Prepared by the
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Pakistan's nuclear forces, 2007

Pakistan, which has a nuclear arsenal of about 60 nuclear weapons, is busily enhancing its nuclear weapons capabilities. In the last five and a half years, Pakistan has deployed two new nuclear-capable ballistic missiles and is readying a third, entered the final development stages of a potentially nuclear-capable cruise missile, started construction of a new plutonium production reactor, and is close to completing a second chemical separation facility.

Pakistan's nuclear weapons program began in earnest after India's "peaceful" nuclear explosion in May 1974. Over a 20-year period, at what is now known as the Abdul Qadeer Khan Research Laboratories in Kahuta near Islamabad, Pakistan pursued a method using gas centrifuges to enrich uranium to produce the fissile material for its nuclear weapons. By the end of the 1980s, with assistance from Canada, China, and France, Pakistan had the capability to rapidly assemble a nuclear device if necessary. A moratorium on the production of highly enriched uranium (HEU) was declared in 1991, but production soon resumed. In late May 1998, Pakistan responded to India's nuclear tests by conducting a small number of nuclear explosions over two days. Seismic measurements of the May 28 and 30 tests suggest that the yields were 9–12 kilotons and 5 kilotons, respectively—lower than what the Pakistani government claimed.[1] Pakistan's first nuclear warheads used an implosion design with a solid core of HEU rather than plutonium, likely requiring 15–20 kilograms of HEU per warhead.

Like other nations that have developed nuclear weapons, Pakistan does not seem content with a first-generation nuclear weapon that uses HEU; it has been pursuing plutonium-based designs for at least a decade. Its 40- to 50-megawatt heavy water Khushab plutonium production reactor, completed in 1998 at Joharabad in the Khushab district of Punjab, is surrounded by six surface-to-air missile batteries to protect against air strikes. Pakistan is building a second heavy water reactor at the Khushab site, which will more than double its plutonium production capability. Our best estimate of the size of the new reactor is that it will be in the 40- to 100-megawatt range.[2]

Plutonium separation takes place at the "New Labs" reprocessing plant next to the Pakistan Institute of Nuclear Science and Technology at Rawalpindi, Pakistan's original chemical separation facility. A 300-megawatt reactor (Chasnupp-1) was completed at Chashma in 1999, and a new chemical separation facility there is nearing completion. Close by is a fuel fabrication plant.[3] The reactors provide the Pakistani military with several options: fabricating weapons that use plutonium cores, mixing plutonium with HEU to make composite cores, or using tritium to "boost" the warheads' yield (loading the reactors' targets with lithium 6 will produce tritium).

These efforts suggest that Pakistan is preparing to increase and enhance its nuclear forces in the coming years, especially if it attempts to match India's ambitious plans to deploy a nuclear triad of aircraft and land- and sea-based missiles. It is difficult to estimate precisely how many nuclear weapons Pakistan has produced and what types they are, and it is equally troublesome to guess what its future plans might be. In 1999, the U.S. Defense Intelligence Agency estimated that Pakistan had 25–35 nuclear warheads.[4] The Institute for Science and International Security's David Albright, a nongovernmental expert who tracks the global amounts of fissile material, estimates that Pakistan had produced 40 kilograms of plutonium and 1,100 kilograms of HEU by the end of 2003—enough, by his measure, for about 60 warheads.[5]

The precise amount of plutonium or uranium needed for a bomb depends upon two variables: the technical capabilities of the scientists and engineers, and the desired yield. The higher the capability, the less material

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is needed, while the higher the yield, the more material is needed. We do not know the skill level of Pakistani bomb designers, but an average technical capability certainly seems plausible. Pakistan's weapons are probably 5–10 kilotons by yield, judging by its few tests. We assume that warhead production has continued since 2003, and with the deployment of two new weapon systems anticipated in the next few years, we estimate a current Pakistani nuclear stockpile of about 60 warheads.

Nuclear-capable aircraft. The aircraft the Pakistani Air Force is most likely to use in a nuclear delivery role is the U.S.-manufactured F-16, although other aircraft, such as the Mirage V or the Chinese-produced A-5, could be used. The United States delivered 28 F-16A (single-seat) and 12 F-16B (two-seat) trainers to the Pakistani Air Force between 1983 and 1987. At least eight of these are no longer in service. Pakistan ordered 11 replacement F-16A/Bs in December 1988, but delivery—and a plan to acquire 60 more F-16s—was held up for nearly 16 years because of the Pressler Amendment, which forbids U.S. military aid to suspected nuclear weapon states. Pakistan's 1998 nuclear tests deepened U.S. opposition to delivering the aircraft, but attempts to enlist Pakistan as an ally against the Taliban in Afghanistan prompted President George W. Bush to waive the Pressler Amendment on September 22, 2001, so that the aircraft could be delivered. On March 25, 2005, the Bush administration announced that it would resume sales of aircraft to Pakistan, and Pakistan quickly asked for 86 F-16s.

The F-16s most likely to have been modified to carry nuclear weapons are deployed with Squadrons 9 and 11 at Sargodha Air Base (AB), 160 kilometers (100 miles) northwest of Lahore. The F-16 has a refueled range of more than 1,600 kilometers (1,000 miles), more if drop tanks are used. It can carry up to 5,450 kilograms externally on one under-fuselage centerline pylon and six underwing stations. The F-16s with nuclear missions in NATO can each carry up to two B61 nuclear bombs, but Pakistan's F-16s most likely carry a single bomb on the centerline pylon because its weapons are probably heavier than the B61.

Sargodha AB's weapons storage area has igloos but lacks the extra security features that would indicate storage of nuclear weapons. Given this, the assembled nuclear bombs and/or bomb components for the F-16s may be kept at the large Sargodha Weapons Storage Complex 10 kilometers (6 miles) south of Sargodha. An alternative possibility is that, fearing a first strike by India if war were to break out, Pakistan stores its weapons at other operational or satellite bases west of Sargodha, where the F-16s could disperse to pick up their bombs.

Ballistic missiles. Pakistan has three types of ballistic missiles that are considered capable of delivering a nuclear warhead. This includes the short-range ballistic missiles Ghaznavi (Hatf-3) and Shaheen-1 (Hatf-4) and the medium-range Ghauri (Hatf-5). A fourth missile, Shaheen-2 (Hatf-6), is under development.

The Ghaznavi entered service in 2004. The solid-fueled, single-stage missile can deliver a 500-kilogram payload to approximately 400 kilometers (250 miles). It is believed to be derived from the Chinese M-11 missile, of which approximately 30 were delivered to Pakistan in the early 1990s. The Ghaznavi is launched from a four-axle, road-mobile transporter-erector-launcher (TEL); Pakistan deploys fewer than 50 launchers for it. Some Ghaznavis are thought to be deployed at the Sargodha Weapons Storage Complex, which has 12 missile garages. A Ghaznavi was test-launched on December 9, 2006, from an undisclosed location in what the Pakistan Army's Strategic Force Command described as "the culmination phase of the training exercise, which validated the operational readiness of the Strategic Missile Group (SMG) equipped with Ghaznavi missiles."[6]

Pakistan's Shaheen-1 ("eagle") is a reverse-engineered M-9 missile originally supplied by China. The solid-fueled, single-stage missile has been in service since 2003, can strike targets in excess of 450 kilometers, or 280 miles (some say 700 kilometers, or 435 miles), and can deliver a payload of up to 1,000 kilograms. It is carried on a four-axle, road-mobile TEL similar to the one that carries the Ghaznavi, and like the Ghaznavi, fewer than 50 launchers are deployed for it. The Shaheen-1 was last test-launched on November 29, 2006.

Islamabad claims that its two-stage Shaheen-2 medium-range ballistic missile, unveiled seven years ago at the Pakistan Day parade but still

Pakistan's arsenal, 2007

	TYPE*	RANGE** (KILOMETERS)	PAYLOAD (KILOGRAMS)
AIRCRAFT	**F-16A/B**	1,600	4,500
BALLISTIC MISSILES	**Ghaznavi (Hatf-3)**	~400	500
	Shaheen-1 (Hatf-4)	>450	1,000
	Shaheen-2 (Hatf-6)* **	2,000–2,500	N/A
	Ghauri (Hatf-5)	>1,200	1,000
CRUISE MISSILE	**Babur (Hatf-7)*** **	~500	N/A

* We estimate that Pakistan has approximately 60 nuclear warheads for these delivery vehicles.

** Missile payloads may have to be reduced to achieve maximum range. Aircraft range is for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading.

*** Under development.

under development, has a range of 2,500 kilometers (1,555 miles) and can carry a 1,000-kilogram payload. It is carried on a six-axle, road-mobile TEL, and satellite images of the National Defense Complex near Fatehjang show 15 TELs at various stages of being equipped with their missile erector. A Shaheen-2 was test-launched February 23, 2007, to a range of 2,000 kilometers (1,240 miles).

Rumors about one or more extended-range versions of the Ghauri appear to have been mistaken. U.S. Air Force intelligence overviews from 2003 and 2006 do not list new Ghauri missiles under development.

Cruise missiles. Pakistan is also developing a cruise missile that U.S. Air Force intelligence estimates may be nuclear-capable. The Babur (Hatf-7) cruise missile was first test-launched on August 11, 2005, and a ground-launched version was test-flown on March 21, 2006, with President Gen. Pervez Musharraf in the audience. The Babur reportedly has a range of approximately 500 kilometers (310 miles) and has been described by Pakistani officials as a "low-flying, terrain-hugging missile with high maneuverability, pinpoint accuracy, and radar-avoidance features."[7] The Babur missile appears similar to the new Chinese DH-10 air-launched cruise missile, which is suspected to be a reverse-engineered U.S. Tomahawk cruise missile. At the 2006 test-flight ceremony, Musharraf said that the "strategic program, which had come to symbolize the nation's resolve for its security, will continue to go from strength to strength with credible minimum deterrence as the cornerstone."[8] The Babur is slimmer than Pakistan's ballistic missiles, which suggests that Pakistani engineers have made progress in warhead miniaturization. In addition to the ground-launched version, Pakistan is also developing sea- and air-launched versions of the cruise missile.

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