Appendix A

The Nuclear Deterrence Landscape

Today's nuclear landscape is quite different than the bipolar days of the Cold War. There are now nine world nuclear powers with significant arsenals compared to the mostly dyadic world before 1991. All these powers possess nuclear weapons for the same fundamental reason discussed previously: to prevent total war, preserving their form of governance and nation. However, each country has different nuclear force mixes, postures, and characteristics designed for its respective milieu, economic situation, and adversaries. This appendix reviews the nuclear force attributes for the United States, Russia, China, India, Pakistan, and North Korea in the framework of Albert Wohlstetter's criteria and then evaluates the stability of each's deterrent posture in the context of an opponent. Overall, this appendix provides the nuclear backdrop to underpin the analysis provided in the article.

Of note, when reviewing a country's nuclear deterrence stability using Wohlstetter's criteria, each attribute is scored on a basic scale: POSITIVE and NEGATIVE. POSITIVE scores are given for a system with attributes that add to deterrent stability. A NEGATIVE score is given to an attribute based on evidence, logic, or questionable theory that detracts from stability. Each attribute is evaluated by itself; that is, if the system was not found survivable, it may still possess attributes that allow it to penetrate defenses like stealth and be awarded POSITIVE for the penetrate defenses attribute. Admittedly, these scores are subjective and academic, but the point of which country is adding or detracting to stability will be evident when the different nuclear states' attributes are used in the stability analysis.

United States

The US triad, according to the DOD's *Nuclear Posture Review* (2010), "maintains strategic stability at reasonable cost, while hedging against potential technical problems or vulnerabilities."[1] The US maintains a portion of its ground and submarine nuclear forces on a 24/7/365 alert launch posture, which is intended to provide a retaliatory attack option before US nuclear forces could be destroyed.[2] See table 1 for the US nuclear inventory.

Table 1. US nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed
ICBM – Minuteman III (Solid Fueled)	454 individual, hardened silos)	1 (capable of 3 MIRV)	416 (416 warheads)
SLBM – Trident II DS (Solid Fueled)	320 (14 Trident submarines w/20 SLBM launchers each)	4 (capable of 4 MIRV)	209 (836 warheads)
Nuclear-Capable Bomber (B-52 & B-2)	74[a]	Variable	56[a] (300 warheads)

Sources: US Department of State, "New START Treaty: Fact Sheets," accessed 1 February 2017, https://www.state.gov/; H. M. Kristensen and R. S. Norris, "Pakistani Nuclear Forces, 2016," *Bulletin of the Atomic Scientists* 72, 376–86, doi:10.1080/00963402.2016.1241520; and Amy F. Woolf, *U.S. Strategic Nuclear Forces: Background, Developments and Issues*, CRS RL33640 (Washington, DC: Congressional Research Service, updated 27 April 2020), 8, accessed 2016, https://crsreports.congress.gov/.

[a]There are a total of 113 B-52 and B-2 bombers, but only 108 of them are reported to be nuclear capable (some are designated for training and testing). Additionally, 60 bombers are designated as primary mission capable of which 56 are in the "deployed" column. (US Department of State, "New START Treaty: Fact Sheets.")

Using Wohlstetter's stability criteria, the US strategic nuclear force attributes are listed below (table 2).

Table 2. US nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
ICBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
SLBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
Bomber	POSITIVE	NEGATIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE

ASSUMPTION: Today's force posture (bombers not on airborne alert); surprise nuclear strike from opponent. Russia and China are the primary US adversaries with North Korea being secondary.

Reliable, Affordable, and Sustainable: All three systems of the triad have been demonstrating this attribute by being operational since at least the 1960s. Although their long-term sustainability has currently been questioned by the DOD and Congress, the system is currently considered mission ready.

Survivable: ICBM – accuracy of adversary (Russia and China) ICBMs is assumed to be increasing, and a direct hit to a hardened ICBM silo is not likely survivable.[3] The actual accuracy of adversary ICBMs is unknown, but they are assumed to be accurate enough to destroy a silo with a nuclear detonation. However, a POSITIVE rating is assigned since the ICBM force is on alert 24/7/365 and can launch weapons within minutes of strike, preventing their demise. An SLBM – POSITIVE rating was given since it is virtually impossible to locate all deployed SLBM submarines and destroy them in a first strike. Bombers received a NEGATIVE rating

since they would not survive a preemptive strike. This score could change to POSITIVE if the bombers were on airborne alert, flying while a surprise attack was initiated against the US.

Credible Perception of Retaliation: This POSITIVE score is based on ICBM and SLBM credible perception provided by their perpetual alert status and ability to react in minutes. The bomber force, although formidable, is not on perpetual alert. The bomber received a POSITIVE score since adversary hackles are regularly raised in show-of-force bomber flights. Of course, these conclusions are subjective and can change based on perception of political policy, rhetoric, and an adversary's view of the policy/rhetoric.

Capable of Reaching Adversary: Each system has demonstrated global reach capability.

Penetrate Active Defenses: The ICBM and SLBM received a POSITIVE rating despite known Russian antiballistic missile (ABM) systems around Moscow (targets around Moscow would presumably be command and control centers). These are point defenses and don't detract from a countrywide ICBM retaliatory attack. The S-400 has missile defense capability largely against medium- and short-range ballistic missiles and are not known to have high altitude intercept capability above 100,000 feet (warheads are 350,000 feet plus upon reentering the atmosphere).[4] Bombers received a POSITIVE rating based on the 20 or so stealth bombers that could be used (assuming they survived an initial attack and are delivering retaliating weapons) to penetrate dense air defense systems.

Destroy Target despite Passive Defenses: All systems received a POSITIVE, but the score is dependent on other factors such as intelligence (how much is known about the target) and the target's passive defenses. This score assumes the systems know where the target is and targeteers know how many weapons to use against the target to destroy it.

The US has a robust integrated tactical warning / attack assessment (ITW/AA) system in place designed to provide ample warning of air, missile, and space-based threats to the US homeland.[5] Of significant concern, and outside the scope of this article, is the credibility of the US to actually employ nuclear weapons (Wohlstetter's Credible Perception of Retaliation), especially in defense of allies under the US nuclear umbrella. According to Keith Payne in *Deterrence in the Second Nuclear Age*, "It [nuclear taboo] simply points to the strong feeling among US political leaders that the use of nuclear weapons is disproportionate to regional interests—even long-standing US security commitments. Declarations

and behavior that contribute to the general perception of this very strong US reluctance to use nuclear weapons *in extremis* may be disadvantageous for deterrence in the second nuclear age, particularly as the US confronts regional challengers."[6] Taking this argument one step further, the development of missile defenses implies that the US does not want to use a nuclear retaliatory strike, even if an adversary attacked first.

Hypersonic Development Motives: According to the Department of Defense, the US is developing hypersonic capability for two reasons: (1) to hold targets at risk around the world with a prompt, conventional weapon and (2) to penetrate and destroy land and sea anti-access and area denial defenses.[7] There is no current, publicly stated intent to mate nuclear capability to these hypersonic weapons.

Overall Nuclear Deterrence Stability Contribution: US nuclear attributes overwhelming *add* to nuclear stability. The detractors, as stated earlier, are the missile defense systems as they degrade an opponent's ability to penetrate defenses in accordance with Wohlstetter's stability attributes.

Russia

Nuclear History and Overview

Russia's nuclear history is intimately linked to the US. At the Potsdam Conference in 1945, following Truman's announcement to Stalin that the US had detonated a "new weapon of unusual destructive force," the USSR transitioned its under-resourced atomic bomb program into overdrive.[8] On 29 August 1949, the USSR exploded its first atomic device and raced to exceed US nuclear capability and arsenal numbers. After the Cold War and dissolution of the USSR in 1991, the Russian Federation inherited a robust and capable nuclear triad. Today, Russia maintains a formidable and aging nuclear force with the intent of leveraging this might to become a preeminent member of the international community.[9] Additionally, some speculate that "Russian leaders seek . . . [to] return to the bygone days of mutual assured destruction and continuous repetitive arms control," acknowledging deterrent theory underpinnings and the desire for a perceived stalemate with the US.[10] Finally, recent announcements by President Putin indicate that the Russian nuclear force is undergoing significant modernization.[11]

Russian ABM systems are not nearly as capable as the US systems, providing point defense against ICBMs and do not pose a significant threat to undermine US nuclear ability. Specifically, this Russian ABM system provides protection to Moscow against a limited nuclear strike and

can be overwhelmed with a massive attack.[12] Other systems such as the mobile Russian S-400 do claim to have antiballistic capability, but estimates state the system is effective primarily against short- and intermediate-range ballistic missiles (IRBM) and not ICBMs.[13]

Nuclear Force Attributes

Like the US, Russia has a robust strategic nuclear force centered on a triad of capability: the ground-based ICBM, the submarine SLBM, and the nuclear-capable bomber (table 3). Russia also maintains a portion of its nuclear forces on 24/7/365 alert.[14]

Table 3. Russian nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed
ICBM – RS28 SARMAT (Liquid Fuel)	0	? (capable of 10 MIRVs)	0
ICBM – SS18 SATAN (Liquid Fuel)[15]	~46 (individual hardened silos)[16]	10 (capable of 10 MIRVs)[17]	46 (460 warheads)[18]
ICBM – SS19 STILETTO (Liquid Fuel)[19]	~20 (individual silos) [20]	6 (capable of 6 MIRVs)[21]	20 (120 warheads)[22]
ICBM – SS25 SICKLE (Solid Fuel)[23]	90 (road-mobile TEL)[24]	1 (not MIRV capable)[25]	90 (90 warheads)[26]
ICBM – SS27 (Solid Fuel)[27]	60 (mod. 1 individual silos)[28] 18 (mod. 1 road-mobile TEL)[29] 58 (mod. 2 road-mobile)[30] 10 (mod. 2 individual silos)[31]	Mod. 1: 1 (not MIRV capable) Mod. 2: 4 (Capable of 4 MIRVs)[32]	Mod. 1: 78 (78 warheads) Mod. 2: 105 (375–420 warheads)[33]
SLBM – SSN18 STING-RAY, SSN23 (Liquid Fuel)[34] **SLBM – SSN**[32] **(Solid Fuel)**[35]	176 (11 SSBNs w/16 SLBM launchers each) [36]	SSN18: 3 (capable of 3 MIRVs) SSN23: 4 (capable of 4 MIRVs) SSN32: 6 (capable of 6 MIRVs)[37]	80 (max. 480 warheads)[38]
Nuclear-Capable Bombers (BEAR-H6/ H16, BLACKJACK)	Blackjack: 16 Bear H: ~60	Blackjack: 12 ALCMs max. Bear: 6–16 cruise missiles[39]	200 warheads[40]

(*Source*: Table information and notes written and compiled by Jeffrey Nocton, intern at Woodrow Wilson International Center for Scholars.)

Additional Notes

On the RS28: The RS28 missile is still in development as a replacement for the SS18. It will also be liquid-fueled, based in individual hardened silos, and be able to carry 10 warheads. Deliveries are expected to begin in 2021.[41] There are reports that a warhead containing a hypersonic glide vehicle is under development for this missile. This warhead is referred to by its "developer designation 'object 4202,' or Aeroballistic Hypersonic

Warhead." This hypersonic warhead may allow the weapon to confuse or avoid modern missile defense systems.[42]

On the SS27: The SS27 missile is separated into two designations, Mod. 1 and Mod. 2, depending on the multiple independently targetable reentry vehicle (MIRV) capability of the missile. It has numerous variations on both the Mod. 1 and Mod. 2, which depends on the method of deployment (in silos or on road-mobile launchers). Additionally, a rail-mobile version may be in development, but it has more than likely been heavily delayed or cancelled due to budget concerns.[43]

On SLBMs: Russia operates 11 SSBNs of three different classes: 6 Delta IVs (carrying the SSN23 SLBMs), 2 Delta IIIs (carrying the SSN18 SLBMs), and 3 Borei-class subs (carrying the SSN32 SLBMs). Only one-third of the 11 Russian SSBNs are deployed at a given time, so the actual number of deployed warheads is less than the 800 warheads assigned to SLBMs. The 480 quoted in table 3 would be true if all of the deployed SSBNs were Delta IVs with full complements of missiles.[44]

On Aircraft: Though the total number of weapons allocated to bombers is thought to be around 789, only 200 are believed to be present at the strategic bomber bases.[45] Russian nuclear bombers are not presently on ground or airborne alert.[46]

On Overall Inventory: The Arms Control Association estimates Russia's total nuclear inventory at 7,000 warheads. Roughly 2,500 of these warheads have been retired. The *Bulletin of the Atomic Scientists* (BAS), on the other hand, estimates the total inventory at 7,300 with ~2,800 retired and awaiting dismantlement. Both sources agree that this leaves ~4,500 warheads deployed with Russian nuclear forces or in military stockpiles. The BAS estimates that this includes ~2,000 nonstrategic warheads, ~1,800 deployed warheads, and ~700 warheads in storage. Of the deployed warheads, the BAS says that 1,040 are mated to 307 ICBMs.[47]

Using Wohlstetter's stability criteria, Russia's strategic nuclear force attributes are listed below (table 4).

Table 4. Russian nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
ICBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
SLBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
Bomber	POSITIVE	NEGATIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE

ASSUMPTION: Today's force posture (bombers not on airborne alert); nuclear strike from opponent is a surprise. US is the primary adversary with NATO and Western Europe a close secondary adversary.

Reliable, Affordable, and Sustainable: Like the US triad systems, all three systems of the Russian triad have been demonstrating these attributes since the 1960s.

Survivable: ICBM – accuracy of adversary (US) ICBMs is assumed to be increasing, and a direct hit to a hardened ICBM silo is not likely survivable.[48] A POSITIVE rating is awarded since, even though silo locations are likely known and targeted in a surprise attack, Russian maintains a force that includes mobile ICBMs as well. It would be unlikely that all ICBMs could be targeted/hit in a surprise attack with many of them purportedly mobile and in unknown locations. SLBM – A POSITIVE rating is given since it is virtually impossible to locate all deployed SLBM submarines and destroy them in a first strike. Bombers received a NEGATIVE rating since they would not survive a preemptive strike. This score could change to POSITIVE if the bombers were on airborne alert, flying while a surprise attack began.

Credible Perception of Retaliation: This POSITIVE score is based on the ICBM and SLBM on perpetual alert and ability to react in minutes (ICBM able to launch on warning) since it sends a message of resolve to retaliate. The bomber received a POSITIVE rating since a nuclear-capable bomber flyby tends to grab headlines as a show of force. Of course, these conclusions are subjective and can change based on perception of political policy, rhetoric, and an adversary's view of the policy/rhetoric.

Capable of Reaching Adversary: Each system has demonstrated global reach capability.

Penetrate Active Defenses: The ICBM and SLBM received a POSITIVE rating since a likely Russian strategy is to overwhelm ballistic defenses with multiple ICBM/SLBMs capable of 10 MIRV per missile. Bombers received a NEGATIVE since Russian inventory of non-stealthy bombers are unlikely to penetrate air defense systems in force—they can be detected and intercepted by North American Aerospace Defense Command (NORAD) capability.[49]

Destroy Target despite Passive Defenses: All systems received a POSITIVE, but the score is dependent on other factors such as intelligence (how much Russia knows about the targets) and a target's passive defenses. This score assumes the systems know where the target is and targeteers know how many weapons to use against the target to destroy it.

Of note, Russia has an early warning constellation reportedly capable of detecting ballistic missile launches worldwide, but it is speculated to be nonfunctional at this time. Russia reportedly relies on ground-based radar for early warning.

Hypersonic Development Motives: Russian officials have stated they are developing hypersonics to counter US homeland missile defenses.[50] However, there is speculation that Russia is also developing this capability for similar reasons as US motives: to hold robustly protected long-range targets at risk.[51]

Overall Nuclear Deterrence Stability Contribution: Russian nuclear attributes (overwhelming positive) *add* to nuclear stability. However, the S-400 (SA-21 Growler) and soon-to-be S-500 are very capable against intermediate-range ballistic missiles. If the US nuclear umbrella were absent, these Russian IRBMs would detract from European regional stability due to their proximity to Europe and intermediate range of the European nuclear forces.

China

Nuclear History and Overview

China began its nuclear weapons program in 1951 with assistance from the USSR.[52] However, when relations with the USSR soured in the late 1950s, China proceeded with atomic bomb research without its assistance. In 1964, China detonated its first atomic device and subsequently became a nuclear power.[53] Since then, China has pursued a strategy of minimal deterrence, developing and deploying what it perceived as just enough nuclear weapon totals to deter the US.[54]

Nuclear Force Attributes

China relies mostly on its ICBM forces in mobile and hardened silo configurations for deterrence purposes. China does possess a nascent SLBM capability and recently modernized nuclear bomber force. Further, China has not been known to maintain a ready alert posture for its nuclear forces likely as part of its declared no-first-use (NFU) policy: no use of nuclear weapons unless nuclear weapons were used first against China.[55] Currently, China is pursuing military modernization to include its nuclear forces.[56] See table 5 for its nuclear inventory.

Table 5. China nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed
ICBM – DF-4, DF-5A/B (Liquid Fuel)[57]	~30[58], [59] (DF-4 on road-mobile TEL), (DF-5A/B in individual hardened silos)[60]	1 (no MIRV capability for DF-4, DF-5A) 3 (DF-5B capable of 3 MIRVs)[61]	0 (~50 warheads in storage)[62], [63]
ICBM – DF-31, DF-41 (Solid Fuel)[64]	~33[65], [66] (road-mobile TEL)	DF-31: 1 (No MIRV capability) DF-41: ? [67]	0 (~33[68], [69] warheads in storage)
SLBM – JL-2 (Solid Fuel)[70]	48[71] (4 Type 094 *Jin* submarines w/12 SLBM launchers each)[72]	1 (no MIRV capability) or (3–8 MIRV capability)	0 (48 warheads in storage)
Nuclear Capable Bomber (H-6K)	~20[73] Bombers	Capable of 4 cruise missiles (w/1 warhead each)[74] or a single bomb	~20

(*Source*: Table information and notes written and compiled by Jeffrey Nocton, intern at Woodrow Wilson International Center for Scholars.)

China is reportedly developing a ballistic missile defense capability designed to intercept ICBM warheads.[75] However, it is unclear when this capability would be operational.

Additional Notes

On the DF-41: The MIRV capability for the DF-41 is currently unknown; the missile is still in development.[76] There are reports suggesting that a capability similar to that of the DF-5B is likely. This would mean a DF-41 with 3 possible MIRVs.[77] There have also been unconfirmed reports the DF-41 will be capable of 6 or even 10 MIRVs.[78] The DF-41 will eventually be deployed on a road-mobile transporter-erector-launcher (TEL).[79]

On Submarine-Launched Ballistic Missiles (SLBM): The JL-2 has been deployed since October 2019.[80] There are conflicting reports on the MIRV capability of the JL-2 with some saying no capability[81] and others reporting between three and eight warheads.[82]

On Aircraft: The H-6K bomber is likely armed with either the LACM CJ-20 or YJ-63/KD-63 cruise missile.

On Other Ballistic and Cruise Missiles: China has numerous intermediate-range (DF-26), medium-range (DF-16, DF-21), and short-range ballistic missiles (DF-11, DF-15) as well as land-attack cruise missiles (DH-10). These lack the range of the ICBMs and are more of a factor for regional deterrence than globally. This is still somewhat relevant as India and North Korea are both nuclear armed and share borders with China. When combined with the total number of ICBMs in China's ar-

senal, the BAS estimates the total number of land-based missiles to be 143 missiles and 163 warheads.[83]

On Deployment: Chinese nuclear doctrine does not normally deploy the warheads on its missiles. Instead these are kept in secure storage from where they would be deployed to the appropriate missiles in the event of proper orders. Despite pressure from the military to shift toward greater readiness, there does not seem to have been a change in this organization.[84]

On Overall Inventory: The Arms Control Association estimates that China's total nuclear warhead inventory amounts to 260.[85]

Using Wohlstetter's stability criteria, the strategic nuclear force attributes for China are listed below (table 6).

Table 6. China's nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
ICBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
SLBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
Bomber	POSITIVE	NEGATIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE

ASSUMPTION: Today's force posture (no forces on ready alert); nuclear strike from opponent is a surprise. US and allies as the primary adversaries with India as an emerging adversary.

Reliable, Affordable, and Sustainable: China largely relies on a nuclear dyad of ICBMs and SLBMs. SLBMs are a current addition to its nuclear capability and assumed to be reliable/sustainable. All systems are currently considered mission-ready and received a POSITIVE rating.

Survivable: Accuracy of adversary (Russia, US and India) ballistic missiles is assumed to be increasing, and a direct hit to a hardened ICBM silo is not likely survivable.[86] Actual accuracy of adversary ICBMs is unknown (assumed to be high) and a POSITIVE rating since, even though silo locations are likely known and targeted in a surprise attack, China maintains a force that includes mobile ICBMs as well. SLBM – POSITIVE rating is given since it is difficult to locate all the deployed SLBM submarines and destroy them in a first strike. Bombers are not on alert and received a NEGATIVE rating since they would not survive a preemptive strike.

Credible Perception of Retaliation: This POSITIVE score was based on China's policy of "No First Use" that does communicate intent to retaliate. The bomber force is not on perpetual alert, but recent upgrades suggest these long-range 1960s-era bombers will carry nuclear gravity bombs. Therefore, like the US and Russian bomber show-of-force flybys, the Chinese nuclear-capable bombers also headline news articles—hence

a POSITIVE score.[87] Of course, perception is also largely based on political policy and rhetoric and an adversary's belief in that policy/rhetoric.

Capable of Reaching Adversary: ICBM and SLBM systems reportedly have global reach capability. The bomber force likely cannot reach continental US, but it can reach US allies in the region, Russia and India. Hence, all three elements have received a POSITIVE rating.

Penetrate Active Defenses: The ICBM and SLBM received a POSITIVE rating since regional Chinese adversaries possess limited ballistic defenses. The Chinese ICBM versus US ballistic defenses is problematic—assuming the US performs a surprise attack on China, this article assumes the US would bolster its BMD in anticipation of retaliation. It is unclear if China would have enough missiles/MIRVs to overwhelm US continental BMD. However, because they still hold US allies and territories at risk, Chinese ICBM and SLBM rating errors towards POSITIVE. Bombers received a NEGATIVE since China's inventory of non-stealthy bombers is unlikely to penetrate modern air defense systems.

Destroy Target despite Passive Defenses: All systems received a POSITIVE, but the score is dependent on other factors such as intelligence (how much is known about the target) and target's passive defenses. This score assumes the systems know where the target is and targeteers know how many weapons to use against the target to destroy it.

Of note, China is suspected to have an early warning satellite capable of detecting ballistic missile launches from the US.[88]

Hypersonic Development Motives: Reports speculate China is developing hypersonics to counter US homeland, regional, and ship missile defenses.[89] At this time, there are no indications China is developing a global hypersonic capability, although it would not be hard once the technology is mature to launch an intercontinental boost-glide weapon on an ICBM motor.[90]

Overall Nuclear Deterrence Stability Contribution: China nuclear attributes (overwhelming positive) *add* to nuclear stability.

India

Nuclear History and Overview

India independently began its nuclear program in 1948 and detonated their first "peaceful" atomic device in 1974.[91] However, it didn't overtly declare itself a nuclear state until 1998.[92] India's nuclear weapons program was primarily designed to deter Pakistan, although India benefits from the second order effect of deterring China.[93] India subscribes to "credible minimum

deterrence" nuclear doctrine with a modified no-first-use policy: NFU against nonnuclear states (implies it reserves the right for first use against a nuclear state). India's nuclear doctrine states that retaliation would be massive following a nuclear attack and that it reserves the right for a nuclear response following chemical or biological attack.[94]

Nuclear Force Attributes

There are conflicting reports that India keeps its nuclear weapons in a disassembled state to underpin its NFU doctrine.[95] From a realistic perspective, India's nuclear forces likely consist of fully assembled and partially assembled weapons in various states of readiness.[96] Recently, India announced that it is pursuing nuclear force modernization, which includes ICBMs for the first time, reportedly to bolster its strategic relationship with China.[97] In 2020, India deployed its SLBMs, declaring a nuclear triad of capability.[98]

India is in the advanced stages of developing a ballistic missile defense system, likely to counter a Pakistan missile threat.[99] It is unclear when this system will be operational. Of note, there are no indications that India possesses an early warning constellation (although reports indicate it has plans to install such a constellation). It relies on early warning radar for ballistic missile launch detection; this system provides 5 to 7 minutes of warning of a launch from Pakistan.[100] See table 7 for India's nuclear inventory.

Table 7. India nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed	Range
ICBM – AGNI V[101] (Solid Fuel)	0	1 (no MIRV capability)	0	5000–8000km
IRBM – ANGI III/IV (Solid Fuel)	~4 launchers[102] (road & rail mobile)[103]/0[104]	1 (no MIRV capability)	0[H]/0[105]	3000–5000km (III) 3500–4000km (IV)
MRBM – AGNI II (Solid Fuel)	~8 launchers[106] (rail & road mobile)[107]	1 (no MIRV capability)	0[108]	2000–3500km
SRBM – AGNI I (Solid Fuel)	~20 launchers[109] (rail & road mobile)[110]	1 (no MIRV capability)	0[111]	700–1200km
SLBM – K-15, K-4 (Solid Fuel)	12 (K-15: *Arihant* submarine w/12 SLBM launchers)[112] 0 (K-4: *Arihant* submarine w/4 SLBM launchers)[113]	1 (no MIRV capability)	~12[114]	700km (K-15)[115] 3000–3500km (K-4)[116]
Nuclear-Capable Fighters (Mirage 2000H, SU-30MKI, Jaguar IS/IB, Rafale)	~32 (Mirage) ~16 (Jaguar) (36) (Rafale)[117]	1 (no MIRV capability)	~48[118, 119]	1850km (Mirage) 1600km (Jaguar) Up to 3500km (Rafale)

(*Source*: Table information and notes written and compiled by Jeffrey Nocton, intern at Woodrow Wilson International Center for Scholars.)

Additional Notes

On the Agni-V: The Agni-V ICBM is still being tested.[120] There are plans to deploy the Agni-V on road-mobile launchers, which is a shift from the earlier rail-mobile launcher used in early testing. Despite suggestions that India will make the Agni-V MIRV capable, there is little evidence that it is able to do so.[121] The Missile Defense Project has stated that the Agni-V will not be MIRV capable.[122]

On the Agni-IV: The Agni-IV IRBM successfully tested in January 2019 appears nearing completion. It will eventually deploy on a rail-mobile launcher.[123]

On the Agni-III: There are unconfirmed reports the Agni-III is capable of 3 MIRVs.[124]

On the Dhamush Missile: The Dhanush ballistic missile is a ship-launched version of the Prithvi II. Its limited range (400 km) means it is unlikely to serve a deterrence function.[125] It is liquid fueled and cannot be stored fully assembled for significant periods.[126]

On the BrahMos Cruise Missile: This missile has a range of 300 and 500 km and currently does not have a nuclear capability, though there are indications it will in the near future.[127] Russia and India worked together on the BrahMos and are currently working on a version of this missile that is hypersonic (the current version being supersonic). This hypersonic variant is usually referred to as BrahMos II.[128] Additionally, India's entry into the Missile Technology Control Regime has removed the 300 km range cap that had limited the BrahMos's further development. India now plans to extend the range of this missile to a minimum of 450 km with the goal of 850 km. This upgraded BrahMos is likely a few years away from deployment.[129] The BrahMos relies on liquid fuel and therefore cannot be stored fully assembled for significant periods.[130]

On the Arihant: In March 2020, the Arihant SSBN was reported deployed on deterrent operations with nuclear missiles.[131]

On Ranges: The lower band is the nominal range of the missiles in question. The upper band indicates missile versions with reduced weight payloads. For aircraft, the increase in range is gained through external fuel tanks.

On Aircraft: The Rafale fighters that India ordered were delivered in July 2020.[132]

On Deployment: There are reports that all India's nuclear weapons are kept unassembled and undeployed as part of India's Credible Minimum Deterrence and NFU policy.[133]

On Overall Inventory: The *Military Balance* estimated the total number of nuclear-capable missiles at 54 in February 2016. When combined

with the number allocated to the Indian air force, the total number of nuclear weapons comes to ~110.[134] The Arms Control Association has more recently substantiated this number.[135]

On Recent Ballistic Missile Defense (BMD) System: In February 2017, India tested a high-altitude interceptor missile that it claims scored a direct hit on a target ballistic missile at an altitude of 97 km. This success has lead the Defense Research and Development Organization to claim that a two-layered missile shield could be deployed to cities or strategic installations in the next two years. This shield reportedly has a range of 2,000 km and is able to intercept missiles both within and outside of the earth's atmosphere. This could create major questions for deterrence in Pakistan, which does not yet have a similar system.[136]

See table 8 for India's nuclear attributes.

Table 8. India nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
IRBM	POSITIVE	NEGATIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
SLBM	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE
Bomber	POSITIVE	NEGATIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE

ASSUMPTION: Today's force posture (bombers not on airborne alert); nuclear strike from opponent is a surprise. Pakistan is the primary adversary with China as a secondary adversary.

Reliable, Affordable, and Sustainable: These attributes were rated POSITIVE since the IRBM and aircraft systems of the triad have been operational for at least a couple of decades. SLBMs have not been declared operational and it is unknown whether they are reliable.[137]

Survivable: IRBM – accuracy of adversary (Pakistan and China) ICBMs/IRBMs is assumed to be increasing, and a relative hit to a mobile IRBM is not survivable.[138] Actual accuracy of adversary ICBM/IRBMs is unknown and a NEGATIVE rating is given since IRBM survivability relies exclusively on mobility (this could change if indicators to a crisis were available, requiring constant mobility of India's forces). SLBMs will have a POSITIVE rating (once operational) since it is virtually impossible to locate all the deployed SLBM submarines and destroy them in a first strike. Bombers received a NEGATIVE rating since they would not survive a preemptive strike. This score could change to POSITIVE if the bombers were on airborne alert, flying during a surprise attack.

Credible Perception of Retaliation: Although India subscribes to a NFU, its nuclear doctrine advocates for massive retaliation.[139] This doctrine,

in combination with the knowledge the IRBM force can reach all targets in Pakistan warrants a POSITIVE rating (primary adversary is Pakistan). The bomber also receives a POSITIVE score for its relative ease of use and flexibility in nuclear operations. Of course, perception is also largely based on political policy and rhetoric and an adversary's belief in that policy/rhetoric.

Capable of Reaching Adversary: India's IRBM and bomber force can reach all targets in Pakistan, warranting a POSITIVE rating in this category (primary adversary is Pakistan). This rating would be a NEGATIVE against China since the IRBM range (5,000 km) cannot hold all targets at risk due to a range deficit (will change to positive once the AGNI V is operational). SLBMs would receive a POSITIVE rating once declared operational.

Penetrate Active Defenses: The IRBM (and SLBM once operational) received a POSITIVE rating since Pakistan is not known to possess a capable antiballistic missile system. Bombers received a NEGATIVE since both Pakistan and China possess capable air defense systems.[140]

Destroy Target despite Passive Defenses: All systems received a POSITIVE rating, but the score is dependent on other factors such as intelligence (how much is known about the target) and a target's passive defenses. This score assumes that the systems know where the target is and targeteers know how many weapons to use against the target to destroy it.

Hypersonic Development Motives: India is reportedly developing hypersonic cruise missiles to prosecute time-critical threats, penetrate heavily defended targets, and strike hardened/deeply buried facilities.[141] There is no evidence that India is building a nuclear-capable hypersonic weapon at this time. However, India is reportedly developing this hypersonic capability in cooperation with Russia (which has declared that it is developing hypersonic nuclear weapons).[142]

Overall Nuclear Deterrence Stability Contribution: India's nuclear attributes *add* to regional stability. A significant detractor from stability is India's ballistic missile defense capability—this especially degrades Pakistan ability to hold targets at risk in India.

Pakistan

Nuclear History and Overview

Pakistan's nuclear weapons program started in response to India's nuclear weapons program and the persistent hostilities and history of conflicts the two nations share. Pakistan has a checkered nuclear development history with the now infamous A. Q. Kahn providing much of the know-how and illicit nuclear networks in 1975.[143] In 1985, with Chinese help,

Pakistan began building a plutonium reactor.[144] Reports indicate that Pakistan had a nuclear device as early as 1984 but had not tested a nuclear weapon until May of 1998.[145] Pakistan has declared a nuclear doctrine of "credible minimum deterrence," stating it has a no-first-use policy against nonnuclear states.[146] Pakistan's regional adversary is India.

Nuclear Force Attributes

Based on President's Musharraf's statement that there is a "geographic separation" between warheads, speculation is that Pakistan keeps its nuclear weapons in a disassembled state to underpin its NFU doctrine.[147] Realistically, Pakistan's nuclear forces are likely in various states of readiness.[148] Despite its minimal deterrent doctrine, Pakistan reportedly has the fastest-growing nuclear arsenal in the world (although its economic situation cannot support such speculation).[149] Pakistan officials have stated that they are pursuing an inventory of tactical nuclear weapons to offset India's conventional capability and will "enhance" strategic stability.[150] Further, evidence suggests that Pakistan is focused on growing its nuclear force as it pursues submarine-based ballistic missile capability.[151] Pakistan relies on a nuclear dyad of capability (SLBM systems are not operational).[152]

There is no current evidence that Pakistan has a substantive antiballistic missile program other than a stated desire for one. Further, there is little information regarding any Pakistani early warning systems to detect inbound ballistic missiles. See table 9 for Pakistan's nuclear inventory.

Table 9. Pakistan nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed	Range
MRBM – HATF-5 (Liquid Fuel) **MRBM – HATF-6, SHAHEEN-3 (Solid Fuel)**	~40[153]/ ~8[154]/ 0[155]	1 (no MIRV capability)	0[156]	1250–1500km (Haft-5) 1500–2000km (Hatf-6) 2750km (Shaheen-3)
SRBM – HATF-2, HATF-3, HATF-4 (Solid Fuel)	"few"/ ~16/ ~16[157]	1 (no MIRV capability)	0[158]	180–200km (Hatf-2) 290km (Hatf-3) 750km (Hatf-4)
BSRBM – HATF-1, HATF-9 (NASR)[159] (Solid Fuel)	?/~6[160]	1 (no MIRV capability)	?	70–100km (Haft-1) 60–120km (Haft-9)
LACM – HATF-7, HATF-8 (Turbojet)	~12/?[161]	1 (no MIRV capability)	0[162]	350–700km (Hatf-7) 350km (Hatf-8)
SLBM[163]	N/A	N/A	N/A	N/A
Nuclear-Capable Fighter Bombers (F-16A/B & MIRAGE III/V)	26 (F-16)[164] ~12 (Mirage)[165]	1	>26?[166]	1600km/2100km[167]m (for aircraft) ~350km (for missiles)

(*Source*: Table information and notes written and compiled by Jeffrey Nocton, intern at Woodrow Wilson International Center for Scholars.)

Additional Notes

On the Shaheen-3: This missile was still in development as of November 2020.[168]

On the Hatf-2: The "few" designation in the above table is taken from the *SIPRI Yearbook 2016* and is listed as such because the Haft-2 missile had not yet entered service, but should be operational in the near future.[169]

On the Babur (Hatf-7): The Babur missile is being tested for launch from a submarine. On 9 January 2017 the first test launch of this missile variant (called Babur-3) from an underwater platform was performed. It is not clear how far into development this version has progressed.[170]

On Battlefield Short-Range Ballistic Missiles (BSRBM): These missiles are intended for use as a quick reaction force in the event of an Indian "Cold Start" war. Hatf-9 (Nasr) has been described as a "shoot-and-scoot" weapon designed for quick use and rapid movement.[171] The Nasr's launch vehicle is used for both conventional and nuclear missiles. It is equipped with four launch tubes and could carry any combination of these different warheads. Given that this weapon is for quick use, it is likely that some number of these are deployed along the Indo-Pakistan border, but determining a number is extremely difficult when using only open-source references.[172]

On Ballistic and Cruise Missiles: Pakistan has not yet made use of missiles with ranges greater than what is generally considered medium-ranged. This is explained by the fact that Pakistan's target for much of its nuclear doctrine and planning is India, and there is little need for missiles with ranges beyond 2,000 km.

On SLBMs: Pakistan is pursuing SLBM technology in response to India's acquisition of this same capability with the launch of the *Arihant*. While it does currently have five attack submarines (SSKs) among its naval forces, it will take time not just to build or purchase a usable SSBN but to be able to effectively deploy it with SLBMs. In April 2015, Pakistan concluded negotiations with China to purchase six Chinese-built *Yuan*-class vessels that make use of air-independent propulsion technology, enabling them to remain submerged for longer periods than other diesel-powered submarines. Pakistan is also considering reconfiguring a number of its *Agosta*-class submarines to carry nuclear weapons.[173]

On Aircraft: The F-16s that Pakistan has procured from the US may be modified to allow them to carry nuclear weapons. The US claims that this is not possible as it monitors the F-16s to ensure this is not happening.[174]

On Deployment: Pakistan reportedly keeps its nuclear weapons disassembled and separate from its delivery vehicles.[175] All of Pakistan's ground-

launched missiles are road-mobile and rely on this mobility to ensure at least some of them survive a potential first strike.[176]

On Overall Inventory: Pakistan's total number of nuclear-capable missiles has been estimated at over 60 by *The Military Balance*[177] and at roughly 140 by the Arms Control Association.[178]

For Pakistan's nuclear attributes, see table 10.

Table 10. Pakistan nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
MRBM	POSITIVE	NEGATIVE	POSITIVE	NEGATIVE	NEGATIVE	POSITIVE
SLCM	N/A	N/A	N/A	N/A	N/A	N/A
Bomber	POSITIVE	NEGATIVE	POSITIVE	NEGATIVE	NEGATIVE	POSITIVE

ASSUMPTION: Today's force posture (bombers not on airborne alert); nuclear strike from opponent is a surprise. India is the adversary.

Reliable, Affordable, and Sustainable: These attributes are rated POSITIVE since the two systems of the dyad have been available for the past decade or more.

Survivable: The accuracy of adversary (India) IRBMs is assumed to be increasing, and a relative hit to a mobile MRBM is not survivable. Actual accuracy of adversary IRBMs is unknown, and a NEGATIVE rating is given since survivability relies exclusively on mobility (this could change if indicators to a crisis were available, requiring constant mobility of Pakistan's forces).

Credible Perception of Retaliation: Although Pakistan subscribes to a no-first-use policy, its nuclear doctrine advocates for massive retaliation, which gives the MRBM a POSITIVE rating.[179] The bomber also receives a POSITIVE score for its relative ease of use and flexibility in nuclear operations. Of course, perception is also largely based on political policy and rhetoric and an adversary's belief in that policy/rhetoric.

Penetrate Active Defenses: The bomber and MRBM received a NEGATIVE rating since India's S-400 (SA-21 Growler) has a probability of kill of at least 50 percent against theater ballistic missiles and above 90 percent against aircraft.[180]

Destroy Target despite Passive Defenses: All systems received a POSITIVE score, but the score is dependent on other factors such as intelligence (how much is known about the target) and the target's passive defenses. The score was assigned assuming that the systems knew where the target was and targeteers knew how many weapons to use against the target to destroy it.

Hypersonic Development Motives: There is no known Pakistan hypersonic weapons program.

Overall Nuclear Deterrence Stability Contribution: Pakistan nuclear capability and posture *detract* from regional stability since half of its attributes are NEGATIVE. Once the SLBM or SLCM is operational, Pakistan will improve nuclear stability in the region. A significant detractor from stability is India's ballistic missile defense capability—this especially degrades Pakistan ability to hold targets at risk in India.

North Korea

Nuclear History and Overview

North Korea has a tumultuous nuclear timeline, originally signing the Nuclear Non-Proliferation Treaty in 1985 and later withdrawing in 2003.[181] Then, in 2006, following years of sanctions and engagements designed at preventing it from obtaining a nuclear weapon, North Korea detonated its first atomic device.[182] Due partly to the opaqueness of the North Korean regime and the relative small amount of time the country has possessed a nuclear weapon, it is unclear what nuclear doctrine Kim Jong-un subscribes to. Regardless of doctrine, this article assumes that the regime is rational, seeks to preserve itself, and will take actions that it thinks will not seal its demise in a nuclear exchange. Finally, there are no indications at this time that North Korea has, or is developing, a ballistic missile defense system.

Nuclear Force Attributes

Although it is aggressively pursuing ICBMs, experts estimate that North Korea can use short- and medium-range ballistic missiles and possibly a number of light bombers to deliver a nuclear device (bombers are not considered in table 11 due to the lack of consensus on whether these bombers could/would deliver nuclear weapons).[183] North Korea experts do not believe the sea-launched missiles are capable of nuclear delivery at this time.[184]

Table 11. North Korea nuclear inventory

Type of System	Total in Inventory	Warheads per Deployed Launcher	Total Deployed
ICBM – KN-08, KN-14, Taepodong-2 (Liquid Fuel)[185, 186]	?	?	0
SLBM – KN-11 (Solid Fuel)	?	?	0

(*Source*: Table information and notes written and compiled by Jeffrey Nocton, intern at Woodrow Wilson International Center for Scholars.)

Additional Notes

On KN-08: The KN-08 missile is usually considered to be a road-mobile ICBM. It has yet to be flight tested, and imagery analysts say it should not enter service earlier than 2020.[187]

On KN-14: This missile seems to be a slightly modified version of the KN-08 and retains many of its characteristics (approximate range, fuel type, mobility, and development status).[188]

On Taepodong-2: The Taepodong-2 missile is likely a militarized version of the Unha-3 satellite launch vehicle. This gives it intercontinental range, though it would still be limited to a single warhead. Its liquid fuel propulsion limits the amount of time that it could remain fully launch capable and vulnerable to preemptive strikes.[189]

On SLBMs: North Korea revealed in 2015 that it was developing a submarine-launched ballistic missile (referred to as the KN-11) but does not seem to have made significant progress in this endeavor.[190]

On North Korea's Nuclear Capability: North Korea had tested five nuclear devices as of November 2020 and has tested numerous missiles, some of which it claims can reach the United States' West Coast. The explosive yields of these tests have been in the 20 kiloton range, leading some to assume that North Korea is using "boosted" plutonium weapons to reduce the overall size and make it easier to mount them as warheads on a missile. The capabilities of its missile program are not fully known, but in 2012 it placed a satellite into orbit and has since launched at least one missile from a submarine platform.[191] The device tested by North Korea in January 2016 was announced to have been a "hydrogen bomb." According to a White House spokesperson, the seismic data for the test was inconsistent with a hydrogen bomb. This would indicate a low-yield explosion, leading many to argue that the test was not likely a real hydrogen bomb. It is more likely that the regular fission bomb was "boosted" with hydrogen isotopes.[192]

On North Korea's Warhead Capability: The US intelligence community has not yet concluded that North Korea has the capability to build nuclear warheads small enough to be placed on ballistic missiles. Further, experts are not convinced that North Korea has mastered the technology needed for reentry. A 2012 RAND report determined that the rocket used for the successful satellite launch would be unable to carry a nuclear warhead at intercontinental ranges. More recently, however, North Korea has displayed what some assert to be a mobile ICBM vehicle paraded through Pyongyang. Others have suggested that this is a mock-up or a missile that has not yet been flight tested.[193] The official US position is that North Korea has not yet demonstrated all the capabilities necessary to add a

nuclear warhead to a long-range missile. There have been no official statements on estimates of warhead stockpiles, but scholarly analyses have used projections from estimated production values to roughly predict the size of North Korea's arsenal in 2020 from 20 to 100 warheads. From these estimations, it is likely that North Korea's current stockpile is somewhere between 14 and 45 individual warheads.[194]

On Overall Inventory: It is estimated that North Korea's current stockpile is somewhere between 14 and 45 individual warheads.[195] The Arms Control Association has estimated North Korea's total nuclear warhead inventory at 10.[196]

See table 12 for North Korea's nuclear attributes.

Table 12. North Korea nuclear attributes

Nuclear Weapon System	Reliable, Affordable, Sustainable	Survivable	Credible Perception of Retaliation	Capable of Reaching Adversary	Penetrate Active Defenses	Destroy Target w/Passive Defenses
ICBM/IRBM	NEGATIVE	POSITIVE	POSITIVE	POSITIVE	NEGATIVE	POSITIVE
SLBM	N/A	N/A	N/A	N/A	N/A	N/A
Bomber	N/A	N/A	N/A	N/A	N/A	N/A

ASSUMPTION: Today's force posture; nuclear strike from opponent is a surprise. South Korea, Japan, and the US are adversaries.

Reliable, Affordable, and Sustainable: The MRBM and IRBM (ICBM still being tested) used by North Korea have proven performance. The NEGATIVE rating is assigned since there is still much doubt as to whether North Korea has mastered the technology to miniaturize a nuclear warhead enough to be mated and launched on any of these ballistic missiles and whether the warhead can survive reentry.

Survivable: ICBM – accuracy of adversary US ICBMs is assumed to be accurate, and a direct hit to any missile system is not survivable.[197] The North Korea ICBMs are mobile (as are the MRBMs/IRBMs) and are also speculated to be hidden in mountain caves to increase their survivability.[198]

Credible Perception of Retaliation: POSITIVE – There is little doubt in this author's mind that North Korea, if it felt that its regime was threatened, would launch a retaliatory strike. Of course, perception is also largely based on political policy and rhetoric and an adversary's belief in that policy/rhetoric.

Capable of Reaching Adversary: South Korea and Japan are squarely in range of MRBMs/IRBMs and received a POSITIVE rating. IRBMs are capable of reaching parts of the US. If the ICBM becomes operational, it theoretically can hold most of the US at risk.

Penetrate Active Defenses: The IRBM receives a NEGATIVE rating based on the ballistic missile defenses deployed throughout the region and along the US Pacific coast.

Destroy Target despite Passive Defenses: All systems received a POSITIVE, but the score is dependent on other factors such as intelligence (how much is known about the target) and the target's passive defenses. The score was assigned assuming the systems knew where the target was and targeteers knew how many weapons to use against the target to destroy it.

Hypersonic Development Motives: North Korea is not known to possess a hypersonic development program.

Overall Nuclear Deterrence Stability Contribution: North Korea's nuclear capability and posture significantly *detract* from regional stability—largely due to the nascent nature of its program and reliance on a single and questionably survivable nuclear delivery system (IRBMs/MRBMs). If North Korea successfully operationalizes a nuclear capable submarine, stability will increase (although the stealth of North Korea submarines is suspect since they are based on 1960 Soviet designs known to be noisy).[199] SSQ

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