960's - First NK reactor built at Yongbong with Soviet help.
- 1970's - Plutonium reprocessing starts with Soviet help.
- 1980's - NK develops nuclear weapons infrastructure with significant outside help.
- 1990's
 - US President G.H.W. Bush announces US withdrawal of all nuclear weapons from S. Korea.
 - US, SK, and NK agree to nuclear-free Korean peninsula, but mutual inspections fail.
 - Agreed Framework “freezes” NK nuclear program and allows inspections in exchange for building power reactors and fuel oil.
- 2000's
 - US President G.W. Bush names NK in the axis of evil.
 - Agreed Framework collapses over delays in inspections (US) and construction of reactors (NK).
 - NK starts reprocessing spent fuel, gets technical support for nuclear weapons from Pakistan in exchange for missile technology.
 - First nuclear tests.
- 2010's
 - NK nuclear tests show increasing yield and technical prowess.
 - Rapid growth in missile technology.

Another Reason To Care - Timeline of North Korean Nuclear Program

- 1 US Defense Intelligence Agency finds that North Korea has produced a miniaturized nuclear warhead for mounting on an ICBM and could have up to 60 nuclear warheads.⁵
- 2 Rapid development of intercontinental ballistic missile capabilities (17 tests in 2017) leading to the Hwasong-15 tested on November 28, 2017 with a potential range of - 13,000km range.
- 3 The population of Seoul, South Korea area is about 25 million and is located 40 km from the Demilitarized Zone. Seven hundred artillery pieces and rockets (out of an arsenal of about 14,000 guns and rockets) can reach Seoul. Twenty-three thousand US troops are stationed in South Korea.

North Korea's missile range



SOURCE: Center for Strategic and International Studies, David Wright

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How do we respond to a nuclear North Korea?

The Nukes are Loose. - NTI Threat Index 2016

The Nuclear Threat Initiative (NTI) is a nonpartisan, nonprofit organization that works to prevent catastrophic attacks and accidents with weapons of mass destruction and disruption. Its threat index ranks the nuclear security practices of 176 countries.

OVERALL SCORE				
Rank / 24	Country	Score / 100	Change since	
			2014	2012
1	Australia	93	0	+3
2	Switzerland	91	+2	+4
3	Canada	87	+2	+8
4	Poland	84	+3	+7
=5	Belgium	83	+3	+13
=5	Germany	83	+1	+6
=5	Norway	83	+2	+5
=8	Belarus	81	0	+7
=8	France	81	+1	+3
10	United States	80	+3	+2

The Nukes are Loose. - NTI Threat Index 2016

The Nuclear Threat Initiative (NTI) is a nonpartisan, nonprofit organization that works to prevent catastrophic attacks and accidents with weapons of mass destruction and disruption. Its threat index ranks the nuclear security practices of 176 countries.

Since early 2010, a dozen countries have eliminated weapons-usable nuclear materials from their territories, dozens more have strengthened their nuclear security practices and policies...

OVERALL SCORE				
Rank / 24	Country	Score / 100	Change since	
			2014	2012
1	Australia	93	0	+3
2	Switzerland	91	+2	+4
3	Canada	87	+2	+8
4	Poland	84	+3	+7
=5	Belgium	83	+3	+13
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However, the global threat environment has worsened...

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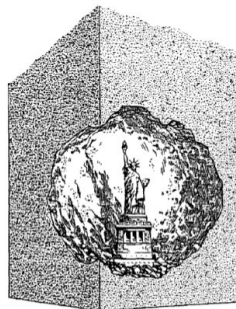
Without a comprehensive and effective global system in place, states' approaches to nuclear security continue to vary widely, thereby creating dangerous weak links that terrorists could exploit as they seek the easiest path to weapons-usable nuclear materials.

Can an Opponent Cheat on the CTBT?

- U.S. and Russian experiments have demonstrated that seismic signals can be muffled, or decoupled, for a nuclear explosion detonated in a large underground cavity.
- Such technical scenarios are credible only for yields of at most a few kilotons.
- Other scenarios require mine-masking, multiple explosions, hide-in-an-earthquake.
- The IMS is expected to detect all seismic events of about magnitude 4 or larger corresponds to an explosive yield of approximately 1 kiloton (the explosive yield of 1,000 tons of TNT).

What can be learned from low-yield, surreptitious blasts?

Can it extrapolated to full-up tests?



Demonstration of size of cavity needed to decouple a 5 kT blast.

US Congress, Office of Technological Assessment, *Verification of Nuclear Testing Treaties*, OTA-ISC-361, (Washington, DC; US Government Printing Office; May, 1988).

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The New York Times

Late Edition
New York: Today, cloudy with some light snow, high 35. Tonight, early snow, low 27. Tomorrow, becoming partly sunny, high 35. Yesterday, high 34, low 25. Weather map, Page D8.

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REPORT TO CLINTON ASKS U.S. TO RATIFY TEST-BAN TREATY

A LAST-DITCH CAMPAIGN

Retired Head of Joint Chiefs
Seeks to Assuage Critics of
Pact Assailed by Bush

By MICHAEL R. GORDON

A former chairman of the Joint Chiefs of Staff who conducted a comprehensive study of the nuclear test ban treaty at the request of President Clinton has concluded that the United States must ratify it in order to mount an effective campaign against the spread of nuclear weapons.

The assessment by Gen. John M. Shalikashvili, who was chairman of the Joint Chiefs from 1983 to 1997, in part of a last-ditch attempt by Mr. Clinton to build support for the treaty, which Senate Republicans rejected in 1999 and on which President-elect George W. Bush's own top aides have sharply disagreed.

General Shalikashvili's report outlines measures intended to assuage critics of the treaty, including increased spending on verification, greater efforts to maintain the United States nuclear arsenal and a joint review by the Senate and administration every 10 years to determine whether the treaty is still in American interests.

President-elect Bush assailed the treaty as unverifiable and unenforce-

Road Ban Set For One-Third Of U.S. Forests

Clinton Order Will Put
Logging Off Limits

By DOUGLAS JEHL

WASHINGTON, Jan. 4 — In the biggest land conservation act in decades, President Clinton will approve an order on Friday putting nearly a third of the national forest land permanently off limits to road building and logging.

The move, covering more than 58 million acres in 39 states, is to be cast by the White House as a capstone in the president's efforts to protect public lands from development. It would effectively prohibit not only commercial logging but also oil and gas development across an area larger than the nation's current national parks. And while not specifically banned, off-road vehicle activity would probably be severely limited in the roadless areas because of their inaccessibility.

The president's order, a strengthened version of an October 1999 administration proposal, is likely to set off furious challenges from Western states and Republican lawmakers who have called the plan hasty and irresponsible.

Among those who plan to head almost immediately to federal court to try to block the sweeping effort is the governor of Idaho, who with other Westerners has denounced the action as an unwise intrusion into land-use decisions better made at a local level.

In the presidential campaign,

Three Who Are Losing Their Old Chairmanships . . .



Associated Press

Bud Shuster of Pennsylvania
Former chairman of the Transportation and Infrastructure Committee announced yesterday that he was resigning.



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. . . and Three New Chairmen of Powerful Committees



Associated Press

Bill Thomas of California
Ways and Means



Source: NBC

Billy Tauzin of Louisiana
Energy and Commerce



Source: Bush for The New York Times

Michael G. Oxley of Ohio
Financial Services

HONORING '95 VOW, HOUSE REPUBLICANS REPLACE 13 CHIEFS

FIGHT FOR COVETED POSTS

In the Evenly Divided Senate,
Democrats Move Toward
a Deal to Share Power

By LIZETTE ALVAREZ

WASHINGTON, Jan. 4 — Six years after promising to change the ways of Washington fundamentally, House Republicans today made good on their pledge to curtail the power of committee barons and replaced 13 of their most senior chairmen.

The newly created selection process created fierce competition among members who sought the positions, intensified party fund-raising by the members seeking to demonstrate loyalty and led to the creation of a new committee.

Representative Bill Thomas, a California known for his sharp intellect and temper, was named as the chairman of the Ways and Means Committee, which oversees tax policy, Medicare and Social Security, defeating a more senior and more conservative competitor. And Representative Henry J. Hyde of Illinois, who as chairman of the Judiciary Committee handled President Clinton's impeachment, will now head the International Relations Committee.

In an institution where change usually comes slowly and against great

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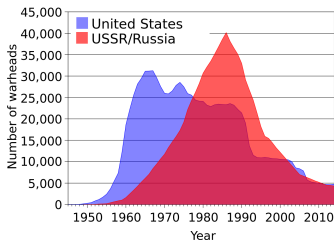
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The Soviet and US Nuclear Arsenals

- By the end of the Cold War the US and USSR had nuclear arsenals containing about 64,000 warheads on various delivery vehicles.
- US and Soviet military stockpiles contained about 1600 tons of highly-enriched uranium (HEU) and about 200 tons of plutonium.



- An unforeseen consequence of the end of the Cold War was the disposition of nuclear weapons materials.

Fissile Material Security in Russia Declines

- The economic situation in Russia left few funds for maintaining the security of now-unused nuclear materials.
- Reports by the National Research Council in 1994, 1997 and 1999 have revealed the extent of the decline of security.



Building at the Kurchatov Institute housing enough HEU for a nuclear bomb. It had no motion sensors, detectors, or portal monitors.

- In the 1990's there have been numerous instances of smugglers apprehended with nuclear materials.
- In late 1998 the Russian FSB (successor to the KGB) reports stopping an attempt to steal 18.5 kg of weapons-usable material.

Why Should You Care?

- The US and most other nations have a long-standing policy of nuclear nonproliferation.
- A nuclear blast would have horrific consequences; loss of life, property, and security.
- Even acquisition of a nuclear weapon by an adversary could have a devastating influence on US security and non-proliferation.
- **One of the highest hurdles to obtaining a nuclear weapon is acquiring enough weapons-grade fissile material to produce a bomb.** Iraq spent \$5-\$10 billion in the 1980's to produce a few grams of plutonium.
- Smuggling fissile material is a 'short-cut' to acquiring nuclear weapons; it lowers the acquisition hurdle.
- Prevention (*i.e.*, security) is critical especially against an 'insider' threat.

What Can an Opponent Do?

- What can a terrorist organization do?
 - Acquiring the necessary technology to enrich uranium or plutonium is beyond the capabilities of most terrorists.
 - Stealing the necessary fissile material is NOT!
 - A gun-type, uranium weapon of low yield is still a difficult endeavor, but could be done.
 - There are other alternatives for terrorists like a 'dirty bomb'.
 - **The likeliest terrorist weapons are still guns and bombs.**
- All of the above can be negated if one of the current nuclear powers gives one away. This is unlikely.
- There is continued smuggling activity for nuclear materials.
- The ITBD includes three incidents involving HEU and three involving plutonium during the period 1992-2015.

Confirmed incidents involving unauthorized possession and related criminal activities, 1993-2015

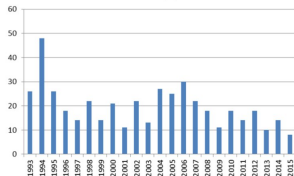


Figure 1 Incidents reported to the ITBD involving unauthorized possession and related criminal activities, 1993-2015.

IAEA Incident and Trafficking Database (2016 Fact Sheet)

The US Response

- In 1991 the US Congress passes the Nunn-Lugar Act. The US pays to improve security of fissile materials and to dismantle the Russian nuclear complex (cooperative threat reduction).
 - The US spent about \$700 million a year to reduce this threat.
 - The Fissile Material Storage Facility (FMSF) securely stores plutonium and uranium from dismantled weapons.
 - HEU Purchase Agreement downblended about 500 metric tons of HEU to reactor fuel (not usable in a nuclear weapon) for \$20 billion.

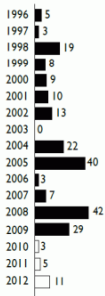


Fissile Material Storage Facility at Mayak financed by the US Cooperative Threat Reduction program.

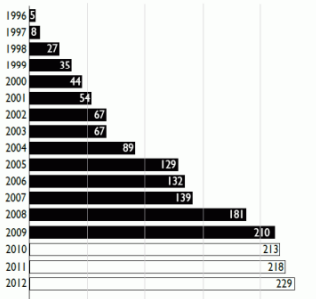
- Most of these cooperative programs ended by December, 2014 due to the conflict over Russian actions in the Ukraine.

How Loose are the Nukes?

Number of Building Upgrades Completed During the Fiscal Year



■ Cumulative Buildings with Comprehensive Upgrades
□ DOE Projections



There exists a publicly unknown number of buildings containing weapon-usable nuclear material in Russia on which the United States and Russia have never agreed to cooperate.

Country Year

Country	Year
Iraq	1992
Colombia	1996
Spain	1997
Denmark	1998
Georgia	1998
Philippines	1999
Thailand	1999
Slovenia	1999
Brazil	1999
Sweden	2002
Greece	2005
South Korea	2007
Latvia	2008
Bulgaria	2008
Portugal	2008
Romania	2009
Libya	2009
Taiwan	2009
Turkey	2010

Countries that have eliminated all weapons-usable fissile material.

Reproduced from M. Bunn, *Securing the Bomb 2010*, Harvard University and the Nuclear Threat Initiative, April 2010).

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Country

Year

Action Taken	Completed	% of 2017 Goal	Action Taken	Completed	% of 2017 Goal
Warheads Deactivated	7616	82.2%	SLBM Launchers Eliminated	492	80.4%
ICBMs Destroyed	914	87.8%	Nuclear Air-to-Surface Missiles Destroyed	906	100%
ICBM Silos Eliminated	498	76.4%	Bombers Eliminated	155	100%
ICBM Mobile Launchers Destroyed	197	54.9%	Nuclear Test Tunnels/Holes Sealed	194	100%
Nuclear Weapons-Carrying Submarines Destroyed	33	84.6%	Nuclear Weapons Transport Train Shipments	611	73.7%
Submarine-Launched Ballistic Missiles (SLBMs) Destroyed	695	95.3%	Nuclear Weapons Storage Facility Upgrades	24	100%
Cooperative Biological Engagement Laboratories Secured	47	57.3%	Declared CW Agent Destroyed (Metric Tons)	4018.6	73.4%

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Public Policy Opportunities

If you want to get paid (jobs):

- The National Academies (NAS, NAE, NRC, IOM) hire Senior Project Assistants and Research Assistants.
- The scientific societies (AIP, APS, AGU, AGI, ACS, AAAS or AAS) hire science policy researchers.
- Other organizations like the Center for Science, Policy, and Outcomes, the Federation of American Scientists, and the Union of Concerned Scientists sometimes hire researchers.
- The General Accounting Office hires researchers.
- The Congressional Research Service (CRS) produces an annual guide of policy jobs in Washington, DC.

- Policy-makers are in dire need of technical expertise in writing laws to evaluate national security threats, handle privacy, and regulate medical diagnostic testing.
- People are hungry for information.
- An educated electorate is essential.
- Training the populace could save lives in the event of an attack.
 - Panic will amplify the effect of an attack.
 - Panic is greatly diminished when people receive training.

Assessing Risk

What should you stay awake worrying about at night?

Deaths in 2019*	Cause
2,854,838	All causes
659,041	Heart disease
606,880	Cancer
224,935	Accidents
40,400	Influenza/Pneumonia
47,500	Suicide

Deaths in 2019*	Cause
45,404 [†]	Car accidents
26,031	Homicide
65,773	Poisoning
39,443	Falling
4,301	Drowning
3,704	Fire

* Assembled from CDC, Statista.com websites.

† Included in “Accidents” category