Physics 280: Session 21

Plan for This Session

Student questions

News and discussion

Module 6: Nuclear Arsenals (cont'd)

News and Discussion

Global Security Newswire
by National Journal Group
Daily news on nuclear, biological and chemical weapons, terrorism and related issues.

U.S. Can Intercept North Korean Ballistic Missiles, General Says

Monday, April 4, 2011

The head of the U.S. Missile Defense Agency on Thursday said the United States is prepared to counter potential ballistic missile strikes from North Korea, the Yonhap News Agency reported (see ***GSN***, April 1).

At a Capitol Hill Hearing, Lt. Gen. Patrick O'Reilly responded to a question on the abilities of the Ground-based Midcourse Defense system, which is intended to protect the country from a long-range ballistic missile attack. The last two intercept tests of the system have been failures (see ***GSN***, Dec. 17, 2010).

News and Discussion

Test fails; Raytheon warhead delivery halted

David Wichner Arizona Daily Star | Posted: Tuesday, April 5, 2011 12:00 am

The U.S. Missile Defense Agency has suspended deliveries of a warhead made by Raytheon for the nation's ground-based missile-defense system, pending the results of an investigation into the system's second failed intercept test.

Deliveries of the Exoatmospheric Kill Vehicle, or EKV, a non-explosive guided warhead made by Tucson-based Raytheon Missile Systems, were halted after the kill vehicle failed to hit its mark in a Dec. 15 flight test, Missile Defense Agency spokesman Rick Lehner said.

When deliveries are resumed depends on the results of a "failure review" launched shortly after the December intercept failure, Lehner said, adding that the agency is likely weeks or months away from releasing a final report.

News and Discussion

ARMS CONTROL ASSOCIATION

The authoritative source on arms control

Funding for U.S. Nuclear Triad Set to Grow

Tom Z. Collina

President Barack Obama last month sent Congress a budget request for fiscal year 2012 that would significantly increase funding for maintenance of the nuclear stockpile, modernization of the weapons production complex, upgrades to strategic delivery systems, and deployment of ballistic missile interceptors.

All told, these commitments, which were key to winning Department of Defense and Senate support for the New Strategic Arms Reduction Treaty (New START), would add up to almost $300 billion over the next decade. The budget documents add specifics to the earlier commitments.

Physics/Global Studies 280
Module 6: Nuclear Arsenals and Proliferation

Part 1: Overview of Programs and Arsenals

Part 2: Arsenals of the NPT Nuclear-Weapon States: The United States, Russia, the United Kingdom, France, and China

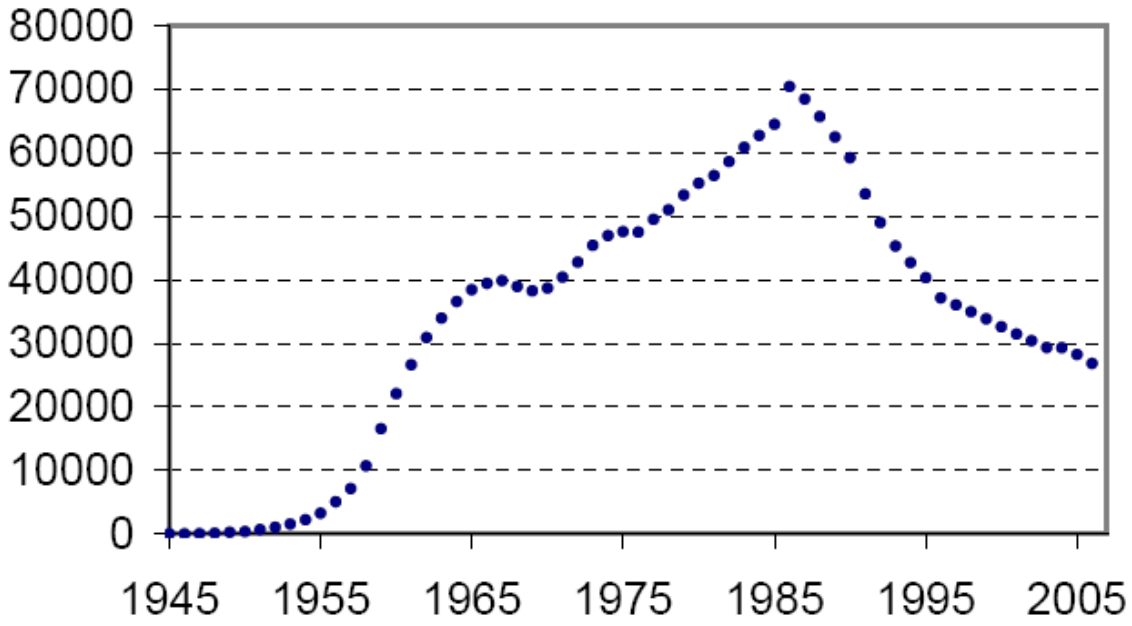
Part 3: Arsenals of non-NPT and Emerging Nuclear-Weapon States: India, Pakistan, Israel, North Korea, and Iran

Part 4: Threat Perceptions

Module 6: Programs and Arsenals

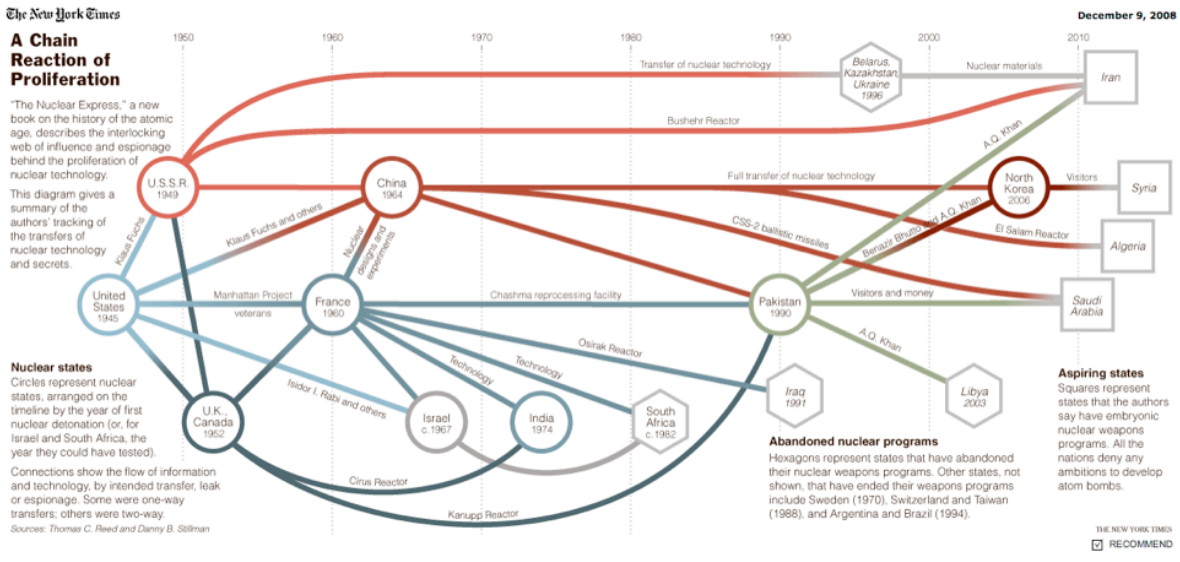
Part 1: Overview of Programs and Arsenals

World Nuclear Weapon Stockpiles 1945–2006



NRDC, Global nuclear stockpiles, 1945-2006, Bulletin of the Atomic Scientists, Jul-Aug 2006

Module 6: Nuclear Arsenals and Proliferation

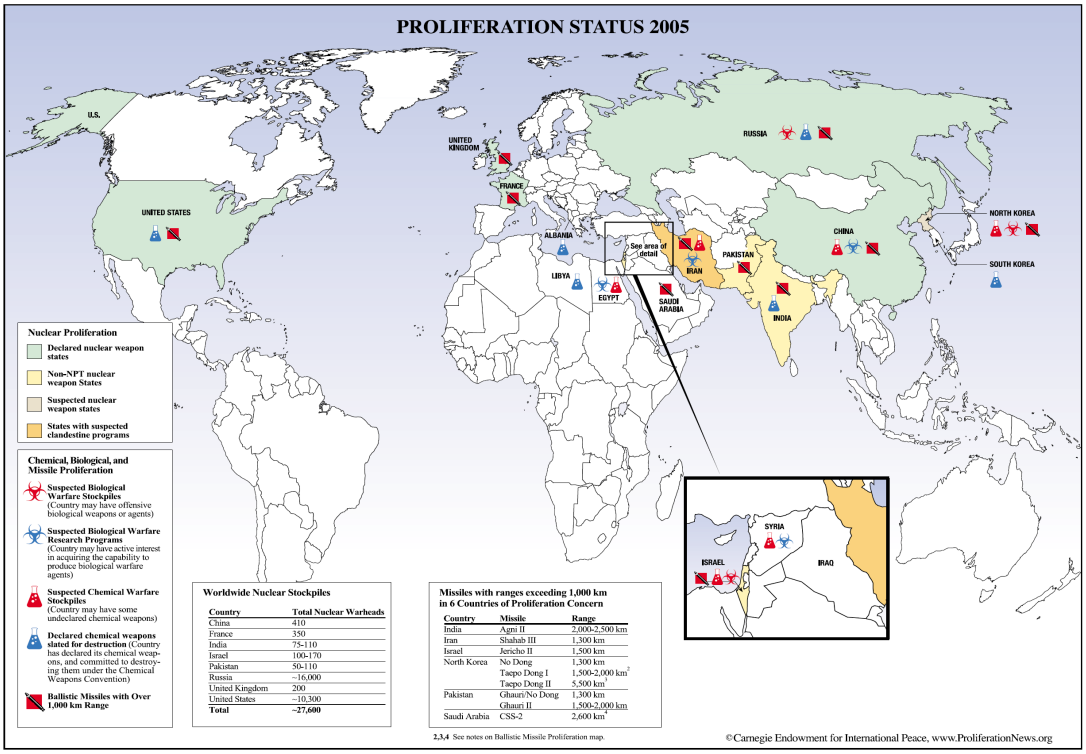


This article has been revised to reflect the following correction:

Correction: December 15, 2008

A chart last Tuesday with an article about the proliferation of the atomic bomb, showing the exchange of nuclear information and technology between countries, misidentified the type of reactor that India acquired from Canada, which allowed India to make fuel for its first nuclear test. It was a CIRUS reactor, not a Candu reactor.

Nuclear Weapons and Proliferation



Global Nuclear Weapon Inventory (2011)

NPT Nuclear Weapon States

China:	Total warheads	~ 240
France:	Operational warheads	< 300
Russia:	Operational strategic warheads:	~ 2,600
	Operational tactical warheads:	~ 2,000
	Stockpiled strategic & tactical warheads:	~ 8,000
UK:	Operational strategic warheads:	< 160
	Total stockpile of warheads:	< 225
US:	Active and inactive warheads:	5,113
	Retired and awaiting dismantlement:	~ 4,500

Of the 5,113 —
- ~ 1,968 are operational strategic warheads
- ~ 500 are operational tactical warheads
- ~ 2,645 are inactive warheads

Global Nuclear Weapon Inventory (2011)

Non-NPT Nuclear Weapon States

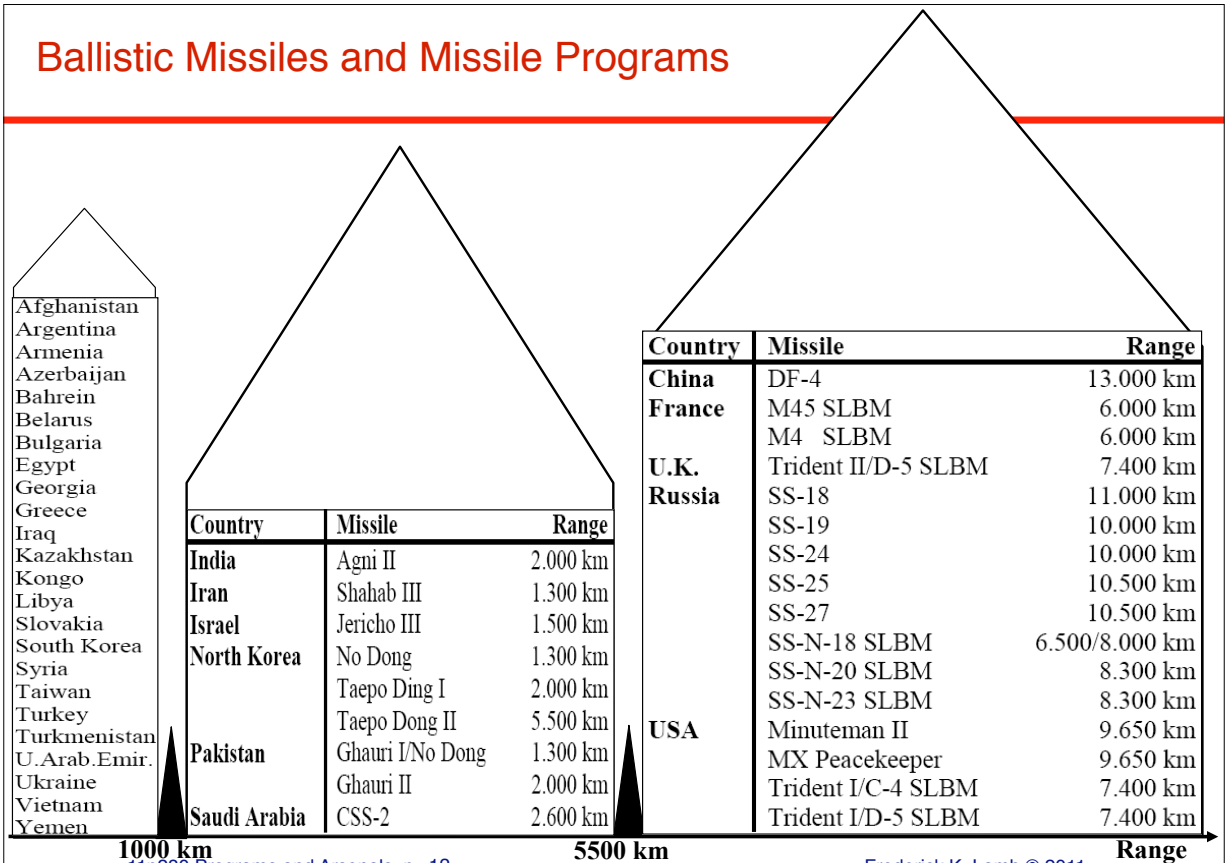
India: Up to 100 nuclear warheads

Israel: 75–200 nuclear warheads

Pakistan: 70–90 nuclear warheads

NK: Enough plutonium for up to 12 nuclear warheads

Ballistic Missiles and Missile Programs

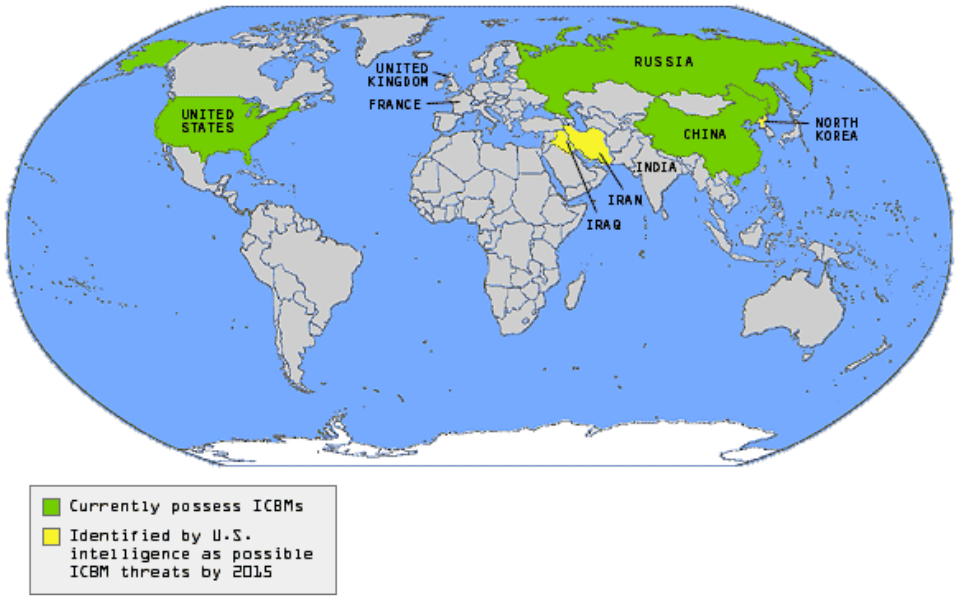


Country	Missile	Range
India	Agni II	2.000 km
Iran	Shahab III	1.300 km
Israel	Jericho III	1.500 km
North Korea	No Dong	1.300 km
	Taepo Ding I	2.000 km
	Taepo Dong II	5.500 km
Pakistan	Ghauri I/No Dong	1.300 km
	Ghauri II	2.000 km
Saudi Arabia	CSS-2	2.600 km

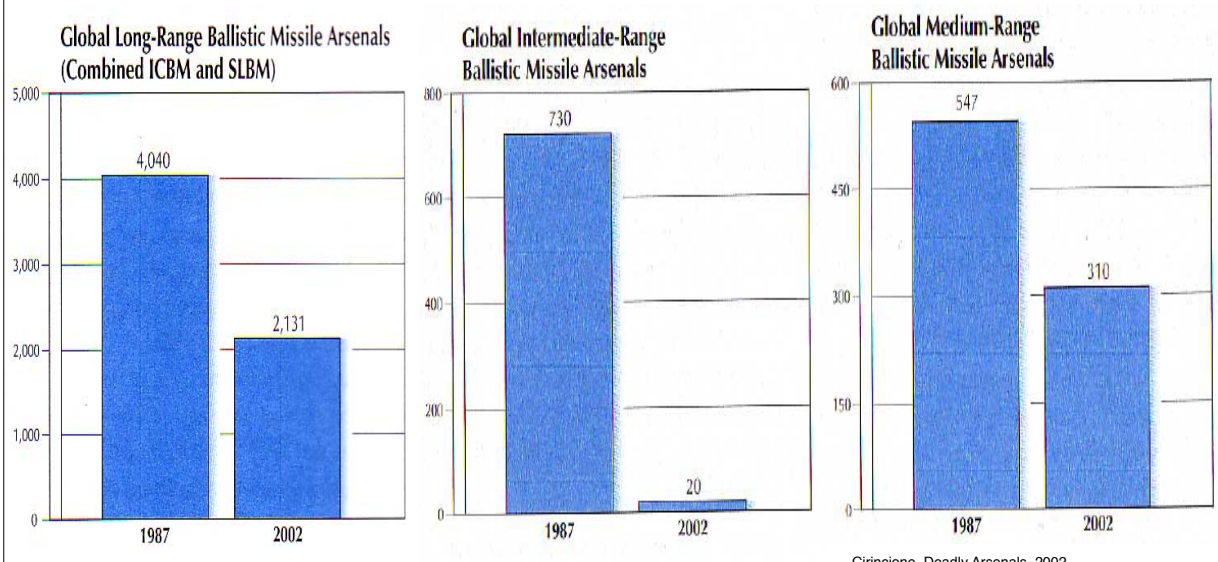
Country	Missile	Range
China	DF-4	13.000 km
France	M45 SLBM	6.000 km
	M4 SLBM	6.000 km
U.K.	Trident II/D-5 SLBM	7.400 km
Russia	SS-18	11.000 km
	SS-19	10.000 km
	SS-24	10.000 km
	SS-25	10.500 km
	SS-27	10.500 km
	SS-N-18 SLBM	6.500/8.000 km
	SS-N-20 SLBM	8.300 km
	SS-N-23 SLBM	8.300 km
USA	Minuteman II	9.650 km
	MX Peacekeeper	9.650 km
	Trident I/C-4 SLBM	7.400 km
	Trident I/D-5 SLBM	7.400 km

Overview of Programs and Arsenals

Map of ICBM Threats (2001 NIC Assessment)



Reductions in Ballistic Missile Numbers 1987–2002



Cirincione, Deadly Arsenals, 2002.

Nuclear Cruise Missiles (2007)

Nuclear cruise missile systems, then and now

COUNTRY	TYPE*	RANGE (KILOMETERS)	YEAR DEPLOYED	STATUS AS OF 1987	STATUS AS OF 2007
United States	Advanced cruise missile (AGM-129A)	>2,500	1990	in production	deployed
	Air-launched cruise missile (AGM-86B)	2,500	1986	deployed	deployed
	Enhanced cruise missile	—	—	not deployed	not deployed
	Ground-launched cruise missile (BGM-109)	2,500	1983	deployed	not deployed
	Sea-launched cruise missile (BGM-109A)	2,500	1984	deployed	deployed
Russia (Soviet Union)	AS-3 Kangaroo	650	1960	deployed	not deployed
	AS-4 Kitchen	300–550	1967	deployed	deployed
	AS-5 Kent	220	1965	deployed	not deployed
	AS-6 Kingfish	460	1970	deployed	not deployed
	AS-9 Kyle	90	1975	deployed	not deployed
	AS-11 Kilter	650	1984	deployed	deployed**
	AS-15 Kent	>2,400	1984	deployed	deployed
	KH-102	>3,000	—	not deployed	in development
	SSC-1b Sepal	460	1962	deployed	deployed**
	SS-N-3a/c Shaddock	460	1962/60	deployed	not deployed
	SS-N-7 Starbright	65	1968	deployed	not deployed
	SS-N-9 Siren	110	1970	deployed	deployed
	SS-N-12 Sandbox	550	1976	deployed	deployed
	SS-N-19 Shipwreck	550	1980	deployed	deployed
	SS-N-21 Sampson	>2,400	1987	deployed	deployed
	SS-N-22 Sunburn	220	1980	deployed	deployed

Nuclear Cruise Missiles (2007)

China	DH-10?	~1,500?	—	not deployed	in development
France	ASMP	~300	1986	deployed	deployed
	ASMP-A	~500	2007/08	not deployed	in production
Pakistan	Babur	~500	—	not deployed	in development
TOTAL				19 deployed	13–17 deployed

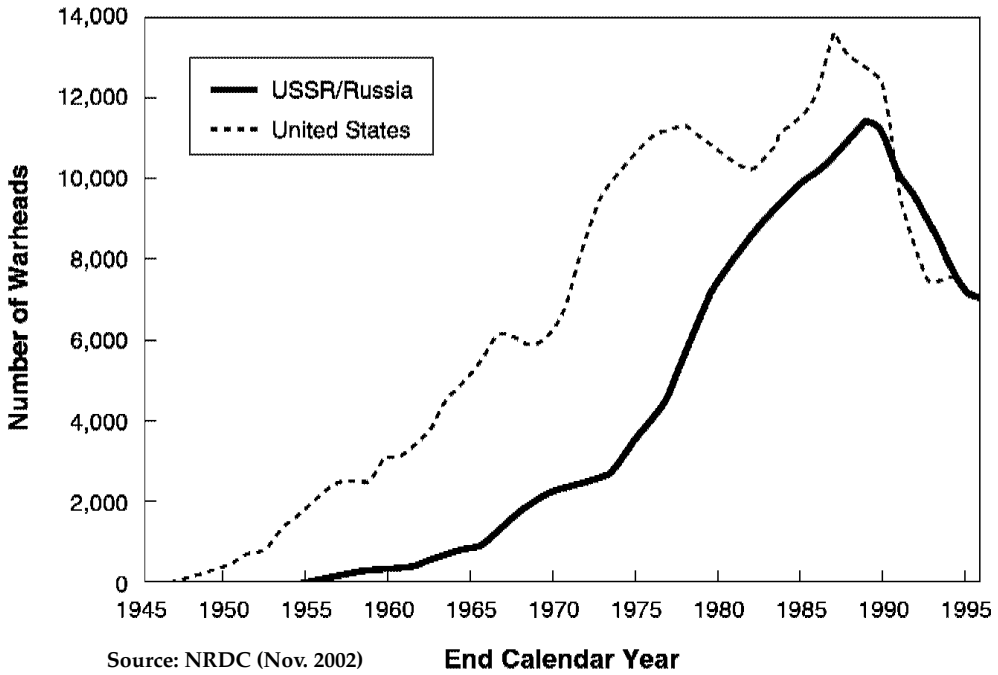
* SOME ANTI-SHIP MISSILES COULD POTENTIALLY BE EMPLOYED IN A LAND-ATTACK MODE. SOME AIR-TO-SURFACE MISSILES MAY ALSO HAVE CHARACTERISTICS SIMILAR TO CRUISE MISSILES.
** STATUS UNCERTAIN.

Module 6: Programs and Arsenals

Part 2: Arsenals of the NPT Nuclear-Weapon States

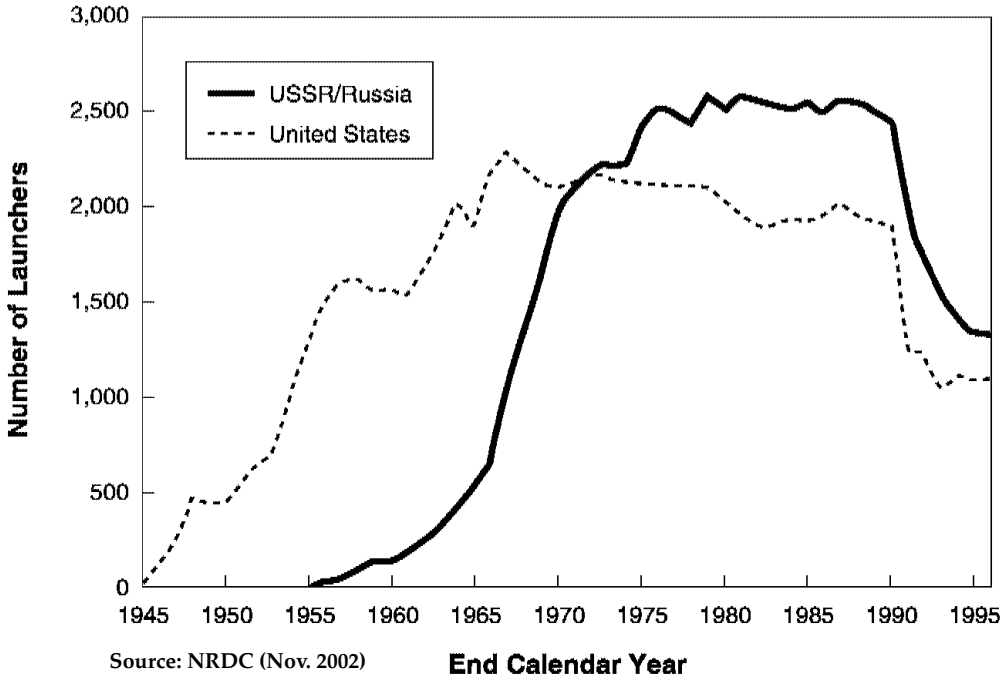
The United States, Russia, the United Kingdom, France, and China

US and SU-Russian Nuclear Warheads



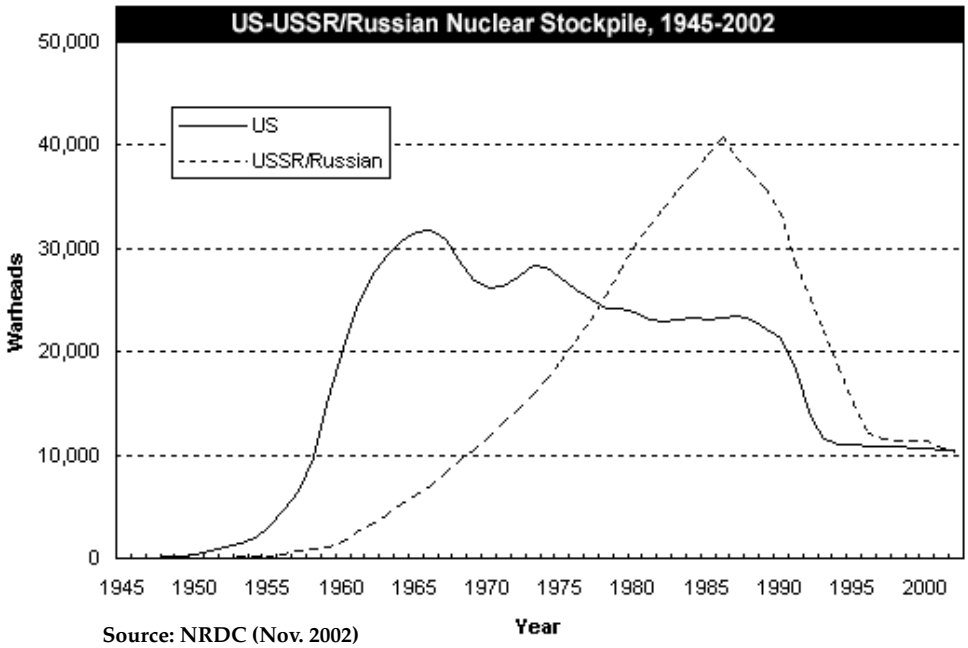
Source: NRDC (Nov. 2002)

US and SU-Russian Nuclear Launchers



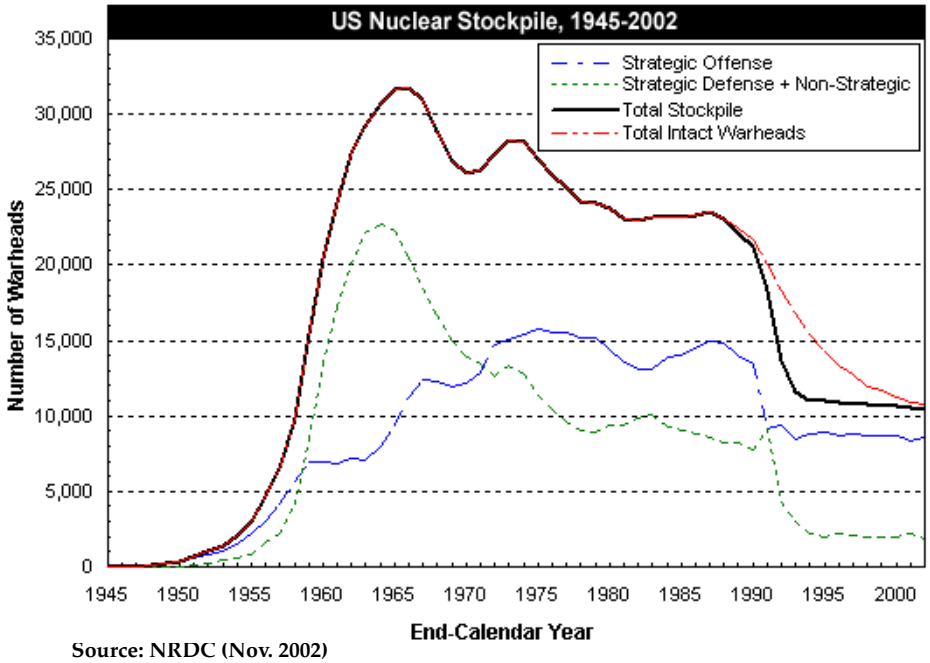
Source: NRDC (Nov. 2002)

US and SU-Russian Nuclear Stockpiles



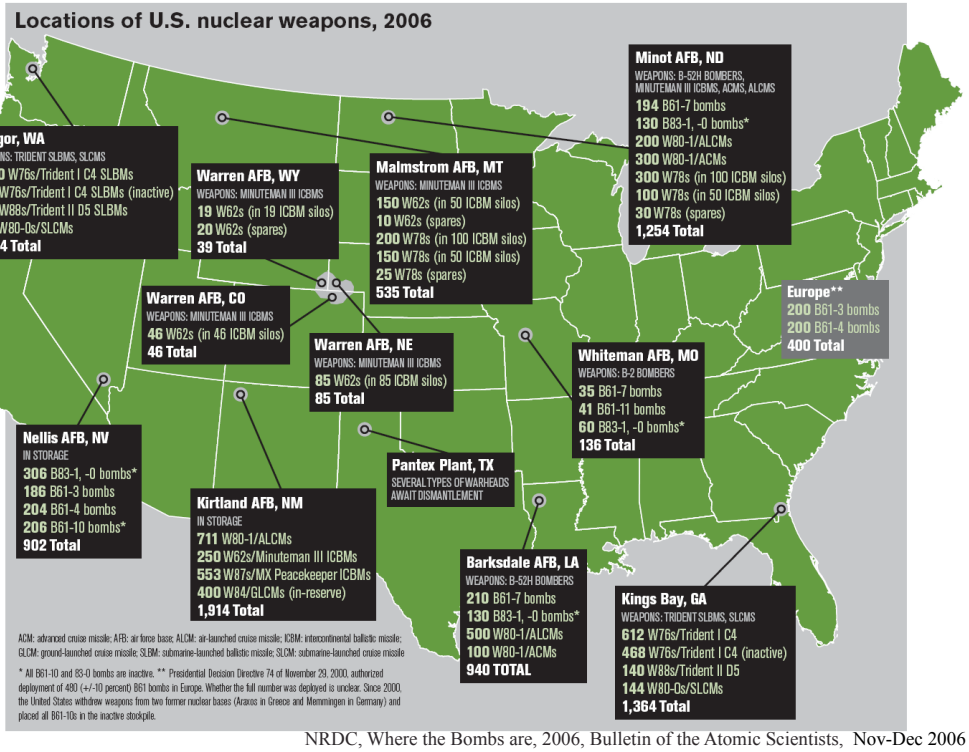
Source: NRDC (Nov. 2002)

U.S. Nuclear Warheads



Source: NRDC (Nov. 2002)

Locations of U.S. Nuclear Weapons



NRDC, Where the Bombs are, 2006, Bulletin of the Atomic Scientists, Nov-Dec 2006

U.S. and Russian "Tactical" Weapons in Europe

- The U.S. is thought to have 150 – 240 "tactical" nuclear weapons based in Europe, in the form of aerial bombs.
- Most are based in Italy and Turkey, but some are based in Germany, Belgium, and the Netherlands.
- Russia is thought to have about 2,000 operational "tactical" nuclear weapons in its arsenal.

Tactical Nuclear Weapons in Europe

The long-standing position of Washington is that its air-to-surface weapons in Europe connect the security of NATO and the United States. Still, the tactical arms are not intended for use against any particular nation and the infrastructure required to employ the weapons no longer stands at combat readiness.

A December 2008 **report** by an advisory panel to the U.S. Defense Department found that the time required to bring the aircraft that would fire the nuclear weapons into battle mode was "now measured in months rather than minutes."

The report detailed different views within the alliance, with some high-level U.S. officials at NATO headquarters in Belgium described as not being supportive of keeping the tactical weapons in Europe. An anonymous U.S. general was quoted to say that the nuclear bombs were no longer required as Washington could extend its nuclear umbrella to cover European allies from outside the continent.

2010 U.S. Nuclear Posture Review

The New York Times Reprints

April 5, 2010

Obama Limits When U.S. Would Use Nuclear Arms

By DAVID E. SANGER and PETER BAKER

WASHINGTON — President Obama said Monday that he was revamping American nuclear strategy to substantially narrow the conditions under which the United States would use nuclear weapons.

But the president said in an interview that he was carving out an exception for "outliers like Iran and North Korea" that have violated or renounced the main treaty to halt nuclear proliferation.

2010 U.S. Nuclear Posture Review

Discussing his approach to nuclear security the day before formally releasing his new strategy, Mr. Obama described his policy as part of a broader effort to edge the world toward making nuclear weapons obsolete, and to create incentives for countries to give up any nuclear ambitions. To set an example, the new strategy renounces the development of any new nuclear weapons, overruling the initial position of his own defense secretary.

Mr. Obama's strategy is a sharp shift from those of his predecessors and seeks to revamp the nation's nuclear posture for a new age in which rogue states and terrorist organizations are greater threats than traditional powers like Russia and China.

2010 U.S. Nuclear Posture Review

It eliminates much of the ambiguity that has deliberately existed in American nuclear policy since the opening days of the cold war. For the first time, the United States is explicitly committing not to use nuclear weapons against nonnuclear states that are in compliance with the Nuclear Nonproliferation Treaty, even if they attacked the United States with biological or chemical weapons or launched a crippling cyberattack.

Those threats, Mr. Obama argued, could be deterred with "a series of graded options," a combination of old and new conventional weapons. "I'm going to preserve all the tools that are necessary in order to make sure that the American people are safe and secure," he said in the interview in the Oval Office.

2010 U.S. Nuclear Posture Review

The release of the new strategy, known as the Nuclear Posture Review, opens an intensive nine days of nuclear diplomacy geared toward reducing weapons. Mr. Obama plans to fly to Prague to sign a new arms-control agreement with Russia on Thursday and then next week will host 47 world leaders in Washington for a summit meeting on nuclear security.

The strategy to be released on Tuesday is months late, partly because Mr. Obama had to adjudicate among advisers who feared he was not changing American policy significantly enough, and those who feared that anything too precipitous could embolden potential adversaries. One senior official said that the new strategy was the product of 150 meetings, including 30 convened by the White House National Security Council, and that even then Mr. Obama had to step in to order rewrites.

2010 U.S. Nuclear Posture Review

He ended up with a document that differed considerably from the one President George W. Bush published in early 2002, just three months after the Sept. 11 attacks. Mr. Bush, too, argued for a post-cold-war rethinking of nuclear deterrence, reducing American reliance on those weapons.

But Mr. Bush's document also reserved the right to use nuclear weapons "to deter a wide range of threats," including banned chemical and biological weapons and large-scale conventional attacks. Mr. Obama's strategy abandons that option — except if the attack is by a nuclear state, or a nonsignatory or violator of the nonproliferation treaty.

2010 U.S. Nuclear Posture Review

The document to be released Tuesday after months of study led by the Defense Department will declare that "the fundamental role" of nuclear weapons is to deter nuclear attacks on the United States, allies or partners, a narrower presumption than the past. But Mr. Obama rejected the formulation sought by arms control advocates to declare that the "sole role" of nuclear weapons is to deter a nuclear attack.

"We are going to pursue opportunities for further reductions in our nuclear posture, working in tandem with Russia but also working in tandem with NATO as a whole," he said.

An obvious such issue would be the estimated 200 tactical nuclear weapons the United States still has stationed in Western Europe. Russia has called for their removal, and there is growing interest among European nations in such a move as well. But Mr. Obama said he wanted to consult with NATO allies before making such a commitment.

United States Plans to Greatly Increase its Spending on Nuclear Weapons

Funding for U.S. Nuclear Triad Set to Grow

iClicker Question

About when did the total worldwide nuclear arsenal peak?

A. 1955
B. 1965
C. 1975
D. 1985
E. 1995

Blank

iClicker Answer

About when did the total worldwide nuclear arsenal peak?

A. 1955
B. 1965
C. 1975
D. 1985
E. 1995

iClicker Question

About how many nuclear weapons were there at the peak?

A. 10,000
B. 30,000
C. 50,000
D. 70,000
E. 90,000

Blank

iClicker Answer

About how many nuclear weapons were there at the peak?

A. 10,000
B. 30,000
C. 50,000
D. 70,000
E. 90,000

iClicker Answer

About how many nuclear weapons does China now have *in total*?

A. 50
B. 100
C. 250
D. 3,000
E. 5,000

Blank

iClicker Answer

About how many nuclear weapons does China now have *in total*?

A. 50
B. 100
c. 250
D. 3,000
E. 5,000

iClicker Question

About how many *operational* nuclear weapons does France now have?

A. < 50
B. < 100
C. < 300
D. 1,000
E. 5,000

Blank

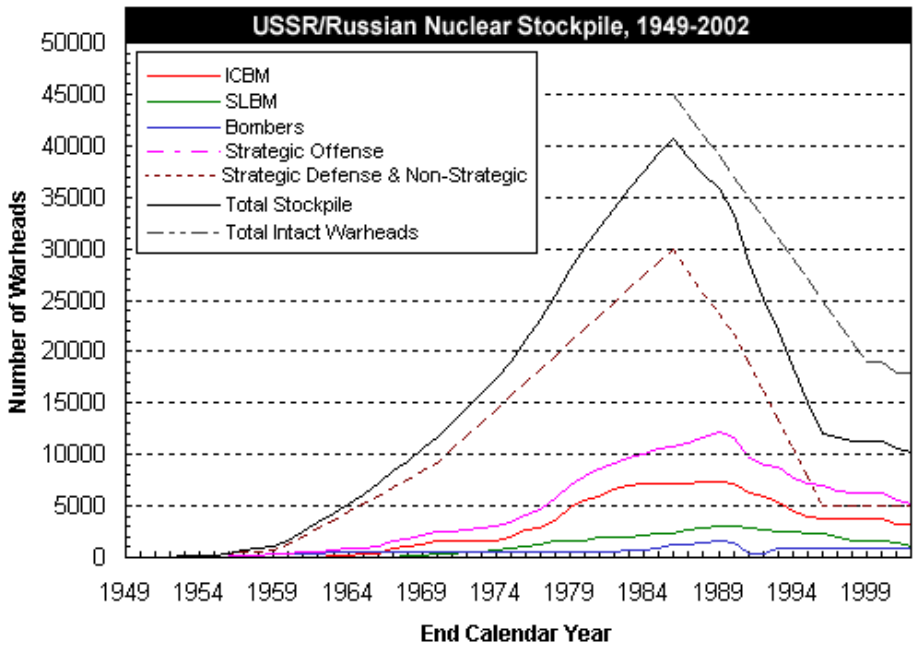
iClicker Answer

About how many *operational* nuclear weapons does France now have?

A. < 50
B. < 100
C. **< 300**
D. 1,000
E. 5,000

Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**

SU-Russian Nuclear Warheads



Source: NRDC (Nov. 2002)

Russian Nuclear Forces (2010)

TYPE	NAME	LAUNCHERS	YEAR DEPLOYED	WARHEADS X YIELD (KILOTONS)	TOTAL WARHEADS
STRATEGIC OFFENSIVE WEAPONS					
ICBMs					
SS-18	Satan	50	1979	10 x 500/800	500
SS-19	Stiletto	60	1980	6 x 400	360
SS-25	Sickle	150	1985	1 x 800	150
SS-27 (Mod. 1)	(Topol-M, silo)	50	1997	1 x 800	50
SS-27 (Mod. 1)	(Topol-M, mobile)	18	2006	1 x 800?	18
SS-27 (Mod. 2)	(RS-24)	3	2009	~4 x 400?	12
SUBTOTAL		**331**			**1,090**
SLBMs					
SS-N-18 M1	Stingray	4/64	1978	3 x 50 (MIRV)	192
SS-N-23	Skiff	2/48	1986	4 x 100 (MIRV)	128
SS-N-23 M1	Sineva	4/48	2007	4 x 100 (MIRV)[1]	256
SS-N-32	Bulava-30	(1/16)	~2010	6 x 100 (MIRV)	0
SUBTOTAL		**10/160**			**576**
Bombers/weapons					
Tu-95 MS6	Bear H6	31	1984	6 x AS-15A ALCMs, bombs	186
Tu-95 MS16	Bear H16	31	1984	16 x AS-15A ALCMs, bombs	496
Tu-160	Blackjack	13	1987	12 x AS-15B ALCMs or AS-16 SRAMs, bombs	156
SUBTOTAL		**75**			**838**
SUBTOTAL STRATEGIC OFFENSIVE FORCES					**~2,600**

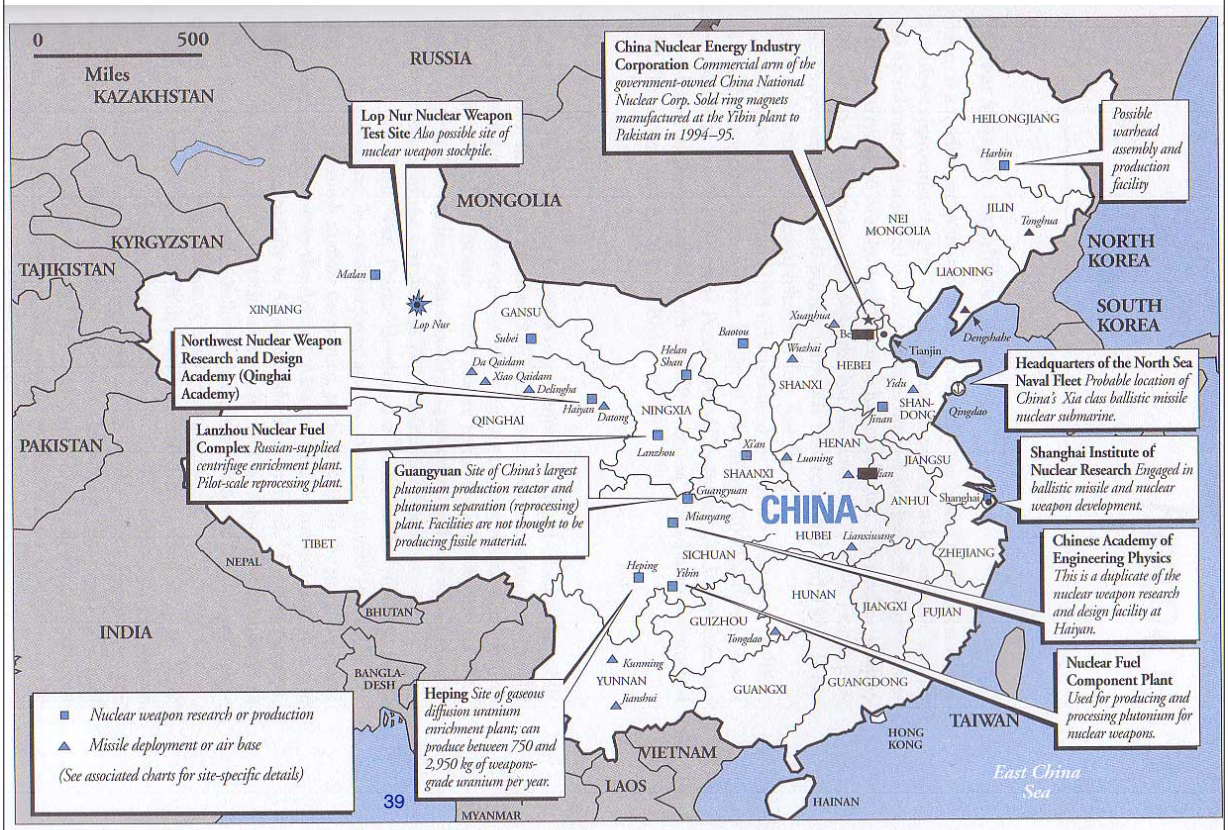
Russian Nuclear Forces (2010)

NONSTRATEGIC AND DEFENSIVE WEAPONS					
ABM/Air defense					
53T6	Gazelle	68	1986	1 x 1,000/10	68[2]
SA-10	Grumble	1,900	1980	1 x low	630
Land-based air					
Bombers/fighters		~524		ASM, bombs	650
Naval					
Submarines/surface ships/air				SLCM, ASW, SAM, ASM, DB, torpedoes	700
SUBTOTAL NONSTRATEGIC AND DEFENSIVE FORCES					**~2,000[3]**
TOTAL					**~4,600[4]**

1. The Sineva probably carries at least four MIRVed warheads. U.S. intelligence in 2006 estimated that the missile can carry "up to 10" warheads.
2. All Gorgon missiles apparently have been removed from the ABM system.
3. We estimate that an additional 3,300 nonstrategic warheads are in reserve or awaiting dismantlement, leaving a total inventory of approximately 5,300 nonstrategic warheads.
4. We estimate that an additional 7,300 intact warheads are in reserve or awaiting dismantlement, for a total inventory of approximately 12,000 warheads.

ABM: Antiballistic missile
ALCM: Air-launched cruise missile
ASM: Air-to-surface missile
ASW: Antisubmarine weapon
DB: Depth bomb
ICBM: Intercontinental ballistic missile
MIRV: Multiple independently targetable reentry vehicle
SAM: Surface-to-air missile
SLBM: Submarine-launched ballistic missile
SLCM: Sea-launched cruise missile
SRAM: Short-range attack missile

China's Nuclear Infrastructure



Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**

Chinese Nuclear Forces (2008)

LAND-BASED MISSILES

TYPE	NATO DESIGNATION	NO.	YEAR DEPLOYED	WARHEADS x YIELD (KILOTONS)	RANGE (KILOMETERS)	WARHEADS
DF-3A	CSS-2	17	1971	3,100	1 x 3,300	17
DF-4	CSS-3	17	1980	5,400+	1 x 3,300	17
DF-5A	CSS-4	20	1981	13,000+	1 x 4,000–5,000	20
DF-21	CSS-5	55	1991	2,100	1 x 200–300	55
DF-31	?	~6	2008	7,200+	1 x 200–300 ?	~6
DF-31A	?	~6	2008	11,200+	1 x 200–300 ?	~6

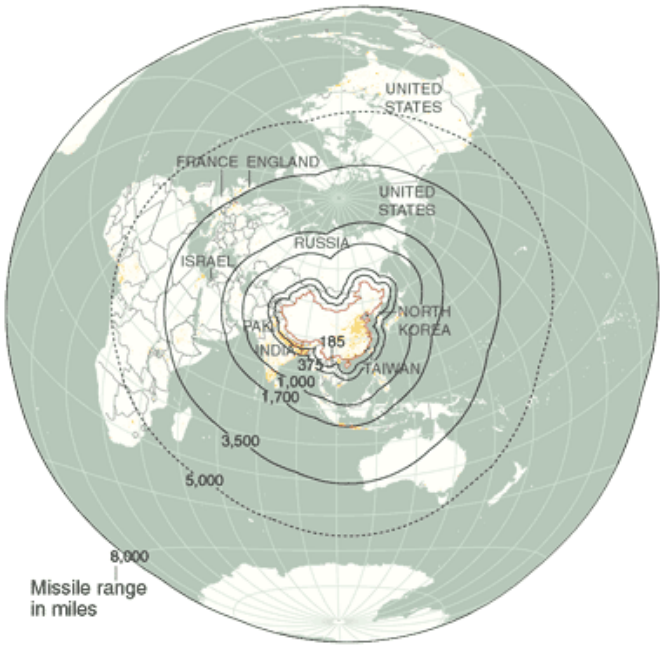
SUBMARINE-LAUNCHED BALLISTIC MISSILES

TYPE	NATO DESIGNATION	NO.	YEAR DEPLOYED	WARHEADS x YIELD (KILOTONS)	RANGE (KILOMETERS)	WARHEADS
JL-1*	CSS-NX-3	0	1986	1,000+	1 x 200–300	0
JL-2	CSS-NX-4	0	2009–10?	7,200+	1 x 200–300 ?	0

AIRCRAFT **

TYPE	NATO DESIGNATION	NO.	YEAR DEPLOYED	WARHEADS x YIELD (KILOTONS)	RANGE (KILOMETERS)	WARHEADS
Hong-6	B-6	20	1965	3,100	1 x bomb	~20
					DH-10	~15
Qian-5, others?	Q-5	?	1972–?	—	1 x bomb	~20
					TOTAL***	**~176**

Ranges of China's Missiles



French Nuclear Forces (2008)

THE FRENCH ARSENAL

LAND-BASED AIRCRAFT	NO.	YEAR OPERATIONAL	RANGE (KILOMETERS)	WARHEADS x YIELD (KILOTONS)	ACTIVE WARHEADS
Mirage 2000N/ASMP	50	1988*	2,750**	1 TN81 X VARIABLE TO 300	50
Rafale F3/ASMP-A	?	2008	2,000	1 TNA X VARIABLE TO ?	—
CARRIER-BASED AIRCRAFT	**NO.**	**YEAR OPERATIONAL**	**RANGE (KILOMETERS)**	**WARHEADS x YIELD (KILOTONS)**	**ACTIVE WARHEADS**
Super Étendard/ASMP	10	1978	650**	1 TN81 X VARIABLE TO 300	10
Rafale MK3/ASMP-A	?	(2010)	2,000	1 TNA X VARIABLE TO ?	—
SLBMs	**NO.**	**YEAR OPERATIONAL**	**RANGE (KILOMETERS)**	**WARHEADS x YIELD (KILOTONS)**	**ACTIVE WARHEADS**
M45***	48	N/A	4,000+	4–6 TN75 X 100	240

* The ASMP first became operational on the Mirage IV in 1986.
** Maximum range of the ASMP is 300 kilometers; for the ASMP-A it is 500 kilometers.
*** Three sets of 16 M45 missiles are deployed on three of four SSBNs in the operational cycle.

TOTAL: 300

FRENCH SSBNs

NAME/SLBM*	YEAR OPERATIONAL	MISSILE RANGE (KILOMETERS)	WARHEADS x YIELD (KILOTONS)	TOTAL WARHEADS
Le Triomphant/M45	1997	4,000+	4–6 TN75 x 100	80
Le Téméraire/M45	1999	4,000+	4–6 TN75 x 100	80
Le Vigilant/M45	2005	4,000+	4–6 TN75 x 100	80
Le Terrible/M51.1**	(2010)	6,000	4–6 TN75 x 100	0

* Three sets of 16 M45 missiles are deployed on three of four SSBNs in the operational cycle.
** Its first deployment is scheduled for 2010.

SSBN: Nuclear-power ballistic missile submarine
SLBM: Submarine-launched ballistic missile

U.K. Strategic Nuclear Forces

Weapon System	Warheads					
	No. deployed	Year deployed	Range (km)	Warhead x yield	Type	No. in stockpile
SLBMs						
Trident II D-5	64	1994	7,400	1-3 x 100 Kt	MIRV	200
# average loading five warheads per missile, some missiles carry one warhead , various yield options						

Source: NRDC (Nov. 2002)

Physics 280: Session 22

Plan for This Session

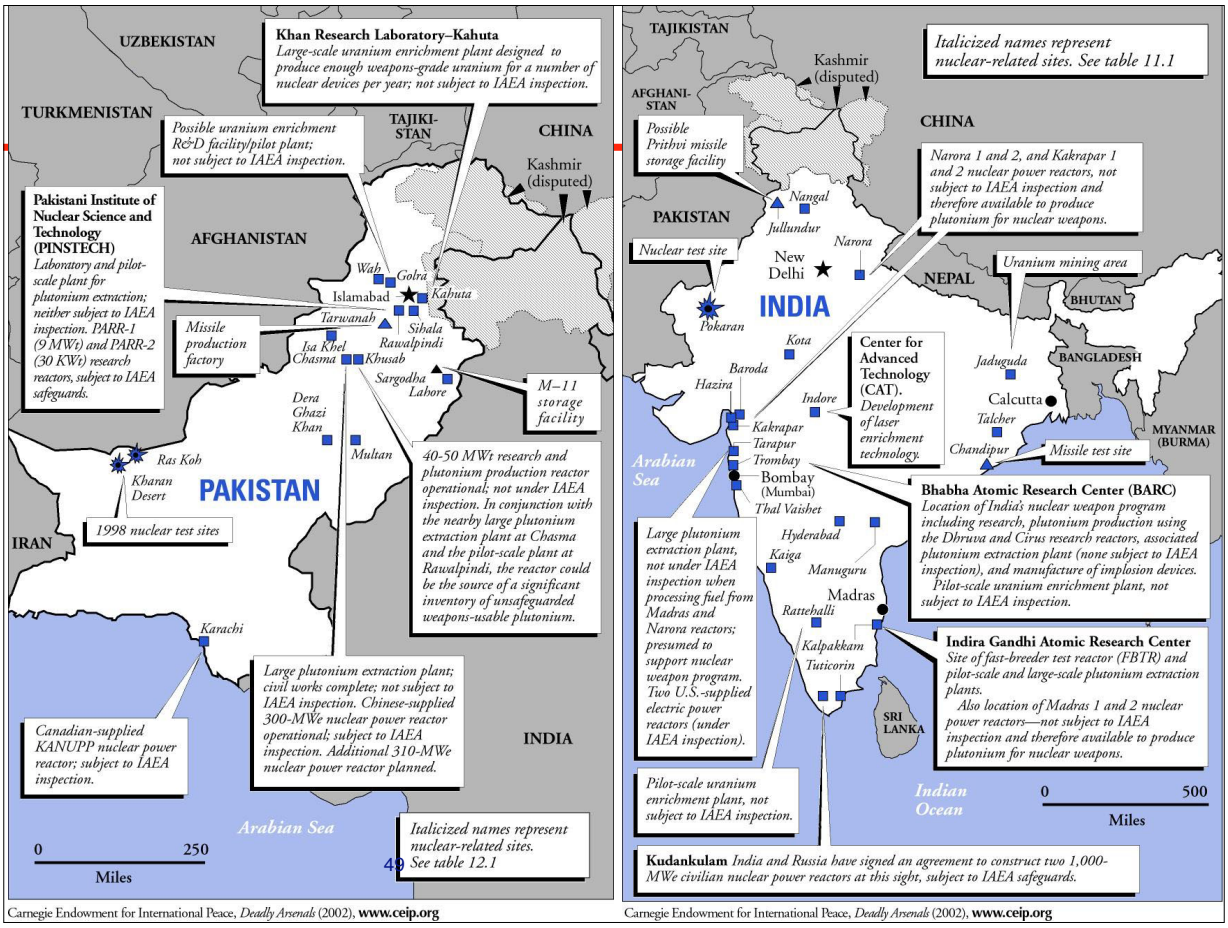
Student questions

Module 6: Nuclear Arsenals (cont'd)

Module 6: Programs and Arsenals

Part 3: Arsenals of non-NPT and Emerging Nuclear-Weapon States

India, Pakistan, Israel,
North Korea, and Iran



Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**

Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**

India's Nuclear and Missile Programs – 1

India's nuclear weapons use plutonium

- India's first nuclear explosive device used explosive material diverted illegally from a civilian nuclear reactor provided by Canada
- Estimated to have produced 225–370 kg of weapons-grade plutonium
- Estimated to have produced a smaller, but publicly unknown, quantity of weapons-grade uranium
- This quantity of plutonium is thought to be enough for India to produce 50–100 nuclear weapons
- The NRDC estimates that India has 30–35 warheads
- India is thought to have the components to deploy a small number of nuclear weapons within days
- No nuclear weapons are known to be deployed among active military units or deployed on missiles

India's Nuclear and Missile Programs – 2

India's nuclear delivery capability

- India has developed several types of ballistic missiles capable of carrying and delivering a nuclear payload
- Three versions of the short-range, liquid-propellant, road-mobile Prithvi have been developed —
  - — Army (range = 150 km, payload = 500 kg)
  - — Air Force (range = 250 km, payload = 500–750 kg)
  - — Navy (range = 350 km, payload = 500 kg)
- India has also developed and in 1999 successfully tested the medium-range Agni II, with a declared range of 2,000–2,500 km
- However, fighter-bombers are thought to be the only delivery system that could be used before 2010

Indian Nuclear Forces (2008)

AIRCRAFT	RANGE (KILOMETERS)	PAYLOAD (KILOGRAMS)	COMMENT
Mirage 2000H/Vajra	1,800	6,300	Squadron 1 or 7 at Gwalior Air Force Station.
Jaguar IS/IB/Shamsher	1,600	4,775	At Ambala Air Force Station.
LAND-BASED MISSILES	**RANGE (KILOMETERS)**	**PAYLOAD (KILOGRAMS)**	**COMMENT**
Prithvi I	150	1,000	Nuclear version entered service after 1998 with the 333rd and 355th Missile Groups. Will be converted from liquid fuel to solid fuel.
Agni I	700	1,000	First operational training test in 2007; second in 2008. Deployed with army's 334th Missile Group in 2004.
Agni II	2,000	1,000	Under development. Tested August 29, 2004. Deployed with army's 335th Missile Group.
Agni III	3,000	1,500	Under development. Test-launched in 2006 (failed), 2007, and 2008.
SEA-BASED MISSILES	**RANGE (KILOMETERS)**	**PAYLOAD (KILOGRAMS)**	**COMMENT**
Dhanush	350	1,000	Under development. Naval version of Prithvi II. Fourth test March 30, 2007.
Sagarika/K-15	300–700	500–600	Under development. K-15 test-launched February 26, 2008, from a submerged platform; deployment expected after 2010.

Pakistan's Nuclear and Missile Programs – 1

Pakistan's current nuclear weapons mainly use HEU

- Pakistan stole uranium enrichment technology from Urenco; has since supplied it to many other countries of concern
- Is estimated to have produced 585–800 kg of highly enriched uranium
- ACA estimates that it could have 70–90 HEU nuclear weapons
- May possess enough weapon-grade plutonium to produce 3–5 nuclear weapons
- Nuclear weapons are thought to be stored in component form, with the fissile core stored separately from the non-nuclear explosives
- Thought to possess enough components and material to assemble a small number of nuclear weapons in a matter of hours or days

Pakistan's Nuclear and Missile Programs – 2

Pakistan's nuclear delivery capability

- Thought to have about 30 nuclear-capable short-range Chinese M-11 surface-to-surface missiles, which have a range of 280–300 km
- Announced deployment of the Shaheen I in 2001
- Tested Ghauri I (range > 1,300 km, payload = 700 kg)
- Tested Ghauri II (range = 2,000 km, payload = 850 kg)
- Displayed but never tested the 2,000-km Shaheen II
- Primary nuclear capable aircraft is the F-16, which can deliver a 1,000-kg bomb to a distance of 1,400 km

Pakistani Nuclear Forces (2009)

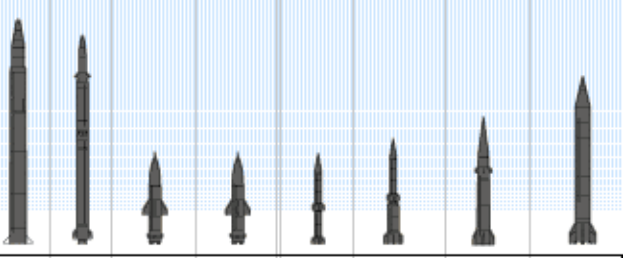
We estimate that Pakistan has produced 70-90 nuclear warheads that can be deployed on the following delivery vehicles:

TYPE	RANGE [1] (kilometers)	PAYLOAD (kilograms)
Aircraft		
F-16A/B	1,600	1 bomb (4,500)
Mirage V	2,100	1 bomb (4,000)
Ballistic missiles		
Ghaznavi (Hatf-3)	~400	Conventional or nuclear (500)
Shaheen-1 (Hatf-4)	450+	Conventional or nuclear (1,000)
Shaheen-2 (Hatf-6)*	2,000+	Conventional or nuclear (1,000)
Ghauri (Hatf-5)	1,200+	Conventional or nuclear (1,000)
Cruise missiles		
Babur (Hatf-7)*	320+	Conventional or nuclear (n/a)
Ra'ad (Hatf-8)*	320+	Conventional or nuclear (n/a)

Summary of India's and Pakistan's Ballistic Missile Systems

With India and Pakistan both possessing nuclear weapons and the means to deliver them great distances, a possible war could result in millions of deaths in both countries. The following illustrates the range of missiles:

SOURCES: Associated Press; Pakistan Armed Forces; Jane's Information Group

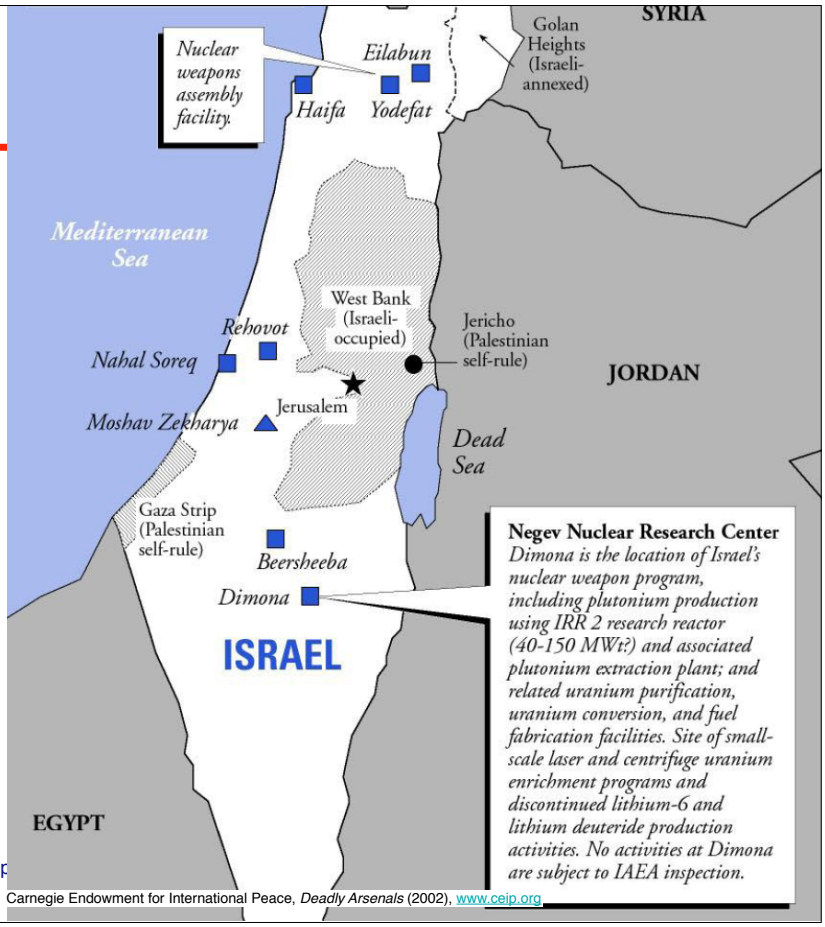


Missile name	Agni 1	Agni 2	Prithvi 1	Prithvi 2	Ghauri 1	Shaheen 1	Ghauri 2	Shaheen 2
Length (ft.)	69.3	66	28.2	28.2	28	33	39.6	52.5
Payload* (lbs.)	2,200	2,200	1,760	1,100**	1,100	1,100	2,200	2,640
Range (mi.)	1,560	2,190	94	156	375	940	1,440	1,560
Accuracy (ft.)	495	330	165	248	660	n/a	660	8,250

*Single warhead **up to 1,650 lbs.

Source: CNN (May 2003)

Israel's Nuclear Weapons Complex



Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), www.ceip.org

Israel's Nuclear and Missile Programs – 1

Israel's nuclear weapons primarily use Pu

- Is thought to have completed its first nuclear device by late 1966 or early 1967, probably using HEU stolen from the United States
- Is reported to have hurriedly assembled deliverable devices just before the 1967 six-day war.
- Is estimated to have produced ~ 400–700 kg of weapons-grade plutonium
- Is thought to have enough plutonium to fabricate ~ 100–200 nuclear weapons
- Is thought to have ~ 75–200 fission weapons (but some sources disagree, claiming much more capability, including modern thermonuclear weapons)

Israel's Nuclear and Missile Programs – 2

Israel's nuclear delivery capability

- Jericho I: short-range, solid-propellant (range = 500 km, payload = 500 kg). Developed with the French. Deployed in 1973. Land- and rail-mobile.
- Jericho II: medium-range, solid-propellant (range = 1,500 km, payload = 1,000 kg). Developed with the French. Deployed in 1990; currently has ~ 100. Land- and rail-mobile.
- Jericho III: intermediate-range, solid-propellant (range approx. 4,000 km, payload = 1,000 kg). Indigenous. Tested. Operational?
- Israel could also deliver nuclear weapons using its U.S.-supplied F-4E and F-16 aircraft.
- Israel could also deliver nuclear weapons using its cruise missiles (the U.S.-supplied Harpoon, range = 120 km, payload = 220 kg, or a new 1,200-km missile).

Summary of Israel's Nuclear Delivery Systems

	Year deployed	Range (kilometer)	Comment
Strategic forces			
Aircraft			
F-16A/B/C/D/I Fighting Falcon	1980	1,600	Bombs possibly stored at Tel Nof, Nevatim, Ramon, Ramat-David, and Hatzor
F-15I Ra'am (Thunder)	1998	4,450	Could be used for long-range strike role
Land-based missiles			
Jericho I	1972	1,200	Possibly 50 at Zekharyeh
Jericho II	1984–85	1,800	Possibly 50 at Zekharyeh, on TELs in caves
Sea-based missiles			
Dolphin-class submarines	2002 (?)	?	Modified Harpoon missiles for land-attack
Non-strategic forces			
Artillery and landmines	?	?	Reports of these weapons cannot be confirmed

Source: Bulletin of the Atomic Scientists (Sept./Oct. 2002)

iClicker Question

About when did the number operational U.S. nuclear warheads peak?

A. 1970
B. 1975
C. 1980
D. 1985
E. 1990

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iClicker Question

About when did the number operational U.S. nuclear warheads peak?

A. 1970
B. 1975
C. 1980
D. 1985
E. 1990

iClicker Question

About how many operational nuclear warheads did the U.S. have when the number peaked?

A. 1,000
B. 5,000
C. 10,000
D. 15,000
E. 20,000

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iClicker Question

About when did the number of operational U.S.S.R. nuclear warheads peak?

A. 1970
B. 1975
C. 1980
D. 1985
E. 1990

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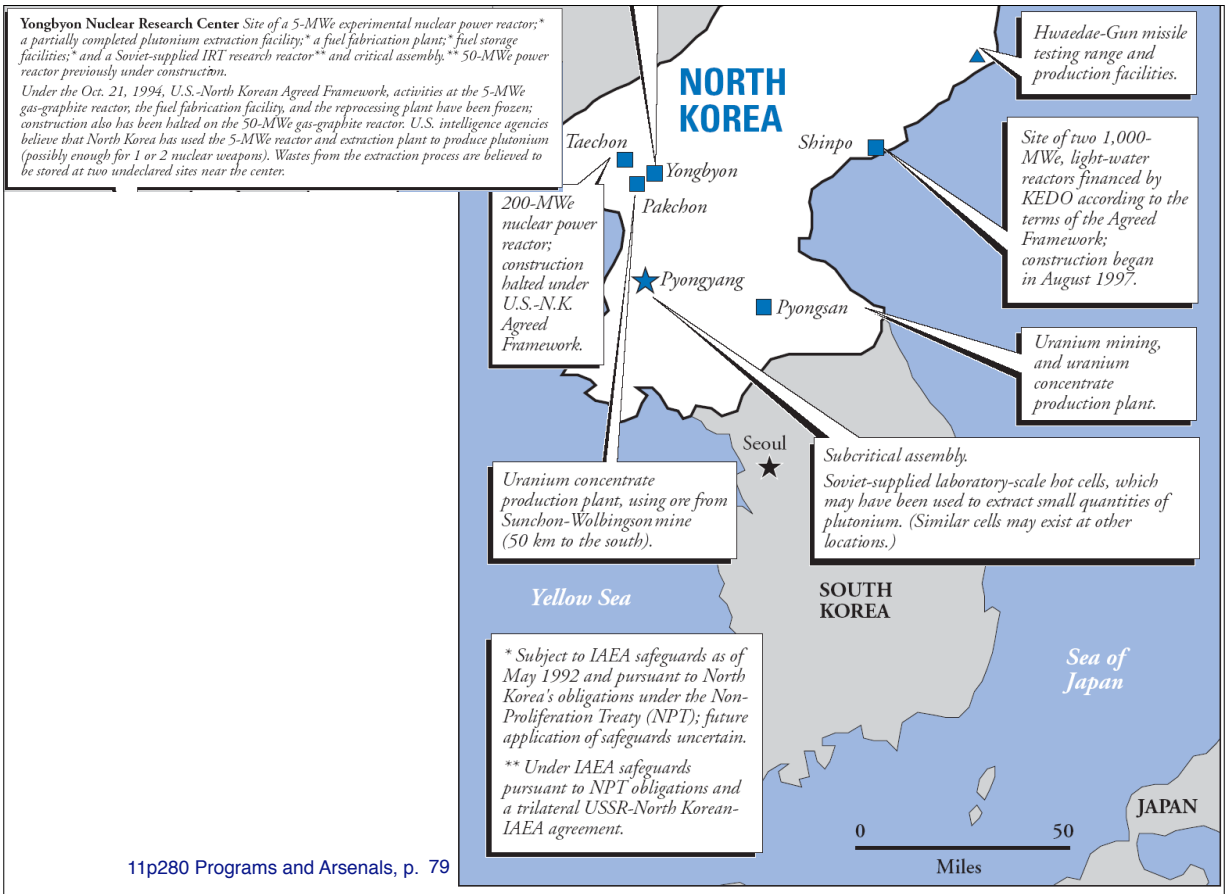


Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**

North Korea's Nuclear Program – 1

History —

- 1950s: NK nuclear research reportedly begins.
- At this time NK was a Soviet Client state and its nuclear engineers were largely trained at Soviet scientific institutes.
- 1965: NK begins operating a small research reactor it received from the USSR.
- mid-1980s: Concerns over NK's nuclear weapons program grow when US intelligence satellites reportedly photograph construction of a research reactor and the beginnings of a reprocessing facility at Yongbyon.
- 1989: Reports in the open press indicate for the first time that NK has a plutonium production reactor and extraction capability.

North Korea's Nuclear Program – 2

History (cont'd) —

- 1989: NK is reported to have shut down its main research and plutonium production reactor for approximately 100 days.
- The US Intelligence Community judges that this was enough time for NK to extract enough nuclear material to build a nuclear device and to refuel the entire reactor
- Neither the US nor any other country takes any direct action in response to this development.
- Instead, the international community presses NK to join the NPT and come into full compliance with its obligations under the NPT and makes this a condition for further progress on diplomatic issues.
- NK is believed to have extracted enough Pu for 1 or 2 nuclear bombs.

North Korea's Nuclear Program – 3

APPROXIMATE FISSILE MATERIAL REQUIREMENTS FOR PURE FISSION NUCLEAR WEAPONS

	technical capability			Yield	*technical capability*			
	low	*medium*	*high*	(kilotons)	*low*	*medium*	*high*	
weapon-grade plutonium (kilograms)	3	1.5	1	1	8	4	2.5	**highly enriched uranium** (kilograms)
	4	2.5	1.5	5	11	6	3.5	
	5	3	2	10	13	7	4	
	6	3.5	3	20	16	9	5	

Source: NRDC (April 2003)

North Korea's Nuclear Program – 4

History (cont'd) —

- 1985 April: NK accedes to the NPT after a concerted sales effort by the USSR, which hopes to sell light-water reactors (LWRs) to NK for electrical power generation. These are never built, in part due to the collapse of the Soviet Union.
- 1986: NK publicly makes withdrawal of US nuclear weapons from SK a condition of its completion of the safeguard agreement required by the NPT, completes negotiation of the safeguard agreement with the IAEA within 18 months after acceding to the NPT, as the NPT requires.
- 1991: US signals it will withdraw its nuclear weapons from SK as part of its global return of tactical nuclear weapons to United States territory. (The United States had stationed a large number — sometimes more than 700 — nuclear weapons in SK as part of its alliance with SK and its Cold War strategy of flexible response to a possible attack by the USSR or its allies.)

North Korea's Nuclear Program – 5

History (cont'd) —

- 1992 April 9: NK finally approves its NPT safeguard agreement.
- 1992 May: Inspections to verify the accuracy of NK's initial declaration begin. NK informs the IAEA it conducted a one-time Pu extraction experiment on "damaged" fuel rods removed from the reactor at Yongbyon in 1989 but extracted only 90 grams of Pu (< 1/40 of the amount needed to produce a nuclear device).
- IAEA chemical analysis indicates NK had separated plutonium in four campaigns over a 3-year period beginning in 1989 and that NK possesses more Pu than it had declared to the IAEA or to the international community.
- 1993: NK announces it is withdrawing from the NPT.
- 1994: US threatens war with NK. President Carter flies to NK and negotiates a nuclear agreement to avoid war.

Key Elements of the 1994 Agreed Framework

North Korea	United States
North Korea freezes its operation and construction of nuclear facilities under IAEA supervision.	The United States agrees to provide heavy fuel oil to replace the electrical production potential of the shutdown 5-MW reactor.
North Korea allows the canning and nonreprocessing of spent fuel from its 5-MW reactor under IAEA monitoring. Fuel to be removed from North Korea.	The United States agrees to establish an international consortium to construct two modern, light-water reactors in North Korea.
North Korea agrees to provide all necessary information and access, "including taking all steps that may be deemed necessary by the IAEA" to determine the accuracy of North Korea's initial declaration on past plutonium production	International consortium agrees to complete a significant portion of the reactor complex, not including key components.
North Korea agrees to begin dismantling its finished and incomplete nuclear facilities and to begin removal of spent fuel upon delivery of key reactor components for first light-water reactor.	International consortium to deliver key components for first light-water reactor.
North Korea agrees to complete dismantling of its nuclear facilities and removal of its spent fuel upon delivery of key components for second reactor.	International consortium to deliver key components for second light-water reactor.

North Korea's Nuclear Program – 6

History (cont'd) —

- 1994 October: The US and NK sign the 1994 Agreed Framework. A key goal of the Agreed Framework is for NK to replace its indigenous gas-graphite reactors with imported LWRs, which are good for electrical power generation but less useful for making bomb material.
- 1994 November: The new Republican majority in the US Congress rejects the Agreed Framework and refuses to fund its execution.
- 1994–1998: Execution of the Agreed Framework is plagued with political and technical problems and fails to make much progress.
- 1998 August: NK launches a 3-stage Taepo Dong-1 rocket with a range of 1,500–2,000 km; 3rd stage explodes at ignition. Rumsfeld says "God bless Kim Jong Il".
- 1999 September: NK agrees to a moratorium on testing of long-range missiles as long as arms talks with the US continue.

North Korea's Nuclear Program – 7

History (cont'd) —

- 2000 September: US and NK resume direct talks in New York on nuclear weapons, missiles, and terrorism.
- 2000 October: NK 2nd in command visits Washington, DC, meets President Clinton and US Secretaries of State and Defense.
- 2000 October: US and NK issue Joint Communique:
  - — Neither government has hostile intent toward the other.
  - — Both commit to building a new relationship free from past enmity.
- 2000 October: NK states that it will not further test the Taepo Dong-1 missile; President Clinton announces he will travel to NK.
- 2000 December: Clinton announces he will not leave US to travel to NK during the constitutional crisis created by the Presidential election dispute; time runs out.

North Korea's Nuclear Program – 8

History (cont'd) —

- 2001 January: President Bush privately insults President of North Korea.
- 2001 March 6: Secretary of State Colin Powell says President Bush will continue the engagement with NK currently in progress.
- 2001 March 7: Clinton administration official says agreement for NK to eliminate its medium- and long-range missiles and cease exports was very close. President Bush rejects existing understandings with NK, delays further discussions, and publicly insults the Presidents of SK and NK.
- 2001 June: President Bush announces desire for "serious discussions" with NK.
- 2002 January: Bush II labels NK part of "an axis of evil".
- 2002 October: Visiting US official publicly challenges NK, US claims NK has uranium enrichment effort that violates the 1994 Agreed Framework.
- 2002 November: KEDO consortium suspends fuel oil deliveries to NK, alleging NK has violated the Agreed Framework.

North Korea's Nuclear Program – 9

History (cont'd) —

- 2002 December: NK announces it is restarting its reactor because US violated the Agreed Framework, ends its cooperation with the IAEA, orders inspectors out.
- 2003 January: NK announces it is withdrawing from the NPT.
- 2004: NK tells visiting US experts it has separated the Pu in the spent reactor fuel at Yongbyon and is making nuclear weapons, shows "Pu" to visiting experts. NK is believed to have extracted 24–42 kg of Pu, enough for 6–12 nuclear bombs.
- 2007 February 28: New 6-party agreement announced (see next slide).
- 2006 October 9: NK tests a Pu nuclear explosive device.
- 2009 April 5: NK launches a long-range rocket, is condemned by the UN, announces it will build its own LWR without outside help.
- 2009 May 25: NK tests a second nuclear explosive device.

New Six-Party Agreement (2007 Feb 28)

An important first step toward complete, verifiable, and irreversible denuclearization of the Korean peninsula and the establishment of a more stable, peaceful, and prosperous Northeast Asia.

The D.P.R.K. agreed that it will, within 60 days:

- Shut down and seal Yongbyon nuclear facility for eventual abandonment
- Invite IAEA to conduct necessary monitoring and verifications
- Discuss with the other parties a list of all its nuclear programs, including plutonium extracted from used fuel rods, that would be abandoned

The other Parties agreed that they will:

- Provide emergency energy assistance to North Korea in the initial phase
- Make an initial shipment of emergency energy assistance equivalent to 50,000 tons of heavy fuel oil (HFO) within the first 60 days of the agreement

Five working groups will be established to carry out initial actions and formulate specific plans to implement the agreement, leading to a denuclearized D.P.R.K. and a permanent peace.

North Korea's Nuclear Program – 10

Current situation (see the assigned reading written by Hecker) —

- 2010 November: NK showed visiting U.S. experts (Carlin, Hecker, and Lewis)
  - — An openly constructed, recently completed small but industrial-scale centrifuge uranium-enrichment facility
  - — An experimental light-water reactor (LWR) under construction
- NK claimed 2,000 P-2 centrifuges in 6 cascades in the modern facility at Yongbyon, with a total capacity of 8,000 SWU/year (got external help from Khan)
- Publicly displayed facility is sufficient to produce
  - — 2 tons of LEU/year, enough to supply the LWR under construction
  - — 1 bomb/year of HEU, if slightly reconfigured
- Experts believe NK has undisclosed centrifuge facilities at other sites, probably producing weapon-grade HEU.
- Experts believe that NK has fundamentally changed its nuclear strategy.

North Korea's Nuclear Program – 11

- NK's new nuclear strategy —
  - — Appears to have abandoned its Pu program, shutting down its 5 MWe gas-graphite reactor and giving up on external assistance for LWRs
  - — Is attempting to construct an experimental 25-30 MWe LWR of indigenous design as part of an electrical power program (probably not for bomb Pu)
- Major concerns about NK's new nuclear strategy —
  - — Can NK construct its own LWR safely?
  - — Will NK's enrichment program lead to additional weapons or export?

North Korea's Nuclear Program – 12

- Can NK construct its own LWR safely?
  - NK appears to have no experience with key LWR design and safety issues.
  - Radiation-resistant steels and stringent construction are needed to withstand the intense, long-term radiation produced by LWRs.
  - NK has little experience with uranium oxide fuels and fuel-cladding alloys.
  - The concrete reactor foundation is insufficiently robust.
  - The concrete containment shell is being poured in small sections from a small concrete mixer.
  - These safety concerns will increase dramatically if NK builds larger LWRs, because the risks would extend well beyond NK's borders.

North Korea's Nuclear Program – 13

- Will NK's enrichment program lead to additional weapons or export?
  - Bomb-grade HEU can be produced by slightly reconfiguring the existing centrifuge cascade
  - NK has indigenous U ore and all the know-how and equipment needed to make feedstock for its centrifuge cascades
- NK can ratchet up the current nuclear threat by
  - Greatly expanding its HEU production at undisclosed sites
  - Increasing substantially the size of its nuclear arsenal
  - Conducting additional nuclear tests to increase the sophistication of its nuclear weapon designs
  - Exporting nuclear weapon materials or technology
- NK's categorical denial of any earlier enrichment activities, when they clearly existed, complicates diplomatic reengagement

What to Do About NK's Nuclear Program?

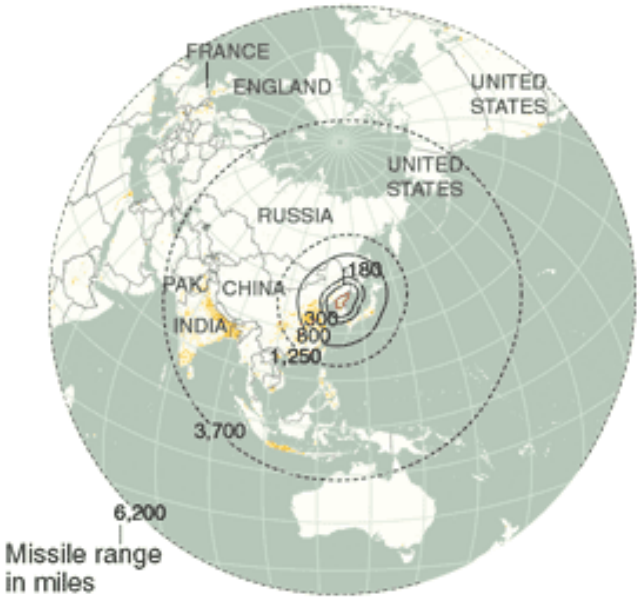
- Top priority: prevent NK from expanding its arsenal or exporting its nuclear technologies
- Long-term goal: denuclearize the Korean peninsula
- Few options but to reengage NK diplomatically
- Hecker advocates 3 No's supported by 1 Yes:
  - — No more bombs
  - — No better bombs (which means no more testing)
  - — No export of bombs or bomb technology and materials
  - — Yes to meeting NK's fundamental security concerns
- What are NK's fundamental security requirements?
  - — Normalization of relations with the United States
  - — Energy and economic aid
  - — Starting point could be the October 2000 agreement abandoned by Bush

North Korea's Ballistic Missile Capabilities

NORTH KOREAN BALLISTIC MISSILES			
	Range (kilometers)	Payload (kilograms)	Comment
Scud B	320	1,000	Reverse-engineered Soviet Scud B
Scud C	500	770	Conventional explosives, chemical, and cluster warheads
Nodong	1,350–1,500	770–1,200	Test fired in May 1993; flew 500 kilometers. Close to 100 deployed. Designed to carry a nuclear warhead
Taepodong-1	1,500–2,500	1,000–1,500	Test-launched August 31,1998
Taepodong-2	3,500–6,000	700–1,000	Not yet tested
Taepodong-2 (three-stage)	up to 15,000	several hundred	More than a decade away

Source: NRDC (April 2003)

Ranges of North Korea's Missiles



Iran's Nuclear Complex

Iran's Nuclear and Missile Programs – 1

Iran's nuclear weapon capability —

- Iran has the basic nuclear technology and infrastructure needed to build nuclear weapons
- The intelligence services of the Germany, Israel, the United Kingdom, and the United States have publicly confirmed that it has a long-term program to manufacture nuclear weapons
- It is thought that Iran has not yet made a nuclear weapon (in February 2003, the U.S. Defense Intelligence Agency estimated that Iran could have a nuclear weapon by 2010)
- Iran's rate of progress in developing nuclear weapons will depend strongly on what assistance it receives from Russia and China and whether it can illicitly acquire the needed special nuclear material

Iran's Nuclear and Missile Programs – 2

Iran's nuclear program has continued to advance —

- It has completed a large gas-centrifuge uranium enrichment facility at Natanz.
- No nuclear material was in the centrifuges at Natanz when the IAEA visited.
- A 1000-centrifuge pilot plant could produce material for one bomb every 1–2 years.
- The IAEA believes Iran probably introduced nuclear material into centrifuges at another, undisclosed location in order to test the centrifuges; this would be a violation of the NPT.

Iran's Nuclear and Missile Programs – 3

In 2003, Iran announced a change in its nuclear program —

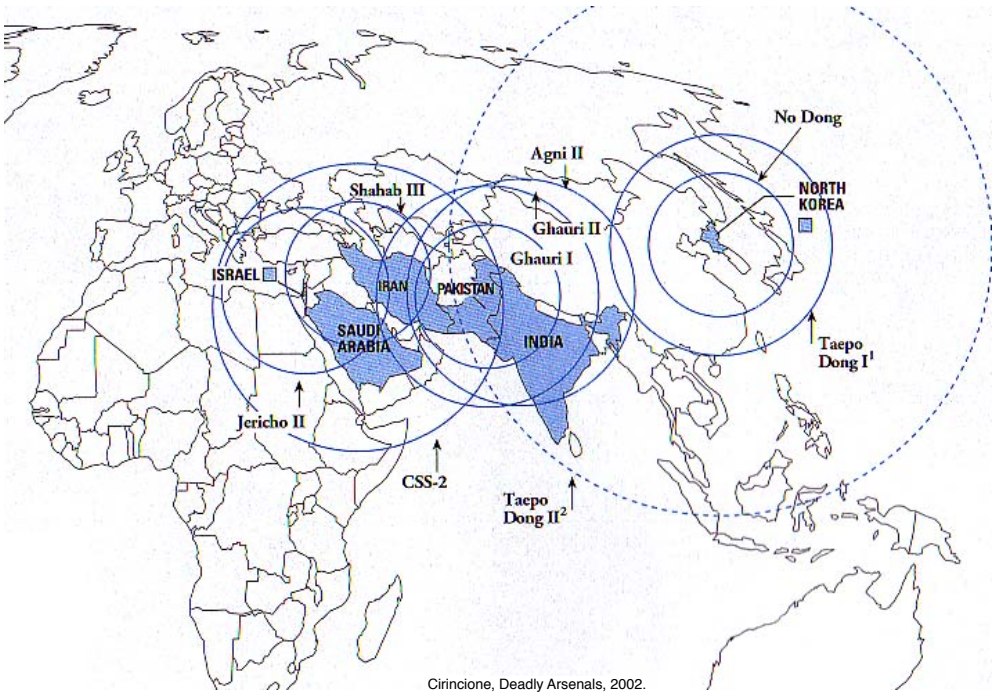
- Iranian President Mohammad Khatami announced that Iran has started mining uranium and is developing the facilities for a complete nuclear fuel cycle
- On March 3, 2003, Hassan Rowhani, the Secretary of the Supreme National Security Council, announced that a plant near Isfahan designed to convert uranium oxide to uranium hexafluoride was now complete.
- Iran is dragging its feet on more rigorous IAEA inspections.
- Russia is constructing a nuclear reactor at Bushehr that will provide dual-use technology that Iran does not now have.

Iran's Nuclear and Missile Programs – 4

Iran's nuclear delivery capability —

- About 300 Scud-B short-range missiles (range = 300 km, payload =1,000 kg)
- About 100 Scud-C short-range missiles (range = 500 km)
- Iran is manufacturing Scuds with North Korean assistance
- Iran has 200 Chinese-supplied CSS-8 short-range missiles (range = 150 km, payload = 150 kg)
- Iran has tested the medium-range Shahab III, a derivative of the North Korean No Dong (range = 1,300 km, payload = 750 kg)
- Iran appears to have abandoned development of the Shahab IV (range = 2,000 km, payload = 1,000 kg)

Ranges of Current and Projected Ballistic Missile



Cirincione, Deadly Arsenals, 2002.

Module 6: Programs and Arsenals

Supplementary Slides

Module 6: Programs and Arsenals

Part 4: Threat Perceptions

The Ballistic Missile Threat Perceived by Students at the University of Illinois at Urbana-Champaign

Questions:

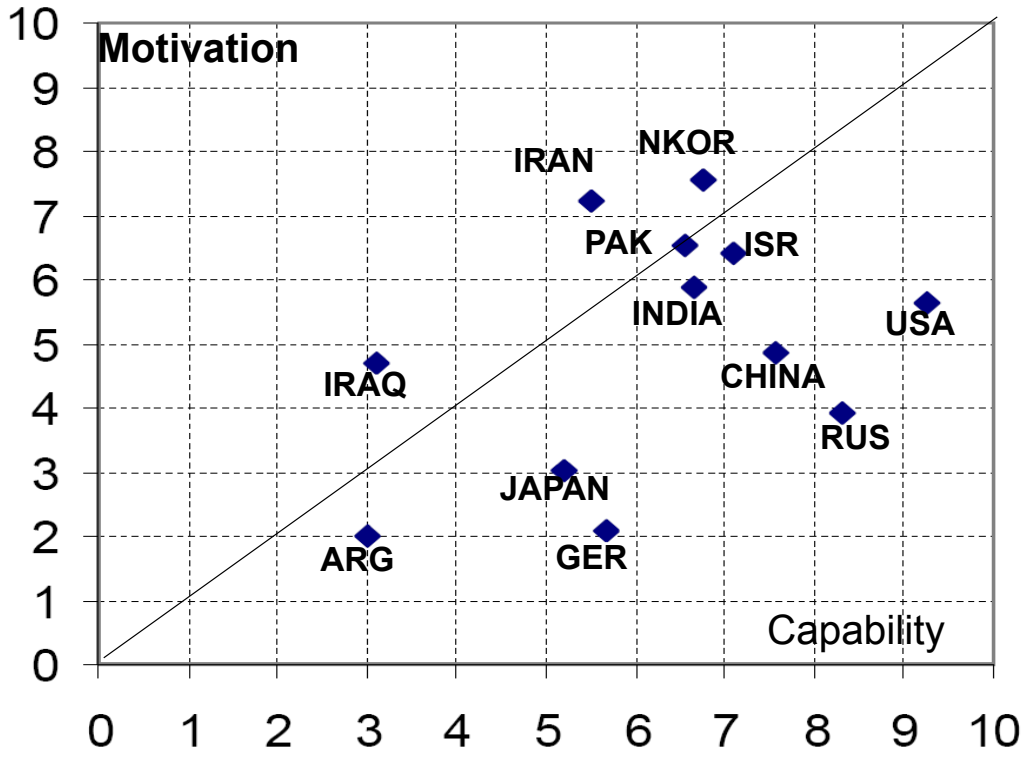
1. How great is the capability of this country to attack other countries with ballistic missiles in the next 5 years?

2. How great is the motivation of this country to attack other countries with ballistic missiles in the next 5 years?

Evaluation: 1= very low to 10 = very high

Consider 12 countries: Argentina, China, Germany, India, Iran, Iraq, Israel, Japan, North Korea, Pakistan, Russia, USA

Average Over Seven Classes (2004–2007)



U.S. Strategic Nuclear Weapons (2009)

ICBMs	
Minuteman III	500
MX	50
Total ICBMs	**550**
Total Warheads	**9,400**

SLBMs	
Trident I/C-4	4/96
Trident II/D-5	14/336
Total SLBMs	**268**
Bombers	
B-1	47
B-2	18
B-52	141
Total bombers	**206**
TOTAL	**1188**

New START Nuclear Force Levels – U.S.

The United States (UPDATED 02/29/10)

	July 2009 Old START	2010 Actual operationally deployed launches (total launchers)	ca. 2020 New START operationally deployed launchers (total launchers) [estimate]	ca. 2020 New START warheads [estimate]
ICBMs				
Minuteman III	500	450	350	350
MX	50	0		
Total ICBMs	**550**	**450**	**350**	**350**

New START Nuclear Force Levels – U.S.

SLBMs				
Trident I/C-4	4/96			
Trident II/D-5	14/336	12/288 (14/336)	12/288 (14/336)	1152
Total SLBMs	**268**	**288 (336)**	**288 (336)**	**1152**
Bombers				
B-1	47	0		
B-2	18	16 (18)	16 (18)	16
B-52	141	44 (93)	32 (93)	32
Total bombers	**206**	**60 (111)**	**48 (111)**	**48**
TOTAL	**1188**	**798 (897)**	**686 (797)**	**1550**

New START Nuclear Force Levels – Russia

Russia

	July 2009 Old START	2010 Actual operationally deployed launches (total launchers)	ca. 2020 New START operationally deployed launchers (total launchers) [estimate]	ca. 2020 New START warheads [estimate]
ICBMs				
SS-25	176	171		
SS-27 silo	50	50	60	60
SS-27 road	15	18	27	27
RS-24			85	255
SS-19	120	70		
SS-18	104	59	20	200
Total ICBMs	**465**	**367**	**192**	**542**

New START Nuclear Force Levels – Russia

SLBMs				
Delta III/SS-N-18	6/96	4/64		
Delta IV/SS-N-23	6/96	4/64 (6/96)	4/64	256
Typhoon/SS-N-20	2/40	0/0		
Borey/Bulava	2/36	0/0	4/64	384
Total SLBMs	**268**	**128 (164)**	**128**	**640**
Bombers				
Tu-160	13	13	13	13
Tu-95MS	63	63	63	63
Total bombers	**76**	**76**	**76**	**76**
TOTAL	**809**	**571 (603)**	**396 (396)**	**1258**

Comparison of Nuclear-Weapon-States

	United States	U.S.S.R./Russia	Britain	France	China
Warheads					
Warheads in stockpile (2003)	7,650 active, ~3,000 reserve or awaiting disassembly	8,200 active, ~10,000 reserve or awaiting disassembly	200	350	400
Peak number of warheads/year	32,500/1967	45,000/1986	410/1969	540/1993	450/1993
Total number of warheads built, years	70,000 1945–1992	55,000 1949–2003	1,200 1952–2001	1,260 1960–2003	750 1964–2003

NRDC, Sept./Oct. 2003.

SU-Russian Nuclear Warheads

End	Strategic Warheads				Non-	Stockpiled	Awaiting	Intact
Year	ICBM	SLBM	Bombers	Total	Strategic	Warheads	Dism'tlem't	Warheads
1989	7,382	3,085	1,651	12,117	23,700	35,817	3,195	39,000
1990	7,285	3,045	1,485	11,815	21,700	33,515	3,583	37,000
1991	6,411	2,932	1,329	10,672	18,933	29,606	6,405	35,000
1992	6,011	2,617	1,462	10,089	16,167	26,256	7,845	33,000
1993	5,414	2,503	1,468	9,385	13,400	22,785	8,899	31,000
1994	4,530	2,436	1,468	8,434	10,633	19,067	10,601	29,000
1995	3,894	2,386	1,468	7,748	7,867	15,615	12,022	27,000
1996	3,768	2,386	1,468	7,622	5,100	12,722	12,915	25,000
1997	3,759	1,915	840	6,514	4,750	11,264	11,736	23,000
1998	3,770	1,655	840	6,264	4,500	10,764	10,236	21,000
1999	3,717	1,655	830	6,201	4,250	10,451	9,799	20,250
2000	3,717	1,655	830	6,201	4,000	10,201	9,299	19,500
2001	3,162	1,453	911	5,526	3,600	9,126	9,076	18,750
2002	3,162	1,126	911	5,199	3,380	8,579	9,421	18,000

Source: NRDC (Nov. 2002)

U.S. Nuclear Warheads

End	Strategic Warheads				Non-Strategic	Stockpiled	Awaiting	Intact
Year	ICBM	SLBM	Bombers	Total	Warheads	Warheads	Dism'tlem't	Warheads
1989	2,592	5,410	5,965	13,967	8,207	22,174	285	22,458
1990	2,591	5,474	5,330	13,395	7,816	21,211	471	21,682
1991	2,128	3,626	3,400	9,154	9,152	18,306	1,764	20,070
1992	2,127	3,626	3,691	9,444	4,287	13,731	4,559	18,290
1993	2,126	2,819	3,567	8,512	3,024	11,536	5,246	16,782
1994	2,215	3,021	3,565	8,801	2,211	11,012	4,426	15,438
1995	2,199	3,222	3,538	8,959	1,994	10,953	3,266	14,219
1996	2,196	3,424	3,028	8,648	2,238	10,886	2,421	13,307
1997	2,111	3,626	3,018	8,755	2,075	10,829	1,881	12,710
1998	2,104	3,626	3,014	8,744	2,019	10,763	1,153	11,916
1999	2,104	3,626	2,951	8,681	2,017	10,698	960	11,658
2000	2,104	3,626	2,949	8,679	1,936	10,615	570	11,185
2001	2,089	3,273	2,947	8,309	2,182	10,491	416	10,907
2002	2,089	3,600	2,945	8,634	1,821	10,455	274	10,729

Source: NRDC (Nov. 2002)

U.S. Strategic Nuclear Warheads – 1

STRATEGIC FORCES					
Warhead/Weapon	**First Produced**	**Yield (kilotons)**	**User**	**Number (warheads)**	**Status**
Bombs					
B61-7 Strategic	10/66	10 to 350	AF	470	The Mod-7 is the only version in the strategic stockpile. The Mod-7 is a converted Mod-1 with a Cat D PAL and IHE.
B61-11	11/97	10 to 350	AF	55	Mod-11 is an earth penetrator.
B83/B83-1	6/83	low to 1,200	AF	620	Strategic bomb replaced B28, B43, B53.
Submarine-launched ballistic missiles					
W76/Trident I C4	6/78	100	N	3,200	Under START I over 1,500 W76 warheads from retired Trident I SSBNs were used to arm Atlantic Fleet Trident II SSBNs.
W88/Trident II D5	9/88	475	N	400	Warheads supplement the W76 warhead to arm Atlantic Fleet Trident II SSBNs.

Source: NRDC (Nov. 2002)

U.S. Strategic Nuclear Warheads – 2

Warhead/Weapon	First Produced	Yield (kilotons)	User	Number (warheads)	Status
Intercontinental ballistic missiles					
W62/Minuteman III	3/70	170	AF	615	Will be retired around 2009.
W78/Minuteman III	8/79	335	AF	920	300 will be used to arm single warhead MMIIIs by 2012.
W87-0/MX	4/86	300	AF	550	Missile will be retired, and 200 W87s used for single warhead MMIII by 2012.
Air-launched cruise missiles					
W80-1/ALCM	12/81	5 and 150	AF	1,400	Some 900 ALCMs are in storage with their warheads removed. W80s are used to arm ACMs.
W80-1/ACM	?/90	5 and 150	AF	400	Operational in 1991. The original program of 1,461 ACMs has been cut to 460. Uses W80 warheads from ALCMs.

Source: NRDC (Nov. 2002)

U.S. Strategic Nuclear Forces – 1

Type	Name	Launchers/ SSBNs	Year deployed	Warheads x yield (kiloton)	Total warheads*	Total megatons*
ICBMs						
LGM-30G	Minuteman III	500	--	--	1,200	353
	Mk-12	(200)	1970	1 or 3 W62 x 170 (MIRV)	(300)	(51)
	Mk-12A	(300)	1979	3 W78 x 335 (MIRV)	(900)	(302)
LGM-118A	MX/Peacekeeper	50 10	1986	10 W87 x 300 (MIRV)	500 100	150
Total ICBMs		**550**			**1,700**	**503**

Source: NRDC (Nov. 2002) 510 1,150

NRDC (Jan/Feb 2005)

U.S. Strategic Nuclear Forces – 2

Type	Name	Launchers/ SSBNs	Year deployed	Warheads x yield (kiloton)	Total warheads*	Total megatons*
SLBMs						
UGM-96A	Trident I C4	168/7 48	1979	6 W76 x 100 (MIRV)	1,008	100
UGM-133A	Trident II D5	264/11 288	--	--	--	--
	Mk 4	--	1992	8 W76 x 100 (MIRV)	1,728	173
	Mk 5	--	1990	8 W88 x 475 (MIRV)	384	--
Total SLBMs		**432/18**			**3,120**	**273**
		336/14				
Bomber/weapons**						
B-2	Spirit	21/16	1994	B61-7/-11, B83 bombs	800	280
B-52H	Stratofortress	94/56	1961	ACM/ALCM/W80 x 5-150 kt	860	130
Total Bomber/weapons		**115/72**			**1,660**	**410**

Source: NRDC (Nov. 2002)

NRDC (Jan/Feb 2005)

U.S. Non-Strategic Nuclear Weapons

NON-STRATEGIC FORCES					
Warhead/Weapon	**First Produced**	**Yield (kilotons)**	**User**	**Number (warheads)**	**Status**
B61 Tactical Bomb	3/75	0.3 to 170	AF, NATO	1,290	Mods-3,-4,-10. The Mod 10 is a converted W85 Pershing II warhead. All three Mods have Cat F PALs and IHE. Each Mod has four yield options: The B61-3 (0.3, 1.5, 60 and 170 Kt), the B61-4 (0.3, 1.5, 10, and 45 Kt), and the B61-10 (0.3, 5, 10, and 80 Kt).
W80-0/SLCM	12/83	5 and 150	N	320	Nuclear SLCMs now stored ashore. Original program of 758 SLCMs for 200 ships and submarines was reduced to 367 SLCMs for 25 Sturgeon-class, 62 Los Angeles-class, and 3 Seawolf-class attack submarines.
ACM: advanced cruise missile; **AF**: Air Force; **ALCM**: air-launched cruise missile; **IHE**: Insensitive High Explosive; **N**: Navy; **NATO**: non-U.S. delivery systems; **PAL**: Permissive Action Link.					

Source: NRDC (Nov. 2002)

Summary of U.S. Nuclear Forces 2007

	Type/Designation	No.	Year deployed	Warheads x yield (KILOTONS)	Active/Spares
ICBMs	LGM-30G Minuteman III				
	Mk-12	150	1970	1 W62 x 170	150
	Mk-12	50	1970	3 W62 x 170 (MIRV)	150/30
	Mk-12A	300	1979	2–3 W78 x 335 (MIRV)	750/35
	Total	500			1,050/65
SLBMs	UGM-133A Trident II D5*				
	Mk-4	n/a	1992	6 W76 x 100 (MIRV)	1,632/80
	Mk-5	n/a	1990	6 W88 x 455 (MIRV)	384/20
	Total	336			2,016/100
Bombers	B-52H Stratofortress	94/56**	1961	ALCM/W80-1 x 5–150 ACM/W80-1 x 5–150	1,000/30 400/20
	B-2A Spirit	21/16	1994	B61-7, -11, B83-1	555
	Total	115/72			1,955/50***
Nonstrategic forces	Tomahawk SLCM	325	1984	1 W80-0 x 5–150	100
	B61-3, -4 bombs	n/a	1979	0.3–170	400
	Total	325			500
	GRAND TOTAL				~5,521/215

NRDC, Jan/Feb. 2007

* Conversion of the Henry Jackson and the Alabama to Trident II D5 SLBMs will be completed in 2007 and 2008, respectively, bringing to 14 the number of SSBNs capable of carrying D5s.

** The first figure is the aircraft inventory, including those used for training, testing, and backup. The second figure is the primary mission aircraft inventory, the number of operational aircraft assigned for nuclear and or conventional missions.

*** The large pool of bombs and cruise missiles allows for multiple loading possibilities, depending upon the mission.

Russian Nuclear Weapons and Delivery Vehicles

- Russia maintain the world's second-largest largest force of deployed strategic nuclear weapons
- Under the counting rules of the START I, Russia maintains an accountable strategic nuclear force of 981 delivery vehicles with 4,732 associated warheads, although the deployed number is less
- In addition, Russia is estimated to have about 3,400 operational nonstrategic warheads and about 8,800 additional intact warheads
- The Russia may have as many as 16,000 intact nuclear weapons
- If present trends continue, Russia may have less than 2,000 deployed strategic nuclear weapons by 2010 and may have less than 200 ICBMs.

Russian Strategic Nuclear Forces – 1

Category/Type	Weapon System	Launchers	Warheads*
Strategic Offense			
ICBMs	SS-18 (144), SS-19 (137), SS-24 (36), SS-25 (360), SS-27 (29)	706	3,011
SLBMs	SS-N-18 (96), SS-N-20 (40), SS-N-23 (96)	232	1,072
Bombers	15 Blackjack, 32Bear-H6, 31 Bear-H16 (AS-15 ALCMs, AS-16 SRAMs, bombs)	78	868
Total Strategic Offense			~5,000
Strategic Defense			
SAMs	SA-5B Gammon, SA-10 Grumble	1,200	1,200
Total Strategic Defense			1,200

Source: NRDC (Nov. 2002)

Russian Strategic Nuclear Forces – 2

Type	Name	Launchers	Year deployed	Warheads x yield (kiloton)	Total warheads	Total megatons
ICBMs						
SS-18 M4/M5/M6	Satan (RS-20)	144	1979	10 x 550/750 (MIRV)	1,440	792
SS-19 M3	Stiletto (RS-18)	137	1979	6 x 550 (MIRV)	822	452
SS-24 M1/M2	Scalpel (RS-22)	36	1987	10 x 550 (MIRV)	360	198
SS-25	Sickle (RS-12M)	360	1985	1 x 550	360	198
SS-27	n.a.	29	1997	1 x 550	29	16
Total ICBMs		**706**			**3,011**	**1,656**

Source: NRDC (Nov. 2002)

Russian Strategic Nuclear Forces – 3

Type	Name	Launchers	Year deployed	Warheads x yield (kiloton)	Total warheads	Total megatons
SLBMs						
SS-N-18 M1	Stingray (RSM-50)	96 (6)#	1978	3 x 500 (MIRV)	288**	144
SS-N-20 M1/M2	Sturgeon (RSM-52)	40 (2)#	1983	10 x 200 (MIRV)	400	80
SS-N-23	Skiff (RSM-54)	96 (6)#	1986	4 x 100 (MIRV)	384	38
Total SLBMs		**232**			**1,072**	**262**
Bomber/weapons						
Tu-95MS6	Bear H6	32	1984	6 AS-15A ALCMs or bombs	192	48
Tu-95MS16	Bear H16	31	--	16 AS-15A ALCM or bombs	496	124
Tu-160	Blackjack	15	1987	12 AS-15B ALCMs or 12 AS-16 SRAMs, or 12 bombs	180	45
Total Bomber/weapons		**78**			**868**	**217**

Source: NRDC (Nov. 2002)

Russian Non-Strategic Nuclear Forces

Category/Type	Weapon System	Launchers	Warheads*
Land-based Non-strategic			
Bombers and fighters	Backfire (105), Fencer (280) (AS-4 ASM, AS-6 ASM, AS-16 SRAM, bombs)	385	1,540
Total Land-based Non-strategic			**1,700**
Naval Non-strategic			
Attack aircraft	Backfire (45), Fencer (50) (AS-4 ASM, bombs)	95	190
SLCMs	SS-N-9, SS-N-12, SS-N-19, SS-N-21, SS-N-22	--	240
ASW weapons	SS-N-15, SS-N-16, torpedoes, depth bombs	na	210
Total Naval Non-strategic			**540**

Source: NRDC (Nov. 2002)

Summary of Russian Strategic Nuclear Forces 2007

	Type	Name	Launchers	Year deployed	Warheads x yield (KILOTONS)	Total warheads
ICBMs	SS-18	Satan	80	1979	10 x 550/750 (MIRV)	800
	SS-19	Stiletto	126	1980	6 x 550/750 (MIRV)	756
	SS-25	Sickle	242	1985	1 x 550	242
	SS-27	Topol-M	42	1997	1 x 550	42
	SS-27A	Topol-M1	3	2006	1 x 550 (?)	3
			493			1,843
SLBMs	SS-N-18 M1	Stingray	5/80*	1978	3 x 200 (MIRV)	240
	SS-N-23	Skiff	6/96	1986	4 x 100 (MIRV)	384
			11/176			624
Bombers	Tu-95 MS6	Bear H6	32	1984	6 x AS-15A ALCMs or bombs	192
	Tu-95 MS16	Bear H16	32	1984	16 x AS-15A ALCMs or bombs	512
	Tu-160	Blackjack	14**	1987	12 x AS-15B ALCMs, AS-16 SRAMs, or bombs	168
			78			872
	GRAND TOTAL					~3,339***

NRDC, March/April. 2007

•One Pacific-based Delta III has been converted to a missile test-launch platform.
** Two Tu-160s that were to enter service in 2005 have not yet become operational.
*** Additional 9,300 intact strategic and nonstrategic warheads are estimated to be in reserve or awaiting dismantlement.

forces 2005

Russian Nonstrategic and Defensive Weapons

	Type	Name	Launchers	Year deployed	Warheads x yield (KILOTONS)	Total warheads
ABM	51T6/53T6	Gorgon/ Gazelle	32/68	1989/1986	1 x 1000/10	100
Air defense	SA-10	Grumble	1,900	1980	1 x low yield	600
Land-based aircraft	Bombers/ fighters	n/a	~490	n/a	ASM or bombs	974
Naval	Submarines/ surface ships/ fighters	n/a	n/a	n/a	SLCMs, ASWs, SAMs, ASMs, bombs, or torpedoes	655
	GRAND TOTAL					2,329

NRDC, March/April. 2007

Russian Projected Strategic Warheads

	2007	2012	2020
ICBMs	1,843	665*	254*
SLBMs	624	600	744
Bombers	872	788	728
Total	**3,339**	**2,053**	**1,726**

*Assumes no MIRV on Topol-Ms.

NRDC, March/April. 2007

French Strategic Nuclear Forces

Weapon System	Warheads					
	No. deployed	Year deployed	Range (km)	Warhead x yield	Type	No. in stockpile
Aircraft						
Mirage 2000N/ASMP	45	1988/1988	2,750	1 x 300 Kt	TN 81	50
Submarine-based missiles						
MSBS M4A/B	16	1985/1987	6,000	6 x 150 Kt	TN 70/71	96
MSBS M45	32	1996	6,000	6 x 100 Kt	TN 75	192
Carrier-based aircraft						
Super Étendard/ASMP	24	1978/1989	650	1 x 300 Kt	TN 81	10
					Total	**~350**

Source: NRDC (Nov. 2002)

Chinese Strategic Nuclear Forces 2006

	Type	NATO designation	Number	Year deployed	Range (KILOMETERS)	Warhead x yield (KILOTONS)	Total warheads
Land-based missiles	DF-3A	CSS-2	16	1971	3,100	1 x 3,300	16
	DF-4	CSS-3	22	1980	> 5,500	1 x 3,300	22
	DF-5A	CSS-4	20	1981	13,000	1 x 4,000–5,000	20
	DF-21, -21A	CSS-5	21	1991	2,100	1 x 200–300	21
	DF-31	CSS-X-10	0	~ 2006	~ 8,000	1 x ?	0
	DF-31A	?	0	2007–09	~ 12,000	1 x ?	0
Sea-based missiles	JL-1*	CSS-NX-3	12	1986	1,000–1,700	1 x 200–300	12
	JL-2	CSS-NX-4	0	2008–10	~ 8,000	1 x ?	0
Nuclear-capable aircraft**	Hong-6	B-6	20	1965	3,100	1 x bomb	~ 20
	Qian-5, etc.	n/a	?	1972, ?	n/a	1 x bomb	~ 20
	TOTAL						~130***

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NRDC, May / June. 2006

Indian Nuclear Forces (2008)

Type/Designation	Range (kilometers)	Payload (kilograms)	Comment
Aircraft			
MiG-27 Flogger/Bahadur	800	4,000	At Hindan Air Base
Jaguar IS/IB/Shamsher	1,600	4,775	At Ambala Air Base
Missiles			
Prithvi I	150	1,000	Deployed, may have nuclear role
Agni I	1,500	1,000	Tested, status unknown
Agni II	2,000	1,000	Test fired January 2001, deployment expected soon; a 700-kilometer-range version test launched January 25, 2002

Summary of India's Nuclear Delivery Systems

Type/Designation	Range (kilometers)	Payload (kilograms)	Comment
Aircraft			
Mirage 2000H/ Vajra	1,800	6,300	India has 40 of this type of aircraft, possibly located at Gwalior Air Force Station.
Jaguar IS/IB/ Shamsher	1,600	4,775	India has 131 of this type of aircraft, possibly located at Shamsher Ambala Air Force Station.
Missiles			
Agni I	700+	1,000	Thirty-six missiles deployed with the army's new 334 Missile Group in 2004.
Agni II	2,000+	1,000	Thirty-six missiles deployed with the army's 335 Missile Group in 2004.
Agni III	3,000+	1,500	Under development. Test scheduled for the end of 2005.
Prithvi	150	1,000	Army version. Deployed with 333 and 355 Missile Groups. Will be converted from liquid to solid fuel.
Dhanush	350	1,000	Under development. Naval version of Prithvi II. Third test was held on November 7, 2004.
Sagarika	300+	?	Under development. Possible flight-test in late 2005; deployment scheduled for 2010 or later.

Source: NRDC (2005)

Summary of Pakistan's Nuclear Delivery Systems

Type/Designation	Range (km)	Payload (kg)	Comment
Aircraft			
F-16A/B	1,600	5,450	At Sargodha AB
Missiles			
Ghauri I (Hatf-5)	1,300-1,500	500-750	Basically North Korean No Dong missile
Ghauri II (Hatf-6)	2,000-2,300	750-1,000	Test-fired on April 14, 1999

Source: NRDC (Nov. 2002)