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Pakistani nuclear forces, 2015

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Abstract

Pakistan has a nuclear weapons stockpile of 110 to 130 warheads, an increase from an estimated 90 to 110 warheads in 2011. With several delivery systems in development, four operating plutonium production reactors, and uranium facilities, the country's stockpile will likely increase over the next 10 years, but by how much will depend on many things. Two key factors will be how many nuclear-capable launchers Islamabad plans to deploy, and how much the Indian nuclear arsenal grows. Based on Pakistan's performance over the past 20 years and its current and anticipated weapons deployments, the authors estimate that its stockpile could realistically grow to 220 to 250 warheads by 2025, making it the world's fifth largest nuclear weapon state. Pakistan appears to have six types of currently operational nuclear-capable ballistic missiles, plus at least two more under development: the short-range Shaheen-1A and medium-range Shaheen-3. Pakistan is also developing two new cruise missiles, the ground-launched Babur (Hatf-7) and the air-launched Ra'ad (Hatf-8).

Keywords

defense, India, missiles, MRBM, nuclear weapons, Pakistan, SRBM

Pakistan continues to expand its nuclear arsenal and is growing its fissile materials production industry. Since our last Nuclear Notebook on the country in 2011 (Kristensen and Norris, 2011), it has deployed two new nuclear-capable short-range ballistic missiles (SRBM) and a new medium-range ballistic missile (MRBM), and is developing two extended-range nuclear-capable ballistic missiles and two new nuclear-capable cruise missiles.

We estimate that Pakistan has a nuclear weapons stockpile of 110 to 130 warheads, an increase from an estimated 90 to 110 warheads in 2011 (Kristensen and Norris, 2011). The US Defense Intelligence Agency projected in 1999 that by 2020 Pakistan would have 60 to 80 warheads (US Defense Intelligence Agency, 1999), but it appears to have reached that level more than a decade early, in 2006 or 2007 (Norris and Kristensen, 2007). In January 2011, our then-estimate of Pakistan's stockpile was confirmed in *The New York Times* by "officials and outsiders familiar with the American assessment" who said that the official US estimate for "deployed weapons" ranged "from the mid-90 s to more than 110" (Sanger and Schmitt, 2011).[1]

With several delivery systems in development, four operating plutonium production reactors, and its uranium facilities, however, Pakistan's stockpile will likely increase over the next 10

years. By how much will depend on many things. Two key factors will be how many nuclear-capable launchers Pakistan plans to deploy, and how much the Indian nuclear arsenal grows. Speculations that Pakistan may become the world's third largest nuclear weapon state—with a stockpile of some 350 warheads a decade from now—are, we believe, exaggerated because that would require a buildup two to three times faster than growth over the past two decades. Pakistan simply does not have the industrial capacity to develop, produce, and deploy that many additional nuclear weapon systems in a decade. Based on Pakistan's performance over the past 20 years and its current and anticipated weapons deployments, we estimate that its stockpile could more realistically grow to 220 to 250 warheads by 2025. If that happens, it would make Pakistan the world's fifth largest nuclear weapons state.

Fissile material and warhead production

As of late 2014, the International Panel on Fissile Materials estimated that Pakistan had an inventory of approximately 3,100 kilograms (kg) of highly enriched uranium (HEU) and roughly 170 kg of weapon-grade plutonium (Glaser and Mian, 2014: 516, 517). This is enough to potentially produce 200 to 300 warheads, assuming that each warhead's solid core uses either 12 to 18 kg of HEU or 4 to 6 kg of plutonium.[2]

Reliable warhead estimates are difficult to arrive at but generally are based upon several kinds information, including: the amount of weapon-grade fissile material produced, warhead design proficiency, production rates, numbers of operational nuclear-capable delivery vehicles, and government officials' statements. Calculations must also take into account that not all of a country's fissile material ends up in warheads. Like other nuclear weapon states, Pakistan probably maintains a reserve of fissile material. Equally important, however, is the fact that Pakistan lacks enough nuclear-capable delivery vehicles to accommodate 200 to 300 warheads; furthermore, all of Pakistan's nuclear-capable delivery systems are dual-capable, which means that some of them are presumably assigned non-nuclear missions. Finally, official statements often refer to "warheads" and "weapons" interchangeably, without making it clear whether it is the number of delivery vehicles or the warheads assigned to them that are being discussed.

Engineering skills are another important factor. How much plutonium or uranium is needed for a Pakistani nuclear warhead depends on many variables, but three are particularly important: warhead design, desired yield, and the technical capabilities of the scientists and engineers. Skilled technicians need less fissile material to achieve a given yield. Though we do not know Pakistani bomb designers' skill level, they have been at it since the 1970s, have had help from China, and have conducted several nuclear tests in 1998; these factors suggest that low- to medium-level technical skills are plausible.

Precise details about Pakistan's nuclear warheads are not publically known, but its initial warhead design was most likely based on an HEU fission implosion configuration. It is generally believed that Beijing provided Pakistani nuclear scientist A. Q. Khan with blueprints for the uranium implosion device that China

Table 1. Pakistani nuclear forces, 2015

TYPE	NATO DESIGNATION	NUMBER OF LAUNCHERS	YEAR DEPLOYED	RANGE[1] (KILOMETERS)	WARHEAD X YIELD (KILOTONS)[2]	NUMBER OF WARHEADS[3]
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)		few	(2015)[4]	180	1 x 12kt	few
Ghaznavi (Hatf-3)		~16	2004	290	1 x 12kt	~16
Shaheen-1 (Hatf-4)		~16	2003	750	1 x 12kt	~16
Shaheen-1A (Hatf-4)		—	(2017)	900	1 x 12kt	N.A.
Shaheen-2 (Hatf-6)		~8	2014	1,500	1 x 12kt	~8
Shaheen-3 (Hatf-?)		—	(2018)	2,750	1 x 12kt	N.A.
Ghauri (Hatf-5)		~40	2003	1,250	1 x 12kt	~40
NASR (Hatf-9)		~6	2013	60	4 x 12kt	~6[5]
SUBTOTAL		**~86**				**~86**[4]
Cruise missiles						
Babur (Hatf-7)		~8	(2014)[6]	350[7]	3 x 12kt	~8[8]
Ra'ad (Hatf-8)		—	(2017)	350	1 x 12kt	N.A.
SUBTOTAL		**~8**				**~8**
TOTAL						**~130**

1 Range listed is unrefueled combat range with drop tanks.
2 Yield estimate is based on the maximum yield measured in the 1998 nuclear tests.
3 There may be more missiles than launchers, but since each missile is dual-capable this table assigns an average of one warhead per launcher.
4 After six test launches, the Abdali might be in the process of deployment with the army.
5 Each NASR launcher has four missile tubes, but because it is a dual-capable system this table only counts one warhead per launcher.
6 The Babur was last test launched in 2012 but has not yet been used by an operational army unit.
7 The Indian government claims the Babur range is 700 kilometers, twice the range reported by the US intelligence community.
8 Each Babur launcher has three missile tubes, but because it is a dual-capable system this table only counts one warhead per launcher.

detonated on October 27, 1966 (the so-called CHIC-4 test/design). It is also suspected that on May 26, 1990 China tested a Pakistani derivative of the CHIC-4 at its Lop Nor test site, with a yield in the 10 to 12 kiloton (kt) range.[3] That yield estimate accords with recorded yields of Pakistan's 1998 nuclear tests, which are somewhere between 5 and 12 kt. Refinements in boosting and efficient plutonium use are the normal next steps in weapon improvement, along with miniaturization of the warheads to fit into smaller and lighter reentry vehicles. Pakistan is probably undertaking all of these improvements to arm its cruise and ballistic missiles with lighter payloads.

With a well-established uranium enrichment capacity and four plutonium production reactors in operation, Pakistan is currently probably producing enough fissile material to potentially build 14 to 27 new warheads per year (International Panel on Fissile Materials, 2013), although we estimate that the actual warhead increase in the stockpile, due to the constraining factors listed above, is closer to just 10 warheads per year.

Nuclear-capable aircraft

Pakistan probably assigns its F-16 A/B aircraft to the nuclear role, and some Mirage IIIs and Mirage Vs might also have a nuclear mission.

The F-16 A/Bs were supplied by the United States between 1983 and 1987. Additional F-16 C/D aircraft that were withheld by the United States in the 1990s in response to Pakistan's nuclear program have also since been supplied to Islamabad. The F-16 A/Bs are based at Mushaf (formerly Sargodha) Air Base 160 kilometers (100 miles) northwest of Lahore. Organized into the 9th and 11th Squadrons ("Griffins" and "Arrows" respectively), these aircraft have a range of 1,600 km (extendable when equipped with drop tanks) and most likely are equipped to each carry a single nuclear bomb on the centerline pylon. The absence of extra security features at Sargodha suggests that nuclear weapons are not stored at the base itself, but they may be kept at the Sargodha Weapons Storage Complex 10 km to the south or at some unknown storage facility elsewhere. In a crisis the bombs would have to be transported to Mushaf Air Base, or the F-16 s could disperse to bases near underground storage facilities to pick up the weapons.

Some of the Mirage III and Mirage V aircraft may also be equipped to carry nuclear bombs. The Mirage was used to test launch the nuclear-capable Ra'ad air-launched cruise missile in 2008 and 2011, and presumably also in 2012. The Pakistani Air Force is adding aerial refueling capability to the Mirage, a capability that would probably be needed for effective nuclear strike missions. The 7th Squadron ("Bandits") of the 32nd Wing at Masroor Air Base outside Karachi is a possible candidate to conduct the Mirage nuclear strike mission. The base is located only five km (three miles) from a possible nuclear weapons storage site (Kristensen, 2009).

Ballistic missiles

Pakistan appears to have six operational nuclear-capable ballistic missiles, three more than in 2011 (Kristensen and Norris, 2011): the short-range Abdali (Hatf-2), Ghaznavi (Hatf-3), Shaheen-1 (Hatf-4), and NASR (Hatf-9); and the medium-range Ghauri (Hatf-5) and Shaheen-2 (Hatf-6). At least two other nuclear-capable ballistic missiles are under development: the short-range Shaheen-1 A and medium-range Shaheen-3.

After six test-launches, with the most recent on February 15, 2013, the short-range, solid-fuel, single-stage Abdali (Hatf-2) appears to be nearing introduction into the armed forces. The 180-km (111-mile) dual-capable missile will need several army training tests before it becomes fully operational, but warheads may already have been produced for it. The missile has been displayed at parades several times on a four-axle road-mobile Transporter Erector Launcher (TEL).

The short-range, solid-fuel, single-stage Ghaznavi (Hatf-3) was likely derived from the Chinese M-11 missile, of which Pakistan acquired approximately 30 in the early 1990s. In 1996—two years before Pakistan's nuclear tests—a classified US National Intelligence Estimate on China's missile-related assistance to Pakistan concluded that the latter probably had developed nuclear warheads for the M-11 (Smith, 1996). Pakistan conducted two test-launches of the Ghaznavi in 2014, in April and May. Islamabad said the second launch had a range of 290 km (180 miles) and "was the culminating point of the Field Training Exercise of Army Strategic Forces Command which

was aimed at testing the operational readiness of a Strategic Missile Group besides up gradation (*sic*) of various capabilities of Weapon Systems" (ISPR, 2014a). Ghaznavi is carried on a four-axle, road-mobile TEL.

The Shaheen-1 (Hatf-4) is a single-stage, solid-fuel, dual-capable, short-range ballistic missile with a maximum range of 750 km (466 miles) that has been operational since 2003. The Shaheen-1 may be a reverse-engineered Chinese M-9 missile, and is carried on a four-axle, road-mobile TEL similar to the one used for the Ghaznavi. Since 2012, Shaheen-1 test-launches have involved an extended-range version widely referred to as Shaheen-1 A. The Pakistani government, which has declared the range to be 900 km (560 miles), has used both designations: Shaheen-1 A in 2012 (ISPR, 2012a) and Shaheen-1 in 2013 (ISPR, 2013).

One of the most controversial new nuclear-capable missiles in the Pakistani arsenal is the NASR (Hatf-9), a short-range, solid-fuel missile with a range of only 60 km (37 miles). With a range too short to attack strategic targets inside India, NASR appears intended for battlefield use against invading Indian troops.[4] According to the Pakistani government, the NASR "carries nuclear warheads of appropriate yield with high accuracy, shoot and scoot attributes" and was developed as a "quick response system" to "add deterrence value" to Pakistan's strategic weapons development program "at shorter ranges" in order "to deter evolving threats" (ISPR, 2011b). The NASR has been tested using a four-axle, road-mobile TEL that appears to use a snap-on system capable of carrying two or more launch-tube boxes. The most recent NASR test on September 26, 2014 launched four missiles. The previous test in November 2013 also involved a quadruple-salvo launch, and a February 2013 test launched two missiles. (Two previous tests in 2012 and 2011 did not involve salvo launches.) The US intelligence community has listed the NASR as a deployed system since 2013 (NASIC, 2013), but because there have been just five test events, involving launch of a total of 12 missiles, we estimate that deployment is only in its very early stages.

The medium-range, two-stage, solid-fuel version of the Shaheen, known as the Shaheen-2 (Hatf-6), appears to finally have become operational after many years of development. Pakistan's National Defence Complex has assembled Shaheen-2 launchers since at least 2004 or 2005 (Kristensen, 2007), and a 2013 US intelligence community report said that the Shaheen-2 "probably will soon be deployed" (NASIC, 2013). The Pakistani government described the most recent Shaheen-2 test-launch, in November 2014, as a "training launch" marking "the culminating point of the Field Training Exercise of Army Strategic Forces Command which was aimed at ensuring operational readiness of a Strategic Missile Group" (ISPR, 2014b). The US National Air and Space Intelligence Center has several times set the Shaheen-2's range at 2,000 km (1,243 miles), but after the November 2014 test the Pakistani government reported the range as only 1,500 km (932 miles). The Shaheen-2 is carried on a six-axle, road-mobile TEL.

On March 9, 2015, Pakistan conducted a surprise test-launch of an even longer-range version of the Shaheen, which it called the Shaheen-3. The Pakistani government said the missile was capable of delivering a nuclear or conventional warhead to a range of 2,750 km (1,709 miles). Since the range exceeded the north-to-south length of Pakistan, the Shaheen-3 test-launch had an impact point in the Arabian Sea (ISPR, 2015a). Once it becomes operational, the Shaheen-3 will for the first time give Pakistan the capability to reach targets all over India.

Pakistan's oldest and most numerous nuclear-capable medium-range ballistic missile, the Ghauri (Hatf-5), was test-launched on April 15, 2015. The government said the "launch was conducted by a Strategic Missile Group of the Army Strategic Forces Command" for the purpose of "testing the operational and technical readiness of Army Strategic Forces Command" (ISPR, 2015b). The Ghauri is a single-stage, liquid-fuel missile that is launched from a road-mobile TEL. The extra time needed to fuel the missile before launch makes the Ghauri more vulnerable to attack than solid-fuel missiles, so it is possible that the longer-range versions of the Shaheen may eventually replace the Ghauri.[5]

Cruise missiles

Pakistan is developing two new cruise missiles, the ground-launched Babur (Hatf-7) and the air-launched Ra'ad (Hatf-8). According to the Pakistani government, the Babur and Ra'ad both have "stealth capabilities" and "pinpoint accuracy," and each is described as "a low-altitude, terrain-hugging missile with high maneuverability" (ISPR 2011a, 2011c). They are both much slimmer than Pakistan's ballistic missiles, suggesting some success with warhead miniaturization based on plutonium instead of uranium.

The Babur has been test-launched eight times, but not since September 2012, which raises questions about whether it has encountered technical problems. Its road-mobile launcher is a unique four-axle TEL with a three-tube box launcher. After the 2012 tests, the Pakistani government reported the range as 700 km (435 miles) (ISPR, 2012b, 2012c), up from 600 km (373 miles) reported in 2011 (ISPR, 2011a), but the US intelligence community sets the range much lower, at 350 km (217 miles) (NASIC, 2013). The Babur looks similar to the US Tomahawk sea-launched cruise missile, the Chinese DH-10 ground-launched cruise missile, and the Russian air-launched AS-15.

The second cruise missile under development, the air-launched, dual-capable Ra'ad (Hatf-8), has been test-launched four times. The test-launches have been conducted from a Mirage III fighter-bomber. The most recent test-launch was conducted in May 2012; the span of time since then also hints at technical challenges. After the last test, the Pakistani government acknowledged that "'Cruise Technology' is extremely complex," and said that the Ra'ad could deliver nuclear and conventional warheads to a range greater than 350 km, and enable Pakistan "to achieve strategic standoff capability on land and at sea" (ISPR, 2012d).

There are also signs that Pakistan is developing a nuclear weapon—initially probably a nuclear-capable cruise missile—for deployment on submarines. In 2012, the Pakistani navy established

Headquarters Naval Strategic Forces Command (NSFC) for the development and deployment of a sea-based strategic nuclear force. The government said that this command would be the "custodian of the nation's second-strike capability" to "strengthen Pakistan's policy of Credible Minimum Deterrence and ensure regional stability" (ISPR, 2012e).

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Notes

1. Note that the reference in the Sanger and Schmitt (2011) article to "deployed weapons" is a *New York Times* formulation, not a quote from a government official. Weapons and warheads can be two different things, with "weapons" referring to delivery vehicles and "warheads" referring to the bombs they deliver or to reentry vehicles. Sometimes the two terms are used interchangeably. Pakistan's nuclear warheads (bombs and reentry vehicles) are not thought to be "deployed" or mated with their delivery vehicles, but rather kept in storage.
2. These amounts of fissile material per warhead are conservative estimates and they may be less (Cochran and Paine, 1995: 9).
3. For an account of Pakistan's reliance on Chinese nuclear technology and knowhow, see Reed and Stillman (2009: 252).
4. For insightful analyses of Pakistan's nuclear doctrine and potential use of ballistic missiles, see Dalton and Krepon (2015); McCausland (2015); Nayyar and Mian (2015).
5. The Ghauri MRBM is based on North Korea's No Dong missile.

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