Getting Serious about Thermonuclear Security: Need for New Tests, Augmented Capability and First use Doctrine & Posture

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Abstract

India has been an economic and military punching bag for China. This is India's fault because it has done less than nothing to counter the pummeling except occasionally reacting (as on the Galwan) and then only defensively. It is time India, a nuclear laggard, adopted the strategy conventionally weak nuclear weapons states (Pakistan against India, North Korea against the US) have successfully wielded against stronger adversaries by threatening nuclear first use, and by substantiating such threat by laying down short fuse, forward nuclear tripwires. For an India that has historically quailed before China, making this new more assertive stance credible will require significant measures—resumption of thermonuclear testing, emplacing a differentiated two-tiered doctrine that replaces the impractical

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"massive retaliation" strategy with flexible and proportional response notions pivoting on nuclear first use but only versus China while retaining the "retaliation only" concept for everyone else, and alighting on a tiered posture supported by the buildup of 'soft' strategic infrastructure (a separate strategic budget, specialist nuclear officer cadres in the three services, and a mechanism for oversight of nuclear weapons designing activity). It is a doable strategy the Indian government should not shy away from.

Introduction

India from the get-go did little right, nuclear military-wise, and has paid the price for it. Strung out between moral pretensions, ideals of a peaceful world, strategic myopia, and foreign pressure, Indian governments have not pursued a straightforward policy the nuclear visionary, Homi J. Bhabha, urged the 1962 War onwards—a series of open-ended underground tests of progressively higher yields culminating in a thermonuclear arsenal.[1] It was a practicable policy once the weapons threshold was attained in March 1964.[2] Instead, in the following decades, there were sporadic nuclear tests aimed at scoring political points or making short-term political capital, not securing a credible strategic deterrent. Bhabha's strategic vision, moreover, got directed by the Trombay leadership of the 1970s and 1980s into the small arsenal-minimum deterrence channel that conformed with government views.[3] It led to the testing "moratorium" in the wake of the 1998 Shakti series despite the government being informed of the thermonuclear/boosted fission device (S-1) "fizzling", and to the 2005 civil nuclear cooperation deal with the United States conditioned on India not testing again. More alarming still, the nuclear weapons programme was nearly terminated by Prime Minister Lal Bahadur Shastri in 1965 in return for joint US-UK security assurances.[4] And but for some inspired bureaucratic shuffling by an MEA official (M.A. Vellodi), the Bomb project would have been

axed by Prime Minister Morarji Desai, ten years later, on the altar of Gandhian values.[5] It would seem that Indian nuclear weapons face greater peril from the country's leadership than from external adversaries.

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Whereas Pakistan had a clear idea why it wanted nuclear weapons—to prevent India from doing a Bangladesh in what remained of that country post-1971 War, there was no such clarity on the Indian side.[6] Nuclear weapons were considered a moral abomination and danger to world peace and, after the 1974 test, as variously an antidote for chemical and biological weapons and even for terrorism. Even a humiliating military defeat in 1962 did not result in the hard-earned capability being converted into nuclear weapons. It is not clear why getting to the nuclear well but not drinking from it was thought to serve the national interest. It set the precedent for dealing the same way with other advanced technologies as well. The multiple independently targetable re-entry vehicle (MIRV) technology, for instance, has been on the DRDO shelf since 2001-2002, but permission for prototype testing is still awaited.[7]

The country is in an extended strategic rut, but this is not recognised because of a sense of complacency—the Indian Establishment's besetting sin where national security is concerned. Three sets of corrective decisions need to be taken fast: to (1) resume open-ended nuclear tests to obtain a panoply of proven nuclear and high-yield thermonuclear weapons and, in parallel, rapid test-launches and induction into service of long-range MIRV-ed missiles; it will instantly endow the Indian strategic deterrent with clout, credibility and reach; (2) revise the "massive retaliation" doctrine with 'credible minimum deterrence' undertones into a two-tiered set of guidelines centred on nuclear First Use to tackle China, and retention of retaliation only principle for Pakistan, and configuring a deterrent posture accordingly; and (3) install the 'soft' but vital

infrastructure supportive of the strategic forces. This article briefly discusses why these decisions are necessary.

Resumed Thermonuclear Testing is Key

Commonsense is a precious commodity in short supply in the Indian milieu when it comes to nuclear weapons. Unless a new weapon technology is iteratively tested, and its performance proved in all conditions to the satisfaction of the end-user, it is not deemed a reliable battle-ready system. It is a metric the armed services use for conventional military hardware. So, it is curious the Indian military accepts the performance of the more consequential thermonuclear armaments on the say-so of the government/Defence Research & Development Organization (DRDO)/Bhabha Atomic Research Centre (BARC). This is, perhaps, because the uniformed brass does not want to make a fuss over something it knows little about. Naturally, the judgment of experts is trusted. Except, the experts, in this case, are the very BARC-DRDO scientists and technologists who design and produce these weapons, and have a vested interest in proclaiming these weapons first-rate and, in the past, have rendered advice the government wanted to hear. For example, regarding the 1998 thermonuclear test.

Despite K. Santhanam, Director, Field Testing, Pokhran, writing to the government immediately after the S-1 test on May 11, 1998, that the hydrogen bomb had "fizzled" and advising more tests, the Vajpayee regime declared it a roaring success and announced on May 28 a testing moratorium.[8] R. Chidambaram, then chairman of the atomic energy commission (AEC), and his BARC cohort did two things to provide scientific cover for furthering the government's political agenda of improving relations with the US but at the expense of the national interest. They claimed success for the hydrogen bomb on the basis of unconvincing seismic data, and despite nuclear veterans such as P.K. Iyengar and A.N. Prasad, former director, BARC, strongly

contesting such claims and offering technical assessments of the failure.[9] Chidambaram further asserted that India need never test again because between computer simulation and component testing the country would always have dependable thermonuclear weapons.[10] Chidambaram and his successor at AEC, Anil Kakodkar, have been charged with "dereliction" for "obscuring the failures of their thermonuclear device design", which Ashley J. Tellis suggests, getting the sequence wrong, "spurred Vajpayee's decision to end nuclear testing prematurely before the performance of India's highest yield warhead—which even at its maximum delivers just about 20 per cent of the explosive power of China's largest weapon—could be credibly demonstrated."[11] In any case, it enabled Vajpayee to forge the 'Next Steps in Strategic Partnership' with Washington, and his successor Manmohan Singh to sign the civil nuclear deal with the US conditioned on India not testing again.[12] The nuclear deal and Chidambaram's stance did lasting damage to the weapons programme.

Computer simulation can replace physical nuclear weapon tests only if a country has "exascale" computational capability (i.e., "one billion billion"—18 zeroes—operations per second) that only the US and China have. Place the fastest Indian supercomputer, Pratyush, with the Indian Institute of Tropical Meteorology capable of 20 petaflops (15 zeroes) capacity alongside, and the problem becomes evident.[13] Assuming optimistically that BARC has a 150 petaflop supercomputer (a level Pratyush expects to reach, finances permitting), it is still dwarfed by the US 'Summit' and the Chinese 'Sunway TaihuLight' exascale supercomputers. More daunting still, in October 2021 China claimed revolutionary technological breakthroughs with its 'Zuchongzhi 2.1' supercomputer featuring superconducting quantum computing and photonics quantum computing that is "10 million times faster" than 'Summit'![14]

Next, consider the scale of resources required. What China spends is unknown. But the US, for example, spends upwards of $5 billion annually on simulating thermonuclear explosions at its many weapons labs, and

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has as many as 700 highly rated scientists and engineers at each of these locations. These simulations are driven, moreover, by real-time injection of data from actual miniature thermonuclear explosions produced at an inertial confinement fusion facility (ICF), where plutonium pellets are bombarded by high-intensity lasers to create fusion phenomena.[15] Because India lacks the financial, technological and skilled manpower resources to replicate such experimental and computational capability on scale, the resumption of underground thermonuclear tests is imperative. Vast explosion physics and material science data collected from actual weapon tests create a body of information about how temperature, pressure, density and other factors affect plutonium during a thermonuclear explosion and assist in designing better weapons. India has to conduct open-ended tests to secure a modicum of such data, which will be infinitely more accurate than information derived from ICF and computer simulation.

The US has carried out 1,032 nuclear tests and fired 1,132 devices/weapons prototypes with a total actual yield of 196,514 kilotons; USSR/Russia 727 tests, 981 devices fired yielded 296,837 KT; China 47 tests, 48 fired, produced 24,409 KT; North Korea six tests, six fired, yield of 197.8 KT; and Pakistan two tests, six fired yielded 51 KT. In the thermonuclear category, China has carried out nine tests, one 300 KT boosted fission shot in 1965 and eight megaton (MT) weapons tests in the 3 MT-4 MT range.[16] China's weapons programme, besides design and material help, also benefitted from Russian thermonuclear test data (as did the UK, French and Israeli fission and fusion weapons projects from American test data) and Pakistan and North Korea from Chinese test data transferred to them as part of the "rogue nuclear triad".[17] As sensitive information

sharing is ongoing within this triad, Islamabad and Pyongyang may not have to test again to enhance their strategic weapons profiles. With this triad in mind, any of the six nuclear tests, two of them thermonuclear, North Korea conducted in the last two decades offered reasonable cause to India to resume testing but New Delhi did not avail of it.

India is apparently satisfied with its three tests, with six devices fired yielding a total of 70 KT, including the failed thermonuclear.[18] According to Richard Garwin, one of the premier US thermonuclear weapons designers, some 2,000 things have to go right for a fusion device to explode to full yield. How are Indian counterparts to discern which and how many of the two thousand things went wrong with the S-1 device, without a host of new tests, leave alone design new and upgraded thermonuclear weapons based on flawed data from one fizzled test? He also added that "without nuclear tests of substantial yield, it is … impossible to have any confidence in a large-yield two-stage thermonuclear weapon".[19] Chidambaram's view, therefore, that a little tinkering with the basic design and some computer simulation is sufficient to validate Indian hydrogen bomb designs and upgrades, is absurd. Yet the government-BARC act as if Indian fusion weapons are the equal of thermonuclear armaments in other inventories.

In any case, if the Indian government had made up its mind not to test again, and knew it lacked ICF and the computational wherewithal, it should have at least extracted from the US its thermonuclear test data in return, the first time for the 1998 moratorium decision and, the second time, for the 2005 nuclear deal. This, incidentally, is what France did for ceasing nuclear testing after its last series of N-tests in 1996.[20] It makes one wonder why the Indian government rarely acts in the country's best interests.

To begin doing strategically correct and impactful things for a change, the Indian government should immediately order frequent test launches of MIRV-equipped long-range missiles on a speedy induction

schedule to provide targeting versatility and, more urgently, full-bore thermonuclear tests of yields in the 300 KT-low megaton range, and get the deep excavation work underway soonest to prepare L-shaped tunnels at depths around 2,000 metres.

The US was never in a position to prevent India from testing and weaponising had it been determined to do so, but it offered an excuse for Indian leaders to escape making difficult decisions. Jawaharlal Nehru in the early 1960s declined to proceed with weaponisation, and in 1974 Indira Gandhi got cold feet after just one test. Had either of them proceeded with nuclear weaponisation Washington could have done little about it. In the emerging international "correlation of forces", the US is unlikely to impose sanctions for restarting nuclear testing because it needs India more than India needs the US, and would prefer a proven Indian thermonuclear arsenal discomfiting the PLA at southern Asia end of the Indo-Pacific.[21]

A Two-tiered Nuclear Doctrine and Posture

The Indian establishment's ambiguous attitude to nuclear weapons is reflected in the stock view of all and sundry that "nuclear weapons are for deterrence, not warfighting". It undergirds the disturbing belief that possessing dread-inspiring bombs is good enough as symbols that their quality and quantity don't matter, i.e., a 20 KT Indian bomb has the same psychological and deterrent effect as a Chinese standard-issue 3.3 MT warhead. This is the pixilated take on nuclear weapons and deterrence the Indian government has internalized and reflects a minimalisation of nuclear weapons by political consensus. It eventuated in Prime Minister Vajpayee's definition in Parliament on May 28, 1998, the two basic parameters of Indian nuclear doctrine and strategy—No First Use (NFU) and minimum deterrence.

A military doctrine is a guideline for action, not a straitjacket to squeeze strategy and operations into. The draft-nuclear doctrine

produced by the First National Security Advisory Board (NSAB) in end-1998 encompassed Vajpayee's parameters but, under the elastic rubric of "credible minimum nuclear deterrence"—credible relative to which adversary, minimum compared to what enemy force, provisioned for strategic forces to grow and improve qualitatively. Inherent in NFU is the retaliation only principle, which the draft finessed to say "rapid punitive response". It then passed into the hands of the National Security Adviser (NSA), Brajesh Mishra, a generalist civil servant of a type Dr Santhanam dismissed as "a babe in the woods on nuclear matters."[22]

Amateurism surfaced in several aspects. Unprecedented for any country's nuclear doctrine, the draft document was made public supposedly to generate debate. It led, as some NSAB members had warned, to foreign public and official pressure (mainly from the US and Western Europe) to define the size and quality of the "minimum deterrent" India proposed to have. It is not known what assurances were conveyed to these countries. But the slow-paced growth of the Indian nuclear arsenal in the new millennium is, perhaps, a consequence. India could have produced 175-200 additional weapons/warheads by now using its stock of separated reactor-grade plutonium to obtain an arsenal the size of China's.[23] In any case, as of mid-2022, India had 160 weapons/warheads—the smallest nuclear weapons stock of any state, lagging behind Pakistan's stockpile (of 165 weapons/warheads), and China's (with 350 weapons/warheads expected to grow to 1,000-weapons by 2030).[24] Ignoring the draft doctrine, the government in 2003 formalised a "massive retaliation" strategy, and stepped into an existential muddle.[25]

Obviously, this strategy won't work at any level against China—a comprehensively superior thermonuclear weapons-armed adversary. Mercifully, no Indian official has claimed otherwise. The infirmities in the massive retaliation strategy against Pakistan are many, and best illustrated by outlining certain contingent scenarios. The threat of the

"massiveness" of response is supposed to so unnerve Islamabad as to dissuade it from initiating nuclear First Use.[26] The scenario is for the Pakistani nuclearised 60 mm Nasr rocket to hit the lead armoured units of an aggressing Indian formation that has broken through the forward defences, penetrated into Pakistani territory, and is poised for a "break out", providing the Pakistan army with plausible cause for going nuclear. Needing to make good on its threat, India will have to decide how massive its "massive retaliation" has to be? Clearly, destroying several Pakistani tanks in return won't do, but an enemy defensive formation? Or, by way of jumping a step in the escalation ladder and pursuing the Russian "escalate to de-escalate"-strategy, attacking Pakistan's II Strike Corps headquarters in Multan with a bigger tacnuke?[27] The problem with escalation inherent in the intended Indian practice of massive retaliation is that it will deplete the weapons stockpile faster than Pakistanis can fire their weapons singly or in salvo, because the logic of such a response requires more weapons to be expended in retaliation to achieve a greater level of destruction than is suffered by India from Pakistani first strike and follow-on attacks. Soon enough in this action-larger reaction sequence, Indian weapons will be exhausted even as Pakistan retains a residual force. In short, minimum deterrence is not compatible with "massive retaliation" strategy.

There's another aspect to consider. Should Pakistan breach the nuclear taboo, the nature of subsequent action could be taken out of New Delhi's hands by forces of nature. The winds in the winter campaign season blow west to east and could turn a Pakistani tactical nuclear strike inside Pakistan into a strategic war. How? Clouds bearing the resulting radioactivity could be carried by the prevailing winds into India where populations in border towns and cities would be contaminated by radioactive rain, compelling the Indian government to skip the tactical response option and hit Pakistani cities.[28] Any way massive retaliation is gamed it leads to unedifying outcomes—why it was jettisoned by both

US and USSR early in the nuclear age.[29] It makes sense for India to revert to a flexible and proportional retaliation nuclear strategy implied in the "punitive response" notion featured in the NSAB draft doctrine. It provides a longer fuse, more political-military off-ramps for de-escalation, and dovetails with a small-sized nuclear force.[30]

Actually, Pakistan is not a serious threat and does not merit nuclear attention for two reasons. One, because the exchange ratio in a nuclear war so lopsidedly favours India—two Indian metro cities for the extinction of Pakistan as a social organism, in the Spenglerian sense, the Pakistan Army will do nothing to facilitate such a *denouement.*[31] And secondly, total war is inconceivable because India-Pakistan conflicts have historically been encounters of manoeuvre restricted in time, space and intensity and with little collateral damage. Nuclear sabre-rattling apart, shared culture, history, ethnicity, language, religion and social norms are, apparently, powerful inhibitors of wars of annihilation.[32]

China, on the other hand, is a different proposition and demands a more aggressive approach. Its policy driver is its vision of its centrality in the world with policies geared to subduing neighbouring states/regions into acknowledging this. Disrupting Beijing's "tianxia" geopolitical design and policies and blunting the Chinese People's Liberation Army's military edge should, therefore, be the chief purpose of Indian policy.[33] Except, the chasm between China's nuclear and conventional militaries and India's is real and widening. India has no choice other than to opt for an asymmetric strategy successfully adopted by weak nuclear weapons against conventionally stronger foes—Pakistan against India, North Korea against the US, and Russia trapped in a losing war in NATO-assisted Ukraine. These countries have laid down short-fuse forward tripwires and threatened nuclear first use.

In theory, India has a triadic deterrent. The air vector is the weakest because, absent a genuine strategic bomber, medium-range strike aircraft (Su-30 MKIs) are tasked with this role. However, the chances of mission

success are bleak owing to the circuitous routing over the sea of this aircraft and of aerial tankers for mid-course refuelling, and complicated tactical routing over densely air-defenced mainland China. Leasing six of the advanced 'White Swan' variants of the Tu-160 Blackjack strategic bomber from Russia is an obvious solution.[34] The sea vector has a different problem as the Arihant-class SSBNs are to be deployed in a protected "bastion" with a restricted patrolling area in the Bay of Bengal.[35] But their protection will consume a large fraction of the navy's submarine and surface combatant fleets, thereby reducing the availability of ships and submarines for other duties, such as sea presence. In this respect, the SSBNs so disposed will become as much an operational liability in crisis as aircraft carriers requiring equally extensive protection.[36]

The principle of not dividing a military force, mandates consolidating the nuclear fighting assets against China and involves, for a start, unilaterally moving nuclearised short-range ballistic missiles (SRBMs) Prithvi and medium range (700 km) Agni-1 ballistic missiles (MRBMs) from the Pakistan border to the LAC in Ladakh and Arunachal Pradesh, and grouping them with, say, nuclearised Prahar/Nirbhay-type area weapons. (Longer-range Agni-5 Prime missiles from hinterland launch points can hit targets in Pakistan as well as in China.) This collection of weapons forming the second tier of a forward deterrent posture on the LAC will balance the Chinese SRBM/MRBM forces in Tibet, the largest such concentration outside the Fujian coast opposite Taiwan. These missiles can be converted to canisterisation on LAC sites for ready use in launch-on-launch (LOL) and launch-on-warning (LOW) modes.[37] China should be publicly warned, moreover, that firing any missile southwards from the Tibetan Plateau would lead to LOL/LOW action because there's no technology to distinguish nuclear from conventional warheads on incoming missiles, and prudence dictates that the worst be assumed. Atomic demolition munitions (ADMs)—simple, compact, low-yield fission devices that can be easily designed and produced in

bulk for placement in mountain sides of passes the PLA will likely pass through, would constitute the tripwire and first tier. When triggered, the ADMs will bring down mountains on Chinese forces that have penetrated Indian territory. The reason ADMs are ultra-credible weapons is because of their usability in that (1) they are activated only by enemy action, (2) there is no venting of radioactivity because the toppled mountains of earth/dirt will effectively absorb and entomb the gamma rays, and (3) they fit India's passive-reactive-defensive military outlook and ideology vis-à-vis China.[38] Optics-wise, moreover, the biggest virtue of this first nuclear use (FNU) policy is that ADMs will act as a guillotine with the rope-tug releasing the falling blade handed to the Chinese theatre commander. The only thing about the revised doctrine that should be made public is this new wrinkle—first nuclear use solely against China. It will end the era of silk-glove handling of China and may even earn for India a smidgeon of respect from Beijing.

Filling the Soft Strategic Infrastructure Void

By their very nature, nuclear armaments are hard, high-end, but minus the soft supportive infrastructure their political and military value gets diminished. In the years since India became a declared nuclear weapons state in 1998, the government has not addressed three critical voids facing the country's strategic forces. The first is the absence of an Indian version of the JASON Committee in the US. Reputed scientists including stalwart weapons designers are appointed as its members with a brief to check and professionally evaluate the scientific and technical viability of new nuclear weapons designs conceived by the weapons laboratories, recommend solutions for glitches they may discover, and even suggest novel design improvements to increase performance. India desperately needs such a committee in light of the experience with R Chidambaram, who stifled the weapons programme, is accused by BARC insiders of letting the experimental ICF at the Centre for Advance Technology,

Indore, go to ruin, and for opposing the renewal of testing.[39] Though essential, the BARC leadership is unsympathetic to having such oversight because they believe it questions their competence.[40] This is where the government, for the sake of national interest, will have to over-rule the nuclear establishment and constitute a JASON Committee-type mechanism to curb the excesses of another Chidambaram.

The second void in fact refers to a budgetary innovation. It is time there was a separate budgetary stream for nuclear forces and infrastructure (including the development of military bases in friendly island-nations and countries on the South China Sea and the Indian Ocean littoral).[41] A systemic solution was attempted during the Vajpayee government. It tried to implement a 1999 plan by Defence Research & Development Laboratory that mooted a "separate strategic weapons directorate" to indigenously design and develop long-range, long endurance, weapons systems to ensure "strategic security" for the country. Such consolidation of the existing design, development, testing and production agencies under one roof would also have resulted in a singular funding stream. But despite Prime Minister Vajpayee and Defence Minister Jaswant Singh's support, this plan died because of bureaucratic politics.[42] Too often programmes relating to strategic systems and infrastructure—nuclear weapons development and acquisition, MIRV, nuclear powered ballistic and cruise missile-firing submarines, N-powered attack submarines, intercontinental range and intermediate-range ballistic and cruise missiles, lease of Tu-160s, hardening of nuclear command, control, communications (NC3) net, excavation of L-tunnels for tests, and of mountain tunnel complexes for long-range missile storage and launch sites, etc., are side-lined because they compete with conventional military priorities. The defence budget should rise to the 3 per cent of GDP level recommended by the 15th Finance Commission and the Parliamentary Standing Committee on Defence. A third of this enlarged defence allocation—0.75-1 per cent of GDP, should be sequestered for

the proposed Strategic Forces budget. Otherwise, the country's meagre nuclear arsenal will continue languishing in the basement to carry on without political direction, until faced with Chinese nuclear coercion by when it will be too late.

The third element is the missing specialist nuclear officer cadre in the three armed services. "Without a specialist cadre that is fully versed and immersed in all aspects of nuclear deterrence—from designs of nuclear weapons and missiles to conceiving and designing command and control networks, from nuances in deterrence theory to practical problems of mobility, and from nuclear forensics to technology for secure command links", I wrote in August 2012, "the country will be stuck with what we have: a Strategic Forces Command with military officers on its rolls who are professionals in conventional warfare but rank amateurs in the nuclear field. They have to perforce learn on the job, only for such learning to go waste once their three-year term ends, and they are posted elsewhere."[43] With the navy running SSBNs, it is the first military service to appreciate the benefits of a dedicated band of specialist nuclear officers. But its efforts have run into the problem of reconciling too few nuclear platforms and too small an officer cadres generally to carve up a separate nuclear stream. The army feels no need to have one because it is not concerned with what the artillery units are asked to fire as long as they control the missile launch units, and the air force has no strategic bomber fleet to make such an officer branch worth its while. The consequences of the missing military nuclear specialists are two-fold. The knowledge of nuclear issues within the SFC being shallow, the commander and his team cannot write up the QSRs for anything relating to nuclear armaments and strategic forces and infrastructure, and have to be satisfied with whatever DRDO-BARC dish out. And such advice as they are now and then called on by the government to give is usually ignored, leaving it to the equally clueless generalists clogging up the system of stove-piped decision-making to come up with what passes for strategic counsel in government.

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Typically, strategic nuclear capacity, capability and infrastructure deficiencies take 25-30 years to make up. The Indian government and military cannot afford to stick to their habitual tardiness in implementing the corrective measures. Smaller, weaker, nuclear weapon states with, survival-wise, smaller margins of error (Pakistan, North Korea, Israel) are naturally more serious and proactive where their nuclear security is concerned. Large and powerful countries (US, Russia, China) are not any less driven because they compete with each other for primacy in the strategic realm. India, uniquely, is the only big state which manifests a stunning level of nuclear complacency and incompetence.[44] Sandwiched between two purposeful nuclear adversaries, for the Indian government to continue to do nothing to alleviate the situation would be to do something definitely wrong.

Notes

1. Why thermonuclear weapons? Because, according to Richard Garwin, who first engineered the theoretical 'Teller-Ulam' configuration into a thermonuclear weapon, for a fission weapon to produce 200 kiloton yield would require 60 kg of plutonium or U-235, which amount of fissile material would suffice for 10 thermonuclear weapons in the megaton class, each weighing less than 1,000 lbs. See Bharat Karnad, *Nuclear Weapons and Indian Security: The Realist Foundations of Strategy*, Second edition (New Delhi: Macmillan India, 2005, 2002), p. 628.
2. Ibid., pp. 180-195.
3. That influential leadership was formed by the duo of Raja Ramanna and P.K. Iyengar. Ibid, pp. 318-323.
4. Ibid., pp. 254-256.
5. Ibid., pp. 332-338.
6. Feroz Hassan Khan, *Eating Grass: The Making of the Pakistani Bomb* (New Delhi, etc: Foundation Books, 2014 reprint), pp. 68-94.
7. Karnad, *India's Nuclear Policy* (Westport, CN & London: Praeger Security International), pp. 80-82.

8. Karnad, *Nuclear Weapons and Indian Security*, pp. 400-420; Karnad, *India's Nuclear Policy*, pp. 65-71; P.K. Iyengar, A.N. Prasad, A. Gopalakrishnan, Bharat Karnad, *Strategic Sell-out: Indian-US Nuclear Deal* (New Delhi: Pentagon Press, 2009).
9. S.K. Sikka, G.J. Nair, Falguni Roy, Anil Kakodkar, "The Recent Indian nuclear tests—A seismic review", *Current Science*, Vol 79, Issue 9, November 2000, https://www.researchgate.net/publication/237222667_The_recent_Indian_nuclear_tests_-_A_seismic_overview. Iyengar's view based on various indices, such as large traces of the thermonuclear fuel—lithium deuteride, evidenced in the rock morphology in Pokhran, was that there was "partial thermonuclear burn", not full combustion, and that's a fry cry from a workable weapon. See Karnad, *Nuclear Weapons and Indian Security*, pp. 412-413.
10. Karnad, *Nuclear Weapons and Indian Security*, pp. 415-419.
11. See his *Striking Asymmetries: Nuclear Transitions in Southern Asia*, [Washington, DC: Carnegie Endowment for International Peace, 2022], pp. 200-201. As special adviser to US ambassador Robert Blackwill, Tellis helped shepherd the 2005 Indian-US nuclear deal at both the Washington and New Delhi ends.
12. It is revealing that Tellis describes the moratorium on testing as a self-imposed "constraint" derived from "the political failures of the BJP leadership". Ibid.
13. Abhijit Ahaskar "India's supercomputing capabilities fall behind its peers", *Mint*, July 6, 2022.
14. "Chinese researchers achieve quantum advantage in two mainstream routes", *Global Times*, October 26, 2021, https://www.globaltimes.cn/page/202110/1237312.shtml
15. Eric Betz, "Testing Nuclear Weapons is More Important Than Ever", *Discover*, March 20, 2019, https://www.discovermagazine.com/technology/testing-nuclear-weapons-is-more-important-than-ever
16. *List of nuclear weapons tests*, https://en.wikipedia.org/wiki/List_of_nuclear_weapons_tests
17. Bharat Karnad, "Countering the Rogue Nuclear Triad of China, Pakistan and North Korea", *The Wire*, July 25, 2016, https://thewire.in/world/countering-the-rogue-nuclear-triad-of-china-pakistan-north-korea
18. Refer n. 16.
19. Karnad, *Nuclear Weapons and Indian Security*, pp. 627-628.
20. R. Jeffrey Smith, "France, US secretly enter pact to share nuclear weapons data", *Washington Post*, June 17, 1996, https://www.washingtonpost.com/archive/politics/1996/06/17/france-us-secretly-enter-pact-to-share-nuclear-weapons-data/cf9d04f3-aabe-4b77-b793-95163527da8e/
21. "We want to be India's defence partner of choice for India: US Official", *The Hindu*, November 3, 2022. Also refer Ashley Tellis' statement to an Indian daily, see "Idea Exchange: India may be compelled to test again and when it does, it's in the US interest to avoid penalising it", *Indian Express*, October 31, 2022.
22. Santhanam said this specifically about Manmohan Singh's NSA, M.K. Narayanan, a policeman, but it applies to most generalist diplomats/civil servants/policemen who have so far been appointed

NSA. See "NSA a babe in the woods on nuclear matters: Santhanam", PTI, *The Hindu*, September 25, 2009.

23. The reasons and the logic for an Indian thermonuclear force of some 470 weapons/warheads is detailed in Karnad, *Nuclear Weapons and Indian Security*, pp. 614-646. A 2015 ISIS study estimated India's then stock of separated reactor grade plutonium at 2.9 metric tons—good enough for as many as 125 weapons/warheads. This stock of plutonium has grown since then. See Elizabeth Whitfield, "Fuzzy math on Indian nuclear weapons", *The Bulletin of Atomic Scientists*, April 19, 2016, https://thebulletin.org/2016/04/fuzzy-math-on-indian-nuclear-weapons/
24. *Status of World Nuclear Forces*, Federation of American Scientists, https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/; Peter Martin and Anthony Capaccio, "China's Nuclear Arsenal Is Growing Faster Than Expected, Pentagon Says", *Bloomberg*, November 3, 2021, https://www.bloomberg.com/news/articles/2021-11-03/pentagon-sees-china-nuclear-arsenal-growing-faster-than-expected#xj4y7vzkg
25. "Cabinet Committee on Security reviews progress in operationalizing India's nuclear doctrine", Prime Minister's Office, January 4, 2003, https://archive.pib.gov.in/archive/releases98/lyr2003/rjan2003/04012003/r040120033.html
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28. Bharat Karnad, *Staggering Forward: Narendra Modi and India's Global Ambition* (Gurugram: Penguin-Viking, 2018), pp. 326-330.
29. For the text of the 1998 NSAB draft nuclear doctrine, https://www.armscontrol.org/act/1999-07/indias-draft-nuclear-doctrine
30. Karnad, *Staggering Forward*, pp. 333-334.
31. Husain Haqqani, *Pakistan: Between Mosque and Military* (Washington, DC: Carnegie Endowment for International Peace, 2005), pp. 199-260.
32. Bharat Karnad, "Key to Peace in South Asia: Fostering 'Social' Links between the Armies of India and Pakistan", *The Round Table: The Commonwealth Journal of International Affairs*, April 1996.
33. Karnad, *Staggering Forward*, pp. 154-220.

34. Karnad, *Why India is Not a Great Power (Yet)*, pp. 335-336; Karnad, *Staggering Forward*, pp. 364-365.
35. Admiral Arun Prakash, "Why the Arihant missile test was critical for India", *Hindustan Times*, October 18, 2022.
36. On large aircraft carriers as operational liability, see Karnad, *Why India is Not a Great Power (Yet)*, pp. 373-376.
37. Tellis claims the Agni missiles are canisterised only to keep nuclear warheads stable in an airconditioned container, and are not ready for instant use. See his *Striking Asymmetries*, pp. 127-129.
38. Karnad, *Staggering Forward*, pp. 344-349.
39. Bharat Karnad, "Incomprehensible position on N-testing", *Security Wise* (Blog), February 7, 2017, https://bharatkarnad.com/2017/02/07/incomprehensible-position-on-n-testing/
40. Karnad, *Nuclear Weapons and Indian Security*, pp. 328, 417.
41. On the urgent need to build up the North and South Agalega island base in Mauritius, the Gan island base in Maldives, Trincomalee in Sri Lanka and Na Thrang in Vietnam, see Karnad, *Why India is Not a Great Power (Yet)*, pp. 346-351.
42. Bharat Karnad, *India's Nuclear Policy* (Westport, CN, & London: Praeger Security International, 2008), pp. 79-80.
43. Bharat Karnad, "Dedicated nuclear cadre", *Security Wise* (Blog), August 16, 2012, https://bharatkarnad.com/2012/08/16/dedicated-nuclear-cadre/
44. Such complacency is labelled "the remarkable persistence of strategic conservatism" by Tellis. See *Striking Asymmetries*, pp. 69-74.