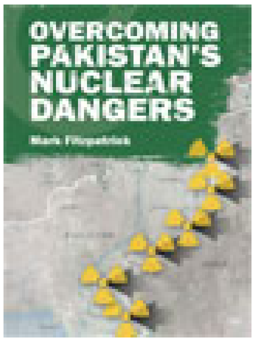

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Chapter One: Pakistan's nuclear programme

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CHAPTER ONE

Pakistan's nuclear programme

In the past few years, Pakistan's nuclear arsenal and strategy have undergone dramatic changes. The first generation of the arsenal consisted of a small number of free-fall weapons based on highly enriched uranium (HEU). Today, Pakistan has moved to plutonium-based weapons that are deliverable by nine different ballistic- and cruise-missile systems and provide options for battlefield use. The latter capability has lowered the nuclear threshold.

Beginnings

Pakistan's nuclear endeavours began with peaceful intentions. In 1955, it was one of the first countries to take advantage of US President Dwight D. Eisenhower's 'Atoms for Peace' programme, signing an agreement for cooperation on the peaceful use of nuclear energy. The Pakistan Atomic Energy Commission (PAEC) was established in 1956 and soon after, hundreds of students were sent overseas for training in nuclear-related fields. In 1963, the Pakistan Institute of Nuclear Sciences and Technology (PINSTECH) was established near Rawalpindi. The United States supplied a 5MWt[1] (megawatt, thermal) civilian research reactor, called PARR-1 (Pakistan Atomic Research Reactor), which went critical in 1965, using 93% HEU fuel. Later it was converted to run on 19.75% enriched uranium fuel and upgraded to 10MWt. In 1972, Pakistan inaugurated a Canadian-supplied nuclear power plant, the 137MWe KANUPP-1 (Karachi Nuclear Power Plant). In 1989, China provided a very small 27kW (kilowatt) research reactor, PARR-2. All three reactors were put under safeguards by the International Atomic Energy Agency (IAEA) under a facility-specific agreement to ensure they would be kept to civilian use.

As minister of mineral resources from 1958 to 1962, Zulfiqar Ali Bhutto was a strong supporter of the civilian programme, but he soon came to advocate that Pakistan should also harness nuclear technology for military purposes. Fear of domination by India, distrust of the US alliance and concern that growing international interest in a treaty to ban the spread of nuclear weapons would close the door on Pakistan's options were among his motivations.[2] In 1964, when China first tested a nuclear weapon, Bhutto, who by then was foreign minister, concluded that India would also go nuclear and that Pakistan would therefore need to as well. In March the next year, as the 1965 India–Pakistan War began to heat up, he famously declared in an interview with the *Manchester Guardian* that 'if India makes an atom bomb, then even if we have to feed on grass and leaves – or even if we have to starve – we shall also produce an atom bomb as we would be left with no other alternative.'[3]

The timeline is significant. Contrary to popular belief that India's nuclear programme stimulated Pakistan to follow the same path, Bhutto began lobbying for nuclear weapons before there was conclusive evidence that India would have the bomb. He was correct, of course, in anticipating India's path but it was not initially an action–reaction sequence. Rather, he

Map 1. **Pakistan's nuclear facilities**

was acting on expectations, a pattern that would be repeated in the unfolding of Pakistan's nuclear history. And as with later events, the US role was significant. As Bhutto makes clear in a monograph he wrote in 1967, the deterioration of US–Pakistan relations was a major factor in his quest for a nuclear deterrent.[4] He was particularly bitter about Washington's failure to come to Pakistan's aid in the 1965 war, as he contended had been guaranteed, and about US economic support for India. He also argued that if Washington's extended deterrence was not good enough for France, it should not be relied upon by Pakistan either. In December 1965, however, President Ayub Khan rejected the idea of pursuing unsafeguarded sensitive nuclear technologies, claiming that Pakistan could buy a bomb off the shelf if it was ever needed.[5]

In 1971, after Pakistan suffered a humiliating defeat to India and the loss of its eastern half (now Bangladesh), and after Bhutto became president, an early priority was to put his nuclear disposition into practice. At a meeting in Multan in January 1972, he asked a group of scientists and officials – unrealistically – to produce a weapon in five years' time. US-trained scientist Munir Ahmad Khan was put in charge of PAEC to oversee the development.

India's first nuclear test in March 1974 gave urgency to the project and the next month a cabinet meeting confirmed a decision to build nuclear weapons, transforming what until then had been seen as a hedging option.[6] PAEC pursued both paths to a nuclear weapon: plutonium via reprocessing spent reactor fuel and HEU.

The uranium path was boosted when A.Q. Khan, then working at a Dutch company connected to the Urenco uranium-enrichment consortium, wrote to Bhutto in September 1974 offering his services. A year later the metallurgist returned to Pakistan with stolen designs of gas centrifuges. He initially was put to work in PAEC, but clashes with M.A. Khan led to Bhutto assigning him full control over the centrifuge project in his own laboratory at Kahuta, later named the Khan Research Laboratories.[7] By April 1984, A.Q. Khan announced the production of HEU, and eight months later said in a promotional video that Pakistan was in a position to detonate a nuclear device 'on a week's notice'.[8] This was probably an exaggeration given that the centrifuge project was marred by technical difficulties and three major earthquakes had destroyed thousands of machines.[9] Meanwhile, on 11 March 1983 PAEC had conducted the first of 24 cold tests of a nuclear device at Kirana Hills in central Punjab.[10] In 1986, a US National Intelligence Estimate concluded that Pakistan was only 'two screwdriver turns' from assembling a weapon and could do so within two weeks of making a decision.[11] The earliest credible report of weapons assembly, however, did not come until the 1990 Kashmir conflict.

Uranium enrichment

Until recently, uranium enrichment was the mainstay of Pakistan's nuclear-weapons programme, while the plutonium infrastructure lay dormant for want of unsafeguarded spent fuel for reprocessing until the completion of the Khushab-1 reactor in 1997 and its commissioning in the following April. The nuclear devices detonated in May 1998 were widely assessed to have used HEU. Pakistan announced that five tests were conducted on 28 May – the same number that India had tested two weeks earlier – two with yields of 25kt and 15kt respectively, and three sub-kiloton tactical devices. The tests generated only one seismic signal, however, which indicated a total yield of 6–13kt. According to Feroz Khan, only one real bomb was exploded, while four other bomb designs were tested 'with triggers and natural uranium'.[12]

An additional test on 30 May at a separate location had a claimed yield of 18–20kt.[13] International experts assessed a much lower yield of 2–8kt, which suggests a fizzle, although it was claimed to be a miniaturised device.[14] According to some reports, including an initial air-sample analysis by the US Los Alamos National Laboratory, the 30 May test was of a plutonium device, although it is unknown where Pakistan could have obtained and separated the plutonium before secret facilities for this purpose were fully operational.[15] What fissile material was used in that test is relevant today in terms of the credibility of Pakistan's battlefield-use nuclear weapons.

Pakistan's enrichment capacity and stockpile are state secrets. Production capacity is estimated to be approximately 100kg of weapons-grade (90%) HEU a year,[16] but may be up to 180kg per year, according to some estimates.[17] Assuming that Pakistan's warheads each require 15–20kg of HEU,[18] that is enough for 5–7 weapons per year, but possibly up to 12. Production sufficient for six weapons per year is a reasonable estimate.

The HEU production estimates vary depending on assumptions about the type of centrifuge employed, for example to what extent the second-generation (P-2) designs that A.Q. Khan stole from the Netherlands are supplemented by more advanced P-3 and P-4 models.[19] According to eminent Pakistani physicist Pervez Hoodbhoy, at least a few thousand of the more advanced models must be in operation by now, hence the yearly HEU production rate can be expected to be several times larger than in the mid-1980s when Kahuta began operating.[20] In addition to Kahuta, smaller enrichment facilities were set up as research and development (R&D) or pilot plants at Gadwal, Sihala and Golra, all located 20–30km from Islamabad,[21] although they probably do not add significantly to the HEU production taking place at Kahuta.

A significant expansion of Pakistan's enrichment production would require complementary expansion of uranium hexafluoride (UF_6) feedstock production. In 2009, commercial satellite imagery appeared to show an expansion of the uranium-conversion facilities at Dera Ghazi Khan.[22] Pakistani scholar Mansoor Ahmed argues that the purpose of any such expansion would be to increase production of uranium oxide for fabricating natural (un-enriched) uranium fuel for new Khushab reactors.[23] He notes that the complex at Dera Ghazi

Khan is reported to have an annual production capacity of at least 200 tonnes of UF_6 – enough for 15,000–20,000 separative work units (SWU) per year.[24] This would be insufficient for the up to 45,000 SWU per year posited as an upper bound by the International Panel on Fissile Materials.[25]

By the end of 2012, the International Panel on Fissile Material estimated Pakistan's total production of HEU to be around 3 tonnes, plus or minus 1.2 tonnes.[26] Assuming 15–20kg is used for each bomb, this translates to a wide estimate of 90–280 weapons. As noted below, most analysts favour the low end of this range.

Plutonium production

As A.Q. Khan perfected enrichment, PAEC, in competition, continued work on plutonium. With assistance from several European companies, PAEC constructed the New Labs pilot plant for reprocessing at the PINSTECH complex which became operational in the early 1980s. To produce plutonium away from the eyes of the IAEA, PAEC in 1986 began constructing a heavy-water moderated 50MWt reactor at Khushab with Chinese assistance. The unsafeguarded reactor, which went critical in 1998, can produce 6–12kg of plutonium per year.[27] A second, similarly sized reactor at Khushab was begun between 2000 and 2002[28] and started operation in late 2009 or early 2010. In 2000, the New Labs facility began separating the plutonium from Khushab-1. Current annual production of separated plutonium is estimated to be about 12–24kg, enough for 2–5 weapons, assuming each requires 5–6kg.[29] At the beginning of 2013, Pakistan was assessed to have a stockpile of 100–200kg of plutonium, enough for 16–40 weapons.[30]

Within the last decade, Pakistan has been putting greater effort into expanding its plutonium-production capabilities. A third plutonium-production reactor at Khushab, which was begun in 2006, appears to be operational.[31] A fourth reactor, under construction since 2011, may begin production by 2015. The larger size of their cooling towers suggests to some analysts that Khushab-2 and -3 are respectively 35% and 65% larger than Khushab-1 in terms of thermal capacity (66MWt and 81MWt respectively).[32] There may be other explanations for the larger cooling towers.[33] Khushab-4 is probably at least the same size as Khushab-3. Together, the four reactors will be able to produce roughly 64kg of plutonium a year, enough for 10–12 plutonium weapons.

To reprocess this increased plutonium production, Pakistan has resumed construction of a large reprocessing plant at Chashma, near Khushab, most of which was built by France before it pulled out of the project in 1978.[34] Another new reprocessing plant is presumed to be under construction next to the existing one at the New Labs facility[35] or that plant's capacity might have been doubled.

Warheads

In addition to free-fall bomb models prepared by PAEC, Pakistan obtained a tested design from China of a 15–25kt HEU implosion-type warhead that is capable of delivery by either aircraft or missiles. This was the design that A.Q. Khan sold to Libya in 2001–02 for a warhead weighing about 500kg and measuring about 90cm in diameter. Foreign investigation of the Khan network later uncovered the existence of two other sophisticated designs for smaller, lighter and more powerful warheads than the first design from China.[36] According to two former US weapons designers, China also assisted by testing a Pakistani weapon design in 1990 with a yield of 10–12kt, although this is not confirmed.[37]

Given its expansion in plutonium production, for the past several years, Pakistan has been considered to have the fastest-growing nuclear-weapons programme in the world.[38] For eight years after the 1998 test, Pakistan's nuclear arsenal was assessed to have expanded by six weapons annually. Beginning in 2007, ten weapons a year were assumed to have been added.[39] With reprocessing of spent fuel from the third Khushab reactor, the estimate increases to about 13 weapons a year. By about 2016, after the fourth Khushab reactor comes online, the annual production could reach 16 or more.

Bruce Riedel, a former CIA analyst who served in the US National Security Council, judges that if it has not done so already, Pakistan's nuclear arsenal will soon surpass that of the United Kingdom,[40] which has no more than 225 weapons and will reduce this number to 180 by the mid-2020s. According to Riedel, Pakistan is even on course to become the fourth-largest nuclear-weapons state, ahead of France,[41] which is deemed to have 300 weapons.

All published estimates of Pakistan's nuclear arsenal are notional; nobody outside a select group within the nation's nuclear establishment knows for certain. Most estimates are based on assumptions about the amount of HEU and separated plutonium used for each weapon, the amount of fissile material produced and the amount converted into weapon cores, taking into account that perhaps 30% of the fissile material is held up in the production pipeline or is otherwise not immediately available for weapons purposes.[42] Washington-based nuclear-weapons specialists Hans Kristensen and Robert Norris estimate that in late 2010, Islamabad had enough fissile material for 160–249 warheads.[43] Fissile material is not the only constraining factor, however. There may be limits to Pakistan's capacity for converting highly enriched UF_6 to metal, and for producing and fabricating the 2,000 parts that comprise nuclear weapons.[44] The number of nuclear-capable launch vehicles is sometimes also considered when deriving arsenal estimates.

The most reliable expert sources assess that as of 2013, Pakistan had about 100–120 nuclear weapons. This is the range provided by the Stockholm International Peace Research Institute for its *Yearbook 2013*, which increased the estimate by ten over the previous year. As of 2014, the arsenal numbers about 110–130. It is possible, however, to calculate a number twice this size.

Pakistan could increase its bomb output by perhaps 60% above typical estimates if a composite core is used, combining a 2–3kg plutonium sphere surrounded by an HEU shell.[45] It is not known if Pakistan uses such a weapons design, but according to Hoodbhoy there is little doubt that Pakistan is seeking to do so. He notes that a plasma-physics group at PAEC has long researched fusion-weapon matters, albeit with little apparent progress.[46]

A caveat is needed here, however. Pakistan's nuclear arsenal will not grow inexorably along an upward trajectory. One reason is because the nation has limited sources of uranium ore. Since 2003, Pakistan's uranium-ore production has remained stable at 40 tonnes per year. This is sufficient to provide fuel for natural uranium-fuelled reactors with a capacity of about 150MWt or three of the Khushab-1-sized plants.[47] But the HEU programme also needs uranium ore. Given these requirements, Ahmed estimates that at current production levels, and unless fresh reserves begin production, the ore might be exhausted by 2020.[48] It could happen even sooner if the newer Khushab reactors are larger than the first one.

Pakistan cannot easily import more uranium because, unlike India, it has been denied an exception to Nuclear Suppliers Group (NSG) guidelines that prohibit nuclear cooperation with non-adherents to the Nuclear Non-Proliferation Treaty (NPT). The enriched uranium fuel that Pakistan receives from China under a grandfathered agreement can only be used in civilian reactors. A high-priority search for additional uranium deposits appears to have produced more media hype than actual results.

Even if no other uranium deposits are discovered, there are three other potential sources of uranium. The easiest source is in the depleted uranium tails from Pakistan's enrichment programme to date. The tails contain about 0.2–0.3% U-235 content. Uranium with a U-235 content of about 0.6% is also available in the spent fuel from military reactors and, at lower enrichment levels, in spent fuel from power reactors. The uranium could be separated using existing reprocessing facilities. A third possibility is the extraction of uranium from rock phosphate, which is removed anyway when di-ammonium phosphate is produced for fertiliser. Pakistan has been producing this fertiliser since 1999 and freely imports phosphoric acid from Morocco.[49] Although extracting uranium in this manner is not economical for commercial ventures, it may suffice for military purposes. Whether any or all of these methods would produce enough uranium for a further expansion in Pakistan's fissile-material production is unclear.

In addition to constraints imposed by the availability of uranium, the size of the arsenal will depend on perceived needs, which can change. Although Pakistan insists that it is not necessary to match India 'weapon for weapon', the size and composition of India's arsenal are significant factors in Pakistan's strategic plans. Pakistani officials have occasionally posited that India aims to acquire 400 nuclear weapons.[50] In 2004, an Indian Ministry of Defence official was quoted as saying that India in the next 5–7 years would have 300–400 fission and thermonuclear weapons distributed to air, sea and land forces.[51] Apart from that unscripted remark by an unnamed official, India has never assigned a specific number to its nuclear policy of credible minimum deterrence. Nor has

Pakistan. The nation's official line is that it needs only enough to deter India. It is doubtful that Pakistan would feel the need for 400 for this purpose, even if India were judged to have that many. The number depends on targeting requirements. American arms-control expert Michael Krepon concludes that at present, the nuclear requirements emphasise credibility over minimalism. The stockpile will likely continue to expand as long as the programme is seen as successful, relations with India remain contentious and Pakistan's sense of international isolation worsens.[52]

According to a senior Pakistani official, by about 2020, plutonium production may be adequate for its defence purposes, although those requirements could change depending on the international environment.[53] Ahmed contends that if uranium-ore limits are reached in 2020, it would impose an upper limit of about 200–250 weapons.[54] Similarly, a senior Pakistani official told a European scholar: 'if China doesn't need more than 200–250 weapons, why should we?'[55]

Delivery systems

The first nuclear weapons were developed for delivery by F-16 A/B model fighter aircraft purchased from the US that were modified indigenously to be nuclear capable. In addition to the F-16s, Pakistan reportedly modified *Mirage*-V fighters from France for use in nuclear missions as well as recently acquired Chinese JF-17 *Thunder* fighters (replacing Chinese A-5 fighters).

When US legislation threatened to cut off military sales over the nuclear programme, Pakistan turned to China and North Korea for ballistic-missile cooperation. Starting in 1988, China supplied the 250–300km-range solid-fuelled M-11 missile, which Pakistan called *Ghaznavi* (after an eleventh-century Afghan conqueror) or *Hatf*-III,[56] and the 700km-range solid-fuelled M-9, which Pakistan named *Hatf*-IV (or *Shaheen* meaning falcon). In 1993, a deal was struck with North Korea to obtain the liquid-fuelled 1,200km-range *Nodong*, which was renamed *Ghauri* (after a twelfth-century Muslim ruler) or *Hatf*-V.

Pakistan today gives priority to solid-fuelled missiles, which are easier to transport and faster to launch. In 2012, the range of the *Shaheen* was extended to over 1,000km. Under development is the *Shaheen*-2 (*Hatf*-VI) missile with a range of 2,000–2,500km, which would bring all of India's major cities within range. It is seen as the mainstay of the nation's future deterrent.[57]

A new missile system that has caused alarm in Western capitals has a far shorter reach. On 19 April 2011, Pakistan announced the successful test of a 60km-range artillery-launched short-range ballistic missile (SRBM) identified as *Hatf*-IX (or *Nasr*, meaning victory). It was tested again in May 2012, February 2013 and November 2013. Designed for battlefield use, the solid-fuelled missile is carried by a multi-tube transporter-erector launcher (TEL) that is also used for some conventional multi-launch rocket systems.[58] The missile has an apparent diameter of about 361mm, meaning it is able to fire rockets with a diameter of 350mm.[59] It can carry both conventional high-explosive warheads and boosted-fission nuclear devices.[60]

Another solid-fuelled SRBM, the *Hatf*-II (or *Abdali*, named after an eighteenth-century Afghan king), with a range of 180km, is also designed to fire both conventional and nuclear weapons. It was first flight-tested in 2002, but the dual-use purpose was not claimed until the second test in 2003.[61] It is 560mm in diameter and can carry a warhead up to 500kg. The missile was tested again in 2005, 2006, 2007, 2011, 2012 and 2013. A press release after the March 2012 test said the *Abdali* 'provides an operational level capability to Pakistan's Strategic Forces, additional to the strategic and tactical level capability, which Pakistan already possesses'.[62]

Pakistan is also developing nuclear-capable cruise missiles: the 500–700km-range ground-launched *Hatf*-VII (or *Babur*, named after the first Mughal emperor) and the 350km-range air-launched *Hatf*-VIII (or *Ra'ad*, meaning thunder), both with a fuselage diameter of 520mm. According to press releases, these are low-flying, terrain-hugging missiles that can deliver both nuclear and conventional warheads with pinpoint accuracy.[63] Air- and sea-launched versions of the *Babur* are also planned.[64]

Although a sea-launched *Babur* could not threaten New Delhi, which is beyond its range, such a system would give Pakistan a more reliable second-strike capability. Indeed, the military describes the Naval Strategic Force Command as the 'custodian of the nation's 2nd strike capability'.[65] The *Babur* missiles would likely be deployed in Pakistan's five *Agosta*-class submarines, which were acquired from France and are currently equipped with anti-ship *Exocet* missiles. Pakistan may also intend to deploy nuclear cruise missiles on new diesel-electric submarines that are supposedly to be purchased from China.[66] However, China itself does not yet field a credible submarine-launched nuclear missile. Some analysts argue that Pakistan does not have the budget to bring the desired triad to fruition.[67]

Whether Pakistan has reliable nuclear weapons for the short-range systems is a matter of some doubt among outside observers. Nuclear weapons small enough for these missiles would probably need to use a plutonium core and it is generally assumed that the complexity of such devices requires testing for assured reliability.[68] As noted above, it is also believed that Pakistan has never tested a plutonium weapon. One possible answer may be that Chinese HEU bomb-design assistance to Pakistan was complemented by a design for a small plutonium bomb, although there is no evidence of such a transfer. A more likely possibility, advocated by Pakistani analysts, is that 20 years of sub-critical cold tests of small plutonium bombs have given the Pakistan military sufficient confidence to introduce the systems without hot testing.[69] India chooses not to believe it and so portrays disinterest in the *Nasr*.[70] But India cannot assume that Pakistan's plutonium warheads would not work. As far as is known, every nuclear-armed country has succeeded in producing a fissile reaction in its first nuclear test.

Nuclear policy

Believing that declared doctrines are nothing but 'verbal posturing' meant only for diplomatic argumentation,[71] Pakistan has not publicly proclaimed a nuclear doctrine as such. Yet on the basis of Strategic Plans Division (SPD) briefings to select visitors and articles by SPD officials, the central tenets of its nuclear posture are clear. Krepon identifies four: an India-specific focus; minimum credible deterrence; readiness to employ against conventional attack; and dynamic strategic requirements.[72]

India specific

Pakistan's stated policy is 'to deter all forms of external aggression'. Like all nuclear powers, Pakistan insists that its nuclear weapons are for defensive purposes. An SPD briefing to a team from the International Institute for Strategic Studies (IISS) in 2013 asserted that 'nuclear weapons are solely for deterrence against aggression, and if deterrence breaks down, then for the defence of sovereignty.'[73]

On occasion, Pakistani officials have spoken about deterring Israel and even the United States.[74] Yet the motivations behind Pakistan's policy are entirely India-specific. Every aspect of Pakistan's nuclear posture has been conceived with that potential aggressor in mind. The first clear exposition of Pakistan's nuclear doctrine, authored by three former officials in October 1999 and surely cleared by the bureaucracy, was written in response to a draft India nuclear doctrine, for example.[75] More recently, SPD Arms Control and Disarmament head Khalid Banuri characterised Pakistan's nuclear arsenal as designed 'to deny India the space for launching any kind of aggression against Pakistan'.[76]

Minimum credible deterrence

'Minimum credible deterrence' has been the slogan since the early days of Pakistan's nuclear programme. The catchphrase itself is a take-off of India's 'credible minimum deterrence', in both cases without a comma, meaning that the first adjective modifies the second. Pakistan inverted the first two words, not just to be different but also to put greater emphasis on the need for credibility. What constitutes 'minimum credible deterrence' is left unstated, other than that it 'cannot be quantified in static numbers'.[77]

To buttress the claim concerning minimalism, Pakistani officials point to their unrequited pursuit of a 'strategic restraint regime' (SRR). This concept stems from the aftermath of the 1998 nuclear tests, when the United States engaged India and Pakistan in an intense eight-month period of bilateral dialogues, urging strategic restraint. Washington advocated adoption of a 'minimum deterrence posture', including the establishment of a finite ceiling for fissile-material production. Other elements included: geographical separation of major components of nuclear arsenals and delivery means; the segregation of delivery systems from warhead locations; and declaring non-nuclear delivery systems with their specific locations. Although neither interlocutor accepted what was referred to as a 'strategic pause', Pakistan put forward its own SRR proposal, matching the principle of nuclear restraint with conventional-force restraint.[78] India has never been interested in talks that would address both strategic and conventional forces.

Credibility depends both on possessing reliable nuclear weapons and projecting the will to use them to inflict unacceptable damage. Thus, Pakistani leaders, more often than their Indian counterparts, speak publicly about their nuclear deterrence.[79] President Pervez Musharraf claimed in 2005 that Pakistan had reached the minimum-deterrence level.[80] As French strategic expert Bruno Tertrais notes, this bold statement probably referred to an initial capability to reliably hit a few Indian cities.[81]

The priority attached to credibility over minimalism has accelerated in recent years, as described in the section above on the growing arsenal and fissile-material production capabilities, and the introduction of battlefield-use strategic weapons. The word 'minimum' was even dropped in one press release in December 2010.[82] It might be noted that India also emphasises credibility over minimalism.[83] Those in charge of Pakistan's nuclear forces recognise the need for limits. They insist, therefore, that one of the first elements of their nuclear posture is the 'maintenance of adequate forces within national resources constraints and avoidance of a costly arms race'.[84]

Allowing for first use

Rejecting notions of 'no first use',[85] Pakistan reserves the right to use nuclear weapons against conventional attack. Indeed, this is the basic premise of Pakistan's nuclear posture. Facing a potential enemy at whose hands it has three times suffered defeat and whose conventional superiority grows ever greater, Pakistan sees nuclear weapons as an equaliser. Pakistani officials also place no credence in India's declared no-first-use doctrine. They assume that India would employ nuclear weapons if it judged vital national interests to be at stake. In fact, India qualified its no-first-use policy in 2003, allowing for use in response to a major attack by biological or chemical weapons.

Pakistan does say that it will not 'use or threat[en] to use nuclear weapons against any non-nuclear weapons state – unless that state joins a hostile military coalition and nuclear-armed state(s)'.[86] Pakistan has also said that while it does not subscribe to a no-first-use policy, it does subscribe to 'no first use of force', as required under the UN Charter.[87]

Under what circumstances Pakistan would use nuclear weapons is left deliberately vague. Pakistani officials fear that drawing too clear a red line would embolden Indian action just short of the threshold.[88] In the years immediately after Pakistan's nuclear test, national leaders said that the weapons would be used only if 'national integrity' or the existence of the state were threatened.[89] Two Italian disarmament experts who met with SPD head Lt.-Gen. Khalid Kidwai in January 2001, during a tense period of confrontation at the Line of Control after the December 2001 assault on the Indian parliament, published his reported characterisation of four thresholds for nuclear use. Frequently referred to in other works on Pakistan's nuclear programme, Kidwai said that in case deterrence fails, nuclear weapons would be used if:

a. 'India attacks Pakistan and conquers a large part of its territory (space threshold);
b. India destroys a large part either of its land or air forces (military threshold);
c. India proceeds to the economic strangling of Pakistan (economic strangling), including a naval blockade or blocking the Indus River;
d. India pushes Pakistan into political destabilization or creates a large scale internal subversion in Pakistan (domestic destabilization).'[90]

Insisting that it was not an attempt at nuclear signalling, Pakistani officials explain that the 'plausible' thresholds are indicative and should not be viewed in isolation from one another.[91] Krepon notes that most of these thresholds are relics of Pakistan's past wars with India and have little relevance to current circumstances. He concludes that the most likely threshold for nuclear use would be significant losses of Pakistani combat aircraft.[92] The space threshold is also relevant, but here the threshold is probably much less than 'a large part' of Pakistan's territory. Most analysts assess that the threshold could be as low as an Indian advancement to Pakistan's lifeline in the Indus Valley, which lies 50–190km into Pakistani territory. Based on Pakistani rhetoric, it is conceivable that even a lesser incursion could provoke nuclear retaliation by Pakistan. A purposeful ambiguity concerning its red line for use of low-yield nuclear weapons is intended to complicate the cost-benefit analysis of any of India's options.

In response to the Indian Army's supposed plans for waging a conventional war under the nuclear threshold, Pakistan has lowered that threshold. It is not clear whether the purpose of using battlefield nuclear weapons would be to slow or halt advancing Indian forces or, rather, to send a political signal. Nor has Pakistan indicated whether it would employ nuclear weapons in the event of an Indian precision conventional attack against targets in Pakistan associated with violent jihadist groups, in retaliation for terrorist attacks by them in India.

Dynamic strategic requirements

Strategic requirements are dynamic, depending on changes in the perceived threat posed by India. Pakistan's military and civilian leaders have never said publicly or, as far as can be known, even privately what the requirements are. They say only that they depend on the evolving nature of the threat. The threat, of course, is in the eyes of the beholder. Although analysts discern little aggressive intent on India's part, Pakistani strategists see a less benign neighbour. Their threat perceptions are focused largely on India's capabilities and an often selective reading of Indian statements. India's strategic requirements are not static either, especially in light of China's growing military might. Dynamic strategic postures in all three countries create mutually reinforcing threat perceptions and a spiralling arms competition.

India's growing conventional military capabilities, as much as its nuclear assets, affect Pakistan's strategic requirements. In 2008, Peter Lavoy, American scholar and later Pentagon official on South Asia strategic issues, wrote that Indian advances in intelligence, surveillance and precision targeting that enabled it to locate and destroy strategic targets could prompt Pakistan to lower its nuclear threshold.[93] A Pakistan foreign ministry spokesman made the same point: 'There are acquisitions of sophisticated weaponry by our neighbour which will disturb the conventional balance between our two countries and hence, lower the nuclear threshold.'[94] Pakistani Brigadier Khawar Hanif put it this way: 'The wider the conventional asymmetry, the lower the nuclear threshold.'[95]

In addition to the move away from minimalism, the growth of Pakistan's nuclear arsenal reflects an evolution of its strategic doctrine. For the first decade after Pakistan became a nuclear power, the deterrence strategy was based entirely on countervalue strikes against Indian cities. Today, Pakistan has both countervalue and counterforce nuclear options. Writing in an academic capacity, SPD Arms Control and Disarmament Director Adil Sultan terms the evolving nuclear strategy 'flexible deterrence options', which he says aims for a proportionate response, rather than massive retaliation against India.[96] Pakistani officials, including Prime Minister Nawaz Sharif,[97] speak of the goal of 'full spectrum deterrence' against the full spectrum of perceived Indian threats at the tactical, operational and strategic levels. Deterrence at the tactical level is defined as against limited incursions by Indian mechanised/armoured brigades and infantry divisions. At the operational level, deterrence refers to a sizeable military offensive including mechanised/armoured divisions, strike corps and corps-plus size forces. At the strategic level, it means preventing an all-out war involving two or more strike corps. Sultan adds that while the 60km-range *Nasr* can be considered a battlefield (tactical-use) weapon, the 180km-range *Abdali* provides an operational-level capability,[98] meaning it is for in-theatre use.

The purpose of introducing these shorter-range systems is to restore Pakistan's nuclear deterrence at lower rungs of crisis situations by denying India the space to operate below Pakistan's perceived nuclear threshold – in other words, 'to plug the deterrence gap'.[99] 'Full spectrum deterrence', which has come to supplant 'credible minimum deterrence' as the SPD's preferred catchphrase, means a menu of options from which to choose a proportionate response. Explaining the evolution, Sultan says moving toward 'full-spectrum' increases credibility. He thus employs the phrase 'a strategy of assured deterrence'.[100]

There is a contradiction between lowering the nuclear threshold by positing a flexible nuclear response and insisting, as is usually claimed, that the nuclear weapons would be used only as a last resort, 'in extremis conditions'.[101] The only answer is to redefine 'last resort'. Such redefining, however, can fuel apprehensions about a nation's true intent. Tertrais suggests, for example, that as Pakistan's arsenal and nuclear options grow, its doctrine could evolve toward not just flexible response, but escalation dominance.

No intention to operationalise *Nasr*

The irony about introducing tactical nuclear weapons is that they have little military utility in the role for which they are envisioned: stopping enemy tank offensives. As conclusively demonstrated by Pakistan-born physicists Abdul Hameed Nayyar and Zia Mian, the enemy can effectively diminish the impact by increasing the spacing between tanks. To stop half of a well-dispersed attacking force of 1,000 tanks would require 100 15kt weapons, nearly exhausting Pakistan's nuclear arsenal and making poor use of limited plutonium stockpiles.[102] Exponentially more weapons would be needed to stop enemy tank formations if the short-range nuclear weapons were sub-kiloton, as has been hinted.

It took some years for Pakistan to make up its mind on whether the smaller-yield weapons or indeed any of its weapons would have a war-fighting purpose. Of late, the planners have sought to emphasise that their role is purely for deterrence. Thus, when presented with calculations on the large number of low-yield weapons that would be needed to stop Indian tank formations, the SPD's answer is that only a few such nuclear weapons need be used for demonstration purposes, in order to initiate political moves to end the incursion.[103]

Pakistani military officials even suggest the counter-intuitive point that there is no plan to operationalise *Nasr*. On the basis of a final briefing by SPD before publication of his book in 2012, Feroz Khan wrote: 'Pakistan has no plans to move toward battlefield weapons.'[104] That is to say, there has been no decision to produce the weapon systems or to incorporate them into battlefield tactics or military doctrine. Ahmed adds a practical spin in making the same point: 'Pakistan will never have the fissile material production capacity to develop battlefield nuclear weapons for war-fighting even on a modest scale. Its existing stocks are only good enough for a few weapons for battlefield use mainly for deterrence purposes.'[105] Academic Christopher Clary, who handled South Asia nuclear issues while working in the Office of the US Secretary of Defense, calls the battlefield nuclear capability a 'force in being'.[106]

Monetary costs

As in most nuclear-armed states, the cost of Pakistan's nuclear weapons cannot be accurately measured because of the secrecy of most aspects of the programme. In 2001, retired Major-General Mahmud Ali Durrani estimated that for the next ten years, the programme would likely require about 0.5% of GDP per year.[107] This meant about US$2.5 billion in 2011, based on purchasing power parity (PPP) estimates of Pakistan's GDP, or about 10% of Pakistan's estimated conventional military budget in PPP terms.[108] In 2009, a Pakistani investigative journalist reached a similar conclusion about the relative size of nuclear spending.[109] It is about one-third of what India spends on its nuclear-weapons programme, which in 2010–11 was estimated to be US$7.7bn based on PPP.[110]

To these past calculations one must add the additional cost of the new plutonium-production reactors and reprocessing facilities, the expansion in size and complexity of the arsenal and the development of new delivery platforms. In Pakistan, however, the cost of the nuclear expansion is rarely questioned. Notwithstanding Pakistan's dismal economic state, the nuclear weapons are viewed by most citizens as a source of technological pride and as a necessity to protect national sovereignty. As Krepon puts it, 'money spent on the bomb' is not begrudged.[111] Recognising resource constraints, military leaders insist that they need to avoid a costly nuclear arms race with India. But they point to the huge disparity in overall military spending – Pakistan's military budget is only around 15% of India's[112] – and see nuclear weapons as a cost-effective equaliser.

Civilian nuclear sector

Pakistan's civilian nuclear sector is also under expansion. Three power reactors are currently in operation. In addition to the Canadian-supplied 137MWe KANUPP-1, which has been running for over 40 years, Pakistan has two 300MWe Chinese-built reactors at Chashma: CHASNUPP-1 (which went online in 2000) and CHASNUPP-2 (online in 2011). According to the IAEA, the three reactors contributed 5.34% of total energy output for 2012 (5,271.41 gigawatt hours (GWh) out of a total 98,709.60 GWh).[113] Hoodbhoy says the actual amount of electricity produced is around 1.6–1.8% of the total.[114] In either case, the contribution from nuclear power is small.

Two new 340MWe Chinese reactors under construction at Chashma are scheduled to begin commercial operation in 2016 and 2017. Under NSG guidelines, as a non-signatory to the NPT and lacking the exemption granted to India in 2008, Pakistan is ineligible for cooperation in nuclear energy. China claims that CHASNUPP-3 and -4 were exempted from NSG rules under a grandfather clause, on grounds that the reactors fall under the terms of a civil nuclear agreement struck with Pakistan in 1991 before China joined the NPT in 1992 and the NSG in 2004. Although China never provided details of the terms of the grandfathered deal, other NSG members acquiesced with varying degrees of enthusiasm.[115]

A deal for two more Chinese reactors – at 1,000MWe, three times larger than the others – was finalised in 2013. The new reactors are being built in Karachi, which complicates the grandfathering argument because the 1991 agreement was for power plants at Chashma.

The new China deal will be a first step toward fulfilment of PAEC's plans for a dramatic expansion of the nation's nuclear-energy infrastructure. In 2005 it was announced that the government had tasked the PAEC with the construction of 13 new civilian reactors to increase total capacity to 8,800MWe by 2030 to help solve the nation's energy crisis.[116] In the years since, the energy crisis has steadily worsened, becoming a major issue in the May 2013 elections that returned Nawaz

Sharif as prime minister. Lights often go out for at least ten hours a day in major cities and for up to 22 hours a day in rural areas, sparking deadly riots and denying 2–4 percentage points to annual GNP growth. The supply deficit is estimated to be around 3,000MWe.[117] At a groundbreaking ceremony for the new nuclear power plant at Karachi, Sharif announced a new plan – 'Nuclear Energy Vision 2050' – which envisages nuclear power generation of about 40,000MW by 2050.[118]

However, a shortage of generational capacity is not Pakistan's biggest energy problem. Distribution losses are staggering. The causes lie in corruption, mismanagement, pilfering and a chronic failure across all sectors of the economy to pay for energy consumed. These practices have produced a circular debt crisis that creates cash-flow problems throughout the energy supply chain, resulting in lack of maintenance and repairs and inability to import fuel oil.[119] According to Hoodbhoy: 'The solution lies in rigidly enforcing the rule: you use, you pay ... Stopping power theft would save far more megawatts than will be generated by Chashma's four nuclear reactors combined.'[120]

This is not to deny Pakistan's need to expand power generational capacity to keep pace with the demand. But expanding the civilian nuclear infrastructure may not be the best solution to the energy crisis, given the security implications, safety concerns in a country prone to earthquakes and floods, huge costs and long lead times. As US nuclear-energy analyst Toby Dalton has argued, 'with a highly unstable grid and moribund economy, there are cheaper and faster ways for Pakistan to improve its energy situation than using nuclear.'[121] He argues that improving efficiency by rehabilitating electricity transmission and distribution systems, rebuilding old turbines at hydroelectric facilities and incorporating combined cycle systems (the exhaust of one heat engine is used as the heat source for another) into new thermal electric generation facilities are three ways in which Pakistan could increase available electricity in the near term.[122] Renewable energy sources that, unlike nuclear, do not require a centralised power-generation source may also offer more promise for increasing electrification rates. Pakistan's solar energy potential is rivalled only by the Sahara[123] and there is significant potential for wind-power generation in the Gharo–Keti Bandar wind corridor.[124]

Notes

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