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# Module 6: Nuclear Arsenals

ACDIS program in arms control & domestic and international security

## Part 1: Overview

# Phys 280 Session 17

Module 6 – Nuclear Arsenals

1. RE4v1 due tomorrow, 3-29 at midnight

# Impact Technology Has on Evolution of Nuclear Arsenals

Bulletin of the Atomic Scientists

# modernization is undermining strategic stability: The burst-height compensating super-fuze

Hans M. Kristensen, Matthew McKinzie, Theodore A. Postol

The US nuclear forces modernization program has been portrayed to the public as an effort to ensure the reliability and safety of warheads in the US nuclear arsenal, rather than to enhance their military capabilities. In reality, however, that program has implemented revolutionary new technologies that will vastly increase the targeting capability of the US ballistic missile arsenal. This increase in capability is astonishing—boosting the overall killing power of existing US ballistic missile forces by a factor of roughly three—and it creates exactly what one would expect to see, if a nuclear-armed state were planning to have the capacity to fight and win a nuclear war by disarming enemies with a surprise first strike.

(/bio/hans-m-kristensen)

**HANS M. KRISTENSEN (/BIO/HANS-M-KRISTENSEN)**

Kristensen is the director of the Nuclear Information Project with the Federation of American Scientists (FAS) in Washington, DC. His work

http://thebulletin.org/how-us-nuclear-force-modernization-undermining-strategic-stability-burst-height-compensating-super10578

Bulletin of the Atomic Scientists

# How US nuclear force modernization is undermining strategic stability: The burst-height compensating super-fuze

Hans M. Kristensen, Matthew McKinzie, Theodore A. Postol

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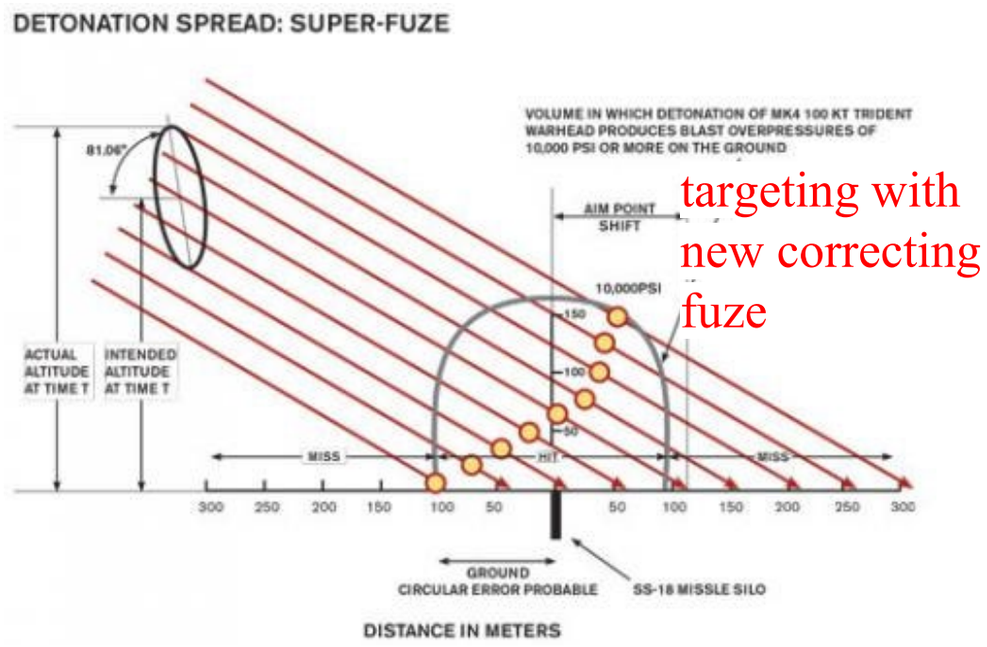
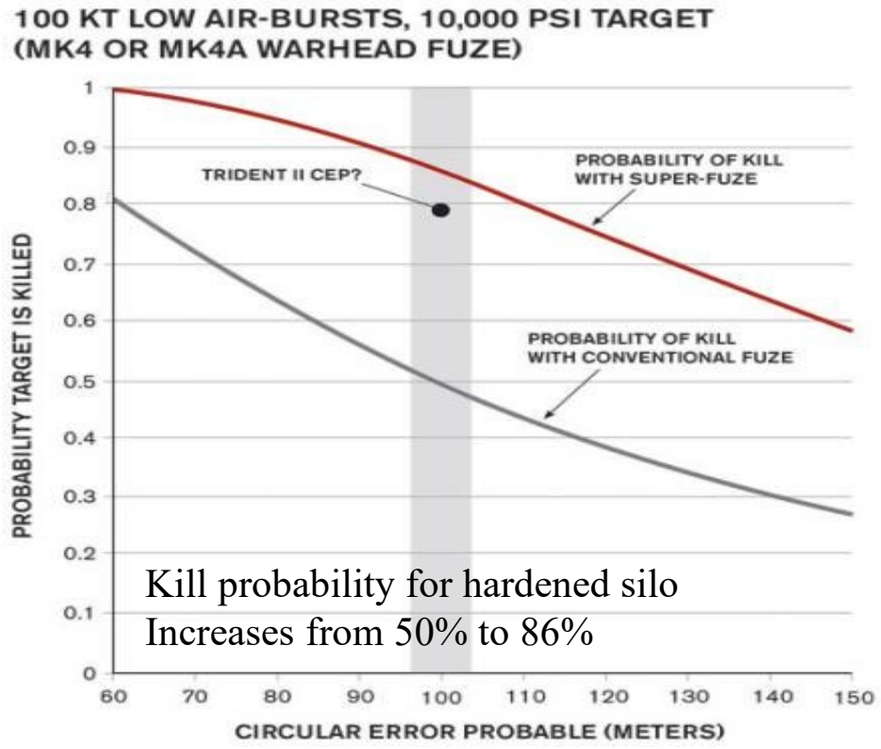
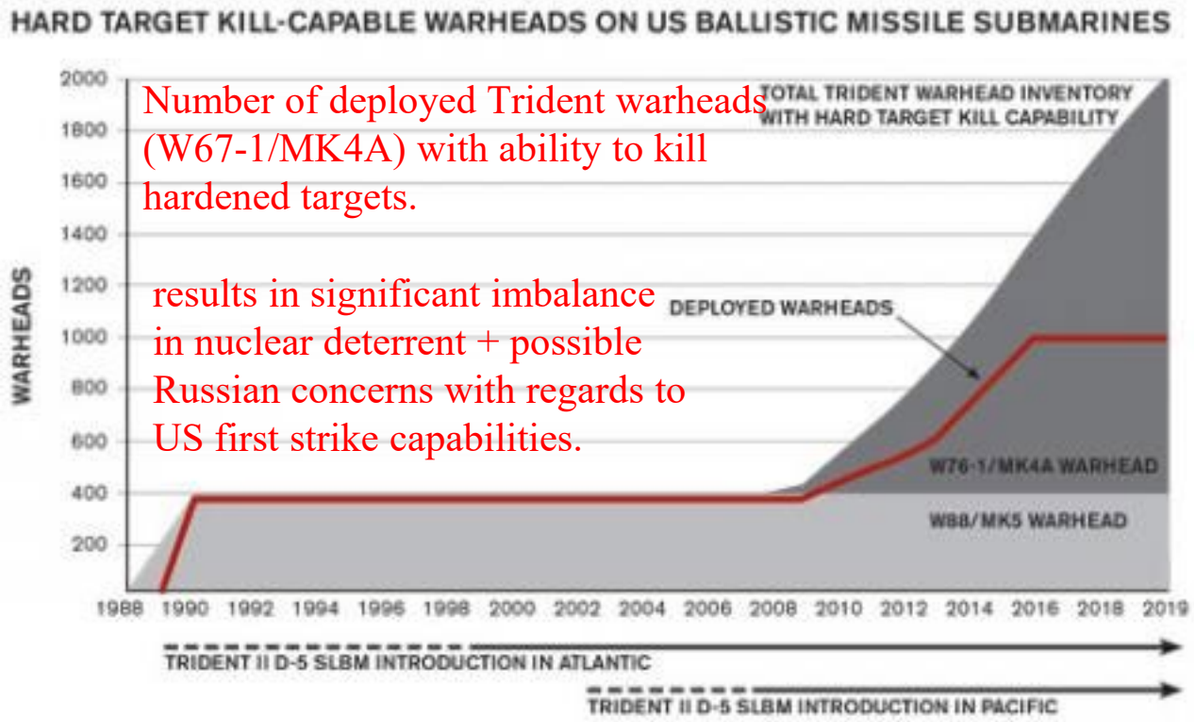
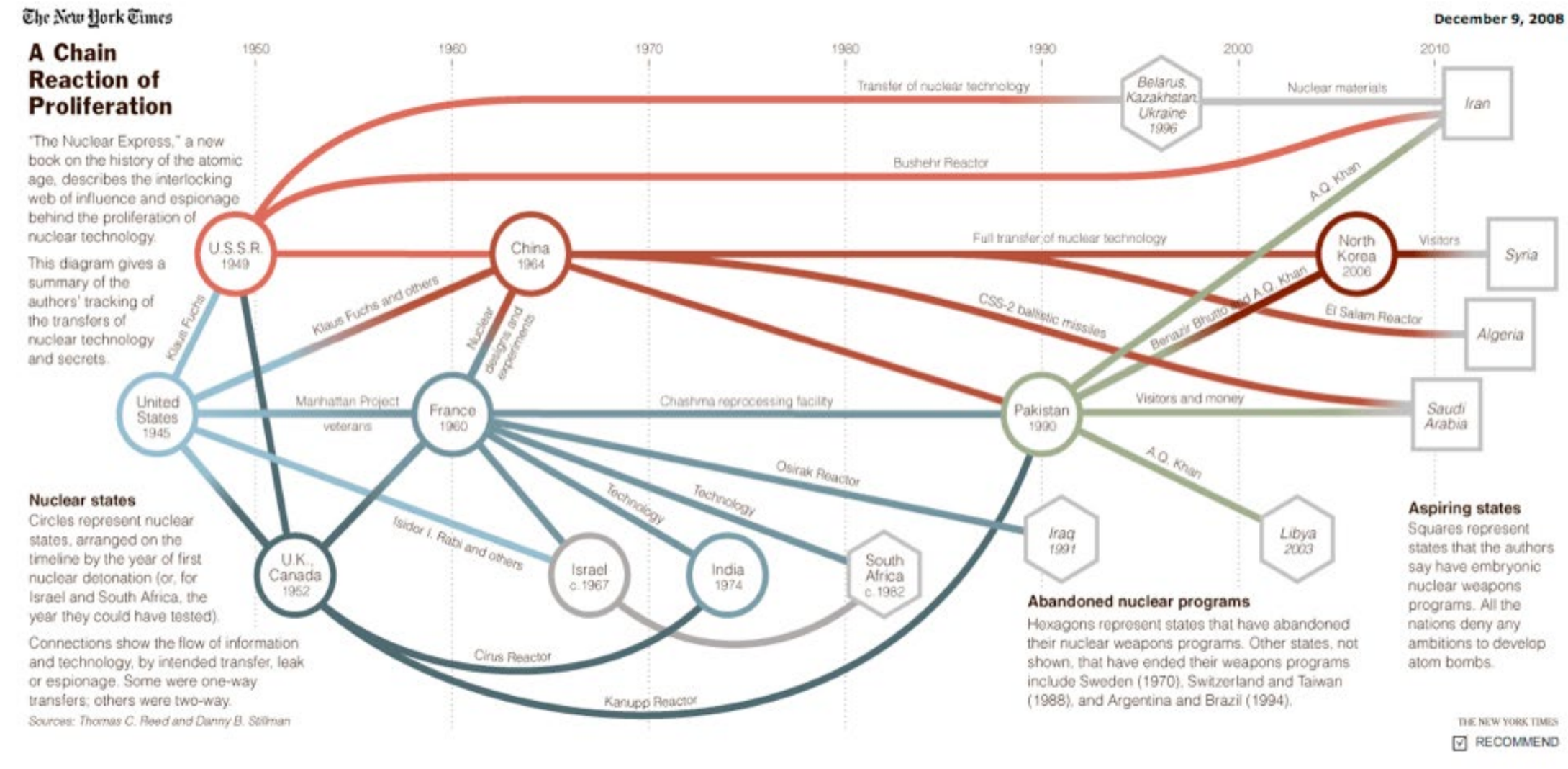
# Impact Technology Has on Evolution of Nuclear Arsenals

# Chain of Proliferation

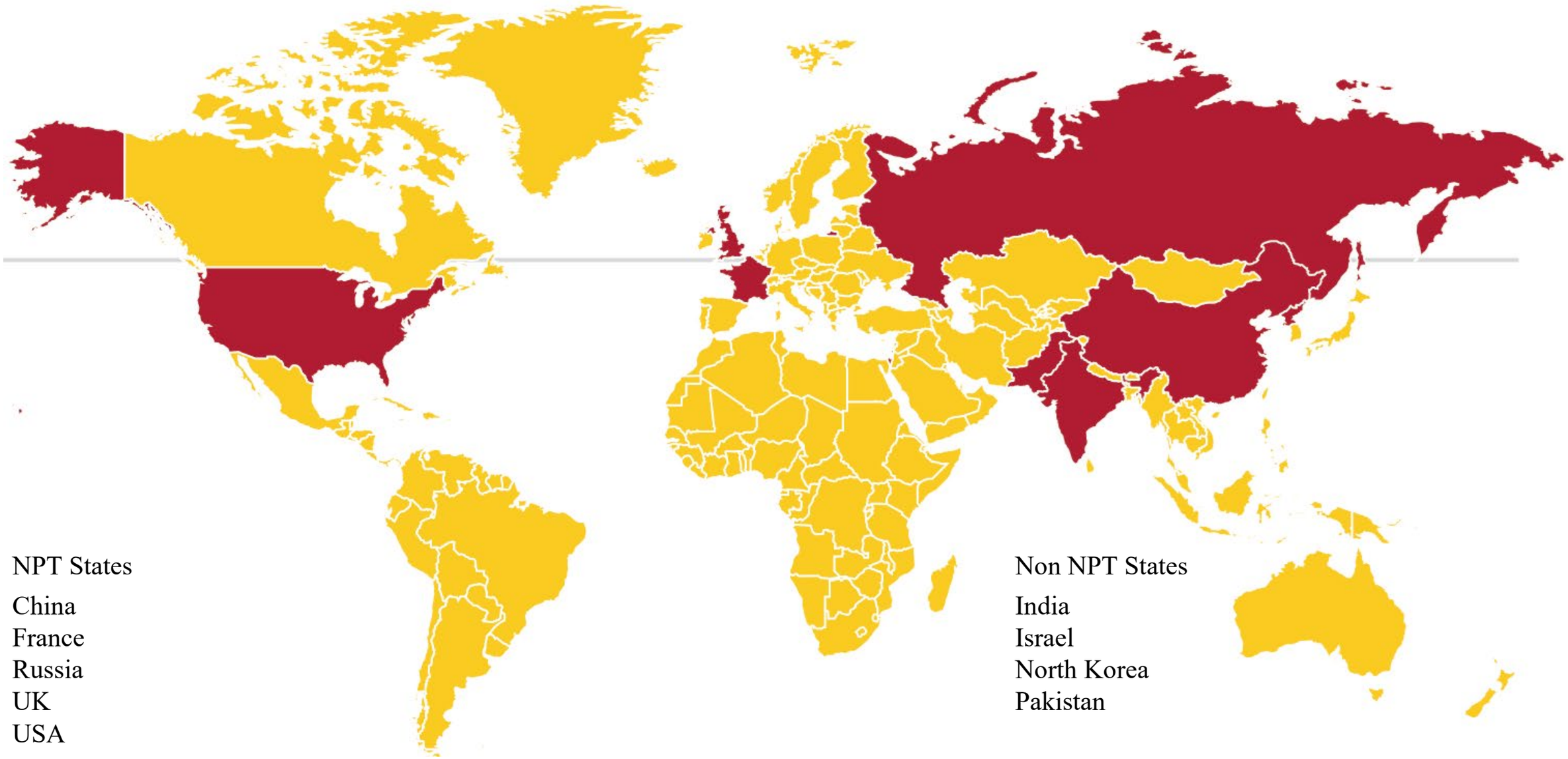



*This article has been revised to reflect the following correction:*

***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.*

# States With Nuclear Weapons in 2019



NPT States

China
France
Russia
UK
USA

Non NPT States

India
Israel
North Korea
Pakistan

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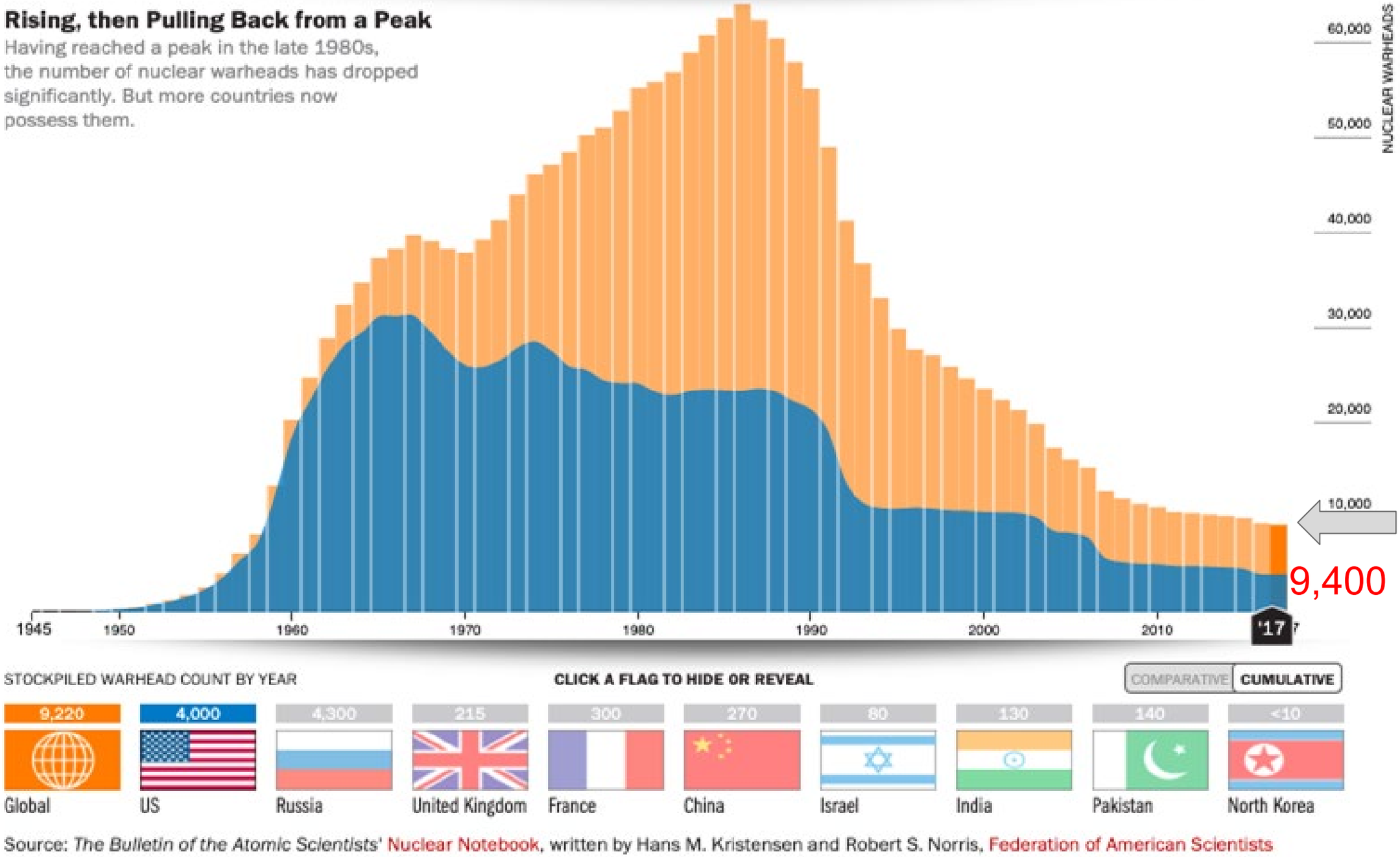
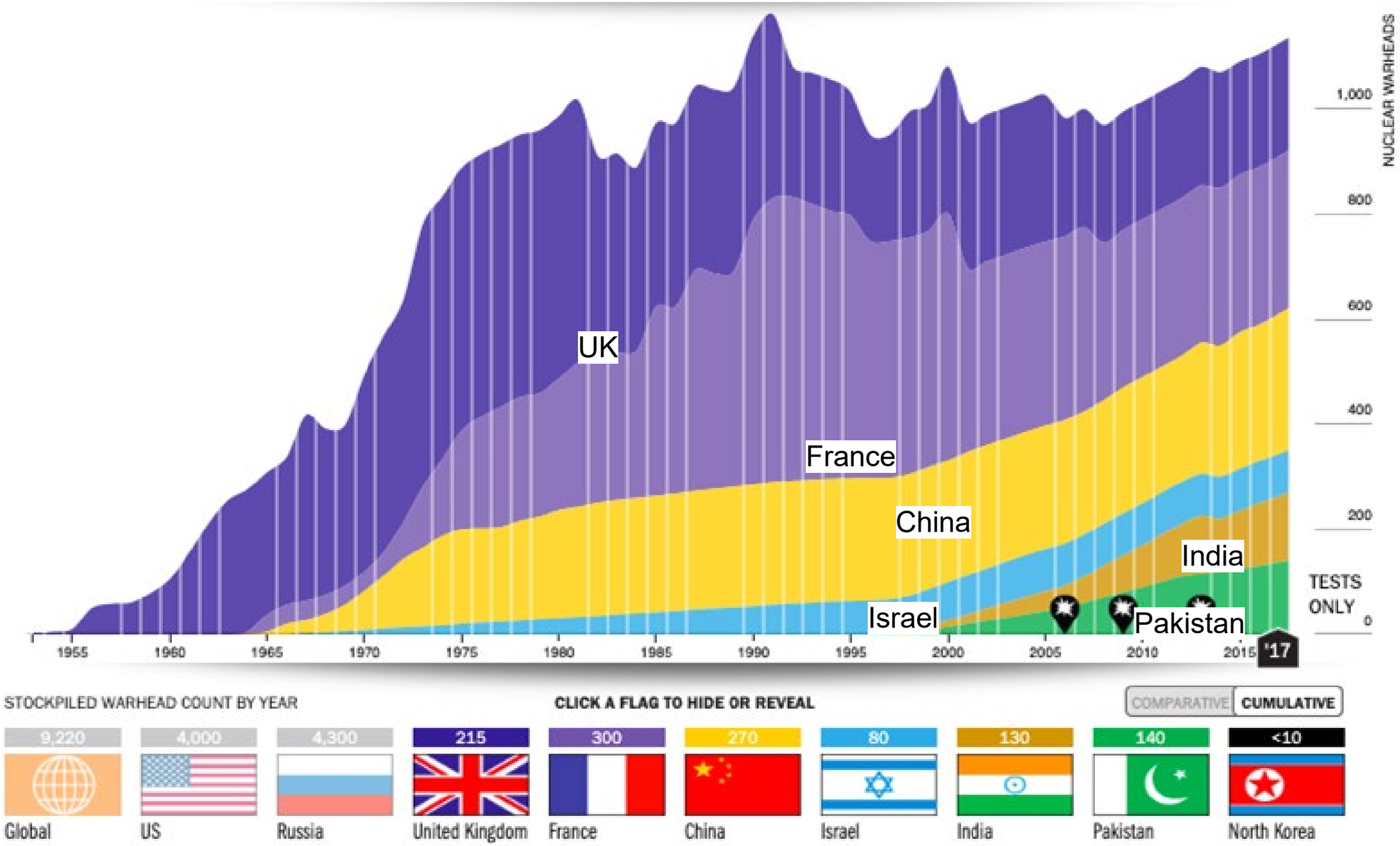
# Nuclear Weapons Stockpiles 1945-2017




9,400 in 2017

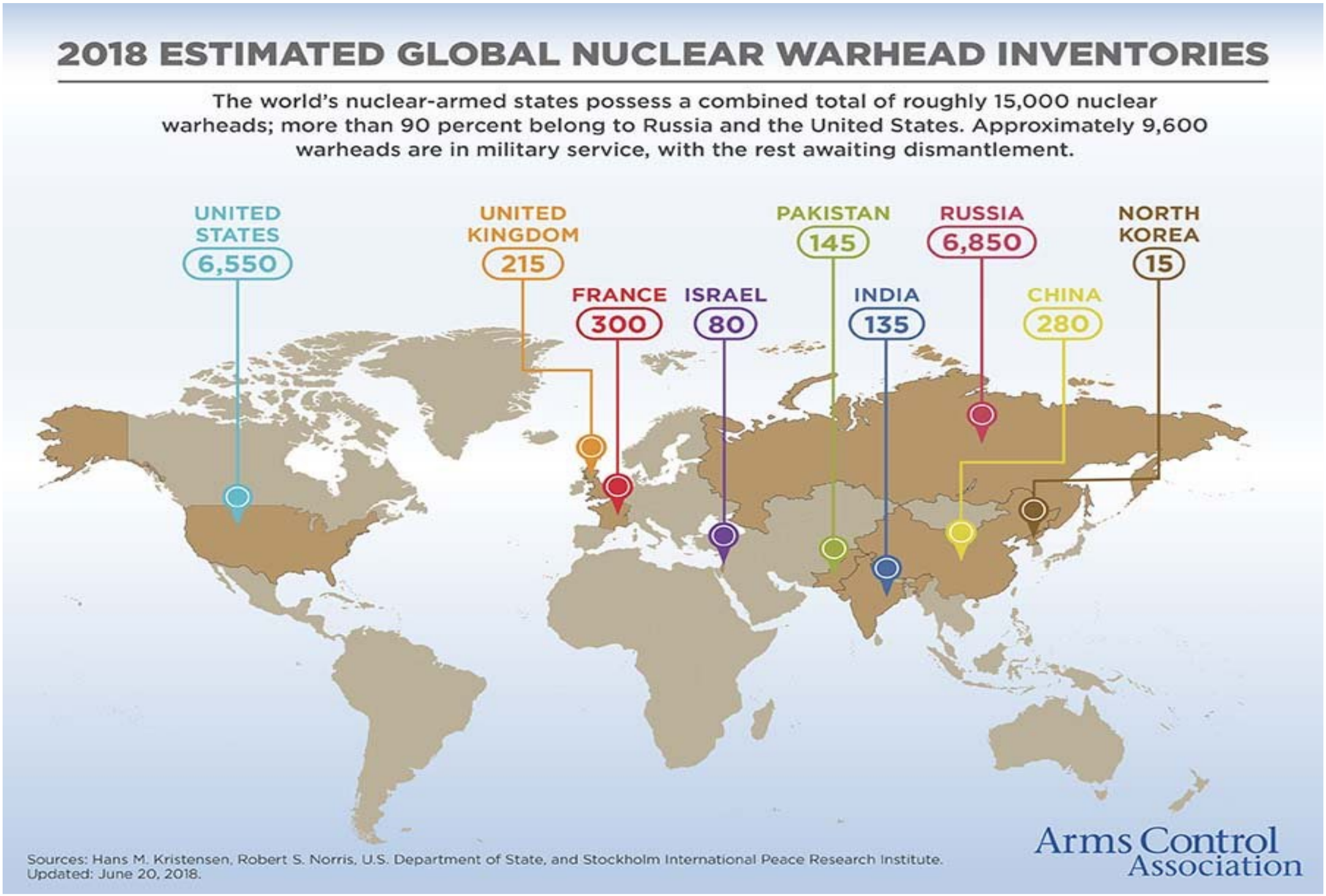
9,330 Nuclear weapons in Military Stockpiles in 2019

# World Nuclear Weapons Stockpile 1945-2017



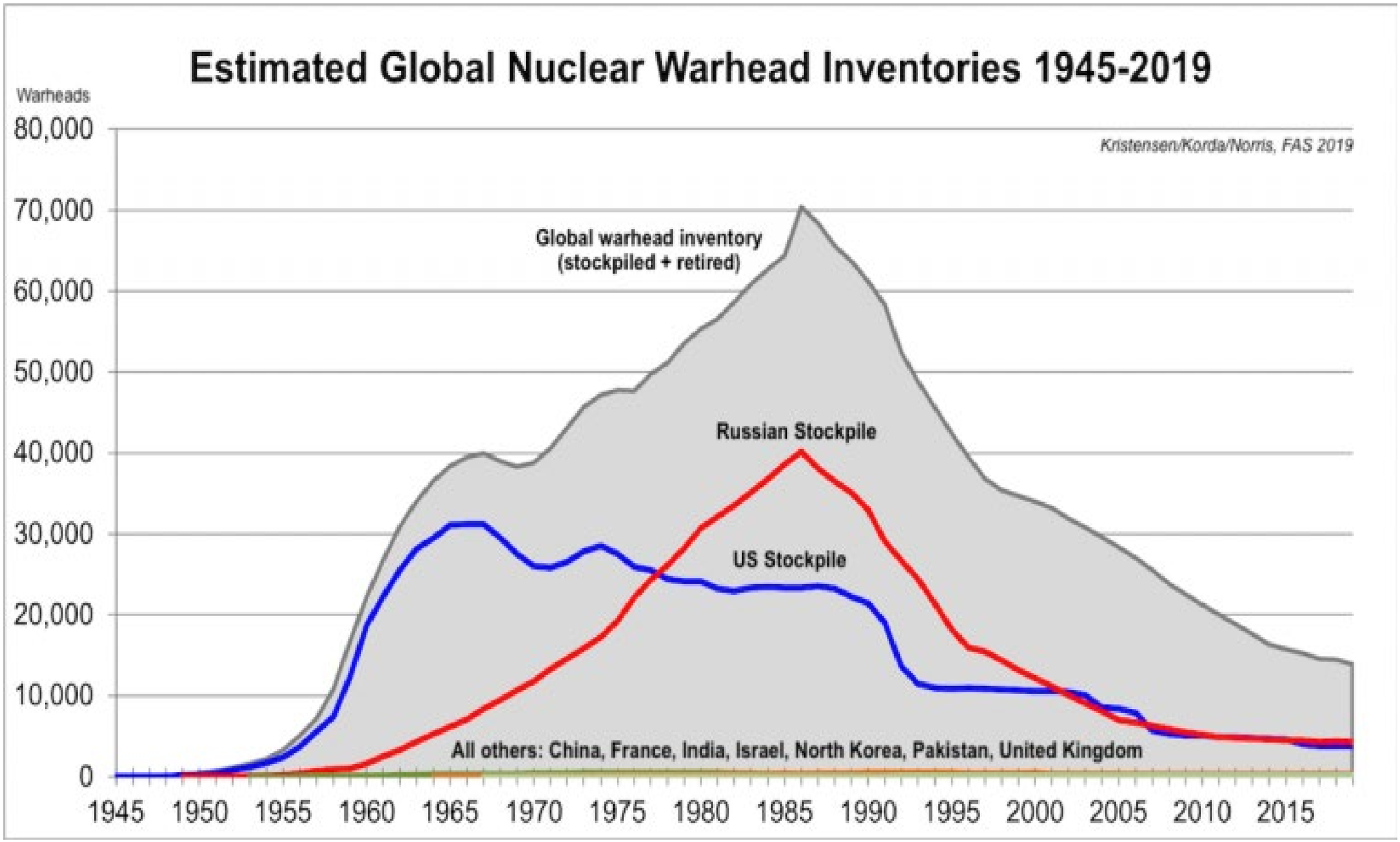

Source: *The Bulletin of the Atomic Scientists'* Nuclear Notebook, written by Hans M. Kristensen and Robert S. Norris, Federation of American Scientists

# Arms Control Association 2018 estimate



# Breakdown of the Nuclear Weapons Stockpile (2019)

# World Nuclear Weapons Stockpile 1945-2019




Source: Federation of Atomic Scientists, Nuclear Notebook, Hans Kristensen

# Global Nuclear Weapon Inventory 2019 (Important)

| NPT Nuclear Weapon States (Total Weapons) | | Non-NPT Nuclear Weapon States (Total Weapons) | |
|---|---|---|---|
| China: | ~ 290 | Pakistan: | ~ 140-150 |
| France: | ~ 300 | Israel: | ~ 80 |
| Russia: | ~ 4,330 | India: | ~ 130-140 |
| UK: | ~ 215 | North Korea: | ~ 20-30 |
| US: | ~ 3,800 | | |

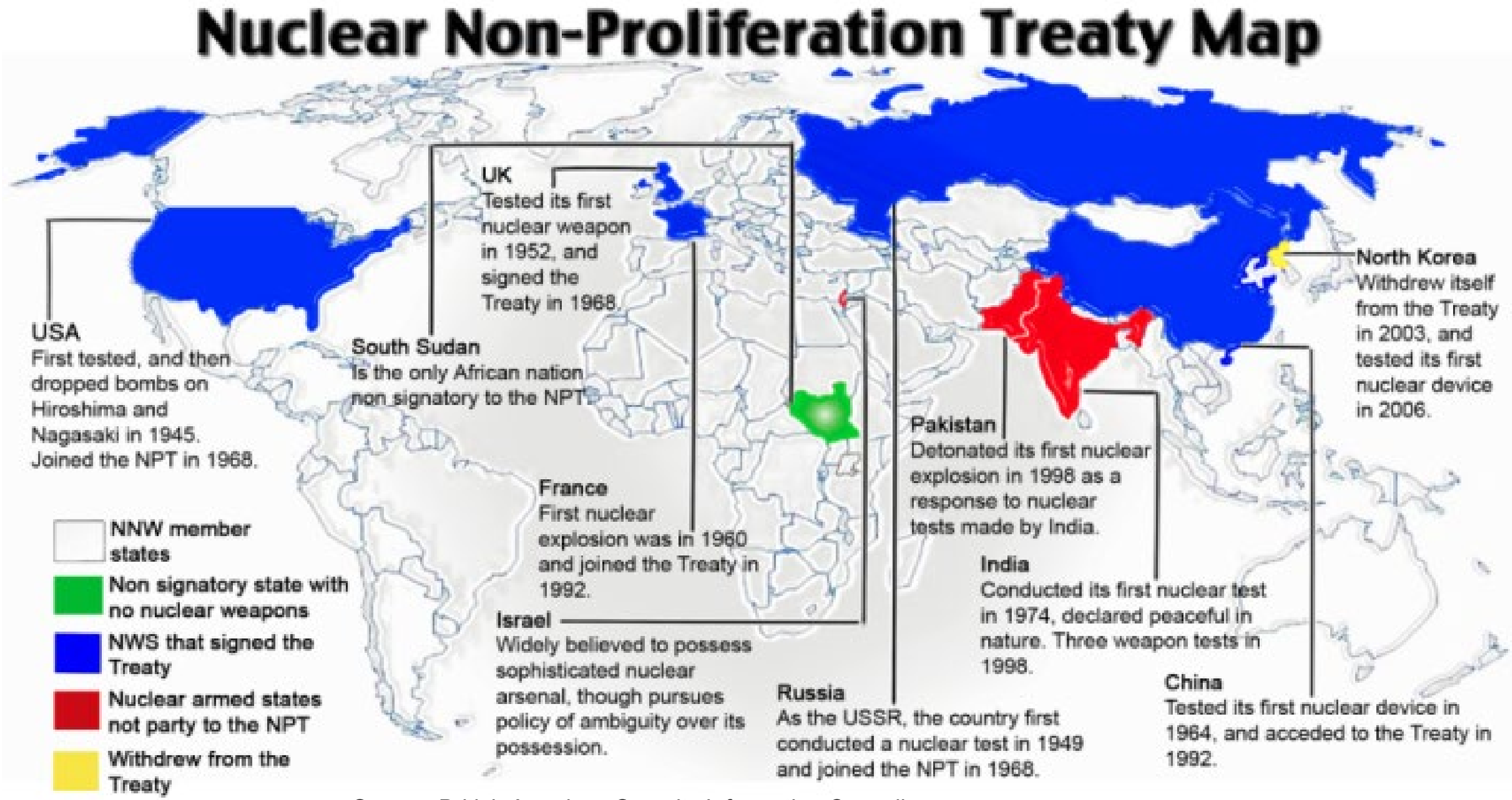
Source: Status of World Nuclear Forces, Written by Hans M. Kristensen and Matt Korda, Federation of American Scientists

# 2019 Breakdown of Nuclear Forces

| Status of World Nuclear Forces 2019* | | | | | |
|---|---|---|---|---|---|
| **Country** | **Deployed Strategic** | **Deployed Nonstrategic** | **Reserve/ Nondeployed** | **Military Stockpile** | **Total Inventory** |
| Russia | 1,600*c* | 0*d* | 2,730*e* | 4,330 | 6,500*f* |
| United States | 1,600*g* | 150*h* | 2,050*i* | 3,800*j* | 6,185*k* |
| France | 280*l* | n.a. | 20*l* | 300 | 300 |
| China | 0*m* | ? | 290 | 290 | 290*m* |
| United Kingdom | 120*n* | n.a. | 95 | 215 | 215*n* |
| Israel | 0 | n.a. | 80 | 80 | 80*o* |
| Pakistan | 0 | n.a. | 140-150 | 140-150 | 140-150*p* |
| India | 0 | n.a. | 130-140 | 130-140 | 130-140*q* |
| North Korea | 0 | n.a. | ? | 20-30 | 20-30*r* |
| **Total:** | **~3,600** | **~150** | **~5,555** | **~9,330** | **~13,890** |

Source: Federation of American Scientists “Status of World Nuclear Forces”

# Non-Proliferation Treaty Map




Source: British American Security Information Council

# Nuclear Warheads on Alert (2017)

| Estimated Nuclear Alert Forces, 2017 | | | |
|---|---|---|---|
| **Country** | **Stockpiled Warheads** | **Alert Warheads** | |
| United States | 4,000 | 852 | 21% of Stockpile on Alert  ICBMs: 392, SSBNs: 460 |
| Russia | 4,300 | 897 | 21% of Stockpile on Alert ICBMs: 686, SSBNs: 211 |
| France | 300 | 80[a] | 27% of Stockpile on Alert SSBNs: 80 |
| Britain | 215 | 40[a] | 19% of Stockpile on Alert SSBNs: 40 |
| China | 270 | 0 | Warheads are not mated with delivery systems |
| Pakistan | 140 | 0 | Warheads are not mated with delivery systems |
| India | 120 | 0 | Warheads are not mated with delivery systems |
| Israel | 80 | 0 | Warheads are not mated with delivery systems |
| North Korea | (10-20) | (0) | Warheads are not mated with delivery sysyems |
| **Total** | **9,425[b]** | **1,869** | |

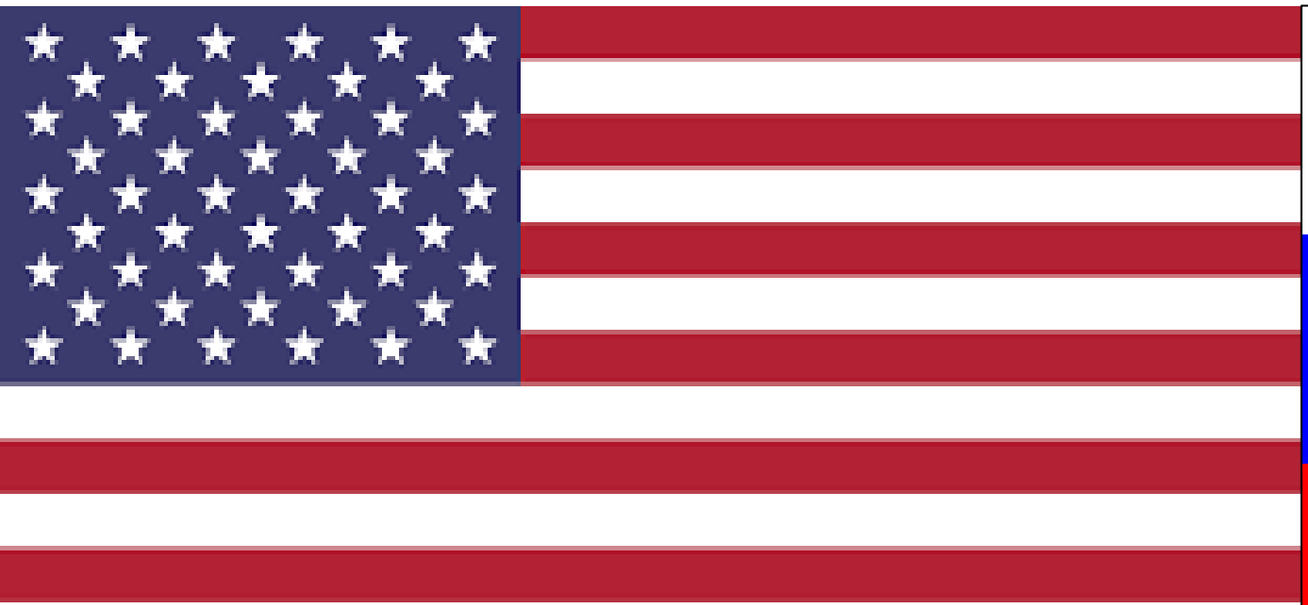
Source:Hans Kristensen,  FAS, Alert Status of Nuclear Weapons

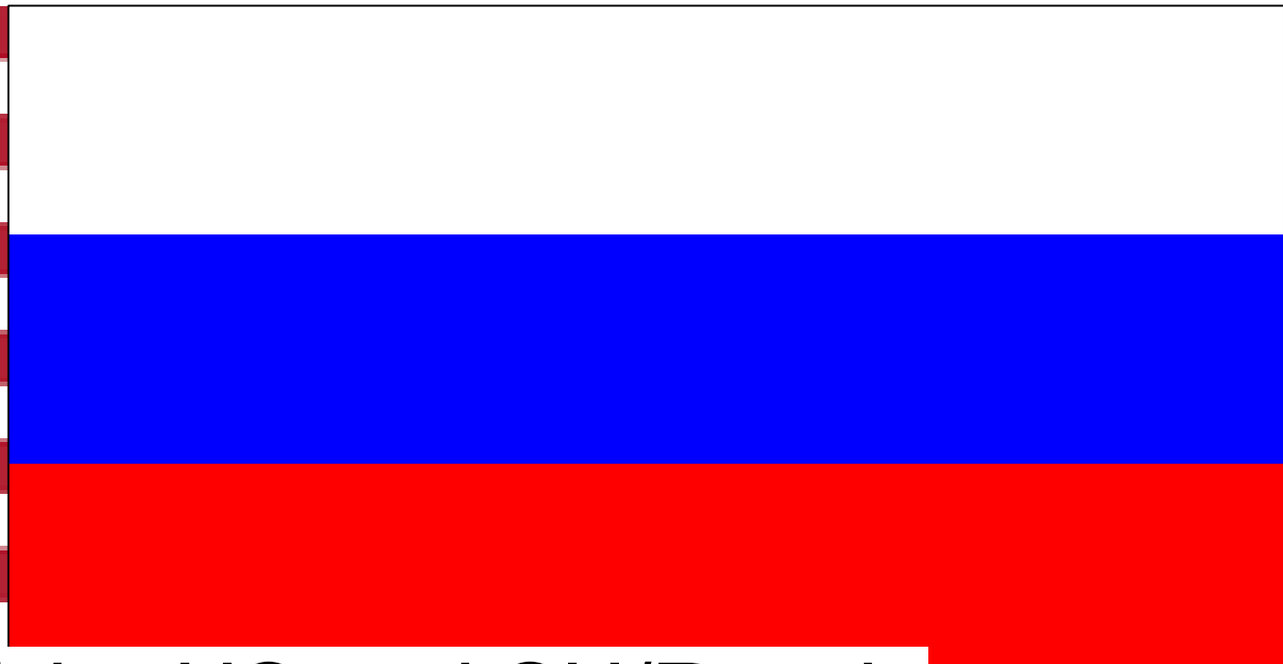
# Arms Control Agreements

| Strategic N… Abandoned by the US andRussia in Feb 1st, 2019 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SALT I | SALT II | INF Treaty | START I | START II | START III | SORT | New START |
| Status | Expired | Never Entered Into Force | In Force* | Expired | Never Entered Into Force | Never Negotiated | Replaced by New START | In Force |
| Deployed Warhead Limit | N/A | N/A | N/A | 6,000 | 3,000-3,500 | 2,000-2,500 | 1,700-2,200 | 1,550 |
| Deployed Delivery Vehicle Limit | US: 1,710 ICBMs & SLBMs USSR: 2,347 | 2,250 | Prohibits ground-based missiles of 500-5,500 km range | 1,600 | N/A | N/A | N/A | 700 |
| Date Signed | May 26, 1972 | June 18, 1979 | Dec. 8, 1987 | July 31, 1991 | Jan. 3, 1993 | N/A | May 24, 2002 | April 8, 2010 |
| Date Ratifed, U.S. | Aug. 3, 1972 | N/A | May 28, 1988 | Oct. 1, 1992 | Jan. 26, 1996 | N/A | March 6, 2003 | Dec. 22, 2010 |
| Ratification Vote, U.S. | 88-2 | N/A | 93-6 | 93-6 | 87-4 | N/A | 95-0 | 71-26 |
| Date Entered Into Force | Oct. 3, 1972 | N/A | June 1, 1988 | Dec. 5, 1994 | N/A | N/A | June 1, 2003 | Feb. 5, 2011 |
| Implementation Deadline | N/A | N/A | June 1, 1991 | Dec. 5, 2001 | N/A | N/A | N/A | Feb. 5, 2018 |
| Expiration Date | Oct. 3, 1977 | N/A | unlimited duration | Dec. 5, 2009 | N/A | N/A | Feb. 5, 2011 | Feb. 5, 2021** |

Source: Arms Control Association “Strategic Nuclear Arms Control Agreements”

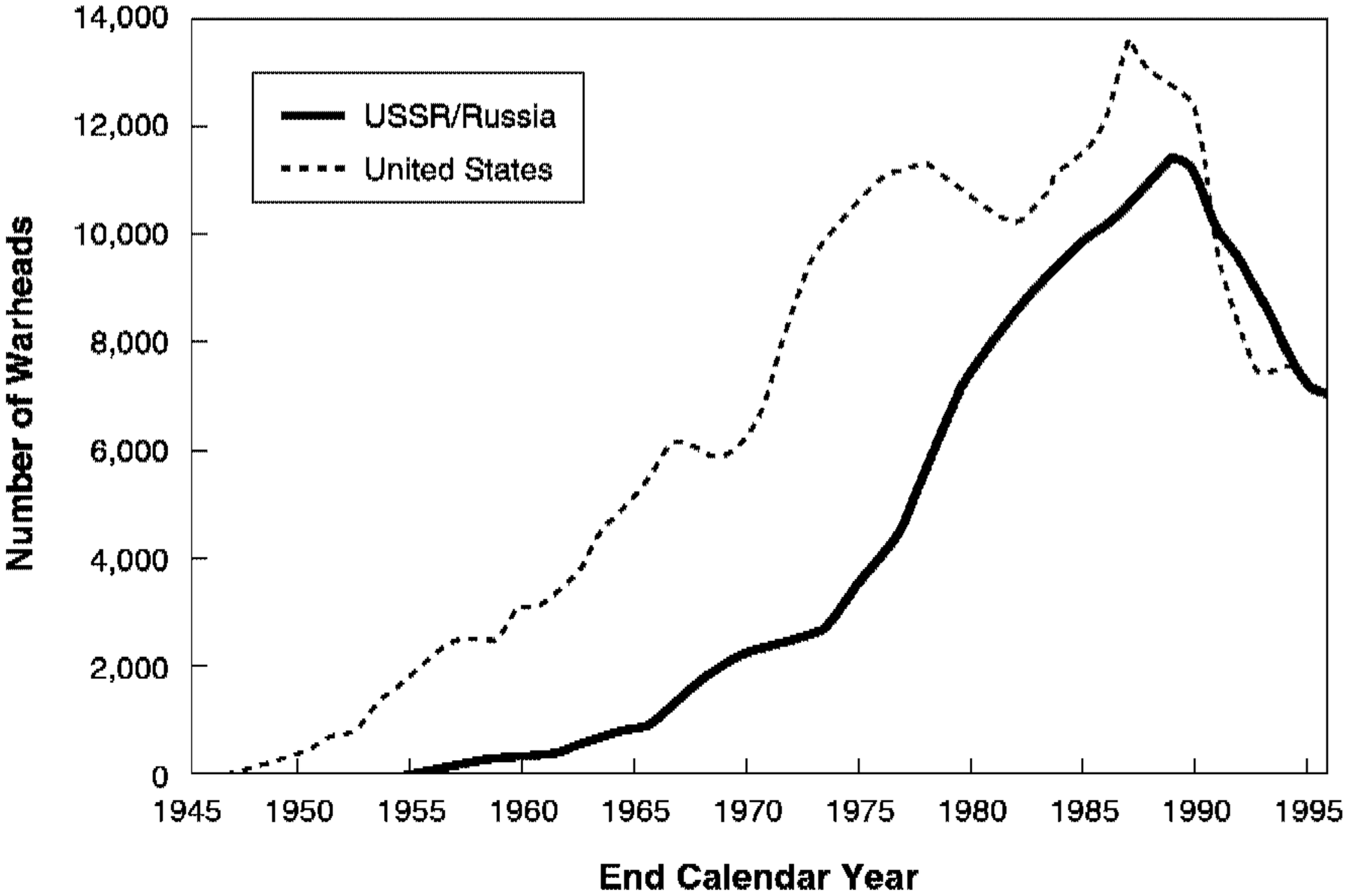
# Module 6: Arsenals





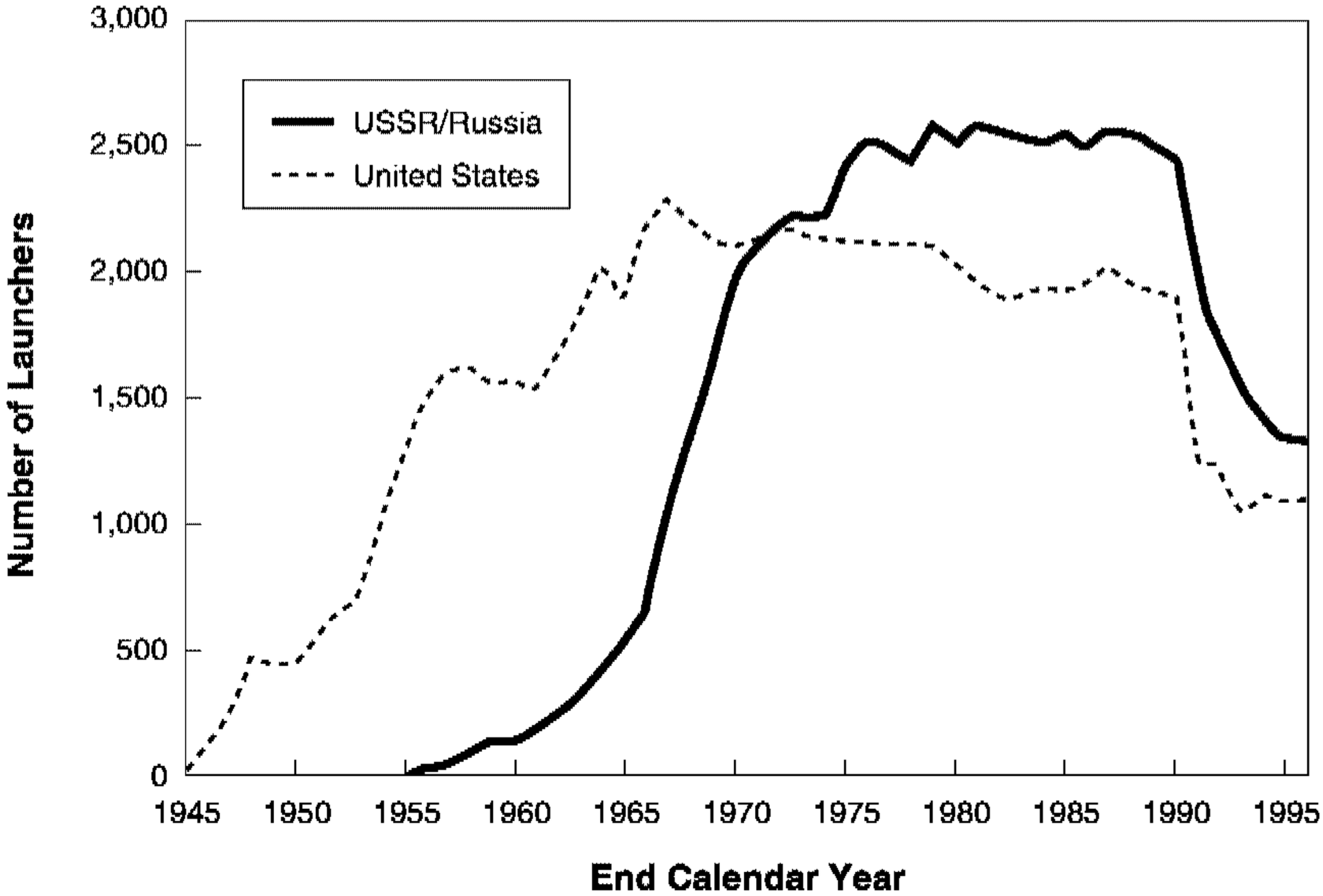
## Part 2: Sec 1 Arsenals of the US and SU/Russia

# Evolution of US and SU-Russian Strategic Nuclear Warhead Numbers



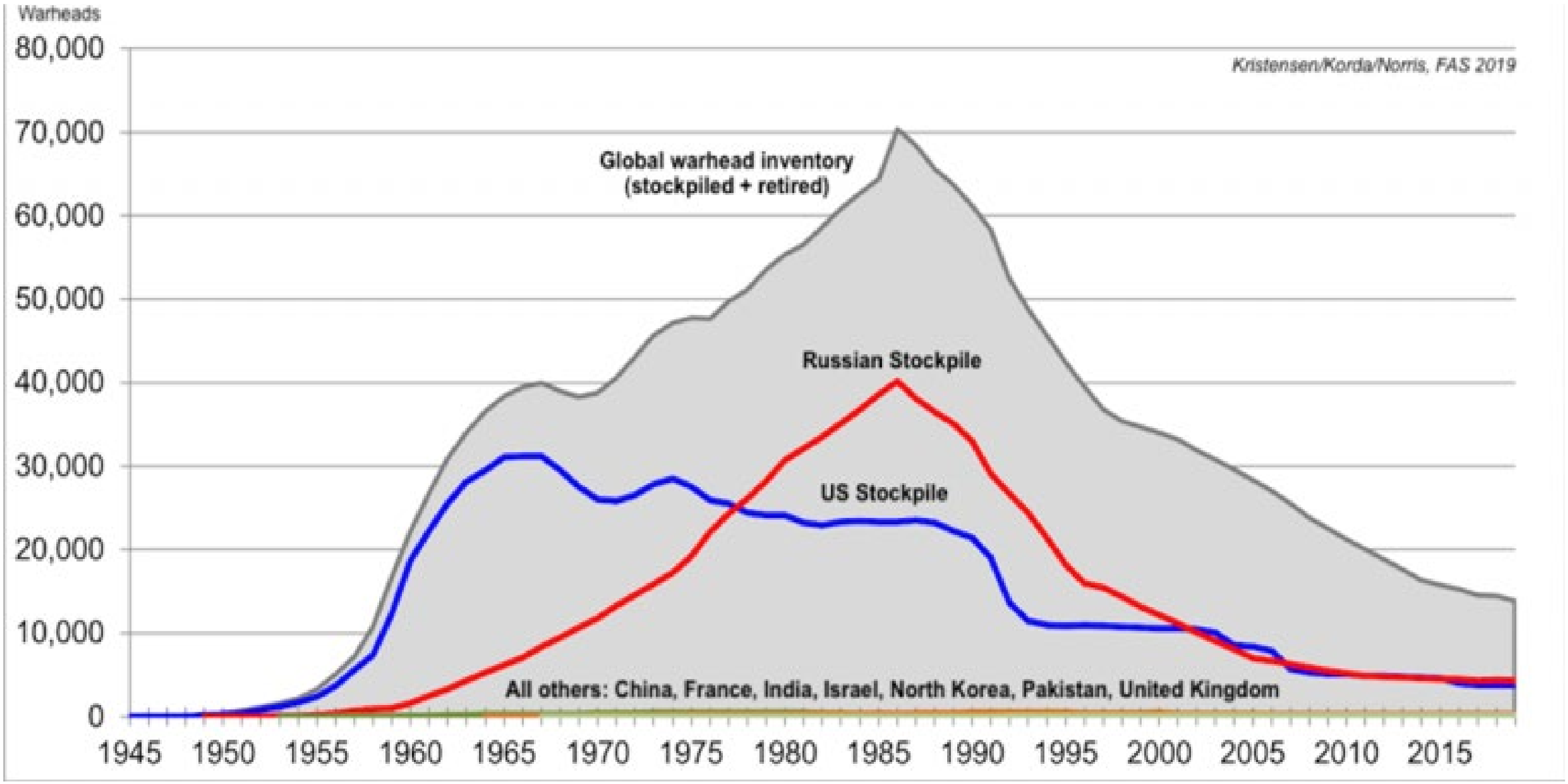

Source: NRDC (Nov. 2002)

# Evolution of US and SU-Russian Strategic Nuclear Launcher Numbers

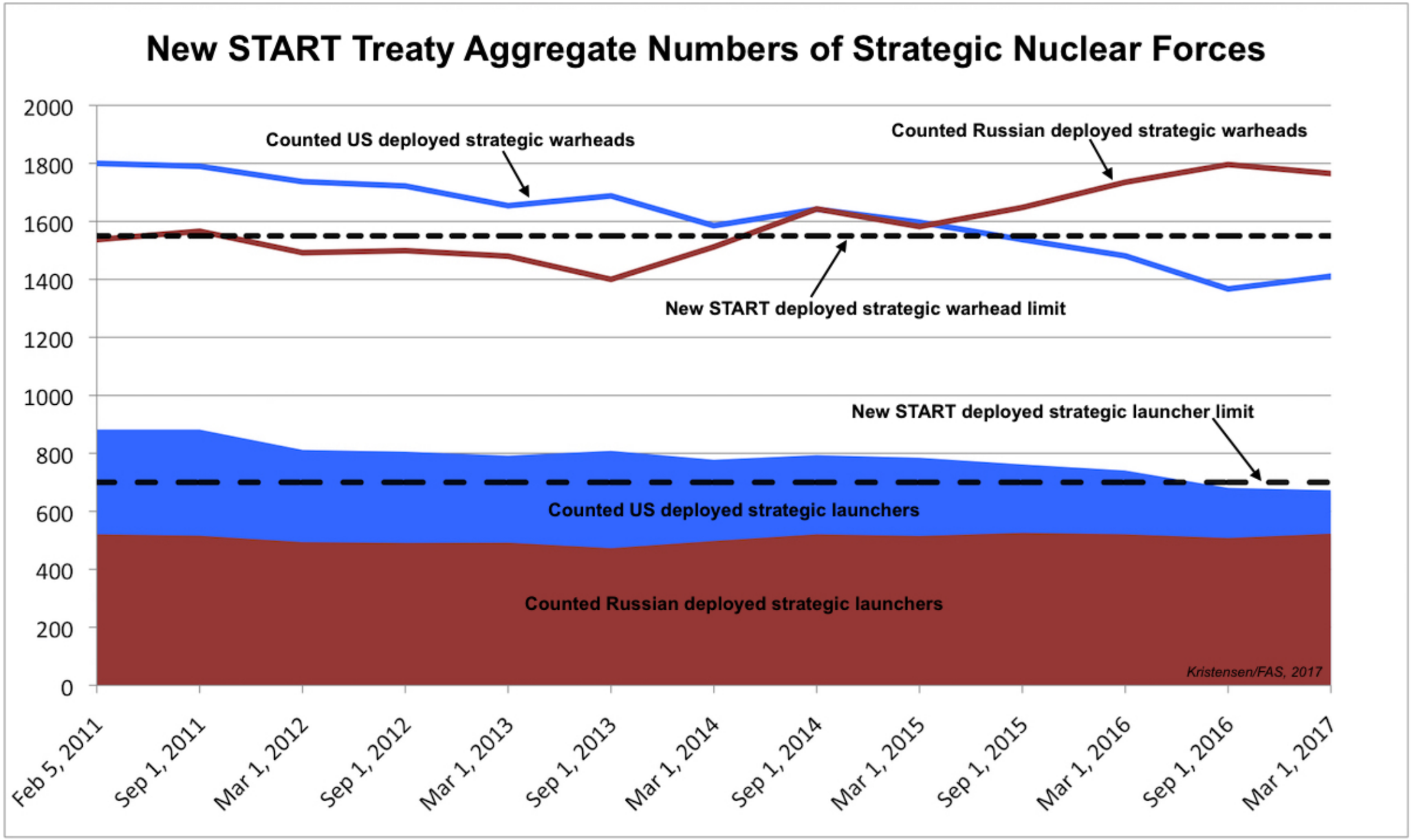



Source: NRDC (Nov. 2002)

# Evolution of US and SU-Russian Nuclear Stockpiles (2019)



# US and Russian Warheads after New START




Source: Federation of American Scientists

# U.S. and Russian “Tactical” Weapons in Europe

- The U.S. is thought to have 150 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.
- At the peak in 1971, 7100 U.S. tactical weapons were stationed in Europe: removed for concerns with regards to decision process of escalating conventional conflict and for security risks arising from political terrorism in Europe.

# Evolution of US SSBN Nuclear Forces

| SSBN Forces | 2000 | 2001 | 2002 | 2007* | 2012** |
|---|---|---|---|---|---|
| **SSBNs** | | | | | |
| Trident [3] | 18 | 18 | 18 | 14 | 14 |
| **Total SSBNs** | **18** | **18** | **18** | **14** | **14** |
| **SLBM Launchers** | | | | | |
| Trident with C4 [9] | 192 | 168 | 168 | | |
| Trident with D5 [10] | 240 | 264 | 264 | 336 | 336 |
| **Total Launchers** | **432** | **432** | **432** | **336** | **336** |
| **SLBM Warheads** | | | | | |
| W76 (C-4) [14] | 1536 | 1008 | 1008 | | |
| W76 (D-5) | 1536 | 1728 | 1728 | 1560 | 1300 |
| W88 (D-5) [15] | 384 | 384 | 384 | 384 | 380 |
| **Total Warheads** | **3456** | **3120** | **3120** | **1944** | **1680** |

Source: NRDC

# Evolution of US ICBM Nuclear Forces

| ICBM Forces | 2000 | 2001 | 2002 | 2007* | 2012** |
|---|---|---|---|---|---|
| **Launchers** | | | | | |
| MINUTEMAN III [8] | 500 | 500 | 500 | 500 | 500 |
| MX (PEACEKEEPER) [9] | 50 | 50 | 50 | 50 | 50 |
| **Total Launchers** | **550** | **550** | **550** | **550** | **550** |
| **ICBM Deployed Warheads** | | | | | |
| W62 (MM III) [16] | 600 | 300 | 300 | 0 | 0 |
| W78 (MM III) [17] | 900 | 900 | 900 | 300 | 300 |
| W87 (MX) [18] | 500 | 500 | 500 | 200 | 200 |
| **Total (Deployed)** | **2000** | **1700** | **1700** | **500** | **500** |

Source: NRDC

# 2018 Estimate of US Forces Under New START

**Table 2. U.S. Strategic Nuclear Forces under New START**

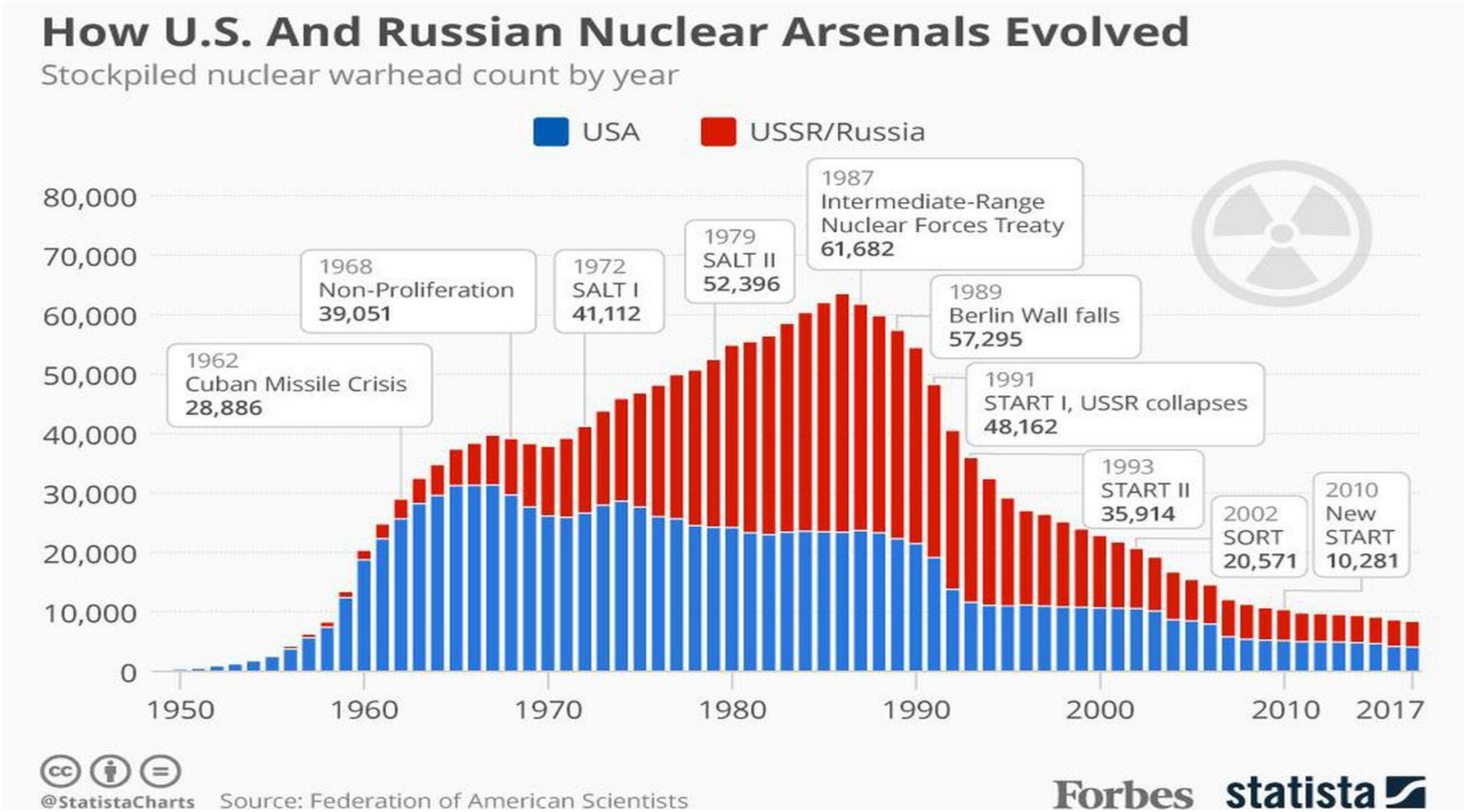
(Estimated Current Forces and Potential New START Forces)

| | Estimated Forces, 2010 | | Planned Forces Under New START[a] | | |
|---|---|---|---|---|---|
| | Launchers | Warheads | Total Launchers | Deployed Launchers | Warheads |
| ICBM Minuteman III | 399 | N/A | 454 | 400 | 400 |
| SLBM Trident | 212 | N/A | 280 | 240 | 1,090 |
| Bomber B-52 | 38 | | 46 | 42 | 42 |
| Bomber B-2 | 11 | 49 | 20 | 18 | 18 |
| Total | 660 | 1393 | 800 | 700 | 1,550 |

Source for 2018 data: US Strategic Forces Uncer New Start (2018), Arms Control Association

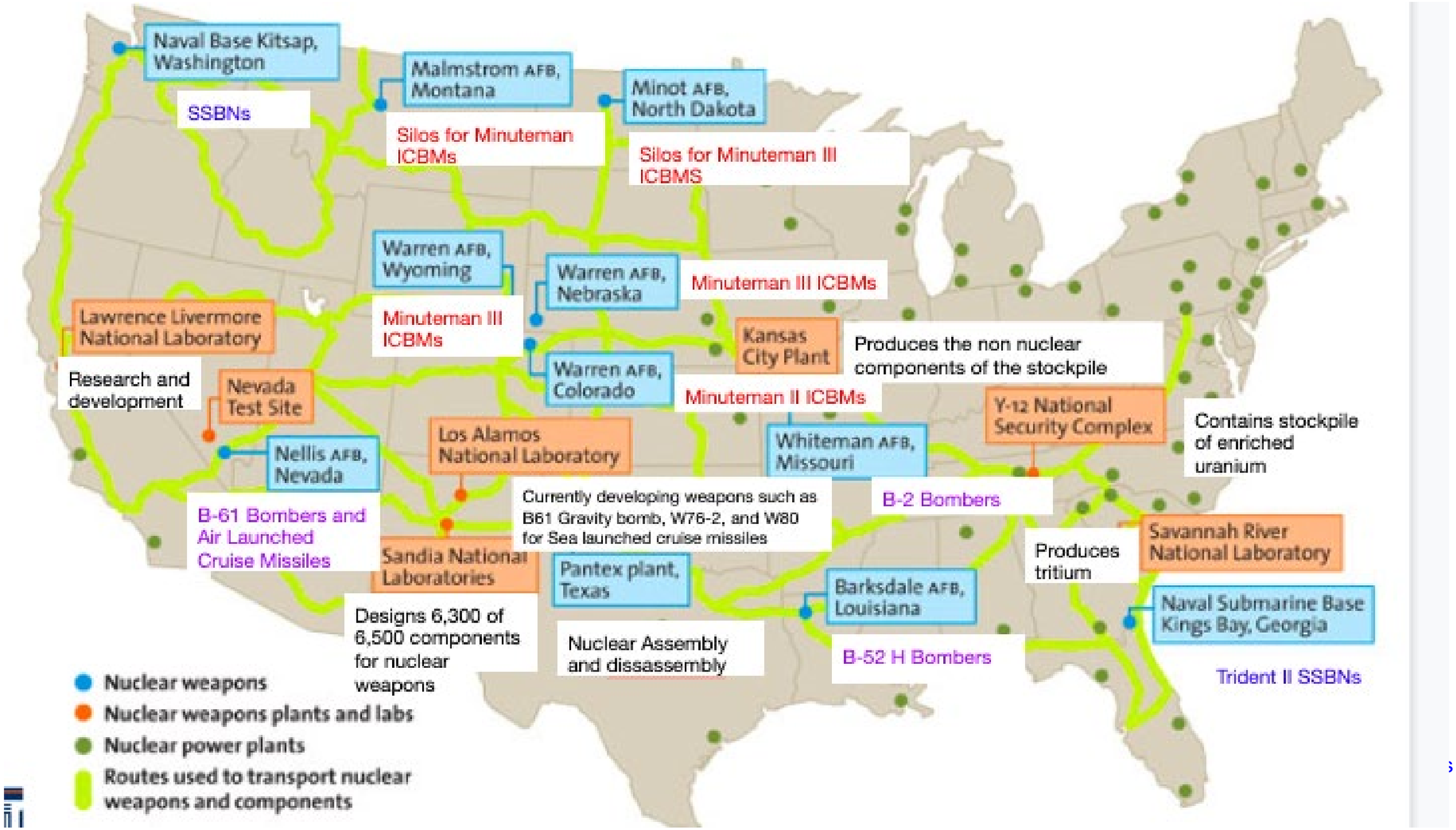
| Nuclear Triad | Type |
|---|---|
| Land | ICBM |
| Air | Bomber |
| Sea | SLBM |

# US and Russian Nuclear Evolution




Source: Information: Federation of American Scientists  Chart: Statista

# Nuclear Labs, Plants, and Weapons locations (2017)



# Specific Warheads at Each Nuclear Weapons Facility (2019)

| Rank | State/Country | Warheads | Remarks |
|---|---|---|---|
| *United States* | | | |
| 1 | New Mexico | 2,485[a] | Kirtland Underground Munitions and Maintenance Storage Complex (KUMMSC)<br>Occasionally at Los Alamos National Laboratory<br>Occasionally at Sandia National Laboratories |
| 2 | Washington | 1,620[b] | Strategic Weapons Facility Pacific (SWFPAC)<br>Naval Submarine Base Kitsap (SSBNs) |
| 3 | Georgia | 1,100[c] | Strategic Weapons Facility Atlantic (SWFLANT)<br>Naval Submarine Base Kings Bay (SSBNs) |
| 4 | North Dakota | 350 | 91st Missile Wing silos for Minuteman III ICBMs<br>Minot AFB weapons storage area (ICBMs/B-52s) |
| 5 | Montana | 150 | 341st Missile Wing silos for Minuteman III ICBMs<br>Malmstrom AFB weapons storage area |
| 6 | Missouri | 100 | Whiteman AFB weapons storage area |
| 7 | Texas | 80 | Pantex Plant (warhead assembly and dismantlement)[d] |
| 8 | Nebraska | 72 | 90th Missile Wing silos for Minuteman III ICBMs |
| 9 | Colorado | 44 | 90th Missile Wing silos for Minuteman III ICBMs |
| 10 | Wyoming | 34 | 90th Missile Wing silos for Minuteman III ICBMs<br>F.E. Warren AFB weapons storage area |
| 11 | California | few | Occasionally at Lawrence Livermore National Laboratory |
| *Europe* | | | |
| 1 | Turkey | 50 | Incirlik AB weapons storage vaults[e] |
| 2 | Italy | 40 | Aviano AB weapons storage vaults<br>Ghedi AB weapon storage vaults |
| 3 | Belgium<br>Germany<br>Holland | 20<br>20<br>20 | Kleine Brogel AB weapon storage vaults<br>Büchel AB weapon storage vaults<br>Volkel AB weapon storage vaults |

Source:Hans M. Kristensen and Matt Korda, United States Nuclear Forces (2019), Bulletin of the Atomic Scientists

# Phys 280 Session 18

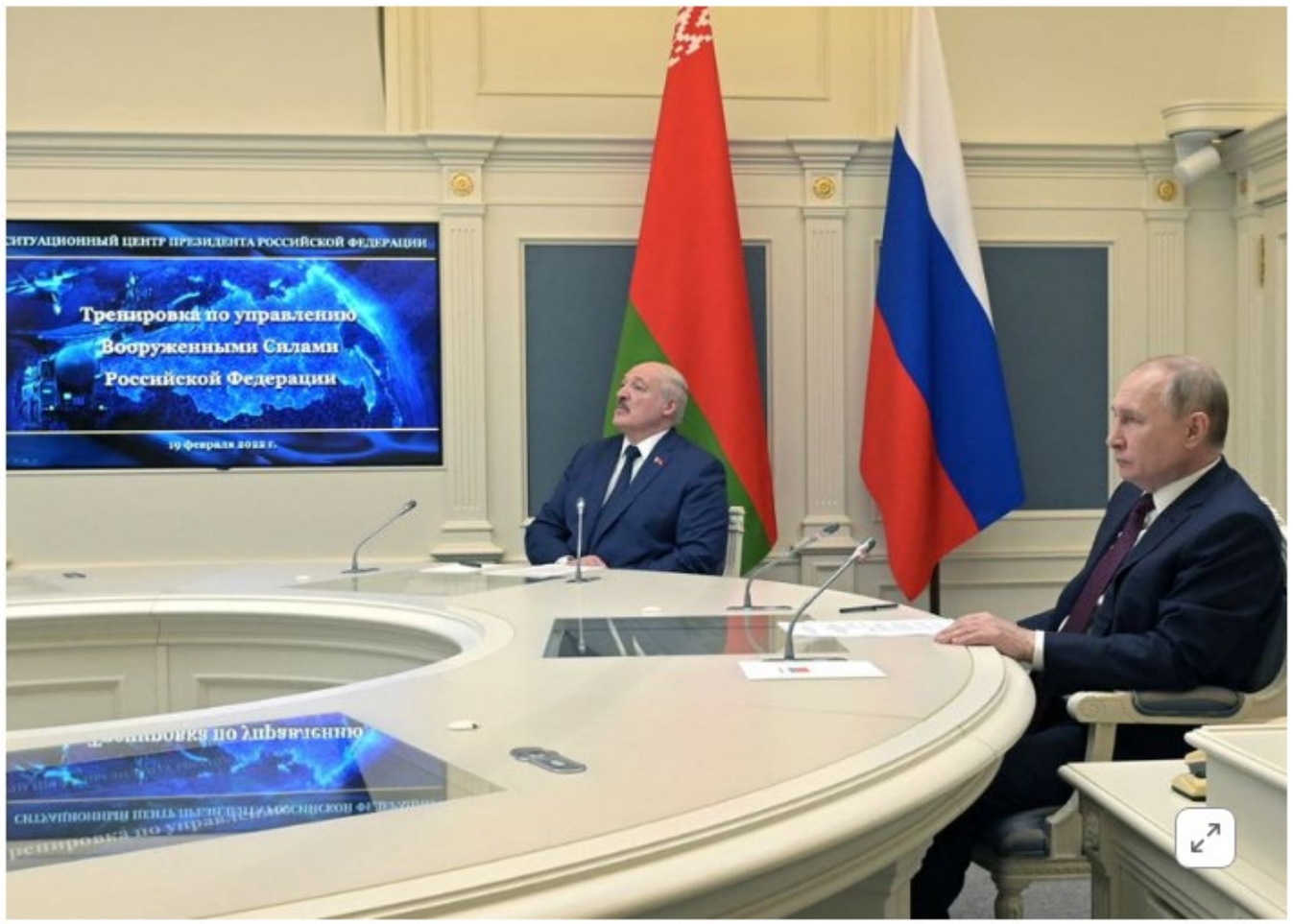
Module 6 – Nuclear Arsenals

5 minute read · March 26, 2023 4:50 AM CDT · Last Updated 4 days ago

REUTERS®

# Putin says Moscow to place nuclear weapons in Belarus, US reacts cautiously

By David Ljunggren




[1/2] Russian President Vladimir Putin and Belarusian President Alexander Lukashenko observe training launches of ballistic missiles as part of the exercise of the strategic deterrence force, in Moscow, Russia February 19, 2022. Sputnik/Aleksey Nikolskyi/Kremlin via REUTERS **Read less**

March 25 (Reuters) - Russia will station tactical nuclear weapons in Belarus, President Vladimir Putin said on Saturday, sending a warning to NATO over its military support for Ukraine and escalating a standoff with the West.

Although not unexpected and while Putin said the move would not violate nuclear non-proliferation promises, it is one of the Russia's most pronounced nuclear signals since the beginning of its invasion of Ukraine 13 months ago.

The United States - the world's other nuclear superpower - has reacted cautiously to Putin's statement, with a senior administration official saying there were no signs Moscow planned to use its nuclear weapons.

Putin likened his plans to the U.S. stationing its weapons in Europe and said that Russia would not be transferring control to Belarus. But this could be the first time since the mid-1990s that Russia were to base such weapons outside the country.

"There is nothing unusual here either: firstly, the United States has been doing this for decades. They have long deployed their tactical nuclear weapons on the territory of their allied countries," Putin told state television.

"We agreed that we will do the same - without violating our obligations, I emphasize, without violating our international obligations on the nonproliferation of nuclear weapons."

5 minute read · March 26, 2023 4:50 AM CDT · Last Updated 4 days ago

REUTERS®

# Putin says Moscow to place nuclear weapons in Belarus, US reacts cautiously

By David Ljunggren

Putin did not specify when the weapons would be transferred to Belarus, which has borders with three NATO members - Poland, Lithuania and Latvia. He said Russia would complete the construction of a storage facility there by July 1.

"This is part of Putin's game to try to intimidate NATO ... because there is no military utility from doing this in Belarus as Russia has so many of these weapons and forces inside Russia," said Hans Kristensen, director of the nuclear information project at the Federation of American Scientists.

It was also unclear where in Belarus the weapons would be stationed. The transfer would expand Russia's nuclear strike ability along NATO's eastern border.

…

Putin said that Belarusian President Alexander Lukashenko had long requested the deployment. There was no immediate reaction from Lukashenko.

…

"We are not handing over (the weapons). And the U.S. does not hand (them) over to its allies. We're basically doing the same thing they've been doing for a decade," Putin said.

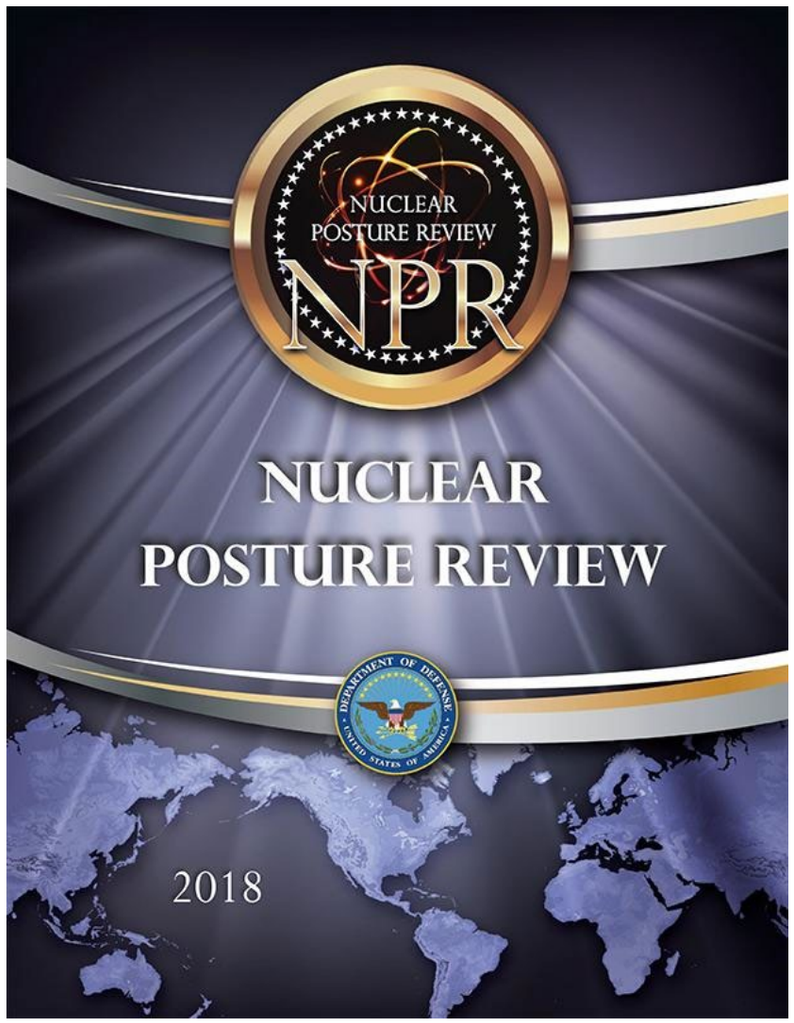
"They have allies in certain countries and they train ... their crews. We are going to do the same thing."

Russia has stationed 10 aircraft in Belarus capable of carrying tactical nuclear weapons, Putin said, adding that it had already transferred to Belarus a number of Iskander tactical missile systems that can launch nuclear weapons.

…

# 2018 U.S. Nuclear Posture Review

https://media.defense.gov/2018/Feb/02/2001872877/-1/-1/1/EXECUTIVE-SUMMARY.PDF




The highest U.S. nuclear policy and strategy priority is to deter potential adversaries from nuclear attack of any scale. However, deterring nuclear attack is not the sole purpose of nuclear weapons. Given the diverse threats and profound uncertainties of the current and future threat environment, U.S. nuclear forces play the following critical roles in U.S. national security strategy. They contribute to the:

› Deterrence of nuclear and non-nuclear attack;
› Assurance of allies and partners;
› Achievement of U.S. objectives if deterrence fails; and
› Capacity to hedge against an uncertain future.

These roles are complementary and interrelated, and the adequacy of U.S. nuclear forces must be assessed against each role and the strategy designed to fulfill it. Preventing proliferation and denying terrorists access to finished weapons, material, or expertise are also key considerations in the elaboration of U.S. nuclear policy and requirements. These multiple roles and objectives constitute the guiding pillars for U.S. nuclear policy and requirements.

2022 NPR published in October 2022
- ➔ Deterrence, Assurance, Achievement of Objectives if deterrence fails
- ➔ No nuclear threat to NPT non-nuclear weapons states
- ➔ Commitment to nuclear weapons modernization program

# 2018 U.S. Nuclear Posture Review on Tactical Weapons in Europe

## Non-Strategic Nuclear Weapons

During the Cold War, the United States possessed large numbers and a wide range of non-strategic nuclear weapons, also known as theater or tactical nuclear weapons. However, we have since retired and dismantled almost all of those weapons. Current U.S. non-strategic nuclear forces consist exclusively of B61 gravity bombs carried by F-15E DCA, supported by responsive air refueling aircraft. Several NATO allies also provide DCA capable of delivering U.S. forward-deployed nuclear weapons. The forthcoming B61-12 gravity bomb will replace earlier versions of the B61, and be available for these DCA beginning in 2021.

Sandia National Laboratory mechanical engineer adjusts a microphone for an acoustic text on a B-61-12 system.

U.S. and NATO DCA, together with U.S. gravity bombs, are forward deployed in European NATO countries. Their forward presence contributes significantly to the deterrence of potential adversaries and the assurance of allies. Their presence is a clear deterrence signal to any potential adversary that the United States possesses the forward-deployed capability to respond to escalation. If necessary, the United States has the ability to deploy DCA and nuclear weapons to other regions, such as Northeast Asia.

Source: 2019 Nuclear Posture Review

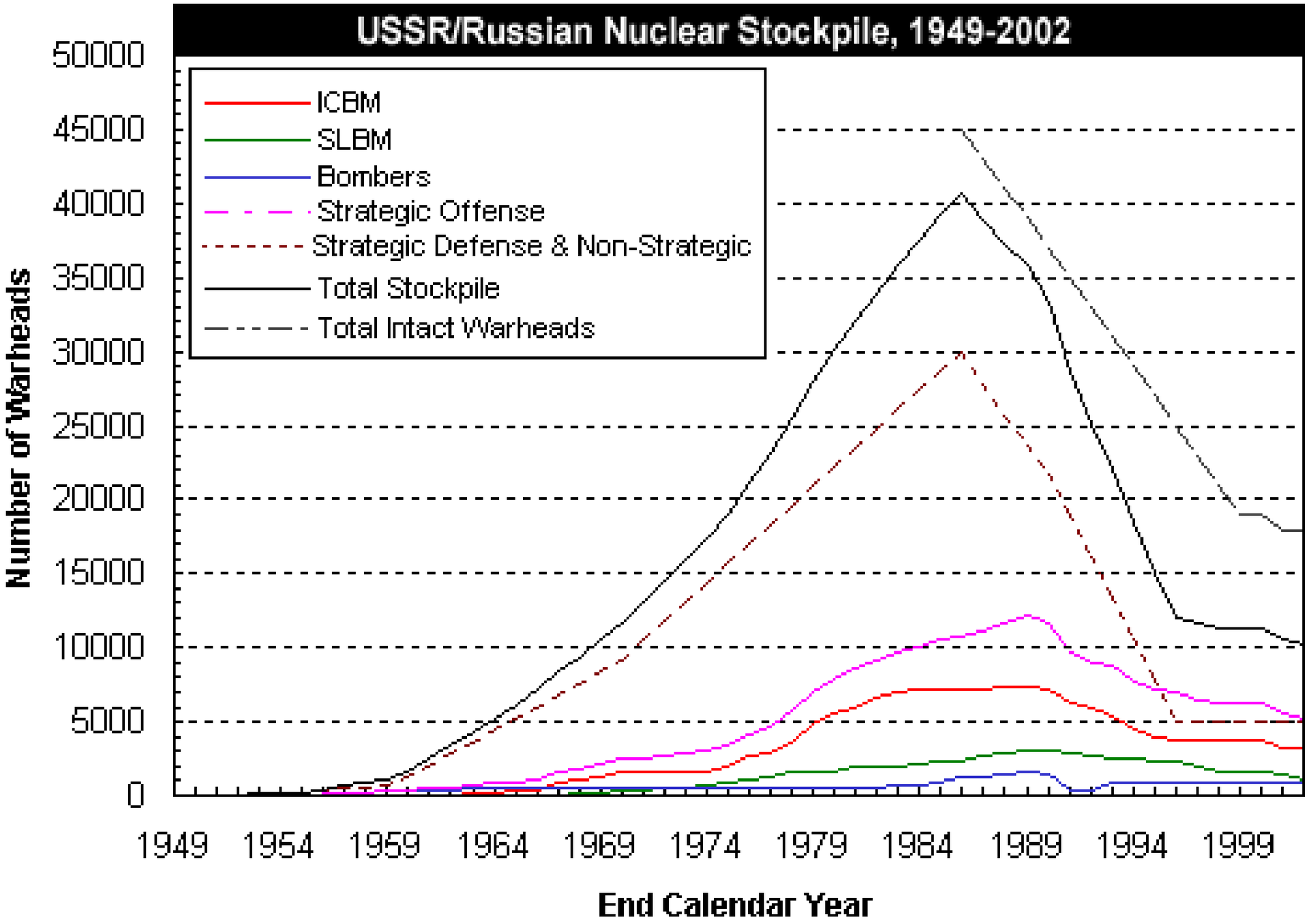
# Russian Nuclear Laboratory and Stockpile Locations


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

# Russian ICBM locations


Source: FAS, Steven Aftergood

# SU-Russian Nuclear Warheads




**Source: NRDC (Nov. 2002)**

# Russian Nuclear Forces ICBMs (2019)

| | Russian | | Year | Warheads | Total |
|---|---|---|---|---|---|
| **Type/name** | **Designation** | **Launchers** | **Deployed** | **x yield (kilotons)** | **Warheads** |
| *Strategic offensive weapons* | | | | | |
| **ICBMs** | | | | | |
| SS-18 M6 Satan | RS-20V | 46 | 1988 | 10 × 500/800 (MIRV) | 460[a] |
| SS-19 M3 Stiletto | RS-18 (UR-100NUTTH) | 20[b] | 1980 | 6 × 400 (MIRV) | 120[c] |
| SS-19 M4 | ? (Avangard) | - | (2019) | 1 × HGV | - |
| SS-25 Sickle | RS-12M (Topol) | 63 | 1988 | 1 × 800 | 63[d] |
| SS-27 Mod 1 (mobile) | RS-12M1 (Topol-M) | 18 | 2006 | 1 × 800? | 18 |
| SS-27 Mod 1 (silo) | RS-12M2 (Topol-M) | 60 | 1997 | 1 × 800 | 60 |
| SS-27 Mod 2 (mobile) | RS-24 (Yars) | 99 | 2010 | 4 × 100? (MIRV) | 396[e] |
| SS-27 Mod 2 (silo) | RS-24 (Yars) | 12 | 2014 | 4 × 100? (MIRV) | 48 |
| SS-X-27 Mod ? (rail) | Barguzin | - | - | 4 × 100? (MIRV) | - |
| SS-X-28 (mobile) | RS-26 (Yars-M) | - | - | 4 × 100? (MIRV) | - |
| SS-X-29 (silo) | RS-28 (Sarmat) | - | (2020) | 10 × 500? (MIRV) | - |
| **Subtotal** | | **318** | | | **1165**[f] |

Source: Bulletin of Atomic Scientists,Russian Nuclear Forces (2019), Hans Kristensen and Robert Norris

# Russian Nuclear Forces Cont. (2019)

| Type/Name | | Designation | Launchers | Year Deployed | Warhead Yield | total |
|---|---|---|---|---|---|---|
| **SLBMs** | | | | | | |
| SS-N-18 M1 Stingray | | RSM-50 | 1/16 | 1978 | 3 × 50 (MIRV) | 48[g] |
| SS-N-23 M1 | | RSM-54 (Sineva) | 6/96 | 2007 | 4 × 100 (MIRV)[h] | 384[i] |
| SS-N-32 | | RSM-56 (Bulava) | 3/48 | 2014 | 6 × 100 (MIRV) | 288[j] |
| **Subtotal** | | **10/160**[k] | | | | **720**[l] |
| **Bombers/weapons** | | | | | | |
| Bear-H6 | | Tu-95 MS6 | 25 | 1984 | 6 × AS-15A ALCMs, bombs | 150 |
| Bear-H16 | | Tu-95 MS16 | 30 | 1984 | 16 × AS-15A ALCMs, bombs | 480 |
| Blackjack | | Tu-160 | 13 | 1987 | 12 × AS-15B ALCMs | 156 |
| **Subtotal** | | | **68**[m] | | | 786[n] |
| **Subtotal strategic offensive forces** | | | **546**[o] | | | **~2,670**[p] |

Source: Bulletin of Atomic Scientists,Russian Nuclear Forces (2019), Hans Kristensen and Robert Norris

# Russian Nuclear Forces Cont. (2019)

| Type/Name | | Designation | Launchers | Year Deployed | Warhead Yield | total |
|---|---|---|---|---|---|---|
| *Nonstrategic and defensive weapons* | | | | | | |
| **ABM/Air/Coastal defense** | | | | | | |
| S-300/S-400 (SA-20/SA-21) | | | ~1000 | 1992/2007 | 1 × low | ~290 |
| 53T6 Gazelle | | | 68 | 1986 | 1 × 10 | 68[q] |
| SSC-1B Sepal (Redut) | | | 8[r] | 1973 | 1 × 350 | 4 |
| SSC-5 Stooge (SS-N-26) (K-300P/3M-55) | | | 48 | 2015 | (1 × 10)[s] | 24 |
| **Land-based air** | | | | | | |
| Bombers/fighters (Tu-22M3/Su-24M/Su-34/ MiG-31K) | | | 300 | 1974/2006/1983 | ASMs, bombs | ~530 |
| **Ground-based** | | | | | | |
| SS-21 Scarab SSM (9K79, Tochka) | | | 12 | 1981 | 1 × 10–100 | 5 |
| SS-26 Stone SSM (9K720, Iskander-M) | | | 132 | 2005 | 1 × 10–100 | 66 |
| SSC-7 GLCM (9M728)[t] | | | | | | |
| SSC-8 GLCM (9M729)[u] | | | 16[v] | 2017 | 1 × 10–100 | 16 |
| **Naval** | | | | | | |
| Submarines/surface ships/air | | | | | LACM, SLCM, ASW, SAM, DB, torpedoes | 820 |
| **Subtotal nonstrategic and defensive forces** | | | | | | **~1,820**[w] |
| **Total** | | | | | | **~4,490**[x] |
| Deployed | | | | | | 1,600 |
| Reserve | | | | | | 2,890 |
| **Retired warheads awaiting dismantlement** | | | | | | **2,000** |
| **Total inventory** | | | | | | **6,490** |

Source: Bulletin of Atomic Scientists,Russian Nuclear Forces (2019), Hans Kristensen and Robert Norris

# Recent Evolution of Russian Nuclear Forces

Evolution of Russian total warheads is very similar to the evolution of US nuclear forces
(because of START and New START limits).

Unlike the US, for geopolitical reasons Russia deploys more warheads on its ICBMs than on its SLBMs.

# Russian Nuclear Forces

**Russian SS-27 Road-Mobile Launcher**

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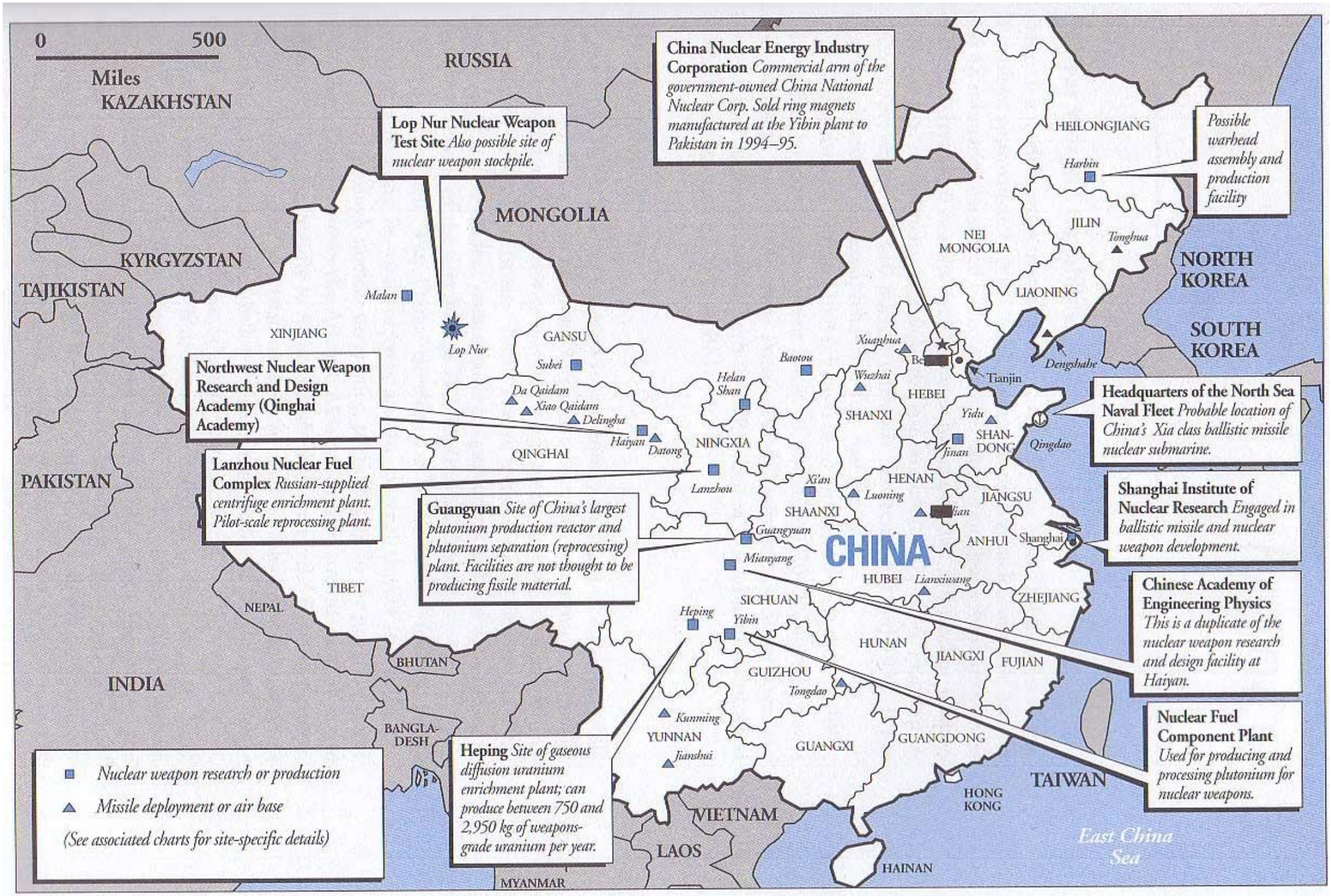
# Module 6:Arsenals

ACDIS program in arms control & domestic and international security

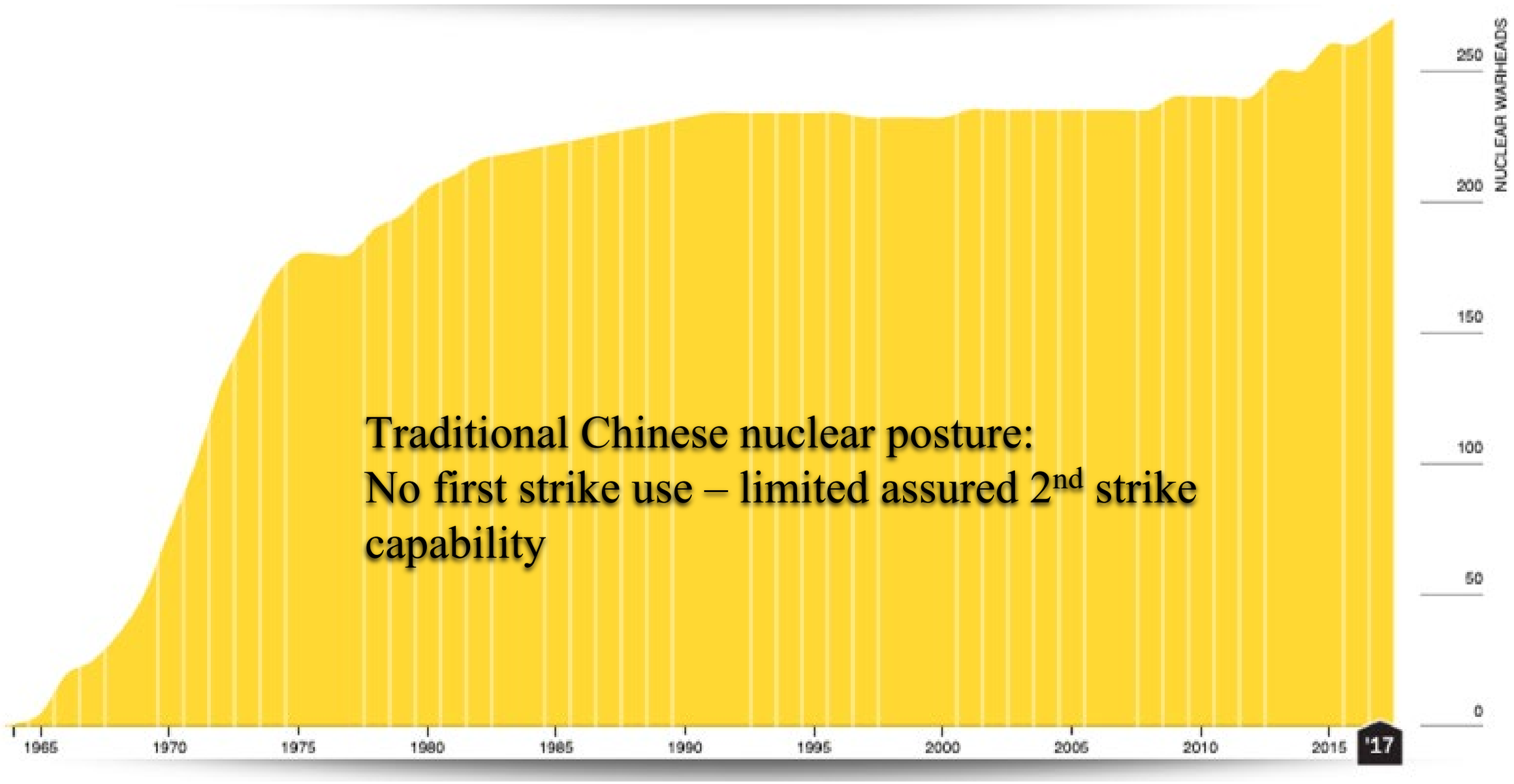
## Part 2 sec 2: Arsenals of the U.K, France, and China

# China's Nuclear Infrastructure




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

# Total Chinese Nuclear Warheads 1945-2017




Source: The Bulletin of the Atomic Scientist Nuclear Notebook, written by Hans M Kristensen and Robert S. Norris, Federation of American Scientists

# Chinese Nuclear Forces (2018)

| Type | NATO designation | Number of launchers | Year deployed | Range (kilometers) | Warhead x yield[a] (kilotons) | Number of warheads |
|---|---|---|---|---|---|---|
| **Land-based ballistic missiles** | | | | | | |
| sDF-4 | CSS-3 | ~5 | 1980 | 5,500+ | 1 x 3,300 | ~10 |
| DF-5A | CSS-4 Mod 2 | ~10 | 1981 | 13,000+ | 1 x 4,000–5,000 | ~10 |
| DF-5B | CSS-4 Mod 3 | ~10 | 2015 | ~13,000 | 3 x 200–300 | ~30 |
| DF-15 | CSS-6 | ? | 1990 | 600 | 1 x ? | ?[b] |
| DF-21 | CSS-5 Mods 2, 6 | ~40 | 1991, 2000, 2016 | 2,150 | 1 x 200–300 | ~80[c] |
| DF-26 | ? | 16 | (2017) | 4,000+ | 1 x 200–300 | 16 |
| DF-31 | CSS-10 Mod 1 | ~8 | 2006 | 7,000+ | 1 x 200–300 | ~8 |
| DF-31A | CSS-10 Mod 2 | ~32 | 2007 | 11,000+ | 1 x 200–300 | ~32 |
| DF-31AG[d] | (CSS-10 Mod 3?) | (16) | (2017) | ? | (1 x ?) | ? |
| DF-41 | CSS-X-20 | n.a. | ? | ? | n.a. | n.a. |
| *Subtotal:* | | | *~121* | | | *~186*[e] |
| **Submarine-launched ballistic missiles**[f] | | | | | | |
| JL-2 | CSS-N-14 | 48 | (2016) | 7,000+ | 1 x 200–300 | 48 |
| ***Aircraft*** | | | | | | |
| H-6[g] | B-6 | (~20) | 1965 | 3,100+ | 1 x bomb | (~20) |
| | | | | | (1 x ALBM) | 0 |
| Fighters[h] | ? | ? | ? | n.a | 1 x bomb | ? |
| **Cruise Missiles**[i] | | | | | | |
| ***Total*** | | | | | | ***~254 (280)***[j] |

Currently: Modernizing nuclear forces to strengthen assured 2nd strike capability

- road mobile ICBM launchers
- new DF-41
- submarine based missiles

See for example:

**China's Transition to a More Credible Nuclear Deterrent: Implications and Challenges for the United States**

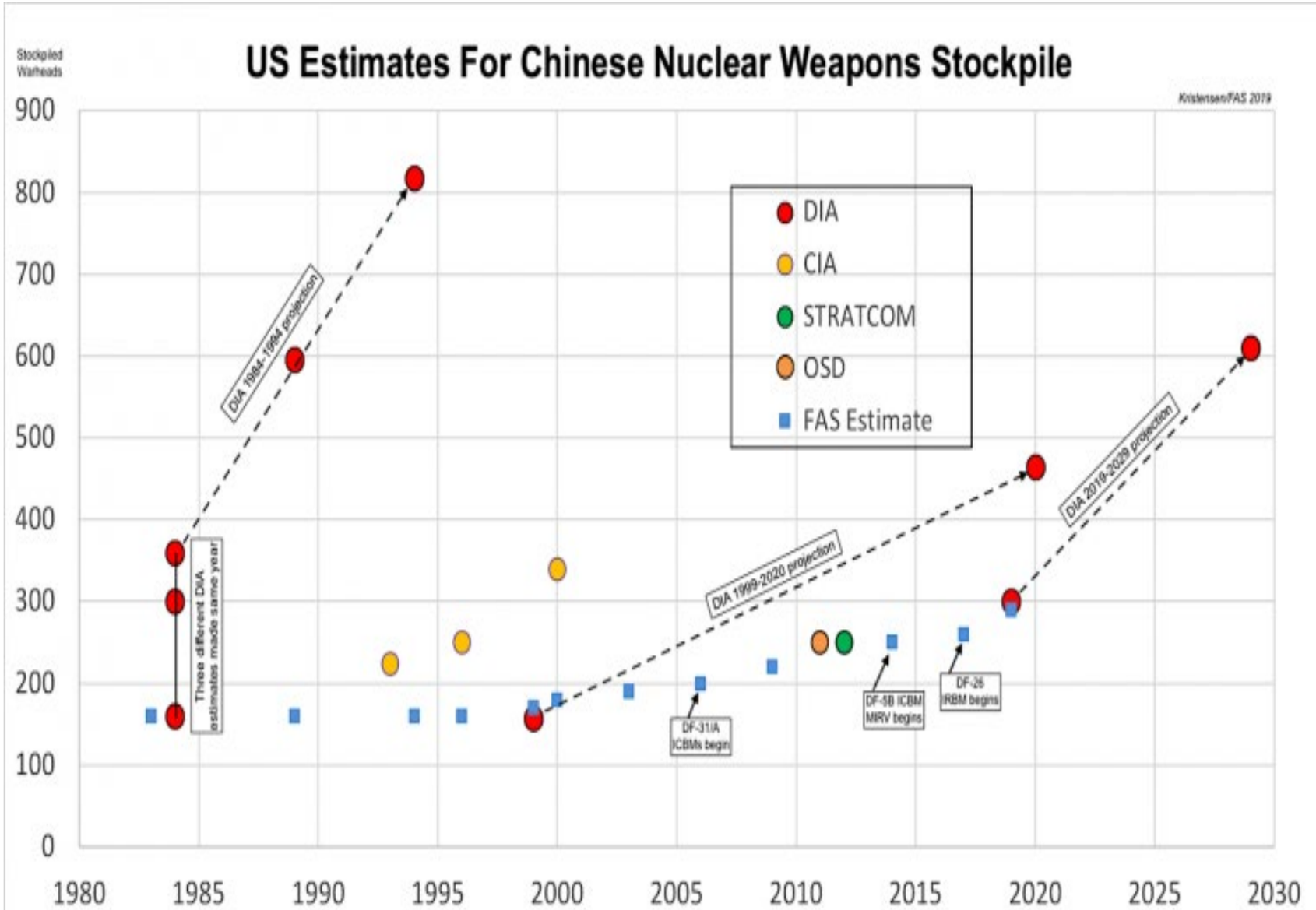
Michael S. Chase in Asia Policy, July 2013

# Chinese Nuclear Stockpile Growth

| Selected Worldwide Nuclear Weapons Inventories | | |
|---|---|---|
| Country | 1999 | 2020 |
| China | | |
| ICBM | 40-45 | 180-220* |
| SLBM | 0-12 | 28-44 |
| SRBM** | 100 | 150-200 |
| **Total** | **140-157** | **358-464** |

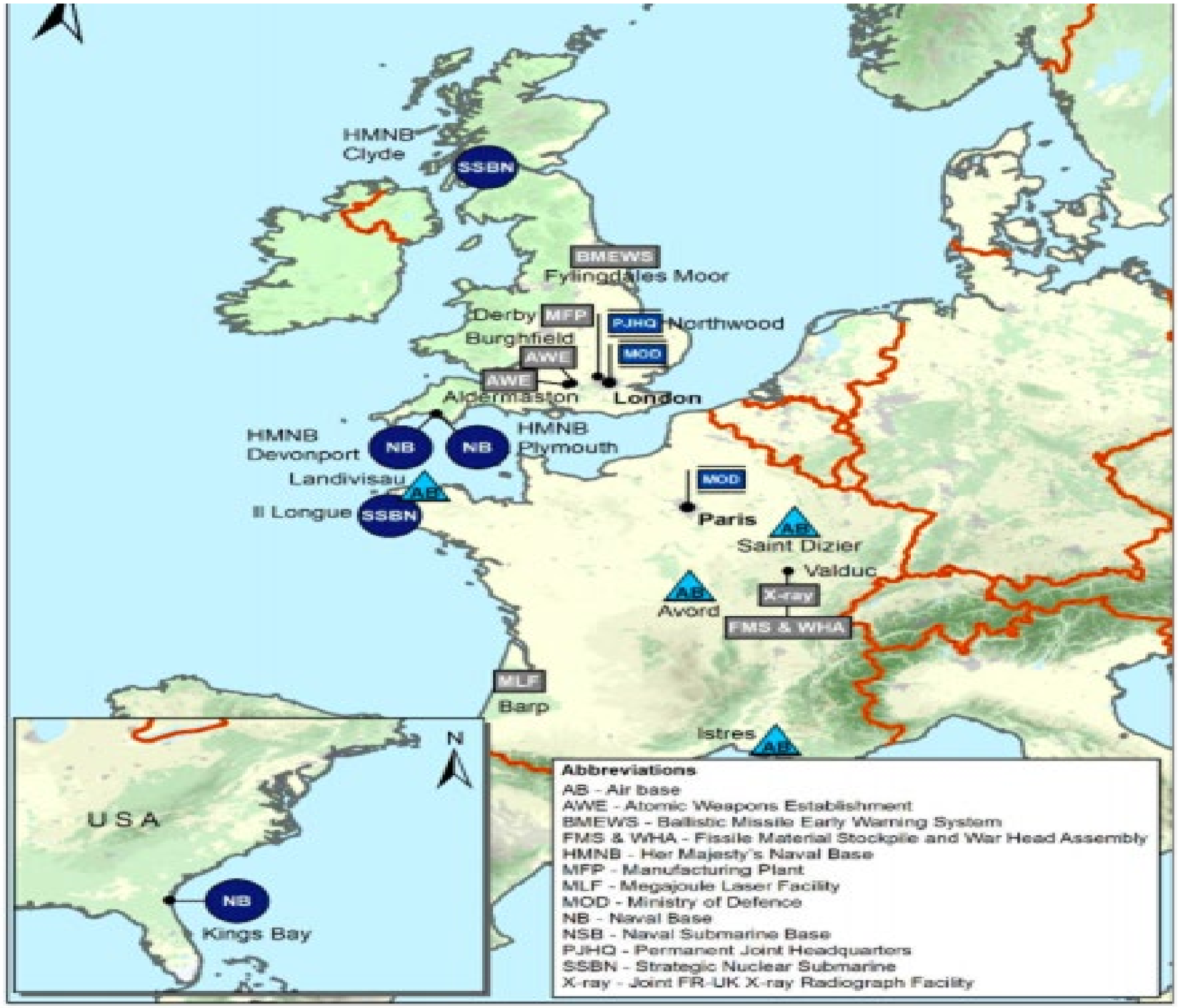
* Assumes U.S. NMD & TMD deployment and Chinese build-up in response to U.S. deployment.
** "SRBM" probably includes all missiles other than ICBMs and SLBMs, including MRBMs.

Source: DIA, The Decades Ahead: 1999-2020, A Primer on the Future Threat, July 1999



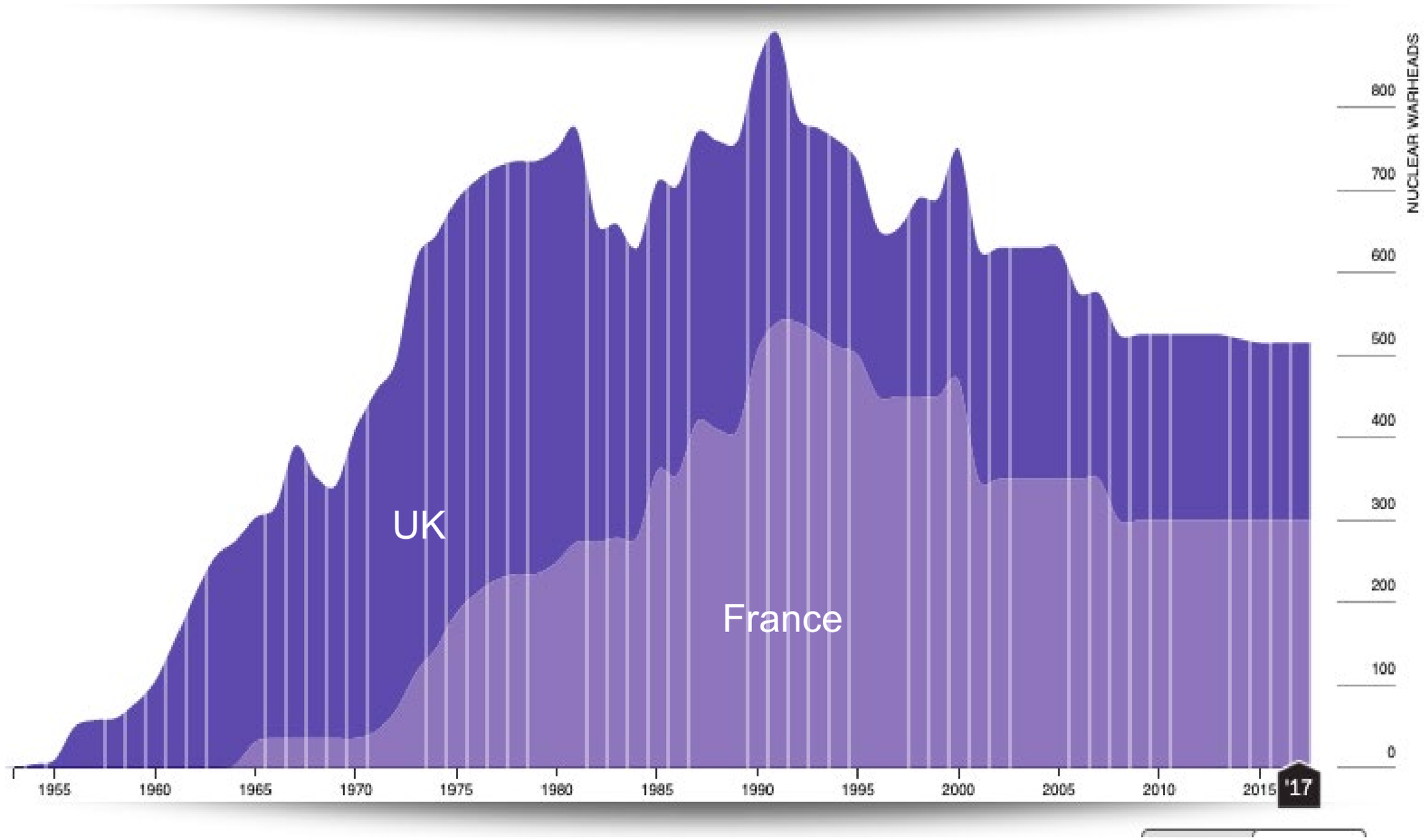

Source: Federation of American Scientists

# French and British Nuclear Structure




Source: Nuclear weapons in Europe: British and French deterrence forces, Niklas Granholm and John Ryvidqist

# French and British Nuclear Forces(2017)




Source: The Bulletin of the Atomic Scientist Nuclear Notebook, written by Hans M Kristensen and Robert S. Norris, Federation of American Scientists

# French Arsenals (2019)

| Weapon System | No. | Yearoperational | Range(km)[a] | Warheadsx yield | WarheadType | Warheads |
|---|---|---|---|---|---|---|
| **Land-based aircraft**[b] | | | | | | |
| Rafale F3/ASMPA | 40 | 2010[c] | 2,000 | 1 x up to 300 kt | TNA | 40 |
| **Carrier-based aircraft** | | | | | | |
| Rafale MF3/ASMPA | 10 | 2011 | 2,000 | 1 x up to 300 kt | TNA | 10 |
| **Submarine-launched ballistic missiles** | | | | | | |
| M51.1 | 32 | 2010 | 6,000+ | 4-6 x 100 kt MIRV | TN75 | 160 |
| M51.2 | 16 | 2017 | 6,000+ | 4-6 x 150 kt MIRV | TNO | 80 |
| **Total** | 98 | | | | | **300**[d] |

**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.

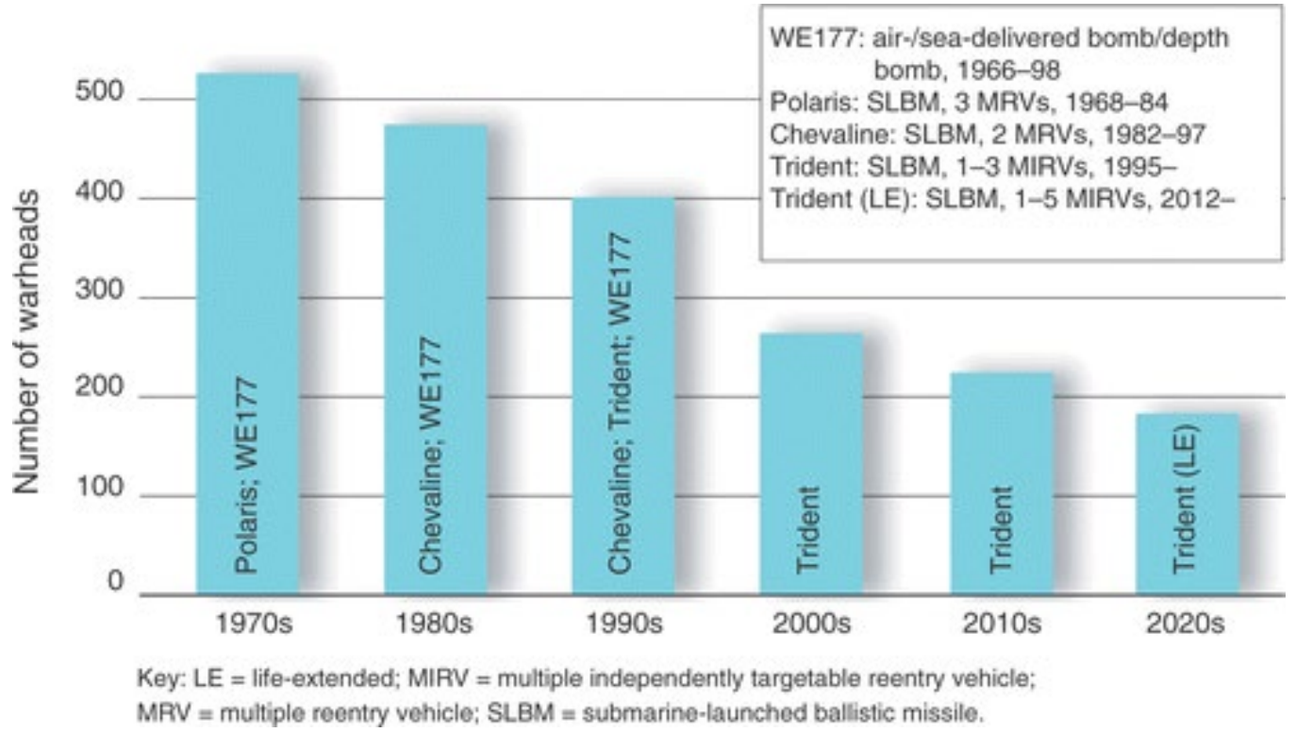
SSBN: Nuclear-power ballistic missile submarine
SLBM: Submarine-launched ballistic missile

Source: Hans M. Kristensen & Matt Korda (2019) French nuclear forces, 2019, Bulletin of the Atomic Scientists

# 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)




Source: Hand Kristensen and Robert S Norris,British Nuclear forces 2011, Bulletin of the Atomic Scientists

The United Kingdom and France (largely) rely on a nuclear deterrent in form of a naval submarine based nuclear arsenal

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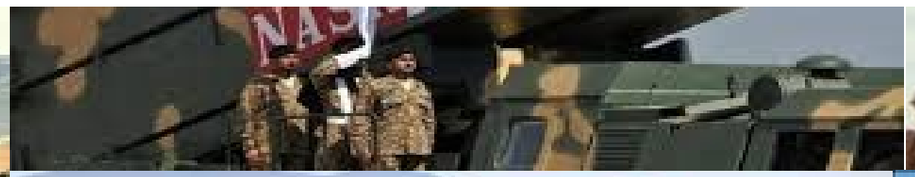
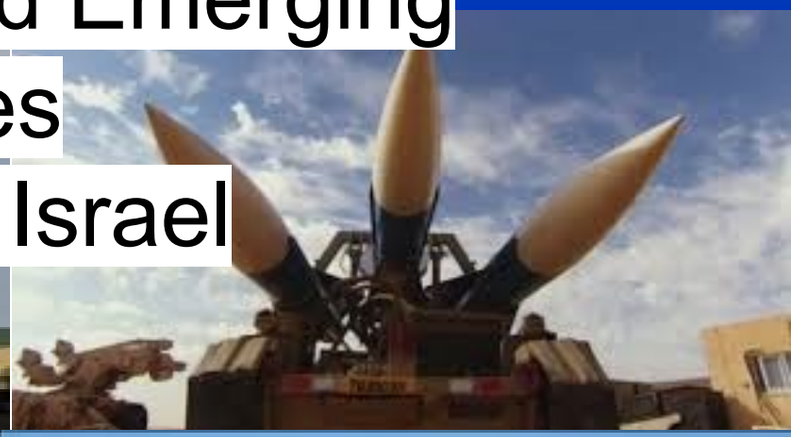
# Module 6: Programs and Arsenals

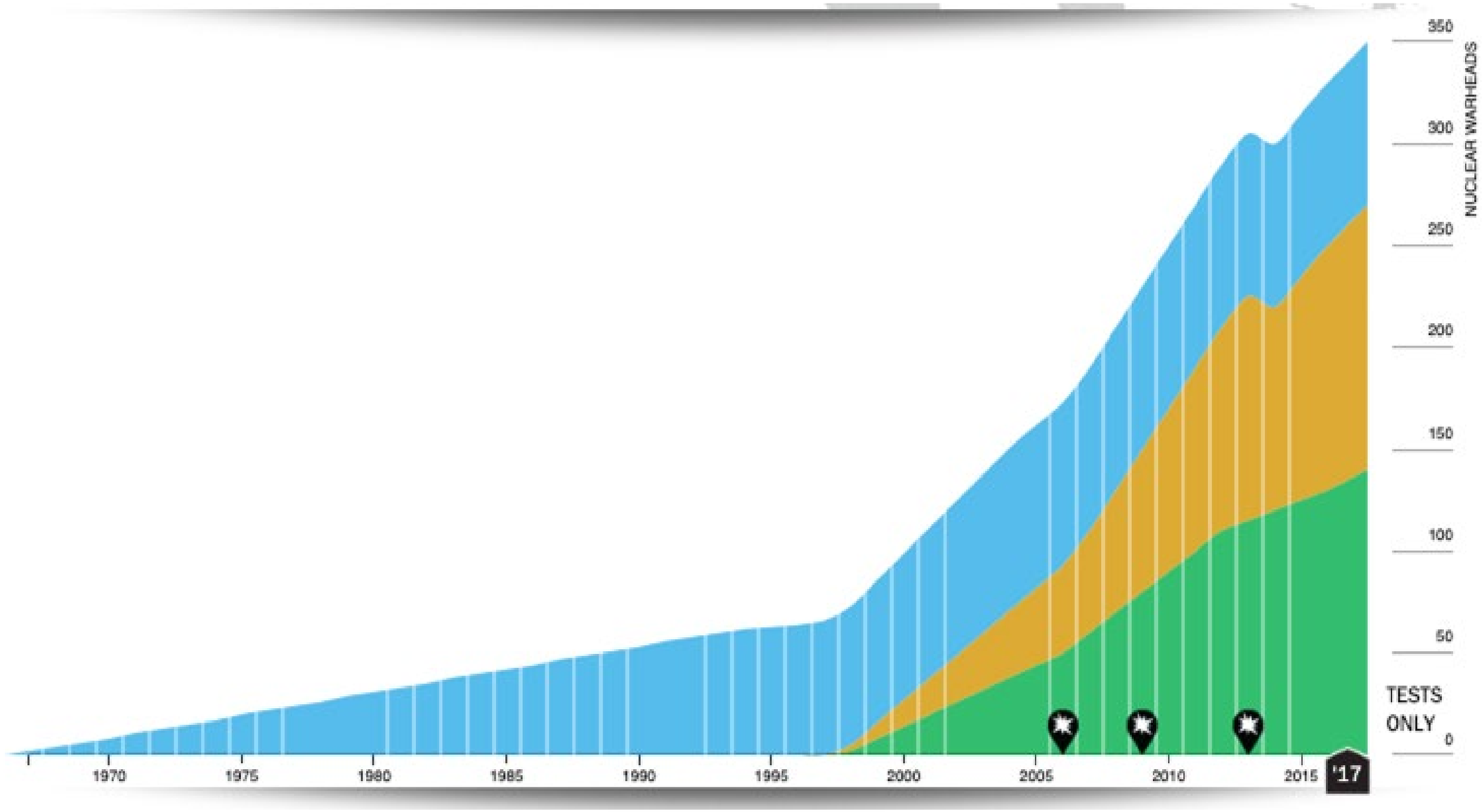
ACDIS program in arms control & domestic and international security

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

## Sec 1:India, Pakistan, and Israel

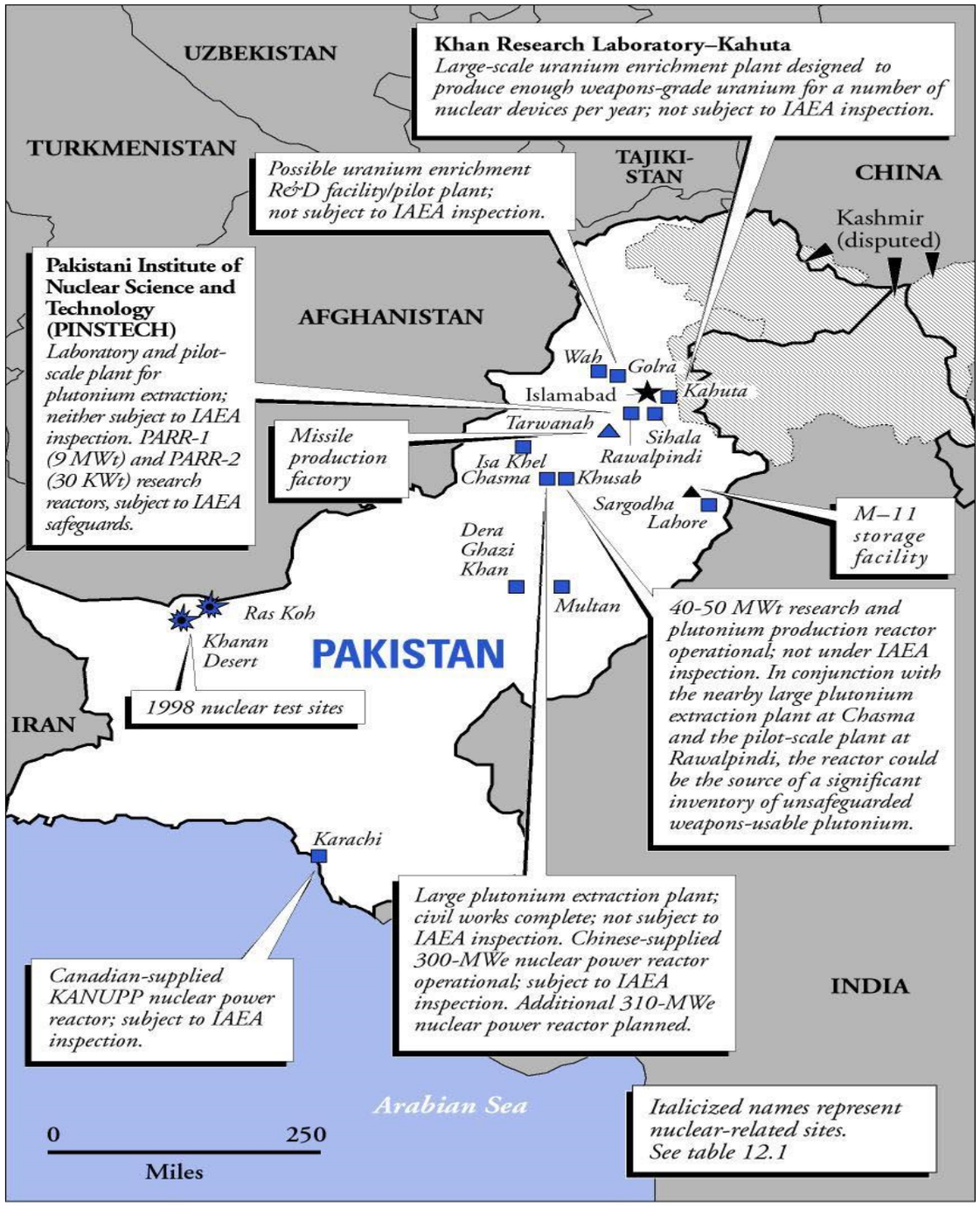

# Estimates for Arsenals in India, Israel, North Korea and Pakistan (2017)



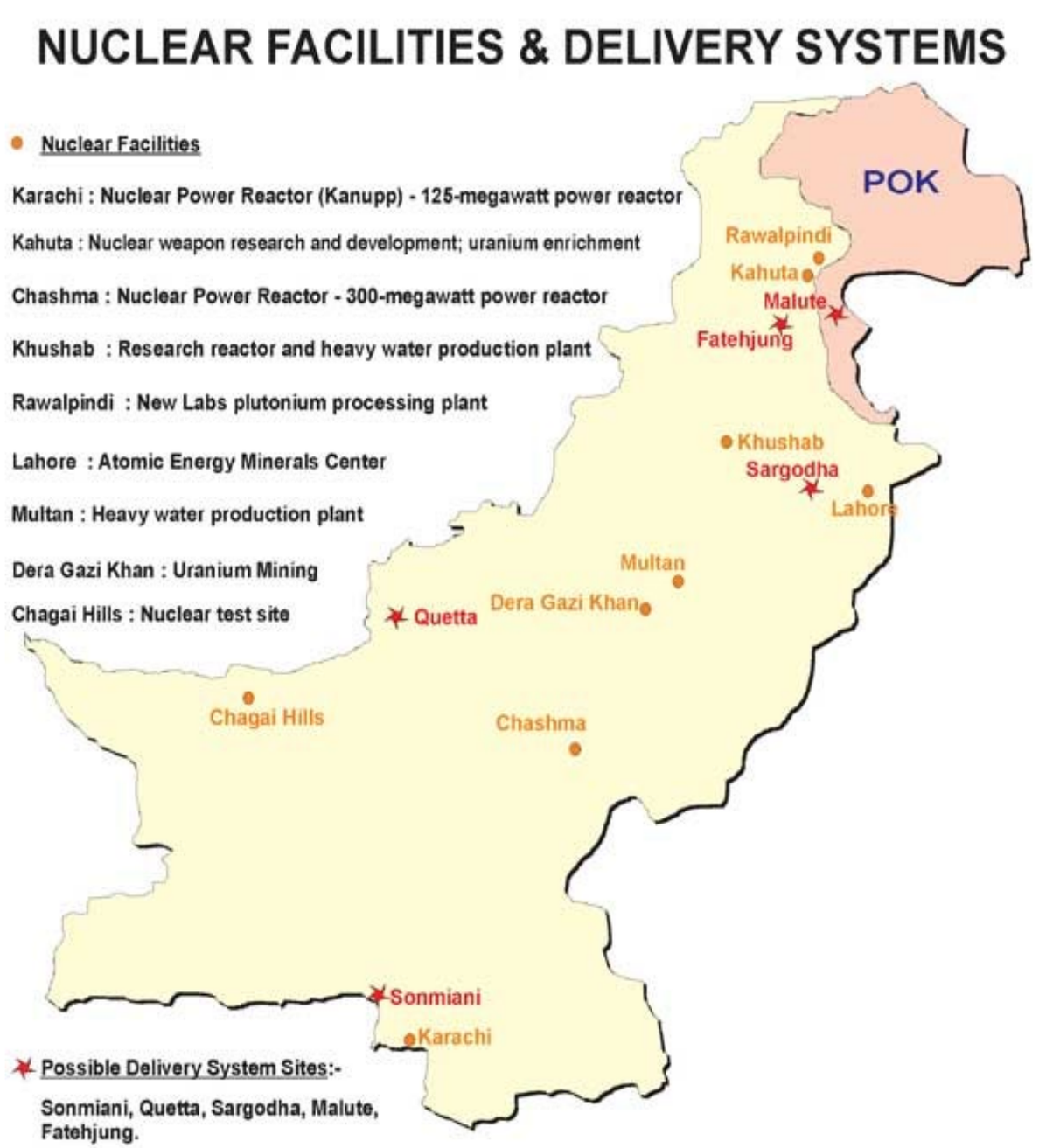

Source: The Bulletin of the Atomic Scientist Nuclear Notebook, written by Hans M Kristensen and Robert S. Norris, Federation of American Scientists

Israel ~ 80 India ~ 130 Pakistan~ 140 North Korea < 10

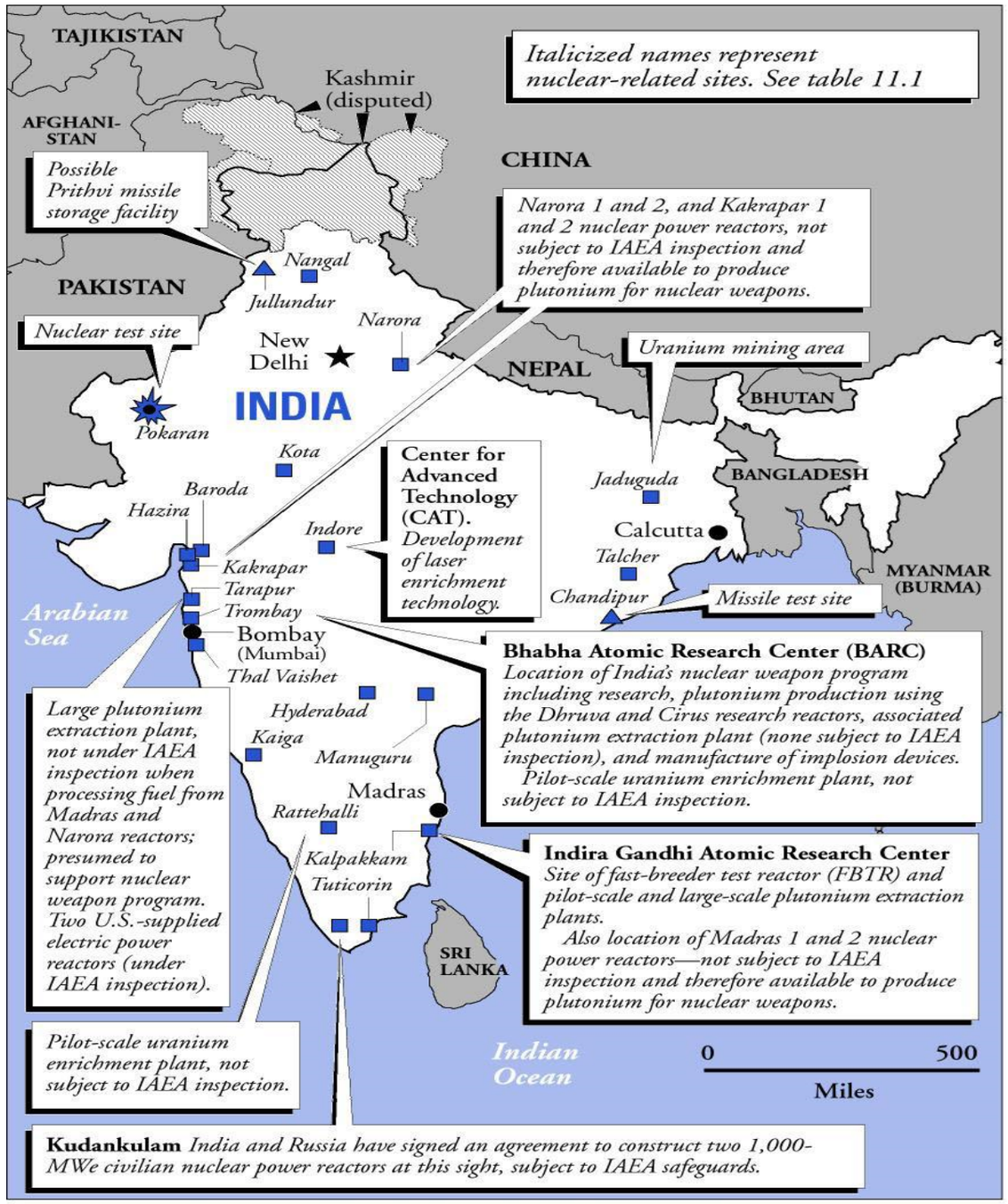
# Indian locations of Nuclear Power and Weapons



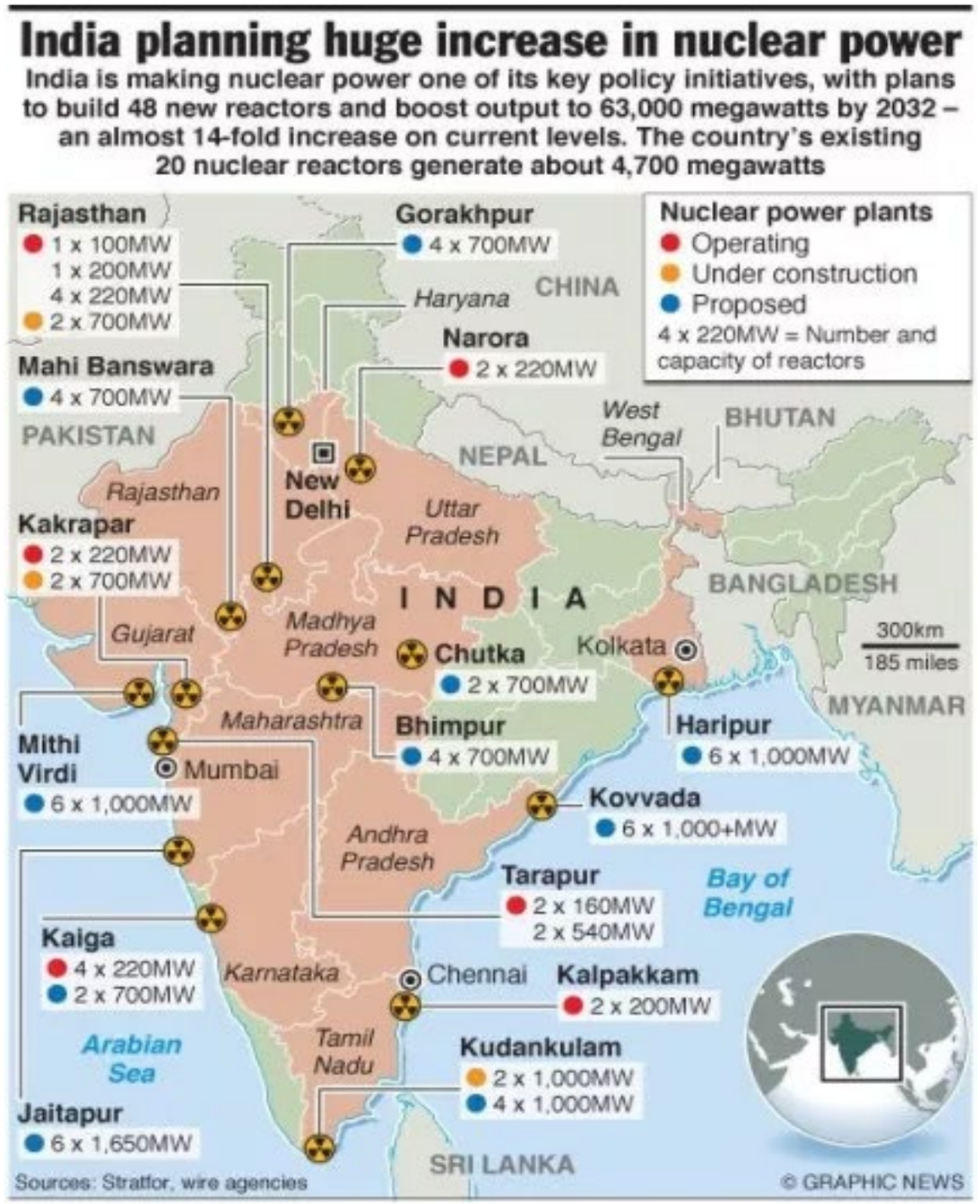

Carnegie Endowment for International Peace, *Deadly Arsenals* (2002), **www.ceip.org**



# Indian locations of Nuclear Power and Weapons




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




Source: Indian Defense Review, RSN Singh

# 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 600 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 ~150-200 nuclear weapons
- The FAS estimates that India has about 130-140 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 weapon tests**

| India | | | |
|---|---|---|---|
| **Date** | | | |
| May 18, 1974 | 02:34:55 | 27.095 N 71.752 E | 2-5 kt |
| May 11, 1998 | 10:13:42 | 27.102 N 71.857 E | 12 kt* |
| May 11, 1998 | 10:13 | ? | ? * |
| May 13, 1998 | 06:51 | ? | ? ** |
| Local time is 5 and one-half hours later than GMT<br><br>* The Indian government announced that three nuclear devices were detonated simultaneously in two shafts, about one kilometer apart. We count this as two tests.<br><br>** Seismic records do not discriminate the explosions of two devices (announced by Indian scientists as being 0.2 kt and 0.6 kt), one or both of which may not have detonated. | | | |

Source: NRDC

# India's Nuclear and Missile Programs – 3

- 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 developed and successfully tested 7 medium range missiles Agni I-III, with a declared range of up to 3,000 km. The payload for the Agni III missile is assumed to be 1.5 tons.
- India has developed and successfully tested Agni-IV with a range of 4,000 km and Agni V with a range of 5,000 and a payload of 1.5 tons.
- In 2018 India became one of three nations to possess a nuclear triad after the successful deterrent patrol of Arihant, India's first

# Indian Nuclear Forces (2018)

| Type | NATO designation | Number of launchers | Year deployed | Range (kilometers) | Warhead x yield (kilotons) | Number of warheads |
|---|---|---|---|---|---|---|
| **Aircraft** | | | | | | |
| Vajra | Mirage 2000H | ~16 | 1985 | 1,850 | 1 × bomb | ~16 |
| Shamsher | Jaguar IS/IB | ~32 | 1981 | 1,600 | 1 × bomb | ~32 |
| Subtotal: | | ~48 | | | | ~48 |
| **Land-based ballistic missiles** | | | | | | |
| Prithvi-II | n.a. | ~24 | 2003 | 350b | 1 × 12 | ~24 |
| Agni-I | n.a. | ~20 | 2007c | 700+ | 1 × 40 | ~20 |
| Agni-II | n.a. | ~8 | 2011d | 2,000+ | 1 × 40 | ~8 |
| Agni-III | n.a. | ~8 | 2014? | 3,200+ | 1 × 40 | ~8 |
| Agni-IV | n.a. | n.a. | (2018) | 3,500+ | 1 × 40 | n.a. |
| Agni-V | n.a. | n.a. | (2020) | 5,200+ | 1 × 40 | n.a. |
| Subtotal: | | ~60 | | | | ~60e |
| **Sea-based ballistic missiles** | | | | | | |
| Dhanush | n.a. | 2 | 2013 | 400 | 1 × 12 | 4 |
| K-15 | (Sagarika) | (12) | (2018) | 700 | 1 × 12 | (12) |
| K-4 | n.a. | (4) | ? | 3,500 | 1 × ? | 0 |
| Subtotal: | | (18) | | | | (16) |
| **Total** | | | | | | **130–140**f |

Source:Bulletin of the Atomic Scientist “Indian Nuclear Forces,  Hans Kristensen and Matt Korda

# India’s Ballistic Missiles (2019)

| Name | Type | Range | Stages/Fuel | Payload Capacity | Last Reported Test | Inducted? | Nuclear Capable? |
|---|---|---|---|---|---|---|---|
| Prithvi-I | Ballistic | 150 km | Single/Liquid | 800 kg* | May 2007 | Y(a) | Y |
| Prithvi-II | Ballistic | 350 km | Single/Liquid | 500-1,000 kg | October 2018* | Y | Y |
| Dhanush | Ballistic | 350 km | Single/Liquid | 500 kg | February 2018* | Y* | Y |
| Agni-I | Ballistic | 700 – 900 km | Single/Solid* | 1,000 kg* | October 2018* | Y | Y* |
| Agni-II | Ballistic | 2,000 km | Two/Solid | 1 ton | February 2018* | Y | Y |
| Agni-III | Ballistic | 3,500 km | Two/Solid | 1.5 tons | April 2017* | Y | Y* |
| Agni-IV | Ballistic | 4,000 km | Two/Solid | 1,000 kg* | December 2018* | Y* | Y |
| Agni-V | Ballistic | +5,000 km | Three/Solid | 1,000 kg* | December 2018 | N | Y |
| Prahaar | Ballistic | 150 km | Single/Solid | 200 kg | September 2018* | N* | N* |
| Pragati | Ballistic* | 60 km – 170 km* | Single/Solid* | 200 kg | Not Tested | N* | N* |

Source: Wisconsin Project on Nuclear Arms Control

# India's SLBM and Cruise Missiles (2019)

| Name | Type | Range | Stages/Fuel | Payload Capacity | Last Reported Test | Inducted? | Nuclear Capable? |
|---|---|---|---|---|---|---|---|
| K-15 (aka B0-5) | SLBM(b) | 750 km* | Two/Solid* | 1,000 kg* | August 2018* | Y* | Y* |
| K-4 | SLBM* | 3,500 km* | Two/Solid* | Unknown | December 2017(c)* | N* | Y* |
| BrahMos | Cruise | 290 – 400 km | Two/Solid and Liquid(d) | 200-300 kg | May 2019 | (e)N-I: Y<br>B-I: Y<br>B-II: Y<br>B-III: Y*<br>ALCM: Y<br>SLCM: N* | N |
| Nirbhay | Cruise | 1,000 km | Two/solid and liquid(f) | 450 kg* | April 2019 | N* | Y* |

Source: Wisconsin Project on Nuclear Arms Control

# 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
- FAS estimates that it could have 120 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 weapon tests**

| Pakistan | | | |
|---|---|---|---|
| **Date** | | | |
| May 28, 1998 | 10:16:15 | 28.862 N 64.818 E | 9-12 kt# |
| May 30, 1998 | 06:54:55 | 28.487 N 63:787 E | 5 kt |
| Local time is 5 hours later than GMT<br><br># Pakistani officials announced that five nuclear devices were tested. Seismic records do not discriminate these and possibly only one device was detonated. | | | |

last revised 11.25.02

Source: NRDC

# Pakistan's Nuclear and Missile Programs – 3

## 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)
- Tested Shaheen II, (range 1,500-2000 km, payload 700kg)
- 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, 2018

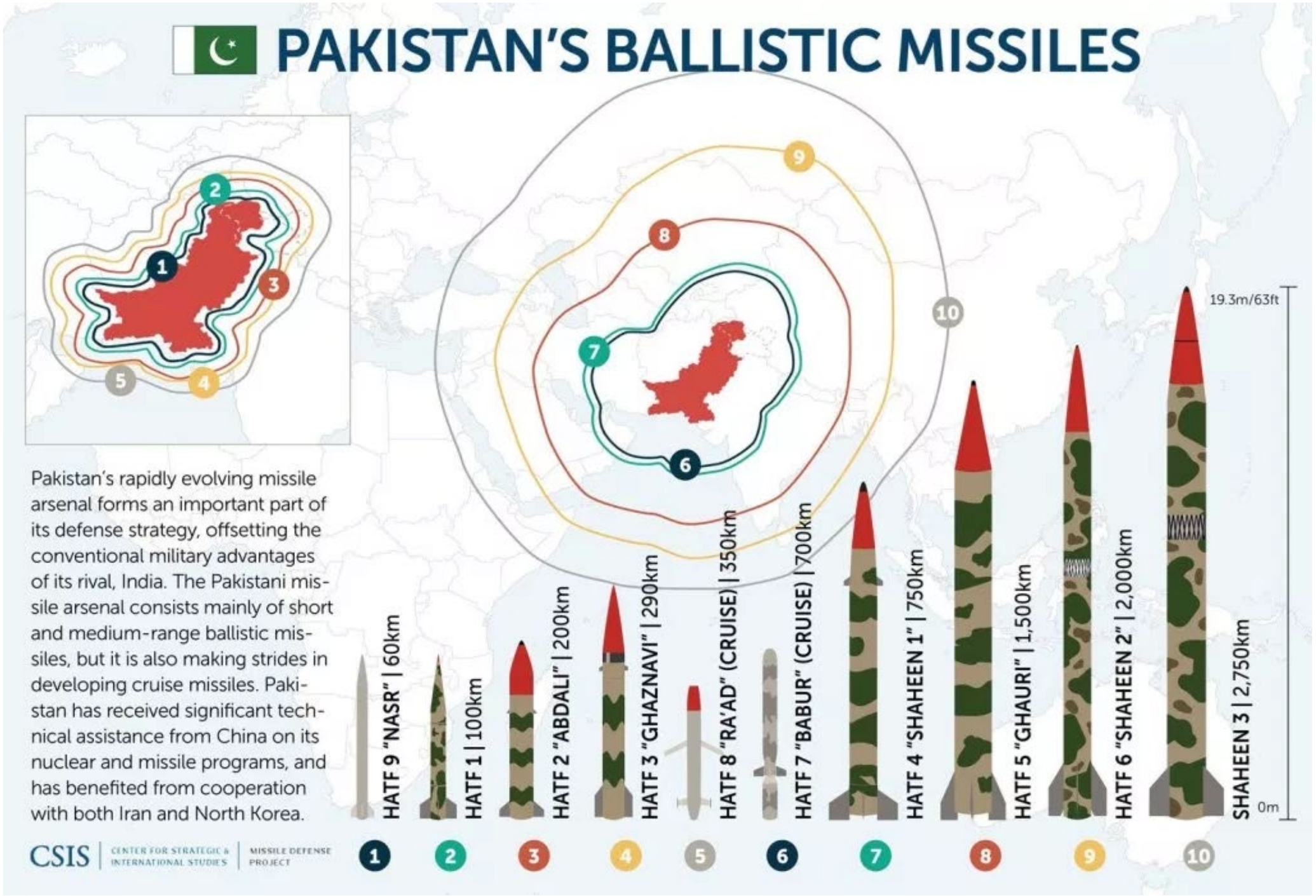
| Type | NATO designation | Number of launchers | Year deployed | Range (kilometers)1 | Warhead x yield (kilotons)3 | Number of warheads2 |
|---|---|---|---|---|---|---|
| **Aircraft** | | | | | | |
| F-16A/B | | ~24 | 1998 | 1,600 | 1 x bomb | ~24 |
| Mirage III/V | | ~12 | 1998 | 2,100 | 1 x bomb (or Ra-ad) | ~12 |
| ***Subtotal:*** | | ***~36*** | | | | ***~36*** |
| **Land-based ballistic missiles** | | | | | | |
| Abdali (Hatf-2) | | 10 | (2015) | 200 | 1 x 5-12 kt | 10 |
| Ghaznavi (Hatf-3) | | ~16 | 2004 | 300 | 1 x 5-12 kt | ~16 |
| Shaheen-1(Hatf-4) | | ~16 | 2003 | 750 | 1 x 5-12 kt | ~16 |
| Shaheen-1A (Hatf-4) | | - | (2018) | 900 | 1 x 5-12 kt | - |
| Shaheen-2(Hatf-6) | | ~12 | 2014 | 1,500 | 1 x 10-40 kt | ~12 |
| Shaheen-3 (Hatf-6) | | - | (2018) | 2,750 | 1 x 10-40 kt | - |
| Ghauri (Hatf-5) | | ~24 | 2003 | 1,250 | 1 x 10-40 kt | ~24 |
| NASR (Hatf-9) | | ~24 | (2013) | 60-70 | 1 x 5-12 kt | ~244 |
| Ababeel (Hatf-?) | | - | - | 2,200 | MIRV or MRV | - |
| ***Subtotal:*** | | ***~102*** | | | | ***~102*** |

Source:Bulletin of the Atomic Scientist “Pakistani Nuclear Forces,  Hans Kristensen and Matt Korda

# Pakistani Ra’ad Air-Launched Cruise Missile

**Pakistani Ra’ad Air Launched Cruise Missile**

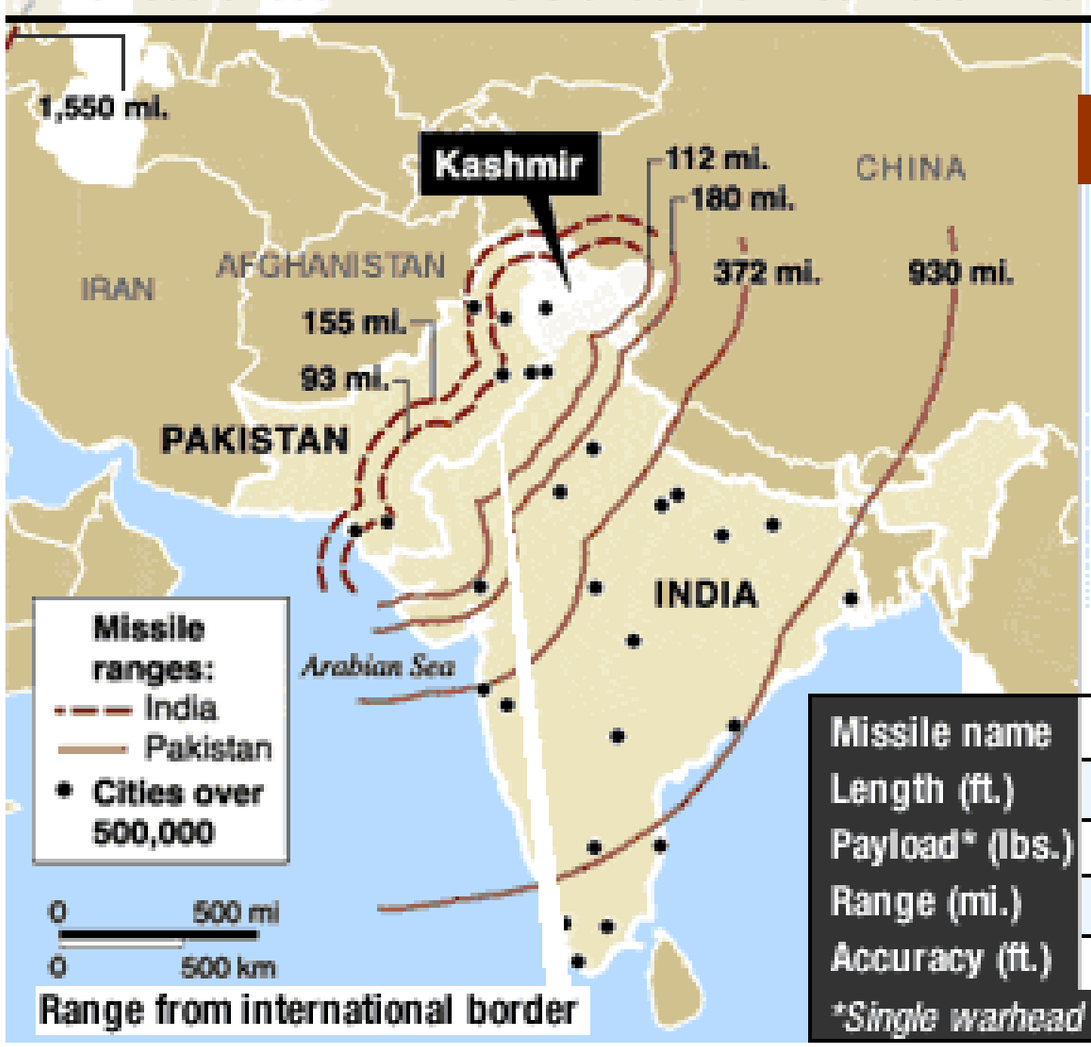
# Pakistan’s Ballistic Missiles Lineup



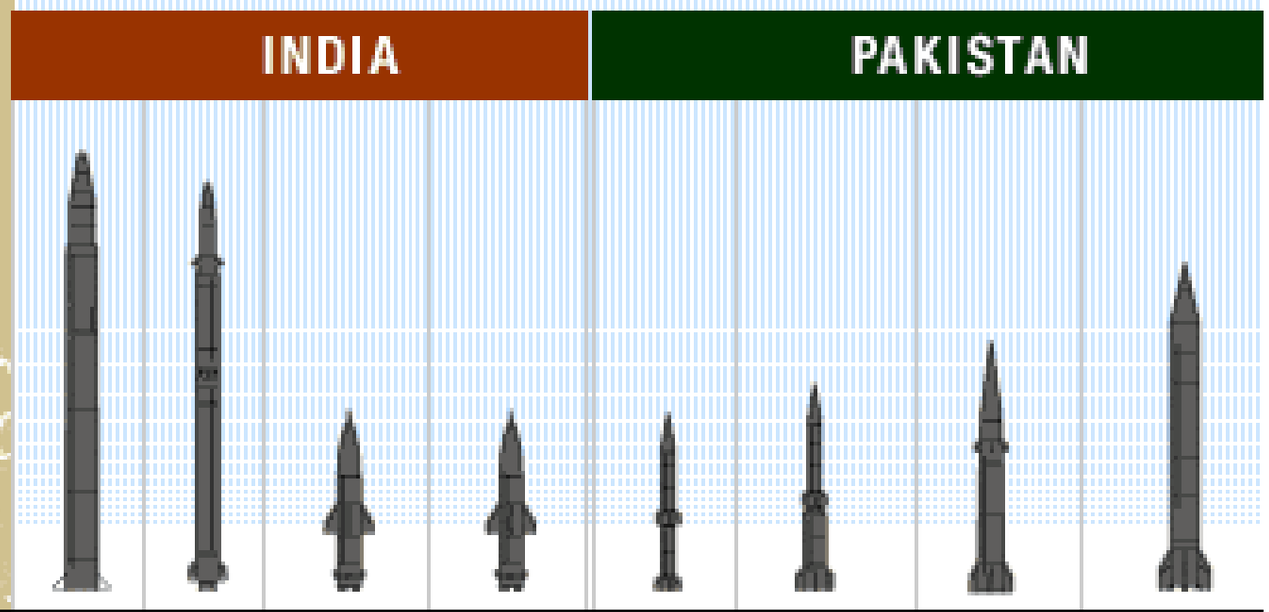

Source: Missile Defense Project, "Missiles of Pakistan," *Missile Threat*, Center for Strategic and International Studies, June 14, 2018, last modified June 15, 2018, https://missilethreat.csis.org/country/pakistan/.

# Security Concerns of India's and Pakistan Define the Parameters of Ballistic Missile Arsenals

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 ~ 860 kg of weapons-grade plutonium as of January 2017
- Is thought to have enough plutonium to fabricate ~ 100–200 nuclear weapons
- Is thought to have ~ 75–200 fission weapons, FAS estimate: 80. (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.
- 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 cruise missile).

# Summary of Israel's Nuclear Delivery Systems

**Table 1.** Israeli nuclear forces, 2014

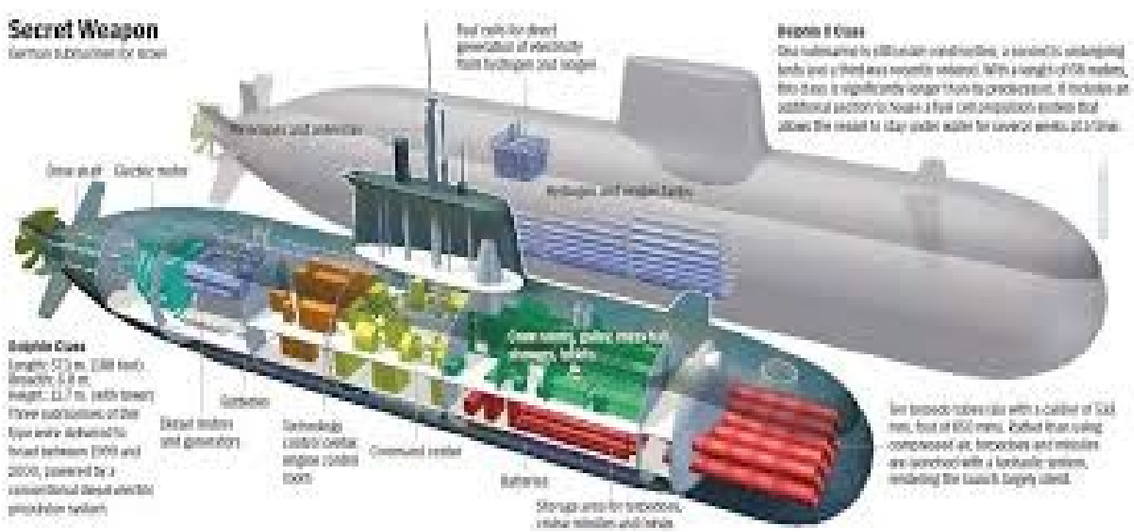
| TYPE | YEAR FIRST DEPLOYED | RANGE (KM) | COMMENT |
|---|---|---|---|
| **AIRCRAFT** | | | |
| F-16A/B/C/D/I Fighting Falcon | 1980 | 1,600 | Nuclear bombs possibly stored at underground facility near Tel Nof Air Base |
| F-15I Ra'am (Thunder) | 1998 | 3,500 | Potential nuclear strike role |
| **LAND-BASED MISSLES** | | | |
| Jericho II | 1984–1985 | 1,500+ | Possibly 25–50 at Zekharia for TELs in caves |
| Jericho III | ? | 4,000 ? | In development |
| **SEA-BASED MISSLES** | | | |
| Dolphin-class submarines | 2002 ? | ? | Possibly modified cruise missile for land-attack |

Dolphin class submarines, if nuclear armed, provide secure nuclear 2nd strike capability.

# Israeli Dolphin Class Submarines


Source: Secret Shores

Source: National Interest




Source: Hi Sutton

Source: Spiegel Online

ILLINOIS
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# Module 6: Arsenals

ACDIS program in arms control & domestic and international security

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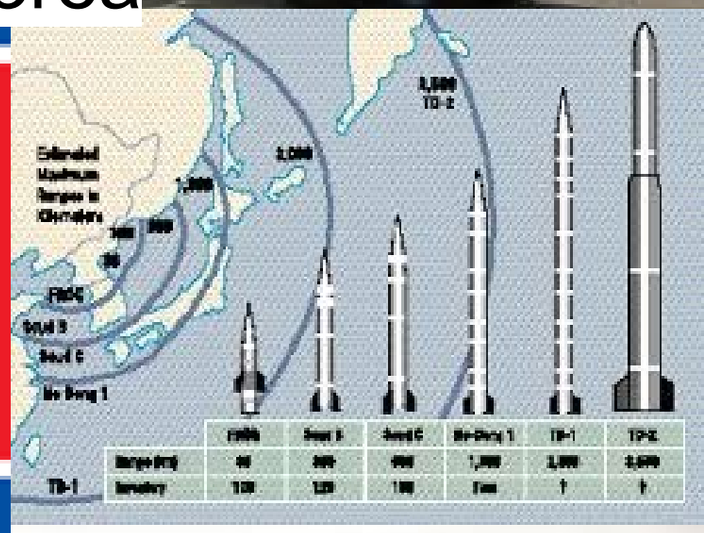
LAS GLOBAL STUDIES



## Part 3 Sec 2: Arsenals of North Korea







# The History between Trump and Kim

Donald J. Trump
@realDonaldTrump
Following

Why would Kim Jong-un insult me by calling me "old," when I would NEVER call him "short and fat?" Oh well, I try so hard to be his friend - and maybe someday that will happen!

Donald J. Trump
@realDonaldTrump

North Korean Leader Kim Jong Un just stated that the "Nuclear Button is on his desk at all times." Will someone from his depleted and food starved regime please inform him that I too have a Nuclear Button, but it is a much bigger & more powerful one than his, and my Button works!

7:49 PM - 2 Jan 2018

Donald J. Trump
@realDonaldTrump
Follow

Just heard Foreign Minister of North Korea speak at U.N. If he echoes thoughts of Little Rocket Man, they won't be around much longer!

11:08 PM - 23 Sep 2017

Donald J. Trump
@realDonaldTrump
Follow

A message from Kim Jong Un: "North Korea will stop nuclear tests and launches of intercontinental ballistic missiles."
Also will "Shut down a nuclear test site in the country's Northern Side to prove the vow to suspend nuclear tests." Progress being made for all!

8:22 PM - 20 Apr 2018

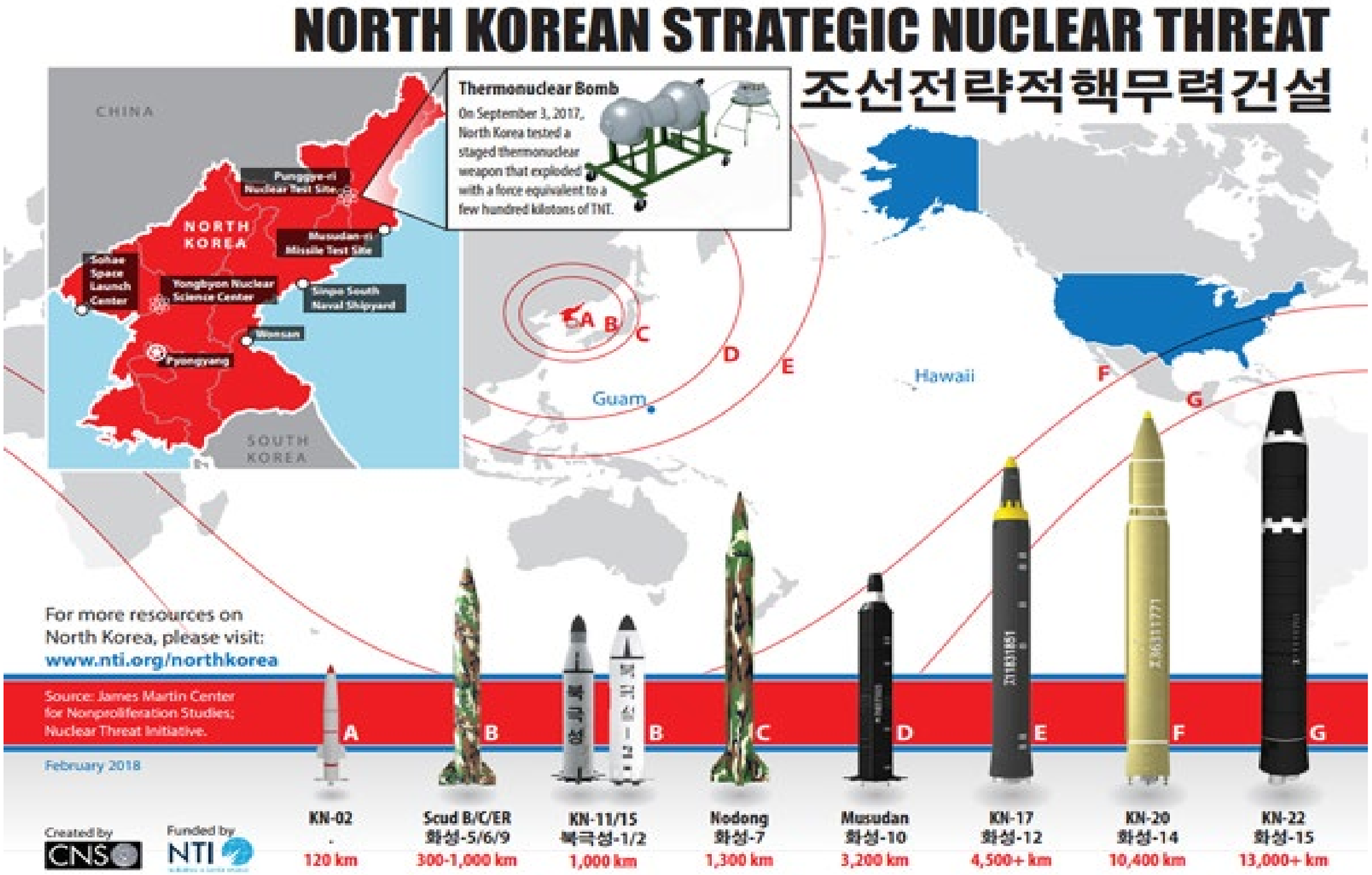
31,009 Retweets 134,354 Likes


Donald J. Trump
@realDonaldTrump
Following

Vietnam is thriving like few places on earth. North Korea would be the same, and very quickly, if it would denuclearize. The potential is AWESOME, a great opportunity, like almost none other in history, for my friend Kim Jong Un. We will know fairly soon - Very Interesting!

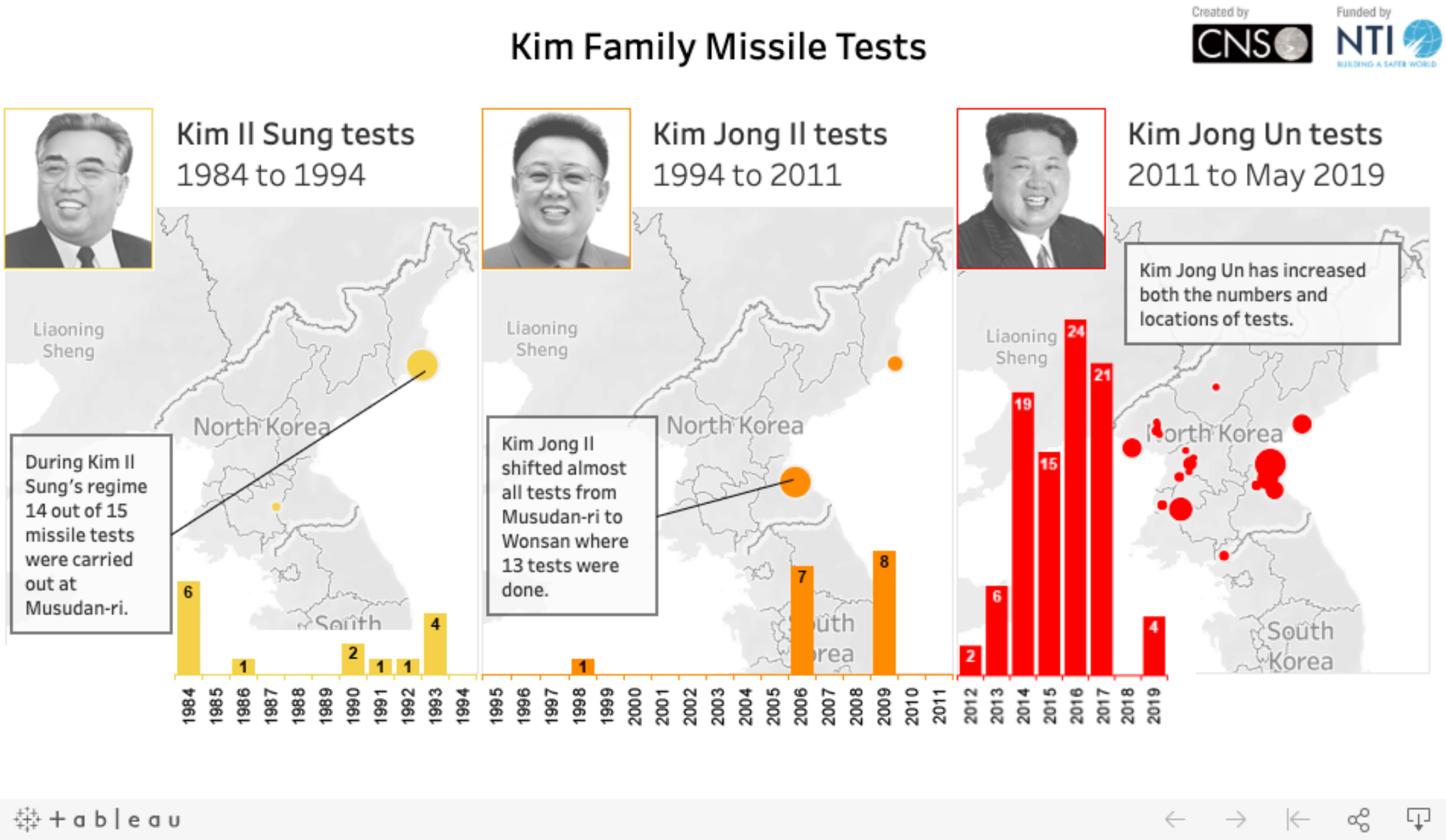
9:31 PM - 26 Feb 2019

# North Korea's Nuclear Capabilities (2018)



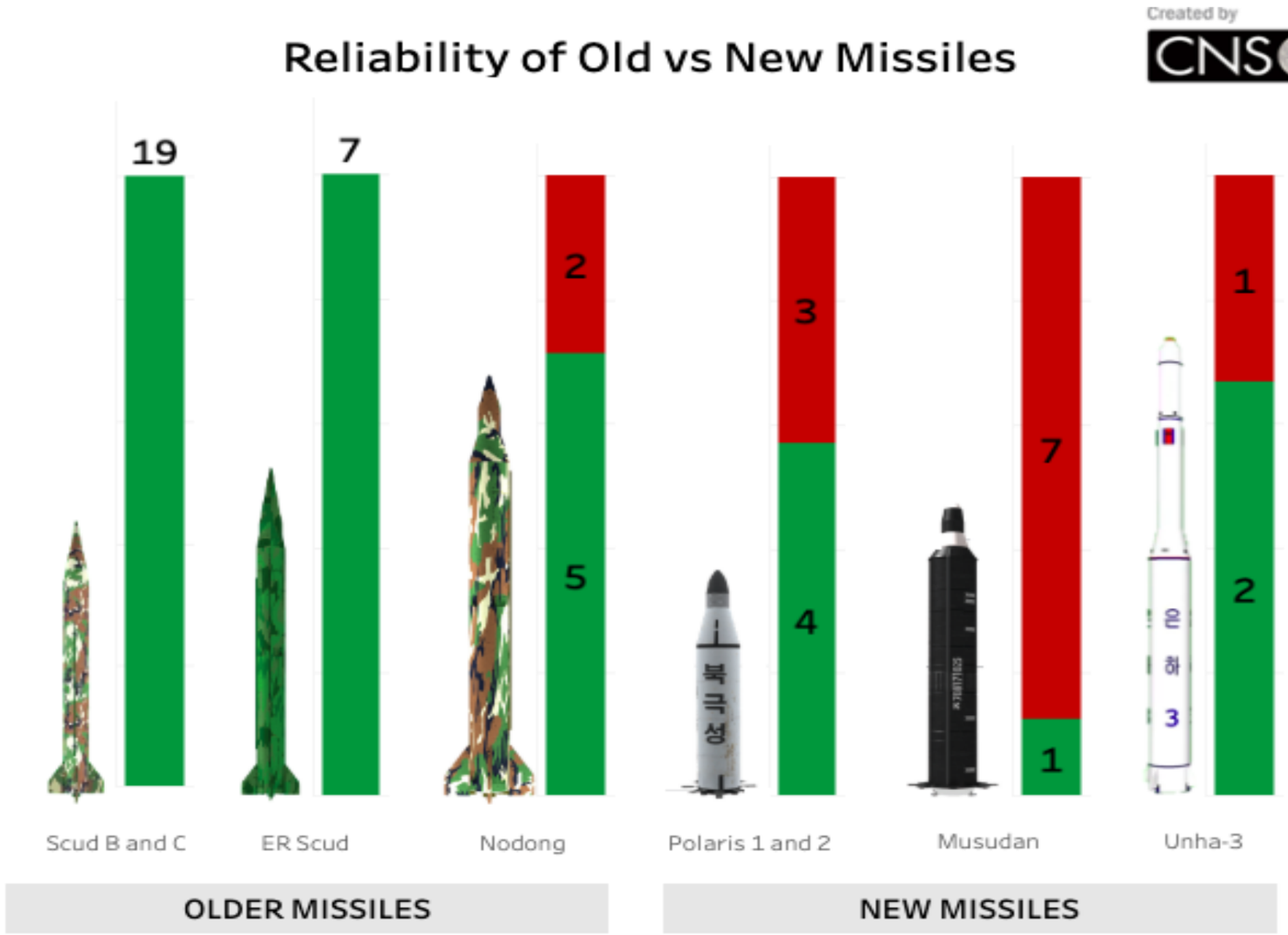

Source: Nuclear Threat Initiative

# History of North Korean Missile Tests




Source: Understanding North Korea's Missile Tests, NTI

# North Korean Missile Test Successes and Failures




Source: Understanding North Korea's Missile Tests, NTI

# North Korean Missiles with Nuclear Capability (2018)

| Type/Name[a] | US/Other Designations | Year Deployed | Range (km)[b] | Stages (Fuel) | Payload × Capacity (kg) | Launchers[c] |
|---|---|---|---|---|---|---|
| Land-based ballistic missiles[d] | | | | | | |
| ICBMs (5,500+ km range) | | | | | | |
| (Bukkeukseong-3) | ? | Dev. | ? | ? (solid) | 1 × ? | TEL (C)[e] |
| Hwasong-15 | KN-22\ | Dev. | 13,000 | 2 × liquid | 1 × 1,000? | TEL |
| Hwasong-14 | KN-20 | Dev. | 10,400 | 2 (liquid) | 1 × ? | TEL |
| Hwasong-? | KN-14 | Dev. | (9,000) | 3 (liquid) | 1 × ? | TEL |
| Hwasong-13 | KN-08[f] | Dev. | 5,500+ | 3 (liquid) | 1 × ? | TEL |
| Taepo Dong-2 | Taepo Dong-2[g] | (2012) | 12,000+ | 3 (liquid) | 1 × 800+ | Fixed |
| IRBMs (3,000–5,500 km range) | | | | | | |
| Hwasong-12 | KN-17 | Dev. | 3,300–4,500 | 1 (liquid) | 1 × 1,000 | TEL |
| Hwasong-10[h] | Musudan, BM-25 | (2017) | 3,000+ | 1 (liquid) | 1 × 1,000 | <50 TEL |
| MRBMs (1,000–3,000 km range) | | | | | | |
| Bukkeukseong-2[i] | KN-15 | Dev. | 1,000+ | 1 (solid) | 1 × ? | TEL (C) |
| Hwasong-7 | Nodong[j] | (1993) | 1,200+ | 1 (liquid) | 1 × 1,000 | <100 TEL |
| Hwasong-9 | Scud ER, KN-4 | (2016) | 1,000[k] | 1 (liquid) | 1 × 500 | TEL |
| *Submarine-launched ballistic missiles (SLBMs)* | | | | | | |
| Bukkeukseong-1[l] | KN-11 | Dev. | (1,000+) | 1 (solid) | n.a. | (1) SSB |

Source:Bulletin of the Atomic Scientist “North Korean Nuclear Capabilities (2018), Hans Kristensen and Matt Korda

# North Korean Nuclear Tests and Resource Capabilities (2018)

| Date | Seismic Signal | Estimated Yield | Remarks |
|---|---|---|---|
| October 9, 2006 | Magnitude 4.1 | 0.5 kilotons | The Director of National Intelligence (DNI) said the test produced a yield of "less than one kiloton – well below the yield of other states' first nuclear test."[a] |
| May 25, 2009 | Magnitude 4.5 | 1–3 kilotons | DNI said the yield of the test was "a few" kilotons,[b] which "suggests the North has the capability to produce nuclear weapons with a yield of roughly a couple kilotons TNT equivalent."[c] |
| February 12, 2013 | Magnitude 5 | 10 kilotons | DNI said "several kilotons."[d] |
| January 6, 2016 | Magnitude 4.8 | 5 kilotons | North Korea said test was a successful "hydrogen bomb," but the US intelligence community said "the low yield of the test is not consistent with a successful test of a thermonuclear device."[e] |
| September 9, 2016 | Magnitude 5.1 | 10–15 kilotons | |
| September 3, 2017 | Magnitude 6.1 | 140–250 kilotons | |
| Total: 6 | | | |

Source:Bulletin of the Atomic Scientist "North Korean Nuclear Capabilities (2018), Hans Kristensen and Matt Korda

# North Korean Missile Displays

# North Korea's Nuclear Program

- 1950s: NK nuclear research reportedly begins.
- 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.
  - 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.

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.

# North Korea's Nuclear Program

History (cont'd) —

- 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. |

# The Aftermath of the 1994 Agreement

The light-water reactors were never built. The US-led consortium taske with constructing them was in severe debt; senators accused Clinton of understating their cost while overstating how much US allies would contribute to funding them. Hawkish Republicans in Congress derided the framework for supposedly rewarding aggressive behaviour.

Heavy fuel shipments were often delayed. Rust Deming, assistant secretary of state, told Congress that "to be frank, we have in past years not always met the fuel year deadline". Meanwhile, Robert Gallucci, a diplomat who had negotiated the framework, warned that it could fail unless the US did "what it said it would do, which is to take responsibilit for the delivery of the heavy fuel oil".

North Korea was not removed from the State Department's list of state sponsors of terrorism until 2008, though it had long met the criteria for removal. A limited number of US sanctions were eased, but not until 2000 – six years later than pledged in the Agreed Framework. Accordin to Gallucci, Congressional scepticism about the deal led to "the minimum interpretation of sanctions lifting". As he told a congressional committee: "the North Koreans have always been disappointed that mo has not been done by the US."

This only worsened under Washington's next regime: in 2002, the Bush administration's Nuclear Posture Review listed North Korea as one country the US might have to use nuclear weapons against, while its 2002 National Security Strategy listed the north as a "rogue" regime against which the US should be prepared to use force. To this day, the US has 28,500 troops stationed across 11 US military bases in South Korea, and the two countries continue with their joint annual military exercises off the coast of the Korean Peninsula.

As abhorrent as the North Korean regime is, it's not hard to see why the ruling clique might have concluded that Pyongyang remains in Washington's crosshairs and that the US was never truly committed to the Agreed Framework. Still, as subsequent negotiations have shown, North Korea remains desperate for fuel, and its regime still exhibits a paranoid, self-serving obsession with security. Its past actions strongly suggest that the nuclear programme is a bargaining chip that Pyongyang is prepared to give up under the right circumstances.

The benefits of a new, more robust peace agreement are obvious: an end to the threat of nuclear war in East Asia, and a boost to the global nuclear non-proliferation regime. The story of the 1994 framework proves this is far from impossible, but also that it will demand both careful, determined diplomacy and a commitment to honouring any promises made. Sadly, the Trump administration so far seems capable of neither.

Source: The Conversation, Why the US's 1994 deal with North Korea failed – and what Trump can learn from it

# North Korea's Nuclear Program

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.
- 2006 October 9: NK tests a Pu nuclear explosive device: 0.7-2 kT.
- 2007 February 28: New 6-party agreement announced (see separate slide).
- 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: 2-5.4 kT.

# 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

Enrichment (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 (build with 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. NK has fundamentally changed its nuclear strategy.
- New leadership under Kim Jong-un appears to continue nuclear weapons program aggressively.

# North Korea's Nuclear Program

History (cont'd) —

- 2011 Dec 17 Kim Jong-un ascends to Supreme Leader of NK
- 2012 Feb 29: NK agrees to freeze nuclear program in exchange for energy and food relieve.
- 2012 Apr. 12: Unsuccessful NK missile test leads to cancellation of food and energy relieve agreement.
- 2012 May 4: Reports that NK has resumed construction of LWR for Pu production at Yongbyon.
- 2012 Dec. 12: Successful test of long range missile launching satellite into orbit
- 2013 Feb. 12: NK tests third nuclear explosive device, 6-16kT.
- 2016 Jan. 6:  NK tests fourth nuclear warhead, 7-9kT, claimed thermonuclear device
- 2016 Sep. 9: NK tests fifth nuclear warhead, 15-25 kT.
- 2017 Sep. 3: NK tests sixth nuclear warhead, 70-280 kT.
- 2018 June 12: First US and North Korean Summit held in Singapore
- 2019 Feb 27: The Second US and North Korean Summit held in Hanoi, Vietnam

# North Korea's Nuclear Program

- 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

- 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

- 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 / Regime survival