

From Testing to Deploying Nuclear Forces The Hard Choices Facing India and Pakistan

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INTRODUCTION

In the aftermath of their May 1998 nuclear tests, the key question remains: Do India and Pakistan intend to develop fully deployed nuclear forces? If they do, then their tests were only the first step. A fully deployed nuclear force must meet many requirements to ensure that it is capable of fulfilling the deterrence function assigned to it without causing other undue risks. These requirements were first delineated by Albert Wohlstetter in his seminal article, "The Delicate Balance of Terror."¹ Although the origins of these requirements were in the context of the U.S.-Soviet Cold War, Wohlstetter made it clear that the requirements applied to any nuclear power and not just the two superpowers.²

A central requirement is that a nuclear force should be able to survive a first strike designed to prevent the force from striking back. Wohlstetter had seen how difficult it was for the United States to achieve this objective against the relatively small Soviet nuclear force in the 1950s, which was one of the main reasons he considered the balance of terror "delicate."³ He believed that meeting this

¹Albert Wohlstetter, "The Delicate Balance of Terror," *Foreign Affairs*, Vol. 37, No. 2, January 1959. A slightly different version was published as P-1472, RAND, December 1958.

²Albert Wohlstetter, "Nuclear Sharing: NATO and the N+1 Country," *Foreign Affairs*, Vol. 39, No. 3, April 1961.

³See A. J. Wohlstetter, F. S. Hoffman, R. J. Lutz, and H. S. Rowen, *Selection and Use of Strategic Air Bases*, RAND, R-266, April 2, 1954; A. J. Wohlstetter, F. S. Hoffman, and H. S. Rowen, *Protecting U.S. Power to Strike Back in the 1950s and 1960s*, RAND, R-290, September 1, 1956; and Albert Wohlstetter and Fred Hoffman, *Defending a Strategic Force After 1960*, RAND, D-2270, February 1, 1954. This work first enunciated the importance of the first strike/second strike distinction, developed "fail-safe" procedures for strategic bomber operations, and formulated the concept and rationale for missile silos.

requirement would be even harder in an environment of many nuclear powers where the capabilities of these powers would vary greatly.⁴

As will be shown, both India and Pakistan are currently unable to deploy a force that can meet these requirements, a situation that is unlikely to change for some time. In particular, if India and Pakistan do proceed with weapons deployment, their forces will probably not be capable of withstanding a first strike, which could lead to instability in a crisis. Depending on how their forces are deployed, it may be difficult to prevent physical accidents or the theft or unauthorized use of these weapons, which will increase the risk of war in South Asia or the risk that other countries or subnational groups could obtain nuclear weapons.

This issue paper describes the requirements for a nuclear deterrent force in general terms, discusses how the

⁴In "Nuclear Sharing: NATO and the N+1 Country" (p. 370), he wrote,

The view that widespread diffusion [of nuclear weapons] will be stabilizing assumes that the prototype relation among the many powers will be mutual deterrence. But it would in fact be a miracle if every pair of countries out of a large number of nuclear powers stood in this relationship. These countries are at different stages of development and in different relative strategic positions. It would be remarkable if there were not strong asymmetries and sometimes symmetrical "preclusive" capabilities.

Not all analysts share Wohlstetter's concerns about Nth country nuclear forces. Kenneth N. Waltz takes a benign view of the proliferation of nuclear forces. "Nuclear forces are seldom delicate because no state wants delicate forces, and nuclear forces can easily be made sturdy." (Kenneth N. Waltz, "More May Be Better," *The Spread of Nuclear Weapons: A Debate*, W. W. Norton & Company, New York, 1995, p. 19.) Given Wohlstetter's extensive real-world analysis of this issue (see footnote 3), his concerns have far more weight than do Waltz's assurances. Furthermore, by his use of the word "seldom," even Waltz concedes that under some circumstances vulnerable forces may exist.

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Indian-Pakistani nuclear relationship is affected by China, and then considers the specific decisions that still must be made in India and Pakistan. Our goal is to provide a road map to the directions that India and Pakistan might take with their nuclear deployments. The paper will also make apparent just how far India and Pakistan still have to go and that if they deploy nuclear forces, the period of heightened risk will persist for many years, if not decades. On the positive side, the long road ahead for India and Pakistan allows for opportunities to head off their nuclear deployments. Indeed, it is important for India and Pakistan to recognize that they are much closer to their starting point than to any possible end point (I point out in the conclusions section that there may be no end point) and that they must seriously consider taking no further steps in nuclear weaponization.

REQUIREMENTS FOR A NUCLEAR DETERRENT FORCE

First, as was discussed in the introduction, a fully deployed nuclear force should be able to survive a first strike designed to prevent that force from striking back. This was a major finding of strategic analyses in the 1950s. The great destructive force associated with nuclear weapons means that this is no trivial requirement.

Second, the delivery systems must be able to reach their targets and to penetrate defenses on their way to the target. Being able to reach the target was an obvious problem in the Cold War, when intercontinental distances separated the combatants. This is still an issue, even though the distances in Asia are smaller. When the delivery vehicles are manned aircraft, being able to penetrate defenses is a concern. For the near term, missile defenses are not a factor, but over the long term they cannot be ruled out.

Third, the force should have a low risk of physical accidents, a problem even the United States has encountered. Aircraft carrying nuclear weapons have crashed. In January 1966, a B-52 carrying four B-28 hydrogen bombs crashed at Palomares, Spain. Two of the weapons were recovered intact (although one had to be retrieved from the bottom of the Mediterranean Sea). The other two weapons did not undergo nuclear detonation, but the accident did cause the high explosives in the weapons to explode, scattering the plutonium in their cores over a considerable area. A similar accident occurred in Greenland in 1968. Ballistic missiles similarly have had accidents—in September 1980, a maintenance accident caused a Titan II missile to explode in its silo. Its 9-MT warhead was blown 600 feet into the air and landed some 1500 feet from the silo. Fortunately, the warhead remained intact.

Fourth, the nuclear weapons should be safe against theft or unauthorized use. This threat can originate from either external or internal sources. The external threat could come from agents of other countries or subnational groups. The internal threat could come from unstable individuals or dissident groups. An example of the latter type of threat occurred in Algeria in 1961. A revolt broke out within the French army there as a nuclear weapon was being readied for a test. This weapon was reportedly detonated hastily in order to prevent the possibility of its seizure.

Fifth, the force should have a low risk of mistaken use by authorized persons. Such use might occur as a result of faulty warning of an attack or in response to an attack from a wrongly identified country or from a subnational group.

Sixth, the command authorities must survive any first strike, be able to make the decision to retaliate, and be able to communicate this decision to the surviving nuclear forces. U.S. law has specified 17 office holders as presidential successors⁵ to ensure that there will always be someone authorized and available to make the decision to use nuclear weapons. Communication with dispersed nuclear forces may not be easy, especially if the command authority must specify targets instead of just giving a "go/no-go" signal.

Seventh, the nuclear forces should be capable of a number of response options. Otherwise, the political authorities may not have an option available that they are willing to carry out. For example, a small minimum-deterrence force capable of striking a few of the enemy's cities would not provide a reasonable option in the face of an attack on military forces. To respond in such circumstances would invite a response on one's own cities, which could be suicidal.

Finally, the force must be procured and operated at a reasonable cost. What is "reasonable" is relative, depending on the defense spending in any particular country.

There is a tension between some of these requirements. Dispersing a nuclear force to improve its ability to withstand a first strike makes it harder to protect against theft and also makes it harder for the political authorities to communicate with it. The solution to many of the problems will involve increased spending (for example, buying additional delivery systems to increase the odds that some will survive a first strike), which may make it hard to control costs.

⁵3 U.S. Code Annotated, Section 19.

In August 1999, India's National Security Advisory Board released its draft "Indian Nuclear Doctrine." The doctrine conformed closely with the above requirements. In particular, it stated that "the survivability of our arsenal is critical"; it recognized the importance of weapons "safety and security" and "the continuity of nuclear command and control"; and it noted that release authority for Indian nuclear weapons would reside "in the person of the Prime Minister of India or the designated successor(s)." However, the document does not explain how these objectives will be achieved, nor is it clear that the Board recognized the difficulty of meeting all of the requirements.⁶

THE EFFECT OF CHINA ON THE INDIAN-PAKISTANI NUCLEAR RELATIONSHIP

Discussions of the recent events in South Asia have tended to focus on the interaction between India and Pakistan—but China is also a player in South Asia. India and China fought a border conflict in 1962 and outstanding border disputes remain. Furthermore, China has been a long-time supporter of Pakistan, and India sees any major conflict with Pakistan as having a Chinese dimension—especially now that India believes China has provided considerable support to Pakistan's nuclear and ballistic missile programs. In May 1998, India's Defense Minister, George Fernandes, declared that China was "potential threat No. 1." India's nuclear tests only eight days after this statement seem to be intended as a direct challenge to China.

Compared with India, China has formidable nuclear forces. China is believed to have deployed some 125 long-range (1700 km or greater) nuclear-armed ballistic missiles.⁷ The missile warheads are thought to have yields of between 200 kT and 5 MT. In addition, China is believed to have some 150 bomber-deliverable nuclear weapons and 120 tactical nuclear weapons deliverable by short-range missiles or artillery. An attack using just a small part of this force could have a devastating effect on an Indian nuclear force.

China's a major modernization program for its nuclear forces is being driven by its concerns related to the United States and Russia. It is developing several new long-range solid-fueled ballistic missiles including the DF-31 that was tested in August 1999. This land-based mobile missile has a range of 8000 km. Changes to China's modernization effort in light of the Indian nuclear tests should not be anticipated because the developing systems would be

⁶Note that Waltz's requirements for deterrent forces, "whether big or small ones," are similar to those laid out in this section. See Waltz, 1995, p. 20.

⁷SIPRI Yearbook 1997, Stockholm International Peace Research Institute, Oxford University Press, New York, 1997, p. 401.

quite capable against India. For example, the DF-31 could hit any part of India from any part of China.

China professes to adhere to no-first-use and minimum deterrence policies. China's deployed nuclear forces, however, can achieve more than minimum deterrence. Nuclear weapons of a minimum deterrence force would need only to reach the homelands of the four other declared nuclear powers. Such a force would consist only of CSS-3s and CSS-4s. But China also has the shorter-range CSS-2s and CSS-5s. The CSS-5 is particularly telling because the missile was developed after the CSS-3 and CSS-4. These missiles have a range of only 1700 km, which makes it clear that they are intended to hit targets near China. These targets could be the conventional forces of the major nuclear powers or China's neighboring countries. Neither is consistent with a minimum deterrence policy. Clearly, China has a more complex nuclear policy that does not rule out nuclear attacks on its neighbors. It is not clear what China's real nuclear policy is, but it might under some circumstances include the first use of nuclear weapons, such as a disarming first strike against India. The risk of such an attack is currently quite low. Nevertheless, Indian planners will have to consider such an attack seriously if they start to deploy nuclear forces.

There are many reports of China having provided Pakistan with substantial aid to both its nuclear and ballistic missile programs. An alternative to a direct Chinese nuclear confrontation with India is for China to continue or even increase its aid to Pakistan. China's goal would be to make it harder for India to use its superior resources to gain an advantage over Pakistan in a nuclear arms race.

DECISIONS FACING INDIA

What choices does India face if it is intent on developing a fully deployed nuclear force? Probably the biggest decision relates to delivery systems. In the near term, aircraft are the only available delivery systems. Fighter-bomber aircraft would be the most likely type used, with India's Jaguar as a good example. It can carry a 1000-kg nuclear weapon to a radius of 900—1400 km depending on the flight profile.⁸ From the base at Ambala (200 km north of New Delhi), the Jaguar could cover most of Pakistan. This base, however, is only 300 km from Pakistan and might be vulnerable to attack. Using the Jaguar base at Gorakpur might make more sense. This base is about 1000 km from Pakistan, which makes it less

⁸The 900-km radius is with external fuel and a lo-lo-lo flight profile. The 1400-km radius is with external fuel and a hi-lo-hi flight profile. See *Jane's All The World's Aircraft, 1994-1995*, Jane's Information Group, Alexandria, Virginia, p. 121.

vulnerable to air attack. To attack Pakistan, aircraft from this base could stage through a base close to Pakistan and thereby cover the entire country. In the near future, the newly acquired Su-30 might be the preferred option. It would not have a much greater range than the Jaguar, but its higher performance and better radar might make it more capable of penetrating defenses.

Fighter-bomber-type aircraft can cover Pakistan, but they do not cover China well. Even if they were to stage through bases in Assam (northeastern India), they can only reach southwestern China. Although India possesses the antisubmarine warfare (ASW) variant of Russia's strategic TU-95 bomber, which can carry a heavy nuclear weapon (or several lighter ones) 5000–6000 km, India has only eight of these aircraft, and their ability to penetrate Chinese air defenses is probably not good. In addition, because these aircraft are navy assets, using them for strategic bombing might be organizationally difficult.

Any aircraft-based Indian delivery system with dependence on fixed airfields would have a problem surviving a first strike, especially from China. China could easily strike Indian military facilities and nuclear weapon production sites with 20 or so nuclear-armed ballistic missiles (mainly CSS-2s and CSS-5s, with a few CSS-3s) and have over 100 nuclear-armed missiles in reserve. India has no way of detecting ballistic missiles in flight. Its first hint that a nuclear attack was under way would come only when Chinese nuclear weapons began exploding over its airfields. China could then mop up with bomber-delivered nuclear attacks. An Indian nuclear force based solely on aircraft delivery would be hard pressed to survive such an attack. (A multimegaton warhead exploded over an airfield would destroy all of the aircraft on the ground even if they were in hardened shelters.) Furthermore, Pakistan's two tests (in April 1998 and April 1999) of its 1500-km-range Gauri missile, which can reach many of India's deep airfields such as Gorakhpur, show that this is a growing problem with respect to Pakistan as well. Combined with the problems associated with penetrating air defenses (again, China is more of a problem than is Pakistan), an aircraft-based delivery system appears doubtful, leading one to consider ballistic missiles.

India is currently developing two medium-range ballistic missiles, the Agni-1 and the Agni-2. The Agni-1 uses a first stage derived from India's SLV-3 space launcher and a second stage derived from India's Prithvi short-range ballistic missile. It was tested three times between 1989 and 1994 and has a range of about 1500 km. India tested the Agni-2 in April 1999. This missile is similar to the Agni-1 but uses a new solid-fuel second stage. Indian sources suggest 2500 km as the intended range of this mis-

sile, but it is more likely to be only 2000–2200 km.⁹ This range is sufficient to cover all of Pakistan from well inside India, but it cannot cover much of China. Even if the Agni-2 were based in extreme northeast India it could not reach northeastern China (including Beijing) or many of the east coast cities. However, operating in such a geographically restricted area would increase the missile's vulnerability to a Chinese first strike. In addition, the state of Assam has been the site of an internal insurrection and is connected to the rest of India by only a narrow corridor.

For these reasons, India might want to base its missile force to the west of Bangladesh. One of the closest viable sites to China would be near the city of Bhagalpur, which is some 3000 km from Beijing. To provide flexibility for basing or for operating a land-based mobile system, a missile range of 3500 km would be required. A missile with a range of 5000 km would be ideal because it could be based almost anywhere in India and still hit Beijing. However, no upgrade of the Agni-2 is likely to produce a missile with a 3500–5000 km range. Thus, India would have to produce a whole new missile. The Polar Space Launch Vehicle (PSLV) shows that India has the technology to produce the required missile, but the new missile cannot be directly derived from the PSLV because it is too big (it would be big even for an ICBM). The 3500–5000 km ballistic missile would have to be a new development, not derived from any existing Indian missile system, so it would be neither quick nor inexpensive. Ultimately, such a missile would probably weigh 25–30 metric tons and look something like the French S-3 or M-20 or the Soviet SS-20 ballistic missiles.

If India procures a 3500–5000 km range missile, what would be its basing options? The easiest option would be to deploy the missile to soft fixed sites, although such a deployment mode would make it vulnerable to a first strike. Silo basing would be quite effective given the large CEPs of Pakistan's and China's current missiles. However, India does not currently have the technology to build hardened silos. In the ten or more years it would take for India to develop such technology, China's missile accuracy could improve enough (perhaps using satellite systems) that silo-based missiles would also be vulnerable.

Another alternative might be some form of mobile basing. A 30-metric-ton missile is light enough to be made road-mobile, but the poor state of India's roads makes this

⁹The 2000-km range is given by a U.S. Defense Department source; the 2200-km range is given by an Indian one. See *Proliferation: Threat and Response*, Office of the Secretary of Defense, U.S. Government Printing Office, Washington, D.C., April 1996, p. 39; and Vivek Raghuvanshi and Barbara Opall-Rome, "India's New Agni Raises Missile Race Stakes," *Defense News*, May 11–17, 1998, p. 4.

a dangerous proposition. Special roads could be built to transport the missile but would be expensive, and it is not clear that a road long enough to ensure the missile force's survival could be built. India's railroads are in fairly good shape, which makes a rail-mobile system a possibility. The identity of trains carrying nuclear weapons would need to be obscured, and the trains would have to move often enough so that China and Pakistan could not learn their locations. As with any mobile system, there are the problems of physical accidents, theft and physical security, and communication with civilian authorities. To minimize some of these problems, various garrisons could be connected by rail. The trains would normally be at one of the protected garrisons and only occasionally moved between them. This would be a compromise between a constantly mobile system and a fixed one. There would have to be enough garrison locations to ensure sufficient locational uncertainty so that some of the force would survive a first strike. This would increase costs.

Mobility on a submarine seems well beyond India's capability for at least ten, and probably 20, years. To build such a submarine, India would have to develop a light water reactor using enriched uranium, which would require India to obtain a source of enriched uranium. Foreign suppliers are not likely to be willing to help India, and in any case India may well not want to be dependent on foreign supplies, with the result that India would have to expand its centrifuge enrichment program to supply the needed material.

India's National Security Advisory Board's draft Nuclear Doctrine calls for "a triad of aircraft, mobile land-based missiles and sea-based assets." The phrase "sea-based assets" implies that India may be considering a surface ship system for delivering nuclear weapons. Such a system would not be as desirable as a submarine; unlike a submarine, which is difficult to find when it is submerged, a surface ship can be readily located.

Another important decision for India is to determine the readiness level of its nuclear force. In the past, India has had an unready force. Presumably, the weapons were kept in pieces at one well-guarded site. South Africa's nuclear force was kept this way.¹⁰ Such an arrangement can be protected against physical accidents, theft, and unauthorized use, and the site is inexpensive and easy to communicate with. However, it is vulnerable to a first strike. South Africa did not need to worry about a first strike but India certainly does. A further complication is that India does not possess any means of detecting ballistic missiles in flight and therefore is forced to adopt a

¹⁰David Albright, "South Africa and the Affordable Bomb," *The Bulletin of the Atomic Scientists*, July / August 1994, p. 44.

strategy of riding out any nuclear missile attack. The more ready India's force is and the more it takes other steps (such as using mobile delivery systems) to reduce its first-strike vulnerability, the better it will be able to survive a ballistic missile attack. But it will have to worry more about physical accidents, theft and unauthorized use, and maintaining reliable and secure communications.

One possible option would be to have a mobile system kept safely guarded in garrison during "normal" peacetime. Only in a crisis or on receipt of strategic warning would the force be sent into mobile operation. This raises the issue of whether strategic warning can be the principal means to protect a nuclear force. Some have argued that Wohlstetter's "delicate balance" assumed a "bolt from the blue" attack and that such attacks are unlikely.¹¹ This argument, however, ignores the fact that some of the most serious instances of surprise attacks were not "bolts from the blue" but rather "bolts from the gray," and indeed sometimes the gray has been very dark indeed.¹² For example, the attack on Pearl Harbor occurred only ten days after a war warning had been sent to its commander from the Chief of Naval Operations.¹³ The Israelis depend on strategic warning to mobilize their military forces, but failed to mobilize until just before the start of the 1973 Yom Kippur war despite a situation that could hardly be characterized as "blue skies."¹⁴ The combat in Kashmir between Indian and Pakistani forces in the spring of 1999 once again illustrates that it is often hard to find "blue skies" in the relations between these two countries.

A nuclear force that depended on its survival by dispersing on the receipt of strategic warning would be vulnerable to a first strike if the warning were not received or recognized. Furthermore, the dispersal of the nuclear

¹¹See for example, Bernard Brodie, "The Development of Nuclear Strategy," *International Security*, Vol. 2, No. 4, Spring 1978. To be fair to Brodie, he was making this argument in the context of the United States and Soviet Union. It is not clear that he would make this same argument in the current South Asian context.

¹²For more on this issue, see Richard Brody, "The Limits of Warning," *Washington Quarterly*, Vol. 6, No. 3, Summer 1983.

¹³In part this message said: "This dispatch is to be considered a war warning. Negotiations with Japan looking toward stabilization of conditions in the Pacific have ceased and an aggressive move by Japan is expected within the next few days." This did not necessarily mean that an attack on Hawaii would take place. In Hawaii, this message was interpreted as referring to a possible Japanese attack in Southeast Asia. As it turned out, both Hawaii and Southeast Asia were attacked. See Roberta Wohlstetter, *Pearl Harbor: Warning and Decision*, Stanford University Press, 1962, p. 45.

¹⁴Israel had already fought three wars with its neighbors. At the end of the Six Day War in 1967, there was a long period of low-level conflict known as the War of Attrition that did not end until August 1970. Only four months before the Yom Kippur war, Israel had partially mobilized its forces in anticipation of an attack. See Chaim Herzog, *The Arab-Israeli Wars*, Random House, New York, 1982.

force during a crisis could be considered an escalatory step. Despite the serious risks associated with this option, India may de facto adopt this or some similar system. Indeed, India's National Security Advisory Board's draft Nuclear Doctrine calls for its nuclear forces to have the "capability to shift from peace-time deployment to fully employable forces," which suggests that this option is being seriously considered. Not only will this option have the first-strike vulnerability problems described, but a hastily dispersed force will be particularly prone to the problems of physical accidents, theft, unauthorized use, and difficulty communicating with its command authorities. For example, the fear that an attack was imminent could lead one to skip certain safety or security procedures in the effort to disperse the force quickly. These problems underline the dangers that would be created should India try to deploy nuclear forces without spending the time and money needed to make them more robust.

Another important decision for India is how to design a command structure that is resistant to an attack aimed at decapitating India's civilian leadership. One option is to delegate nuclear-use authority to subordinate commanders so that nuclear response is still possible even if the civilian leadership is disabled. This, however, exacerbates the problem of unauthorized use because nothing would prevent a subordinate commander from proclaiming the civilian leadership disabled and using the weapons as he sees fit. In fact, the Indian government seems unlikely to want to delegate authority.¹⁵ If this is so, and if the Indian government wants to always maintain "top-down" control, then there are two things it must clarify. First, India must, like the United States, codify civilian succession through a large enough number of governmental officers so that one or more is likely to survive a decapitating attack. At the present time, the ruling party in India would have to convene to elect a successor—something that would be difficult in a nuclear war. Second, India must develop the mechanism to enforce the civilian control of its nuclear weapons. There are two ways to do this. One way is to use a mechanical device, which prevents the arming of the weapon unless the proper code is entered. In the United States, such devices, used extensively on U.S. weapons, are called Permissive Action Links (PALs). The other way is to use specially selected personnel in an organization separate from the military to maintain weapons control. This method was used in the old Soviet

Union and is still used by Russia. India must decide on the combination of these two methods that it wants to use.

India must also decide on a targeting and use doctrine. Open Indian sources (including the National Security Advisory Board's draft Nuclear Doctrine) call for a minimum or proportional deterrence doctrine. Such a doctrine would require only a small number of delivery vehicles and would target only the opponent's cities. This doctrine might be sufficient for deterring Pakistan, especially if India's main goal were to ensure that nuclear weapons are not used in any conflict. Against China this doctrine might not be enough. A first strike by China against India using approximately 20 nuclear weapons could devastate India's nuclear and air forces, yet China would still have over one hundred nuclear weapons to hit Indian cities should India strike Chinese cities in response. India must determine how it would respond to such an attack. Such a response would probably involve attacking Chinese military targets, which would require a larger and more discriminate nuclear force than would be required by a minimum deterrence doctrine.

Ironically, a leading proponent of the proportional deterrence variant of minimum deterrence, Pierre Gallois, came to recognize the flaw in this strategy. When he had originally formulated his views on proportional deterrence, he had done so in the context of an attack that jeopardized national survival.¹⁶ However, in the 1980s Gallois realized that discriminate attacks on military targets would require a different kind of response. "For a medium-size power victim of such an attack, retaliation would pose a difficult political and strategic problem. Hence, for this medium power, the necessity of adding to the minimum deterrence weapons, the instruments of a selective nuclear reaction against the aggressor's military installations with accurate and low yield atomic weapons."¹⁷

An issue that will be dictated by the choice of doctrine is whether India will require a prompt response (in less than an hour) to any nuclear attack. Presumably, a quick response would be required to strike military targets (not necessarily only nuclear ones). A rapid response would require India to maintain a very ready nuclear force and would have implications for command, control, and intelligence. Rapid reaction would require not only that the top Indian leadership survive and decide to retaliate, but also that the command links to the nuclear forces survive, so that a message to respond could be received quickly.

¹⁵India's National Security Advisory Board's draft Nuclear Doctrine says: "The authority to release nuclear weapons for use resides in the person of the Prime Minister of India, or the designated successor(s)."

¹⁶Pierre Gallois, *The Balance of Terror*, Houghton Mifflin Company, Boston, Massachusetts, 1961, p. 119.

¹⁷Pierre Gallois, "Precision, The Fourth Age of Strategy," paper presented at "Disarmament and Peace Seminar," Istanbul, November 25-26, 1983, p. 5.

Rapid response would place heavy demands on Indian intelligence to provide targeting information related to enemy military forces. Having a force that can respond rapidly raises the problems of not only unauthorized use and theft but also of mistaken authorized use. In particular, India would have to quickly decide that an attack had occurred and ascertain where it had come from.

A final issue that India must address is whether to further develop its nuclear weapons. There are two parts to this question. The first is whether India needs to conduct additional nuclear weapons tests. India says that it tested five devices on May 11 and 13, 1998, and that four of them were fission devices with yields of 0.2 kT, 0.2 kT, 0.6 kT and 12 kT.¹⁸ The three subkiloton tests are unusual, and have led some to speculate that these low-yield devices are intended for battlefield use. But even if these devices had the yield reported by India, there is no reason to assume that the intended yield is the same as the test yield. When the British were testing in Australia, they deliberately tested reduced-yield versions of their weapons to limit the test's environmental effects.¹⁹ India's three subkiloton tests, along with the 12-kT test and its May 1974 test might have provided enough information for India to produce a reliable weapon with a 10–20 kT yield that would be light enough (1000 kg or less) to be deliverable by tactical aircraft or ballistic missile.

India has said that its other nuclear test was of a thermonuclear device with a yield of 42 kT.²⁰ This again is somewhat unusual, since the whole point of India producing a thermonuclear weapon would be to have a weapon with a yield in the 100-kT to 1-MT range. India has specifically said that the weapon yield was deliberately reduced to minimize environmental damage. This might include not only seismic damage to nearby villages but also containment of radioactivity. But how confident can India be that its scaled-up thermonuclear weapon will produce the desired yield? All five nuclear powers undertook many tests not only to perfect their thermonuclear weapons but also to produce relatively lightweight versions of this type of weapon. China's first deployed thermonuclear missile

warhead weighed over 2000 kg, yet India's Agni-2 missile has only a 1000-kg payload.²¹

Nor can India easily forgo the possession of thermonuclear weapons if it wants to maintain any sort of balance with China. Despite the common belief that one atomic weapon is enough to destroy a city, in actuality a 10-kT weapon will destroy about 9 sq km of an urban area.²² While this yield would be quite enough for a medium-sized city like Hiroshima with a population of about one-quarter million and a built-up area of about 18 sq km, large modern cities typically have populations of 5 to 10 million and built-up areas of 500 to 1,000 sq km or more. A small Indian retaliatory force of, say, ten 10-kT weapons would barely be enough to disable even one large Chinese city (bearing in mind that not every square kilometer of a city must be destroyed before it stops functioning). However, a 1-MT weapon will destroy an area at least 20 times larger than that of a 10-kT one. Approximately 20 Chinese megaton weapons would be enough to disable every Indian city with a population of more than 1 million.

These considerations lead one to conclude that India might want to conduct additional thermonuclear tests. India has currently proclaimed a test moratorium and has said that it will enter negotiations on signing the Comprehensive Test Ban Treaty—but it is hard to tell how serious India is. Whether India conducts additional nuclear tests will ultimately depend upon political considerations, not just technical ones.

Our discussion thus far has taken India's test claims at face value. However, the seismic data do not totally agree with India's statements. India said its three tests on May 11, 1998 had yields of 42 kT, 12 kT and 0.2 kT. The tests, however, registered a body-wave magnitude of 5.0, which corresponds to a total yield of only 9–16 kT.²³ India said that its two tests on May 13, 1998 had yields of 0.6 kT and 0.2 kT. However, no seismic signals were detected, though at these yields, some should have been. Clearly (at least on May 11), some type of nuclear explosion took place, so it is not hard to credit India with a simple fission

¹⁸John F. Burns, "Indian Scientists Confirm They Detonated a Hydrogen Bomb," *The New York Times*, May 18, 1998, p. 1.

¹⁹During the "Buffalo" test series in 1956, the second and third tests were of the "Blue Danube" bomb. The full yield of this bomb was 40 kT, yet the yields of the two tests were 1.5 kT and 3 kT. As the official history of these tests states: "The yield of a test warhead or device bore no necessary relation to that of a production bomb, since the yield of a given device could be varied at will." See Lorna Arnold, *A Very Special Relationship—British Atomic Weapon Trials in Australia*, Her Majesty's Stationery Office, London, 1987, pp. 63–64, 70.

²⁰Burns, 1998.

²¹This was on the DF-3 (CSS-2). See Robert S. Norris, Andrew S. Burrows, and Richard W. Fieldhouse, *Nuclear Weapons Databook*, Volume V, *British, French, and Chinese Nuclear Weapons*, Westview Press, Boulder, Colorado, 1994, p. 380.

²²About 12 sq km were destroyed at Hiroshima. I used two-thirds power scaling to reduce this area from the 15-kT weapon used at Hiroshima to that for a 10-kT one. See *The Effects of Atomic Bombs on Hiroshima and Nagasaki*, The United States Strategic Bombing Survey, U.S. Government Printing Office, June 30, 1946. Note that this area is not the same as the lethal area, which at Hiroshima was about 8 sq km.

²³Brian Barker *et al.*, "Monitoring Nuclear Tests," *Science*, Vol. 281, September 25, 1998, p. 1967.

weapon capability. The yield discrepancies throw doubt on India's thermonuclear claims—a doubt that must undercut any deterrent effect India's supposed possession of thermonuclear weapons might have. The need to remove this doubt is yet another reason why India may well want to conduct more nuclear tests.

The second part of the question of further Indian nuclear weapons development concerns stockpile size and how it affects fissile nuclear material requirements. India currently has about 450 kg of separated weapons-grade plutonium,²⁴ which would allow the manufacture of about 90 simple fission weapons.²⁵ India is currently producing about 25 kg of weapons-grade plutonium per year, which could be increased to about 100 kg per year if India felt it to be necessary. This stockpile of plutonium and its current production rate are probably enough to supply India with an adequate supply of fission weapons. India's fissile material requirements for its thermonuclear weapons are less clear; there is no unclassified estimate of the amount of plutonium required per weapon. Furthermore, all of the five established nuclear-weapon states have produced both plutonium and highly enriched uranium (HEU). The usual reason given is that thermonuclear weapons require highly enriched uranium. India has only a very small uranium enrichment capacity. It could currently produce at most only 10 kg of HEU per year. It also has produced kilogram quantities of U-233 by irradiating thorium in its power reactors. It is unclear whether it used some of its limited supplies of HEU or U-233 in its thermonuclear test or whether it has found a way to make thermonuclear weapons without HEU. Either way, India might have to increase its fissile material production if it wants to make tens of thermonuclear weapons. If it makes plutonium-only thermonuclear weapons, then these weapons might well use more plutonium than a standard fission weapon. If India uses HEU or U-233, then it will have to undertake a major expansion in its ability to produce these materials.

DECISIONS FACING PAKISTAN

Much of the discussion on India applies to Pakistan as well, for if Pakistan is to deploy a fully weaponized force, many of the choices it must make are similar to those facing India. I will highlight some of the significant differences. Just as the potential of a first strike from Pakistan or, especially, China places difficult requirements on

India, so India, with its relatively large size and resources, generates difficult decisions for Pakistan.

Pakistan, like India, must make decisions about a nuclear delivery system. Pakistan has fighter-bombers, such as the F-16, suitable for nuclear delivery. The F-16 can carry a 1000-kg nuclear weapon to a range of 1400 km,²⁶ which would allow for fairly deep strikes into India. But, like India, Pakistan's aircraft are vulnerable to a first strike. Its handful of tactical fighter bases are nearly all within 200 km of India (less than 10 minutes flying time). The problem of first-strike vulnerability, combined with the need to penetrate deeply into Indian air defenses, leads to the consideration of ballistic missiles for nuclear delivery.

Thanks to foreign assistance, Pakistan's missile programs are further along than are India's. The M-11 missiles Pakistan is reported to have received from China are highly capable mobile missiles that would make excellent nuclear delivery vehicles. Their main drawback is that their range is only 300 km, which means that they cannot cover most of India. Pakistan's two tests of its Ghauri missile may have solved this problem. The Ghauri is believed to be derived from the North Korean No Dong missile and to have a range of 1500 km. The videos of its tests showed that it was launched from a road-mobile launcher. If Pakistan is able to acquire or build enough of these missiles, they could be quite a satisfactory delivery system. The 750-km-range Shaheen-1 that Pakistan tested in April 1999 could also be a nuclear-delivery vehicle, although its shorter range would limit the targets in India that it could reach.

Even if Pakistan decides to place its nuclear weapons on a mobile ballistic missile, it, like India, must then decide how ready this force will be. If it is deployed in the field, moving frequently from site to site, and is armed with its nuclear warheads, then a missile force will be more likely to survive a first strike but will at the same time be more vulnerable to physical accidents, theft and unauthorized use, and problems communicating with its command authorities. If it is deployed at a few secure garrisons, perhaps without the nuclear warheads attached, then it will have far fewer problems with physical accidents and the like but will be much more vulnerable to a first strike. Like India, there is a serious risk that Pakistan will keep its forces in unready garrison mode and try to

²⁴This is an update of a previous estimate. See Brian G. Chow, Richard H. Speier, and Gregory S. Jones, *The Proposed Fissile Material Production Cutoff—Next Steps*, RAND, MR-586-1-OSD, 1995, pp. 43–45.

²⁵India also has about 200 kg of separated reactor-grade plutonium. Although this material is less desirable for weapons, it could be used to

make about 30 additional weapons (assuming 7 kg of plutonium per weapon). India's stocks of weapons-grade plutonium are large enough that it probably would not use its stock of reactor-grade plutonium to make weapons.

²⁶*Jane's All The World's Aircraft*, 1994–1995, p. 572.

rely on strategic warning to disperse its force. Such a strategy is vulnerable to warning failure and a hasty dispersal can increase the physical accident and other problems, and could be considered an escalatory action.

Like India, Pakistan must make important decisions regarding its command arrangements and must develop a targeting and use doctrine. These include devising an arrangement to maintain "top-down" control of its nuclear forces even in the face of an attack designed to decapitate the leadership, and deciding under what circumstances and against which targets it might actually use nuclear weapons.

Pakistan must also decide on any further development of its nuclear stockpile. There has been no official Pakistani statement regarding the types of weapons and the yields for its six claimed tests. The first five tests on May 28, 1998 produced a single seismic signal with a body-wave magnitude of 4.9.²⁷ This is equivalent to a total yield of 6–13 kT. The sixth test on May 30, 1998 had a body-wave magnitude of 4.3, which is equivalent to a yield of 2–8 kT. It seems likely that all of Pakistan's tests involved simple fission weapons, with the most powerful one having a yield no greater than 15 kT. As a result of these tests, Pakistan may have a reliable weapon with a 10–15 kT yield that is light enough (1000 kg or less) to be carried on its F-16s or its M-11s and Ghauris. If this is true, then in the short term Pakistan will have no need to conduct further tests for weapons development, although for political reasons, it might still test if India does.

In the long term, the situation is less clear. If India has really tested a thermonuclear weapon and if it conducts additional tests (especially with large yields of 100 kT–1 MT), then Pakistan will likely try to develop its own thermonuclear weapon—not only for political reasons but for technical ones as well. As was discussed earlier, it takes at least twenty times as many 10-kT warheads to cause urban damage similar to that of a 1-MT warhead. A small Pakistani force equipped with 10-kT weapons would have difficulty disabling even one large Indian city, whereas an Indian force equipped with megaton-yield weapons would probably be able to disable every major city in Pakistan.

Pakistan has already made the decision to expand its stockpile of fissile material. From the mid-1980s to the early 1990s (when production stopped as a result of U.S. pressure) Pakistan produced some 200 kg of HEU at its enrichment plant at Kahuta.²⁸ Assuming 15 kg of HEU

per weapon, this would have given Pakistan enough HEU for approximately 13 fission nuclear weapons. If Pakistan really did test six nuclear weapons in May 1998, afterwards it would have had only enough HEU for seven more weapons. Given this fact, it is not surprising that there are reports that Pakistan restarted production of HEU at Kahuta in the spring of 1998.²⁹ Although HEU may not have been produced at Kahuta during the 1991–1998 period, Kahuta was in operation during this time and the Pakistanis stockpiled medium enriched uranium product. Using this intermediate product to produce HEU would have given Pakistan some 200 kg of additional HEU by the end of 1998.³⁰ Pakistan would then have had enough total HEU to produce approximately 20 nuclear weapons. At this point, the intermediate product stockpile would be exhausted and Kahuta would have gone back to producing HEU from natural uranium. When Kahuta last operated, it produced some 25 kg of HEU per year (starting from natural uranium), which is enough for about 1.7 weapons per year. Pakistan may have already expanded the production rate at this facility or it may expand it in the future.

In addition, Pakistan is reported to have started the operation of its 50-MW heavy-water plutonium production reactor at Khushab.³¹ Significantly, this reactor is reported to have started operation in April 1998, before the Indian tests. Where Pakistan obtained the heavy water needed to start this reactor has not been publicly stated. It probably took about a year for the reactor to reach full-power operation and the plutonium production in the fuel to achieve equilibrium. At this point, the reactor would start discharging about 11 kg of plutonium per year. Assuming 5 kg of plutonium per weapon, this will be enough for some 2.2 weapons per year. The number of plutonium weapons is additive with whatever HEU weapons are produced by Kahuta's output.

CONCLUSIONS

Each of the five major nuclear powers has had to create deployed nuclear forces that meet the requirements for a deterrent force. It has been a long and expensive pro-

²⁹Mark Hibbs, Shahid-Ur-Rehman, and Abdul Rauf Siddiqi, "Pakistan's Prime Minister Will Not Order a Hasty Test," *Nucleonics Week*, May 21, 1998, p. 14.

³⁰Pakistan's total stockpile of HEU will be the same as if it had never stopped producing HEU at Kahuta. In other words, the moratorium on HEU production at Kahuta during these seven years will have had no effect on Pakistan's long-term HEU production.

³¹Testimony of Paul Leventhal, President, Nuclear Control Institute, to the Subcommittee on Telecommunications, Trade, and Consumer Protection, Committee on Commerce, U.S. House of Representatives, May 14, 1998.

²⁷Barker *et al.*, 1998.

²⁸Brian G. Chow, Richard H. Speier, and Gregory S. Jones, 1995, p. 46.

cess. When the British, French, and Chinese first deployed their nuclear forces, they could not survive a Soviet first strike. These countries wanted (and needed) such forces anyway. As soon as they had the capability, both Britain and France deployed nuclear ballistic missile submarines. China has moved toward survivable forces somewhat more slowly, but even it has developed nuclear ballistic missile submarines and land-mobile missiles.

Because no nuclear disasters occurred while these three powers had vulnerable nuclear forces, there may be some in India and Pakistan who think that this paper has overstated the risks that they face. But the British and French were always protected by U.S. nuclear forces. In the Chinese case, it is well known that the Soviets were seriously considering a preventive nuclear war against China in the late 1960s, which clearly illustrates the magnitude of the risks.³²

These three powers eventually managed to minimize some of the risks discussed in this paper by deploying large diverse arsenals. An important element in their arsenals was the deployment of mobile missiles on submarines. The submarine's mobility and its invisibility under water not only protect it from a first strike but also from theft. In the case of a physical accident (as has happened to two Soviet ballistic missile submarines), the vessel simply sinks into deep water, with minimal environmental effects.³³

However, it will be a long time before there are Indian ballistic missile submarines cruising the Indian Ocean and even longer before there are Pakistani ones. In the interim, if India and Pakistan go ahead with their nuclear deployments, their forces could be vulnerable to a first strike (which could lead to crisis instability), to physical accidents, to theft, and to unauthorized use. As such, Indian and Pakistani nuclear deployments are a threat to the whole world.

Even if some day India and Pakistan were able to make all of the decisions, take all of the actions, and afford all of the expenditures needed to bring them to where the major nuclear powers are today, neither country should think that this would be the end of it. Maintaining a

nuclear deterrent force is a dynamic process,³⁴ a point that was illustrated to some extent above. For example, Pakistan's two tests of its Ghaury ballistic missile has forced India to consider the vulnerability of many more of its air bases. India's claim to have tested a thermonuclear weapon has forced Pakistan to consider the development of similar weapons. Additional events should be expected in the future. It was considerations such as these that forced the five nuclear powers to maintain significant expenditures on their nuclear forces. One of the more extreme cases was France, which for many years spent around 30 percent of its defense budget on its nuclear forces. India and Pakistan may face expenditures of a similar magnitude.

Some Indians will argue that the possibility of conflict with China requires India to deploy nuclear weapons. But as this paper has shown, the mere possession of nuclear forces does not necessarily mean that one can deter one's enemies. The key issue is, does the deployment of nuclear forces increase or decrease Indian security? Because Indian nuclear forces will be unlikely to be able to withstand a Chinese first strike, an Indian deployment of nuclear weapons will actually make a Chinese nuclear strike more likely. This, combined with the risks of physical accidents, theft, and unauthorized use, and the drain of resources away from conventional military forces, makes it clear that by deploying nuclear forces India will be decreasing its security.

Given all of these problems, the U.S. policy to try to stop nuclear weaponization in India and Pakistan is eminently sensible. The risks to the rest of the world are undeniable. And as this paper has shown, weaponization would present India and Pakistan not only with substantial risks but also with major expenditures should they try to reduce these risks. The United States needs to be frank with India and Pakistan about the problems they are getting into and how complex those problems can be. It is one thing to say, "Have safe nuclear weapons." The Indians and Pakistanis will surely respond, "Of course we will." It is another to say, "A small, unsophisticated nuclear force may have to choose whether it can survive a first strike or whether it can avoid physical accidents and

³²Ultimately, even China's security depended on U.S. protection; it was strong U.S. opposition that discouraged the Soviet attack. See Scott D. Sagan, "The Perils of Proliferation," *International Security*, Vol. 18, No. 4, Spring 1994, p. 84. New information makes it clear that Brezhnev himself favored truncating China's nuclear weapons development, but that he wanted U.S. concurrence. See William Burr (ed.), *The Kissinger Transcripts*, The New Press, New York, 1998, pp. 131, 142.

³³Peter Huchthausen, Igor Kurdin, and R. Alan White, *Hostile Waters*, St. Martin's Press, New York, 1997.

³⁴Albert Wohlstetter first pointed out this problem facing small nuclear powers.

The problem of deterring a major power requires a continuing effort because the requirements for deterrence will change with the counter-measures taken by the major power. Therefore, the costs can never be computed with certainty; one can be sure only that the initiation fee is merely a down payment on the expense of membership in the nuclear club.

("Nuclear Sharing: NATO and the N+1 Country," 1961, p. 363.)

have weapons that are safe from theft and unauthorized use.”

At the same time, the United States should see what can be done to lessen the underlying tensions in the region. For example, resolution of India’s border disputes with China would help to build on the force reductions that have already taken place in the last few years on the Sino-Indian border. It is steps like these, rather than India and Pakistan’s deployment of vulnerable nuclear forces, that hold the key to stability in South Asia.

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