Trends in Technological Maturation and Strategic Modernization: The Next Decade

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The past decade and a half has seen the operationalization of Indian and Pakistani nuclear capability, followed by the consolidation and growth of their strategic forces, operational doctrines and force postures.. Even as technological innovation has been a source of their strategic modernization, it is primarily influenced by the dynamics of evolving force postures in the region—from minimum credible deterrence to credible minimum deterrence and now full-spectrum deterrence—all designed to meet a complex pattern of perceived challenges. This paper explores the impact of technological maturation and innovation on the nuclear learning process in South Asia.

The technological maturation curve is visible through a steady expansion of fissile material production infrastructure and evolution of a triad of strategic delivery platforms for an assured second-strike capability. This process has remained steady where India has been allocating far greater resources to conventional and nuclear force modernization given its rapid economic growth, compared to Pakistan, with the latter attempting to maintain a semblance of strategic balance through innovation and modernization of its strategic forces.

Despite acute resource constraints, Pakistan has been resolutely improving and modernizing its nuclear deterrent, acting as a balancer against India's conventional superiority and nuclear threat. This capability has helped Pakistan to reduce its defense spending since 1998 from 5.3% of GDP ($3.2 billion) to 3.0% ($5.2 billion) in 2010, which amounts to a net decrease in real terms.[1] Nuclear weapons are thus largely viewed as the only affordable option to maintain a credible deterrent against a threat, which is perceived as real and existential. One of the two most significant signs of the evolution and modernization of strategic forces in South Asia is the palpable expansion of fuel cycle facilities—plutonium production and reprocessing and uranium enrichment, designed to produce fissile material for nuclear weapons.

South Asia's Fissile Material Race

Pakistan's expansion of fissile material production infrastructure is largely driven by India's existing advantage in fissile material stockpiles, and is therefore aimed at reducing a yawning gap, particularly in plutonium stocks.[2] In my assessment, a huge disparity with Pakistan exists in

[1] Ian S. Livingston and Michael O'Hanlon, *Pakistan Index: Tracking Variables of Reconstruction and Security* (Brookings Institution: Washington DC: November 29, 2011), 6. Available at http://www.brookings.edu/~/media/Programs/foreign%20policy/pakistan%20index/index20111129.pdf.

[2] India is believed to enjoy a huge advantage in weapon-grade plutonium stocks. Estimates show that as of 2011, India may have accumulated about more than 11.5 tons of potentially weapon-usable unsafeguarded reactor-grade plutonium, with none on the Pakistani side. See Zia Mian, et. al., "Fissile Materials in South Asia and the Implications of the U.S.-India Nuclear Deal," *Science & Global Security* 14, no. 2 (2006), https://www.princeton.edu/sgs/publications/articles/Fissile-Materials-South_Asia-SGS-2006.pdf.

potentially weapon-usable (unsafeguarded) reactor-grade plutonium over and above the weapon-grade plutonium stocks.[3] Further, India is doubling its plutonium production capacities with the construction of new reactors and reprocessing plants.[4] This asymmetry is exacerbated with the rapid expansion of India's centrifuge program for uranium enrichment.[5] Soon India is approaching near-parity with Pakistan in the weapon-grade enriched uranium holdings as well.[6] Pakistan's traditional threat perception is further accentuated by the Indo-US nuclear deal, which allows India to exclusively divert its domestic uranium resources for military program. Consequently, these developments have served to aggravate Pakistan's strategic anxieties, leading up to a corresponding expansion of its fissile material [plutonium] production capacity—at the Khushab production and the New Labs and Chashma reprocessing plants. The country's security anxiety is clearly visible at the Conference on Disarmament in Geneva, where Pakistan is holding out and not participating in negotiations on finalizing a Fissile Material Cut-off Treaty. [7]

Pakistan is calling for the accounting of existing stockpiles of fissile materials before it could agree to a future cut-off in production. In the absence of accountability, existing disparities would freeze to the disadvantage of countries with relatively meager stocks. Pakistan's plutonium production infrastructure was dormant for most part of its nuclear history and it was only able to activate it at relatively late stages in its nuclear operational development. This is because the requirements of an

[3] Although Indian reactor-grade plutonium largely remains in spent reactor fuel and has yet to be reprocessed (and is claimed to have been retained for future use as fuel for India's breeder reactors), it is factored in Pakistani calculations, as reflected by its position on the FMCT. The eight heavy water power reactors designated to remain outside the scope of safeguards under the Indo-US nuclear deal would allow India to add 1250 kg per year of reactor-grade plutonium while three out of six Indian heavy water plants would remain unsafeguarded. If India's (11.5 tons + 4.3 tons = 15.8 tons) of reactor grade plutonium is not put under safeguards, it could theoretically offer India the option to make several hundred warheads (assuming 10 kg per weapon for reactor-grade plutonium). The 500 MW Prototype Fast Breeder Reactor (PFBR) and four additional planned PFBRs are also kept outside safeguards, the PFBR alone can produce 135 kg of WG Pu/year, sufficient for about 25-30 weapons These estimates are based on Ibid and Zia Mian and Alexander Glaser, "Global Fissile Material Report 2011: Nuclear Weapon and Fissile Material Stockpiles and Production," *International Panel on Fissile Materials* (2011), http://fissilematerials.org/library/gfmr11.pdf.

[4] Another unsafeguarded 100 MWt Plutonium Production Reactor (Dhruva-2) is nearing commissioning and another unsafeguarded commercial-scale reprocessing plant at Tarapur was commissioned in January 2011. In addition, plans for building two more reprocessing plants during the next decade were also announced which would also include "a fairly large [reprocessing] facility" at Kalpakkam. Ibid.

[5] Zia Mian, "India developing new centrifuges and increasing enrichment capacity," *IPFM Blog*, June 4, 2010, http://fissilematerials.org/blog/2010/06/india_developing_new_cent.html. In addition to expansion at the RMP, India is also known to be building another enrichment plant at Chitradurga for producing 1.1 percent enriched uranium to fuel India's Pressurized Heavy Water Reactors. This industrial-scale production enrichment facility, like the RMP, would not be placed under safeguards and would meet civil and military needs thus keeping the option open for it to be used for producing weapon-grade HEU. Pavel Podvic, "Some details of India's Nuclear Program," *IPFM Blog*, November 26, 2011. http://www.fissilematerials.org/blog/2011/11/some_details_of_indias_nu.html.

[6] According to a 2004 estimate, the enrichment capacity of the Rattehalli Rare Materials centrifuge plant (RMP) was about 4000 Separative Work Unit or SWU/year. This corresponds to the facility producing about 40-70 kg/year of 45% to 30% enriched uranium respectively. This enrichment capacity could yield 20 kg/year of weapon grade uranium (93% U-235). Hence, the capacity at the end of 2009 is an estimated 14,000 to 31,000 SWU/year, enough to produce one or two submarine-reactor cores per year, or 100-200 kg/year of weapon-grade HEU. Ibid.

[7] Zia Mian and A. H. Nayyar, "Playing the Nuclear Game: Pakistan and the Fissile Material Cut-off Treaty," *Arms Control Today*, (April, 2010). http://www.armscontrol.org/act/2010_04/Mian.

operational deterrent have compounded the urgency to augment plutonium stocks for the production of deliverable missile warheads.[8]

However, this new focus on plutonium production is not to suggest that Pakistan has, or might stop the production of highly enriched uranium. Pakistan continues to expand its uranium hexafluouride production capacity at its Chemical Plants Complex, Dera Ghazi Khan and new generation gas centrifuges at Kahuta are added or replaced without any visible expansion of the Kahuta plant itself.[9]

Nonetheless, in spite of obvious trends in expansion in Pakistan's fissile material infrastructure, there are limitations to the extent to which existing and planned production capacities can be utilized, which could impact the country's force goals. Some studies have speculated that Pakistan will begin to face shortages of natural uranium ore from 2020 onwards,[10] which have increased the urgency to continue to produce fissile material, particularly plutonium, before uranium constraints begin to affect production timelines.

Once the country begins to feel the effects of these shortages, it might have to scale down fissile material production. In this case, Pakistan is likely to prioritize all available uranium ore for making fuel for the Khushab reactors, and keep the HEU program on the backburner, pending fresh discoveries of uranium deposits.[11] However, the construction of the Khushab-IV reactor and the expansion at CPC suggest that Pakistan has confidence in future uranium prospection and processing of additional indigenous uranium resources. The expansion of the Khushab Complex demonstrates that plutonium production has secured priority over HEU production as the preferred fissile material. This is likely to limit production of HEU due to the possible under-utilization of more powerful P3 and P4 centrifuges due to diversion of natural uranium ore in the production of fuel for the Khushab

[8] Commissioned in 1998, the Khushab Nuclear Complex—comprising the 50 MWt plutonium production reactor (K-I/KCP-II) and the heavy water production plant (KCP-I), can on average produce 9-11.5 kg of weapon-grade plutonium in a year. Khushab-II and III, commissioned in 2009 and 2011 respectively, are also believed to be of the same capacity, whereas construction of Khushab-IV is reportedly almost-complete and is likely to be commissioned in the next few years. The latter could also produce around 9-11.5 kg of weapon-grade plutonium. Khushab-I went critical in 1997 and was commissioned the following year. Since then, it would have theoretically produced around 150 kg of weapon-grade plutonium. Khushab-II was commissioned in early 2011. Since then, if it was operated at a similar burn-up and capacity as Khushab-I, it would have yielded another 11.5 kg of weapon-grade plutonium. The New Laboratories reprocessing plant has a reprocessing capacity of handling spent fuel of two 50 MWt Khushab reactors and was inactive since its completion in 1981 for want of unsafeguarded spent fuel. The larger Chashma plant having more than twice the size of New Labs (40-100 kg Pu-239/year) was left half complete by the French in 1978. It has now believed to have been commissioned to handle spent fuel from additional Khushab reactors to reprocess plutonium. IPFM Reports, 2010, 2011.

[9] David Albright, Paul Brannan, and Robert Kelley, "Pakistan Expanding Dera Ghazi Khan Nuclear Site: Time for U.S. to Call for Limits," *Institute for Science and International Security*, May 19, 2009. http://isis-online.org/uploads/isisreports/documents/PakistanExpandingCPC_19May2009.pdf.

[10] See for example Zia Mian, et. al., "Exploring Uranium Resource Constraints on Fissile Material Production in Pakistan" *Science & Global Security*, Vol.17, No.2 (2009). http://www.princeton.edu/sgs/publications/sgs/archive/17-2-3-Mian-Nay-Raj.pdf.

[11] At present, Pakistan has 2.0 to 2.75 tons of HEU and is expected to add 150-200 kg/year of HEU between now and 2020. Each 50 MWt production reactor at Khushab, operating at 70 percent capacity, requires 13 tons of natural uranium fuel each year. This amounts to 52 tons fuel requirement each year for the Khushab Complex alone and is likely to consume the entire estimated annual natural uranium ore production of Pakistan. Ibid.

reactors instead of its processing and conversion into uranium hexafluoride feedstock for enrichment.[12]

Nevertheless, available estimates suggest that Pakistan's current domestic uranium ore production of 40 tons/year is only sufficient for three production reactors at Khushab.[13] With these three reactors, Pakistan could accumulate approximately 450 kg of weapons-grade plutonium by 2020.[14] This stockpile would be sufficient for perhaps 100–240 simple fission weapons based on HEU and 90 plutonium-based weapons, assuming 25 kg of HEU or 5 kg of weapon-grade plutonium per weapon. Pakistan could produce additional number of weapons if it is able to mine more uranium or develops hybrid/composite core designs, combining the plutonium and highly enriched uranium, and once boosted with deuterium-tritium, would require less fissile material.[15]

A theoretical/hypothetical assessment of fissile material stockpiles for India and Pakistan as of early 2013 is as under:

	Weapon-Grade Plutonium (kg)	Reactor-Grade Plutonium (kg)	Highly Enriched Uranium (kg) (@90%)	Warhead*** Worth HEU 20 kg/warhead	Warhead Worth Weapon-Grade Plutonium 4 kg/warhead**	Warhead Worth Reactor-Grade Plutonium (unsafeguarded) 8 kg/ warhead
India	700-890	15800	800*	40	175-222	1975
Pakistan	150	0	1600-2500	80-125	37	0

* Although India's HEU program is aimed at producing fuel for its nuclear submarine reactor, the HEU percentage can be quickly raised from 45% to 90% weapon-grade enrichment. This analysis/table is based on analyses of three reports [https://www.princeton.edu/sgs/publications/articles/Fissile-Materials-South_Asia-SGS-2006.pdf;http://fissilematerials.org/library/gfmr11.pdf; http://fissilematerials.org/library/gfmr13.pdf] with inconsistencies and sharp variations.

** http://www.ricin.com/nuke/bg/bomb.html. This assumes the use of a good neutron reflector. Boosted fission weapons and/or boosted composite cores can further reduce the amount of material required.

*** All warhead estimates are notional.

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[12] In the absence of Khushab-IV, Pakistan could have explored the option to "alternatively move to an arrangement where it use[d] its 40 tons a year of natural uranium production to fuel the three Khushab reactors, and then enriche[d] the reprocessed uranium from their spent fuel to make HEU. This [could] be accomplished with an enrichment capacity of 30,000 SWU, for tails of 0.3 percent. This arrangement could in principle [have] last[ed] for the lifetime of the [three] Khushab reactors, as long as Pakistan can produce at least 40 tons of uranium a year, and would [have] yielded 35 kg of plutonium and 140 kg of HEU per year. In this scenario, much larger enrichment capacities would remain underutilized." Ibid., 101.

[13] Ibid.

[14] Ibid.

[15] Ibid.

The aforementioned estimates reflect the current levels of stockpiles that reflect potential contours of Pakistani and Indian force goals at present. Warhead guestimates can vary considerably depending on the type, sophistication level and their anticipated operational role whose numbers may either increase with the availability of more fissile material in the near future or become static with material constraints. Nonetheless, any force goals would include the development of strategic and non-strategic/tactical/miniaturized warheads (especially in Pakistan's case) which would need to be distributed amongst the nine different types of missile delivery systems along with the air force and the navy.

Pakistan's Strategic Force Posture

A hypothetical estimate of current Pakistani Nuclear Force Requirements shows that the country has diversified its strategic forces consisting of various types of ballistic and cruise missiles—from short-range to medium-range systems with the former built for counter-force targeting and the latter mainly as counter-value delivery systems. These include the *Hatf-1A*, *Hatf-II (Abdali)*, *Hatf-III (Ghaznavi)*, *Hatf-IV (Shaheen-1*, *Shaheen-1A)*, *Hatf-V (Ghauri)*, *Hatf-VI (Shaheen-2)*, *Hatf-VII (Babar)*, *Hatf-VIII (Raad) and Hatf-IX (NASR).*[16] The *Raad* is the air-launched version of the *Babar* Land Attack Cruise Missile (LACM) while its naval version is also believed to be under development. If each one of the aforementioned systems were theoretically allocated ten warheads, it would require a total of ninety warheads. This would leave another thirty warheads for the NASR and the SLCM/LACM each that would consume the near-total allocation for the estimated warheads which Pakistan can currently produce from its existing stockpile of fissile material. Considering the ongoing diversification of Indian delivery platforms and an emerging Indian triad, Pakistan's response options could be:

- Build a deterrent force comprising at least 250-300 triad-based warheads.
- Accumulate enough plutonium for 200 nuclear (and some thermonuclear) weapons of 20-200 kilotons. This is needed for ballistic and cruise missiles and/or future development of Multiple Independently Targetable Re-entry Vehicles (MIRVed) missiles in the wake of Indian Ballistic Missile Defense (BMD) plans.

Thus a 200-warhead force requires a weapon-grade plutonium stockpile of at least 800 kg and a 100-warhead force would probably need 400 kg between now and 2020. The same force, if boosted by tritium, may require less than half weapon-grade plutonium, i.e. 200-400 kg.

India's Strategic Triad and Modernization

India is known to be actively developing a BMD system and is vigorously erecting a nuclear triad. The flight test of the 5000 km Agni-V solid-fuelled ballistic missile in April 2012 was dubbed as an Intercontinental Ballistic Missile (ICBM), expected to be operational by 2015. It would also be

[16] For details, see Feroz Hassan Khan, *Eating Grass: The Making of the Pakistani Bomb* (Palo Alto: Stanford University Press, 2012), 250.

equipped with MIRVs, designed to defeat enemy missile defenses.[17] India also carried out a maiden test of its 290-km range, supersonic SLCM *Brahmos*, which was declared to be "ready for fitment on submarines in vertical launch configuration."[18] India also has plans to develop submarine launched ballistic missiles (SLBMs)—the 750 km-range K-15 *Sagarika*, whose development trials were completed in January 2013 with the twelfth test carried out "from an underwater pontoon simulating a submarine launcher." It is designed to carry a 1000 kg nuclear warhead from the *Arihant* SSBNs[19], each boat capable of carrying12 K-15 missiles which would later be replaced by the 3500 km-range K-X SLBMs. Three additional *Arihant*-class SSBNs are under construction— one at Visakhapatnam and two in Vadodara, India.[20] The first nuclear powered vessel of this class was launched in July 2009 at Visakhapatnam by Prime Minister Manmohan Singh with great fanfare, with talk of India joining the elite club of nations equipped with nuclear submarines.[21]

Pakistan's Quest for a Credible Deterrent

In view of the growing Indian nuclear, missile and offensive capabilities, Pakistan is likely to opt for an affordable and effective response. It does not have access to missile defense technology, nor is likely to acquire it from a foreign supplier. Therefore, it is expected to resort to the development of indigenous capabilities to neutralize any Indian missile shield, which could undermine the strategic balance in the region. Such systems include the *Babar* and *Raad* LACMs/SLCMs; maneuverable warheads for single-warhead ballistic missiles and/or decoy equipped solid-fuelled (*Shaheen-IA*, *Ghaznavi*, *Abdali*); and MIRVs for a possible future version of Shaheen-3 long-range ballistic missile.

Counter-force targeting using the 700 km-range *Babar* and 350 km-range *Raad* land and air launched cruise missiles is assuming added significance for Pakistan since they can be launched from stand-off ranges, out of reach of Indian air defenses.[22] Between 1998 and 2012, India and Pakistan have carried out a total of 60 and 55 flight tests of nuclear-capable missiles respectively—32 ballistic and 28 cruise missile tests for India and 42 ballistic,13 cruise missile tests.[23] Pakistan's cruise missile development program—whose tests commenced in 2005—appears to have been influenced by

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[17] Raja Pandit, "Agni-V, India's first ICBM test-fired successfully," *The Times of India*, April 19, 2012. http://articles.timesofindia.indiatimes.com/2012-04-19/india/31367147_1_agni-v-mirv-payload-targetable-re-entry-vehicles.

[18] Press Trust of India, "India test-fires submarine-launched version of BrahMos missile," *Times of India*, March 20, 2013. http://articles.timesofindia.indiatimes.com/2013-03-20/india/37871259_1_underwater-pontoon-brahmos-missile-cruise-missile.

[19] Nuclear Powered Ballistic Missile Submarine

[20] "Indian Navy's K-15 SLBM successfully completes development trials," January 29, 2013, Naval-Technology.com. http://www.naval-technology.com/news/newsindian-navys-k-15-slbm-successfully-completes-development-trials.

[21] "PM launches INS Arihant at Visakhapatnam," *The Economic Times*, July 26, 2009. http://articles.economictimes.indiatimes.com/2009-07-26/news/27650185_1_indigenously-built-nuclear-powered-submarine-ins-arihant-naval-dockyard.

[22] Toby Dalton and Jaclyn Tandler, "Understanding the Arms Race in South Asia," *The Carnegie Nuclear Policy Papers* (Washington DC: Carnegie Endowment for International Peace, September 2012), 7. http://carnegieendowment.org/files/south_asia_arms_race.pdf.

[23] Ibid.

India's Cold Start doctrine and plans to acquire and deploy ballistic missile defenses. Although an Indian BMD shield would largely be ineffective against cruise missiles, it would primarily be aimed at intercepting Pakistani ballistic missiles, which constitute the country's counter-value and first-strike capability.

To meet the growing challenges of missile defense and naval nuclearization, Pakistan has apparently embarked upon its own program for placing nuclear warheads on its naval platforms. In 2003, Pakistan's Chief of the Naval Staff, Admiral Shahid Karimullah declared that even as no immediate plans for deploying nuclear warheads onboard ships and submarines existed, Pakistan would not hesitate to act on that line if it felt so compelled. Amid long-standing rumors of an indigenous nuclear powered submarine (SSN), the Pakistan Naval Strategic Force Command Head Quarters was inaugurated on May 19, 2012, which was termed as the "Custodian of Second Strike Capability."[24] In view of acute resource constraints, short of building a prohibitively expensive SSBN, Pakistan appears to be aiming at relatively less expensive and doable solutions. The country's Navy is likely to seek achieving deterrence at sea by way of equipping Agosta-90 B /Type-041 Class Air Independent Propulsion (AIP)-equipped conventional attack submarines (SSKs) with cruise missiles armed with miniaturized nuclear or two-stage warheads. In March 2011 Pakistan's cabinet approved the purchase of six new diesel-electric submarines from China, most likely the improved version of the Type-041.[25] Each one of these AIP-equipped boats would have greater submerged endurance than ordinary SSKs and is believed to be capable of carrying three CJ-10K submarine-launched, 1,500-kilometer-range cruise missiles, which could be mated with single boosted fission plutonium warheads.[26]

In this respect, the Pakistan Navy carried out flight tests of various long-range "land-attack" cruise missiles from different naval platforms on December 19 and 21, 2012 in the north Arabian Sea. While the official statement refrained from mentioning the naval version of the Babar cruise missile, it point out that "the test included firings of a variety of modern missiles including the maiden Land Attack Missile (LAM)" and the test "reaffirms credibility of deterrence at sea."[27] Other missiles involved in the test may also have included a land attack variant of the 120 km-range Chinese C-802/CSS-N-8 Saccade anti-ship missile. The C-802 can be launched from different Pakistani surface ships and submarines, while the naval version of the Hatf-VIII cruise missile could be container/cylinder or canister-launched from similar platforms.[28]

[24] Usman Ansari, "Pakistan Acknowledges Sea-Based Nuclear Deterrent," *Defense News*, May 23, 2013. http://www.defensenews.com/apps/pbcs.dll/article?AID=2012305230004.
[25] Farhan Bokhari, "Pakistan to Start Formal Talks with China to Buy Submarines," *Jane's Defence Weekly*, March 18, 2011.
[26] Iskander Rehman, "Drowning Stability: The Perils of Naval Nuclearization and Brinkmanship in the Indian Ocean," *Naval War College Review*, Vol. 65, No. 4 (Autumn 2012), 75. http://www.usnwc.edu/getattachment/187a93e1-db4c-474e-9be8-038bb7a64edb/Drowning-Stability--The-Perils-of-Naval-Nucleariza.aspx.
[27] Usman Ansari, "Pakistan Navy test-fires Land Attack Missile," *Defense News*, December 21, 2012. http://www.defensenews.com/apps/pbcs.dll/article?AID=2012312210004.
[28] Ibid.

That Pakistan had developed and tested the naval version of the Babar cruise missile was further authenticated by the presence at of the Chairman of the National Engineering and Scientific Commission (NESCOM)—the strategic organization charged with the development of almost all the cruise and ballistic missiles for Pakistan since 2001—at the live firing exercises along with the Chief of the Naval Staff.[29]

However, before Pakistan is able to claim a naval deterrent as part of its strategic triad, several formidable challenges related to command and control and integration of weapon systems would have to be overcome..[30]

Pakistan is also seemingly pursuing the ability to defeat upcoming Indian missile defenses as a potential destabilizer of the balancer of terror appears to have been factored into its missile modernization plans. This is evident from the development of an air, land and naval version of the *Babar* LACM. Equally important has been the testing of the 1000-1300 km range *Shaheen-IA* solid-fuelled ballistic missile on April 25, 2012. This is an improved version of the 750 km-range *Shaheen-1* ballistic missile and is believed to be equipped with maneuverable warheads capable of defeating enemy missile defenses. Although this test came shortly after India tested its 5000 km-range *Agni-V* missile, the much shorter range reflected a focus by Pakistan on improving the accuracy and survivability of its strategic forces than engaging in a tit-for-tat response. [31] Yet another improved version of the *Shaheen-1* missile was tested with an improved range of 900 km over the 600-750 km for previous versions. These missile tests are "part of an ongoing process of ensuring the survivability and effectiveness of its strategic forces in order to diversify its response options through a nuclear triad that provides assured deterrence for all levels of the threat spectrum."[32]

Both India and Pakistan claimed to have tested sub-kiloton warheads in May 1998, thus keeping the option open for developing battlefield nuclear weapons. Hydrodynamic/ Hydro-nuclear and sub-critical testing coupled with availability of weapon-grade plutonium and tritium has opened the way for Pakistan to design and develop miniaturized warheads for use on cruise missiles, maneuverable

[29] Ibid.

[30] The most critical question in this respect remains whether Pakistan's National Command Authority would continue to exercise assertive command and control over nuclear-armed ships or submarines through the Naval Strategic Force Command or would be willing to delegate such authority to individual platforms at sea. Perhaps a greater challenge would be ensuring foolproof communications between the submerged submarine and the shore-based command. An electromagnetic pulse following a nuclear burst could disrupt the earth's electromagnetic spectrum, resulting in a partial or complete breakdown of communications, including shore-submarine. This problem is compounded by the absence of domestic communication satellites. "A very-low-frequency (VLF) communications system can provide an answer. Satellite imagery taken in early 2013 shows the construction of an Extremely Low Frequency (ELF) communications facility in Tamil Nadu, India……which can withstand a nuclear attack comprising hardened command and control bunkers and is expected to be operational by 2015. The ELF station would be used to communicate with nuclear submarines submerged for long periods at sea when normal communication channels break down." Also see James Hardy, "India makes headway with ELF site construction," *Defense and Security Intelligence and Analysis: IHS Jane's*, April 3, 2013. http://www.janes.com/products/janes/defence-security-report.aspx?ID=1065976790.

[31] Usman Ansari, "Pakistan Test-fires Improved Shaheen-1 missile," *Defense News*, April 25, 2012. http://www.defensenews.com/apps/pbcs.dll/article?AID=2012304250005.

[32] Usman Ansari, "Pakistan Tests Improved Shaheen Missile," *Defense News*, April 20, 2013. http://www.defensenews.com/article/20130410/DEFREG03/304100018/Pakistan-Tests-Improved-Shaheen-Missile.

warheads for ballistic missiles, miniaturized warheads for short-range ballistic and cruise missiles such as the 100 km range *Hatf-1A*, the 180 km-range *Abdali* and the 280 km range *Ghaznavi*—all solid fuelled, road-mobile systems along with sub-strategic or battlefield nuclear weapons. Some of these short-range ballistic missile systems supplemented by cruise missiles indicate a doctrinal shift in Pakistan's strategic thinking about the role of nuclear weapons, particularly battlefield nuclear weapons. However, the development of these missile systems and their batch testing and induction by the strategic forces commands of the three services have been driven by the availability of weapon-grade plutonium suitable for lightweight, yet powerful warheads requiring at least five times less fissile material per weapon as opposed to highly-enriched uranium.[33]

Nevertheless, the most important milestone in this regard has been the development of the 60 km-range, solid fuelled and multi-tube/four barreled *Nasr* short-range ballistic missile system, which was tested on May 29, 2012. *Nasr* "is designed for counterforce targets. In this respect, it symbolizes Pakistan's resolve to develop nuclear weapons and delivery systems for use at the sub-strategic level, designed to deter India from exploiting Pakistan's nuclear thresholds and attempting limited war or pro-active military operations."[34] Moreover, *Nasr* is "particularly aimed at augmenting Pakistan's conventional deterrence at the tactical level for eventual employment in case of collapse of conventional defenses on any vulnerable theater of operations."[35] The development of *Nasr* has been perceived as the direct consequence of India's Cold Start Doctrine, which called for exploiting gaps in Pakistan's nuclear thresholds and carrying out limited conventional war without triggering an escalation to all-out war, thus precluding chances for escalation. Also, a growing technological and quantitative imbalance in conventional forces with India will justify Pakistan's development of TNWs to provide all-aspect deterrence capability. [36]

Proactive Military Operations and Battlefield Nuclear Weapons

One of the most important milestones in Pakistan's technological maturation has been the development of the 60-km range, solid fuelled and multi-tube/four barreled *Nasr* short-range ballistic missile system, which was tested on May 29, 2012. *Nasr* "is designed for counterforce targets. In this respect, it symbolizes Pakistan's resolve to develop nuclear weapons and delivery systems for use at the sub-strategic level, designed to deter India from exploiting Pakistan's nuclear thresholds and attempting limited war or pro-active military operations."[37] Moreover, *Nasr* is "particularly aimed at augmenting Pakistan's conventional deterrence at the tactical level for eventual employment in case of collapse of conventional defenses on any vulnerable theater of operations." [38]The development of *Nasr* has been perceived as the direct consequence of India's Cold Start Doctrine, which called for exploiting gaps in Pakistan's nuclear thresholds and carrying out limited conventional war without

[33] Mansoor Ahmed, "Why Pakistan Needs Tactical Nuclear Weapons," *Weekly Pulse,* May 6, 2011. http://www.weeklypulse.org/details.aspx?contentID=563&storylist=9.
[34] Usman Ansari, "Pakistan Missile Test Underscores Need for Deterrence," *Defense News,* June 1, 2012.http://www.defensenews.com/apps/pbcs.dll/article?AID=2012306010001.
[35] Ibid.
[36] Ibid.
[37] Ibid.
[38] Ibid.

triggering an escalation to all-out war, thus precluding chances for escalation. Also, a growing technological and quantitative imbalance in conventional forces with India will justify Pakistan's development of the TNW's to provide all-aspect deterrence capability.[39]

The testing of *Nasr* demonstrated that, "Pakistan is developing miniaturized warheads of appropriate counter-force yields. Because the test was carried out using a new four-round box launcher layout, *Nasr* will probably be used to salvo-launch low-yield nuclear weapons on an incoming enemy armored column that breaks through the conventional defenses."[40] Interestingly, India also tested a short-range ballistic missile *Prahaar* following the *Nasr* test. Though it was not claimed that it could carry nuclear warheads, it is well understood to have the capability to striking targets between 50-150 km with great accuracy and is therefore a counter-force weapon system.[41] The relatively short time in which India conducted *Prahaar's* test following that of *Nasr* indicates that this system must have been in development long before Nasr was tested.

Nonetheless, given the fissile material constraints, *Nasr* cannot be deployed in large numbers for war fighting and will most likely be used to supplement conventional defenses in limited numbers only to buttress theatre-level deterrence.[42] Once a decision is taken by the NCA for its eventual employment as a last resort, it would be the first among other strategic weapons in the country's arsenal that would be used in a mix of counter-force and counter-value strikes in the face of collapsing conventional defenses or triggering of the country's military, territorial, economic or integration thresholds. While the introduction of battlefield nuclear weapons are seen by some as force multipliers, critics argue that they are highly destabilizing because of the risks associated with escalation of the conflict from limited counter-force strikes to massive retaliation by the enemy. This is particularly the case in South Asia where India's nuclear doctrine clearly threatens such a response against the employment of any weapon of mass destruction of any magnitude on Indian forces, even outside Indian territory. Yet another complicating factor with the deployment of systems like *Nasr* in times of crises is effective command and control and security of the missile systems coupled with the risk of a pre-emptive strike. Pakistan's first use doctrine and the deployment of a 60 km range short-range ballistic missile system close to the international border would require the fissile core to be mated with the trigger package, and the assembled nuclear warhead to be mounted onto the missile, thus giving rise to fears of a pre-emptive attack in case of early detection.

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[39] Ibid.
[40] Ibid.
[41] Vivek Raghuvanshi, "India Tests New Tactical Missile," *Defense News*, July 21, 2011. Available at: http://www.defensenews.com/apps/pbcs.dll/article?AID=2011107210309.
[42] Mark Fitzpatrick, "Overcoming Pakistan's Nuclear Dangers," *Adelphi Paper 443*, (London: International Institute for Strategic Studies, March 2014), 34, https://www.iiss.org/en/publications/adelphi/by%20year/2014-de9e/overcoming-pakistans-nuclear-dangers-7ef0. In this respect, it is pertinent to mention that, "Pakistan has no plans to move toward battlefield weapons. The introduction of Nasr is a purely defensive measure meant to bolster conventional deterrence by creating strong barriers that will deter assaulting forces at the tactical level. The Pakistani strategic command authorities do not think that Nasr is a tactical nuclear weapon in the classic sense. Any system, in their belief, that is capable of carrying a nuclear warhead cannot be dubbed tactical. Should a nuclear warhead system be used in a tactical role, it will still have strategic impact; regardless of terminology it crosses the threshold from the conventional to the nuclear realm. This warrants the highest level of command and control and use authorization from the National Command Authority (NCA)." Khan, *Eating Grass*, 394.

However, any such deployment by Pakistan would most likely be as a last resort and it would strive to ensure suitable camouflage and centralized command and control by the NCA through the "Strategic Command and Control Support System." Pakistan has consistently maintained that it will continue to exercise assertive command and control over all strategic and sub-strategic nuclear weapon systems under all circumstances, thereby barring the possibility of premature or unauthorized use. "The short-range nuclear weapons will not be deployed to forward positions, nor will its use be delegated to the field commanders."[43] Thus, *Nasr* appears to be designed to plug the perceived gap below Pakistan's nuclear thresholds that signifies Pakistan's newly acquired ability to miniaturize warheads for possible battlefield use, ranging from 0.5 to 10 kilotons. *Nasr* is believed to have a diameter of around 300 mm (11.8 inches), which appears to be close to the design of the U.S. W-80, W-84 and B-61 nuclear warheads.[44] The W-80 is a small thermonuclear warhead yield varying between 5 to 150 kilotons and weighs around 132 kg. The W-84 is almost similar to the W-80 with a range of 10-50 kilotons.[45]

Doubts have also been raised on whether Pakistan's claims of developing miniaturized warheads for the *Nasr* without hot tests are credible. [46] Similarly, questions were raised in India in 2009 by one of the scientists involved in the 1998 tests who claimed that the thermonuclear test along with a few fission tests had fizzled.[47] This may have been designed to test reactions of various interest groups and decision-makers regarding prospects of a possible round of fresh Indian tests. From a technical standpoint, Pakistan also needs to conduct hot tests for validating new weapon designs. However, a new round of testing is highly unlikely in the region under the overhang of debates on global zero and possible US ratification of the Comprehensive Test Ban Treaty—all of which would bring international isolation for India or Pakistan if anyone were to test again.

Outlook for the Future

Strategic Stability in South Asia would in all probability depend on force postures, doctrines and mutual perceptions of military capabilities that are invariably the product of technological maturation and innovation. India and Pakistan are also likely continue their to move on the path of pursuing—an assured in case of India—and a reliable second strike capability for Pakistan, by building a triad-based deterrent". In this respect, the size and shape of their respective strategic forces would depend

[43] "The no pre-delegation decision is explained by geographic logic. Because Pakistan's territory is relatively narrow, the TNWs will only have to be moved a short distance to be readied for battlefield use. For strategic use, nuclear weapons might be deployed 200 km away from the border. For battlefield use, they might be stationed 60–100km away from the border. The short-range systems reportedly can be moved from storage sites to forward locations within a few hours, not days. Thus, it is claimed that there is no need for pre-delegation of firing authority and therefore no possibility of misuse by a field commander." *Adelphi* Ibid, 90.

[44] Rodney Jones, "Pakistan‘s Answer to Cold Start," *The Friday Times* 23, no. 13, May 13-19, 2011. http://www.thefridaytimes.com/13052011/page7.shtml.

[45] Chuck Hansen, *U.S. Nuclear Weapons: The Secret History* (Arlington, Texas: Aerofax Inc, 1988), 201-203.

[46] Michael Krepon, "Tac Nukes in South Asia," *Arms Control Wonk*, April 18, 2012: http://krepon.armscontrolwonk.com/archive/3419/tac-nukes-in-south-asia; Jeffrey Lewis, "Pakistan's Nuclear Artillery," *Arms Control Wonk*, December 12, 2011. http://lewis.armscontrolwonk.com/archive/4866/pakistans-nuclear-artillery.

[47] Daniel Horner, "Indian Scientist Triggers Debate on Testing," *Arms Control Today*, October 2009. http://www.armscontrol.org/act/2009_10/India.

on the number of nuclear warheads made available through additional fissile material production. Pakistan is likely to continue this production with India expanding its existing production capabilities, with a fissile material race in the making. At the same time, emerging Indian ballistic missile defenses would inevitably push Pakistan to increasing the payload/range/accuracy of its ballistic missiles while putting greater emphasis on its cruise missile program. Concurrently, an increasing technological and quantitative imbalance in conventional forces will justify Pakistan's development of battlefield nuclear weapons.

Considering the pattern of developments in military technology and integration of new weapon systems in South Asia, it is evident that India is seeking power projection through long-range missile systems, SSBNs, and an ambitious military space program geared towards strong Intelligence, Surveillance and Reconnaissance capabilities. This modernization spree has had the effect of nullifying India's claims of pursuing a minimum deterrent. Pakistan's modernization is primarily aimed at ensuring the survivability and credibility of its deterrent by acquiring second-strike capabilities and improving the accuracy and effectiveness of its strategic forces with an emphasis on survivability and diversification. This in turn is guided by the demands of "full-spectrum deterrence," designed to deter aggression at all levels of the threat spectrum—by developing and if necessary, deploying triad-based strategic forces along with battlefield nuclear weapons to deal with limited war/pro-active military operations.[48] Once this is achieved, corresponding developments across the border would not be seen as inherently destabilizing (*Agni*-V verses *Shaheen*-1A test is an example.) Till such time that both countries ensure the survivability of their respective nuclear forces, current modernization trends are likely to follow a predictable trajectory with the credibility of deterrent postures gaining clear priority in order of preference over any declared minimum levels.

Secondly, it is palpable that doctrinal shifts in both countries are being shaped by the exigencies of operational requirements, such as battlefield nuclear weapons in the case of Pakistan and sea-based strategic nuclear forces along with inter-continental range ballistic missiles in the case of India, which are driven by their respective threat perceptions. Clearly, a technological arms race is in full swing in South Asia which has rendered all claims of pursuing minimum deterrent postures meaningless. Emerging capabilities and spin-offs of technological innovation and modernization such as miniaturization of warheads has opened the door to further possibilities such as the introduction of MIRVs and battlefield nuclear weapons—the latter seen by critics to be as de-stabilizing as BMDs even though they are meant to augment Pakistan's conventional defenses. Technologies and the products of the military industrial complex in South Asia have generated their own momentum for demand of new weapon systems, aimed at consolidating existing capabilities, which invariably impacts on force postures and leads to subtle shifts in doctrines.

While economic growth and the availability of financial resources are necessary for poverty alleviation, it also helps fuel huge spending on military modernization and the acquisition of high-tech and big-tech weaponry from potential suppliers. This is especially true for India. In a complex,

[48] Baqir Sajjad Syed," NCA Stresses Full-spectrum deterrence, *Dawn*, September 9, 2013: http://dawn.com/news/1040865/nca-stresses-full-spectrum-deterrence.

polarized and crisis prone strategic environment as South Asia, demand is automatically created for large acquisitions with an aggravated conventional asymmetry in the region.[49] Therefore, it is imperative for the future of South Asian stability and maintaining a measure of strategic balance that the big powers and suppliers of high-tech conventional military hardware and civilian nuclear technologies with potential applications for weapon-related nuclear programs ought to prioritize between their commercial interests and preventing a technological arms race in the region. Nuclear Learning in the next decade appears to be a gradual process and is dependent on the vision, foresight and pragmatism of the political leadership of India and Pakistan and the confidence, which they and their advisors might have, in their own respective deterrent capabilities that would be sufficient and necessary to prevent a future crisis. Technology and military modernization can only add to the credibility of the adversary's deterrent capabilities but is no substitute for rational decision-making.

[49] In 2013, India remained the world's biggest arms importer, ahead of China for a third consecutive year. Please see: K. K. Sruthijith, "India remains top arms importer while China becomes fifth largest exporter," The Economic Times, May 18, 2013. http://articles.economictimes.indiatimes.com/2013-03-18/news/37815093_1_top-arms=importer-largest-importer-weapons-importer.