The Problematic of a Nuclear Force-in-Being, a Stable Deterrence, and the Issue of Non-deployment

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Acronyms

CBMs	Confidence Building Measures
COSC	Chiefs of Staff Committee
DRDO	Defence Research and Development Organization
IDS	Integrated Defence Staff
LDZ	Limited Deployment Zone
NCA	National Command Authority
NBC	Nuclear chemical biological
NSAB	National Security Advisory Board
SFC	Strategic Forces Command
SPD	Strategic Plans Division
TEL	Transporter Erector Launcher

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Abstract

There is a need for India and Pakistan to exert restraint and undertake measures to make their nuclear standoff more stable. Their existing postures of a recessed deterrence, or a force-in-being, should not make the two sides complacent. There are steps the two sides could take and provide reassurances around, so that when and if in a crisis nuclear forces are assembled risks are minimized and crisis resolution is not precluded. Steps proposed here include restraints on the movement of nuclear forces during crises, establishing restraint measures on technologies for targeting mobile nuclear launch systems, and establishing limited deployment zones for mobile missile launchers. A non-intrusive strategy for verifying the exclusion of short-range missile systems from border areas is presented.

1. Introduction

The state of nuclear deterrence assumed to prevail in South Asia, with nuclear warheads disassembled and stored separately from delivery vehicles, is recognized widely as playing a stabilizing role in the India-Pakistan nuclear standoff. This state has been called a force-in-being as opposed to a ready arsenal.[1] The state is also characterized as a recessed deterrence. However, as a crisis develops and if nuclear forces are ever constituted and deployed, the two countries will face all the dilemmas that are realized by the possession of ready nuclear arsenals.[2] There is a need, therefore, for India and Pakistan to exert restraint and undertake measures to make their nuclear standoff more stable, especially when and if a crisis begins to unfold. The posture of a force-in-being should not make the two sides complacent. There are steps the two sides could take and provide reassurances around, so that if in a crisis nuclear forces are assembled risks are minimized and crisis resolution is not precluded.

[1] Ashley Tellis, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal* (New Delhi: Oxford University Press, 2001).

[2] See, for example, Michael Ryan Kraig, "The Political and Strategic Imperatives of Nuclear Deterrence in South Asia", *India Review*, Volume 2, Number 1, pp. 1-48.

In this paper I discuss some of the unique and complex characteristics for the force-in-being postures adopted by India and Pakistan as compared to postures in which nuclear weapons are fully assembled and deployed in a clearly identifiable manner. One of these is the issue of the balance between ambiguity and transparency needed for strategic stability that is difficult to attain for force-in-being postures. Issues of transport safety and tests for weapon reliabilities for the existing postures have complicating features that deserve examination, and some of these are considered here. A disassembled nuclear force upon assembly may rely on delivery systems that are designated for conventional as well as for nuclear roles. As has been noted by various analysts, such dual-role systems can be struck inadvertently in a conflict.[3] To minimize the risks of inadvertent and/or deliberate attacks, I propose a set of possible restraint measures. If India and Pakistan formally agree to the non-deployment of nuclear weapons and/or the non-deployment of specific delivery systems in specified geographical zones, the paper discusses a possible strategy for verification that might be sufficiently non-intrusive enough to be acceptable and adopted by India and Pakistan.

I would like to state unambiguously that the point of this study is not to argue for India and Pakistan to implement a hair-trigger alert posture with fully deployed nuclear weapons and systems. Rather, what I wish to argue for and demonstrate is that a posture of a force-in-being is not a panacea for all the problems associated with possessing fledgling nuclear forces. The postures adopted produce some unique problems that India and Pakistan need to recognize and build an understanding and mutual reassurances around, so that in a crisis room for misperceptions and inadvertent mistakes is lessened.

A posture of a force-in-being is not a panacea for all the problems associated with possessing fledgling nuclear forces.

Some of the complicating factors unique to a posture of a force-in-being can be characterized as follows:

- The demonstration of preparedness and survivability is difficult with a non-deployed deterrence. With fully deployed forces, controlled transparency is more readily possible and, if the forces are identifiably proven able to survive a preemptive strike, such transparency can increase crisis stability. In the case of hidden and distributed forces, such controlled transparency is much more difficult though, perhaps, even more essential. Disassembled forces also increase the survivability requirements for a nation's command and control structures, and the lack or perceived lack of survivability of an adversary's command and control system creates further room for misperceptions as well as incentives to contemplate a decapitation strike.

- For a disassembled posture, when, and if, the fissile cores, warheads and delivery vehicles are moved, so that the weapon systems can be constituted, there is an increased risk of transport accidents. In contrast, in the case of deployed systems in fixed and hardened silos transport occurs less frequently and the transport risks are less. I examine these transport risks semi-quantitatively. By assessing these risks, I suggest

[3] V. R. Raghavan, "Limited War and Nuclear Escalation" *Non-Proliferation Review*, Fall/Winter 2001, pp. 83-98.

approaches that India and Pakistan could implement to minimize the likelihood of transport-related accidents.

- Probabilistic risk assessments to certify the safety and reliability of nuclear weapons will have to deal with some complicating issues related to the storage of the components in a distributed form. For example, the fact of warheads not being constituted implies that components of the total system are aging in differing chemical, thermal and stress environments. An analysis of failure modes may, therefore, be compounded in difficulty, as compared to a situation in which fully constituted weapon systems are available for testing and study on a routine basis.

- For disassembled forces, there is ambiguity between the conventional and nuclear roles of delivery systems – unlike for the case of fully deployed nuclear forces. With a force-in-being, the delivery systems that may be assigned a nuclear role could also play a conventional role. Therefore, during hostilities, there is a risk of inadvertent attacks on the distributed forces. To minimize such risks, I propose restraint regimes in targeting and other related technologies. Risks of inadvertent attacks could also be reduced by the non-deployment of strategic systems in specific exclusionary zones. I present an option for verifying non-deployment that could assist in managing and reducing such risks while maintaining stability.

After a discussion of all the issues enumerated above, I end with some policy recommendations that could enhance strategic stability in South Asia. First, to set the context for the remaining discussions, I establish to the extent possible (given the relatively opaque nature of India and Pakistan's nuclear postures) that India and Pakistan do, in fact, employ a posture of a force-in-being.

2. The Evidence for a Force-in-Being

Official statements by India and Pakistan about the deployment status of their nuclear weapons, though infrequent and not always explicit, do provide some insight.

An official statement that speaks to this issue for India is by Jaswant Singh, then India's External Affairs minister. When asked by *The Hindu* newspaper on 29 November 1999, if it was correct to conclude that India follows different peace-time and war-time deployment postures, Jaswant Singh replied: "This would be a correct assessment. You know that we would like to convey a sense of assurance in our region, also beyond so that our deployment posture is not perceived as destabilizing. We have rejected notions of 'launch on warning postures' that lead to maintaining hair trigger alerts, thus increasing the risks of unauthorized launch."[4]

An extensive discussion of this issue for India, with numerous references from the open literature and based on interviews with Indian officials, is contained in a book by Ashley Tellis.[5]

Pakistan has not formally declared a nuclear doctrine but official statements imply a similar approach. For example, in a speech at the plenary of the Conference on Disarmament on 25 January 2001, the Pakistani Foreign Secretary formally proposed the non-mating of nuclear weapons and delivery systems.[6]

As a result of statements like these, analysts commonly assume Indian and Pakistani nuclear deployment to be in a disassembled form – a force-in-being, also often termed a recessed deterrence.

[4] Indian Government Ministry of External Affairs website. Available at <http://www.meadev.nic.in/govt/eamint-nov28.htm>.

[5] Ashley Tellis, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal* (New Delhi: Oxford University Press, 2001).

[6] Naeem Ahmad Salik, "Missile Issues in South Asia," *The Nonproliferation Review*, Summer 2002, Volume 9, Number 2, pp. 47-48.

3. Ambiguities and Misperceptions

In the case of India and Pakistan, warning times are low and capabilities limited. It is difficult, therefore, for the two sides to adopt a posture of launch on warning with ready-to-go fully constituted systems. One could argue that with a constituted system the adversary is perhaps better deterred, and there is little risk of a fully constituted system being attacked inadvertently. This does not hold true for a distributed and hidden system. Such a system has an increased risk of being attacked inadvertently, as the attacking side has no or little knowledge of the locations of its adversary's nuclear forces. In the initial conventional phase of a conflict, attacks against conventional targets such as military bases and airfields could inadvertently damage hidden and non-deployed nuclear forces.

A code of conduct could be created that would disallow the early constituting of forces in a crisis.

Therefore, India and Pakistan need to evolve a system that minimizes this risk. Perhaps, a code of conduct could be created that would disallow the early constituting of forces in a crisis, or even if a conventional border conflict began.

In fact, they may wish to reassure each other that constitution will not take place in the case of a border conflict, but only if a full-fledged conventional war breaks out and cities and critical infrastructure start being attacked.[7] The weapons would be viewed as weapons of last resort, and only constituted if forces of one country began to penetrate the territory of the other to an extent greater than what is involved in border skirmishes. Each side would guarantee that nuclear forces would not be brought into the border areas (to a previously agreed distance, perhaps outside the range of their short-range missiles) and, thus, the risks that in a border conflict inadvertent attacks on nuclear forces could occur would be minimized.

It can be argued that it is to Pakistan's advantage to deter an Indian conventional attack with the threat of nuclear escalation at even a "single step" across the border – but certainly it is to the advantage of both to not let a crisis involve dangerous practices.

[7] This suggestion has also been proposed by Major General Mahmud Ali Durrani (ret.) of Pakistan in a recent study completed at the Cooperative Monitoring Center, Sandia National Laboratories: *Pakistan's Strategic Thinking and the Role of Nuclear Weapons*. Available at <http://www.cmc.sandia.gov/links/cmc-papers/sand2004-3375P.pdf>.

4. The Difficulties of Controlled Transparency for Disassembled Forces

With a sufficient number of missiles in fixed and hardened silos, as well as a fraction deployed on mobile platforms, such as submarines or trains, it is possible to unequivocally demonstrate to an enemy the impossibility of destroying all of the nuclear forces in a country's possession.

The situation for India and Pakistan is far murkier. With their forces in a distributed mode and concealed to the best of their abilities, the two countries signal resolve through official statements meant to demonstrate their strength-of-will, and even, sometimes, use missile flight tests in the middle of a crisis to send a message. Sometimes, these signals send a conflicting message. For example, in some crises Pakistan has warned of an impending Indian preemptive strike and put its nuclear forces on an alert status.[8] [9] The statements warning of Indian plans for preemptive attacks could be directed at an international audience to establish the aggressive nature of the Indian state. However, the underlying message is that Pakistan either fears real vulnerabilities, or fears that there has not been adequate demonstration to the Indians of the futility of contemplating a preemptive strike.

The inability to physically demonstrate the invulnerability of fully deployed fixed and mobile forces leads India and Pakistan to rely on bellicose statements in a crisis. Such statements carry an increased risk of escalation, and could complicate the defusing of a crisis.

For crisis stability, both sides have to believe that no advantage can be gained by initiating a preemptive strike.[10] To foster this belief requires some amount of transparency that can establish the guaranteed survivability of one's nuclear forces. With non-deployed forces, transparency will have to be carefully managed so that it enhances crisis stability and does not unnecessarily expose vulnerabilities. If the forces disassembled were ever identified with excessive transparency regarding their storage locations and likely modes of transport, the adversary would have an increased temptation to consider a damage limiting preemptive strike.

[8] For example, a story in Pakistan's Daily Jang newspaper stated that Pakistani military officials were tracking hostile Indian moves of augmenting air squadrons and naval ships in what they believed might be preparations of a preemptive conventional strike against Pakistan. See, Aslam Khan, "Pakistan Says India Planning pre-Emptive Strikes", *Daily Jang*, 30 September 2002.

[9] A recent study by Rahul-Roy Chaudhry discusses this issue of signals and conflicting messages in greater detail: *Nuclear Doctrine, Declaratory Policy and Escalation Control*. Available at <http://www.stimson.org/pub.cfm?id=105>.

[10] This definition has been developed by the Center for Nonproliferation Studies of the Monterey Institute of International Studies (Monterey, CA).

5. Problems of Command and Control for Disassembled Forces

Controlled transparency and the sharing of relevant information would also help in avoiding miscalculations and misperceptions regarding the survivability of command and control systems. Each side needs to reassure the other that the nuclear weapons in its possession are safe and secure, and that a robust command and control system exists that would survive a first strike, thereby eliminating any temptation for considering such a strike.

The aim of nuclear operations, including command and control systems, is to "prevent peacetime nuclear operations from leading to nuclear war, especially in crises, and to carry out in wartime the missions assigned to nuclear forces".[11] In peacetime, a time of crisis, or a time of war, each country will attempt to manage its nuclear operations for maximum advantage. A danger exists that in doing so, either side could create conditions that spiral out of control and lead towards a nuclear confrontation. This is the dyadic coupling of two command and control structures recognized as existing between the US and Soviet systems during the Cold War, reaching a very tightly coupled state by the 1970's as global warning and intelligence systems became closely integrated with strategic forces. The Indian and Pakistani systems, though loosely coupled at this time, will continue to get more tightly coupled over time, especially in a time of crisis or war when they are at maximum alert. As pointed out by Paul Bracken, "Although each side may well believe that it was taking necessary precautionary moves, the other side might see a precaution as a threat. This would in turn click the alert level upward another notch."[12] There is a danger, therefore, that India and Pakistan's command and control structures could become locked into an unstable, escalating process.

The Indian and Pakistani nuclear command and control structures are evolving, as are the military institutions that control nuclear forces. The Indian and Pakistani military institutions that control nuclear forces are changing at an extremely deliberate and often ponderous pace. As new military institutions are created that have links to nuclear forces, these institutions by their very conception force a shift in Indian and Pakistani thinking about the war-fighting efficacy of nuclear weapons. No matter how vehemently each side's politicians declare that their weapons are not meant for war fighting and solely for deterrence, their militaries will prepare operationally to fight and, if not win, at least maintain escalation dominance in a nuclear exchange.

Pakistan has had a National Command Authority (NCA) in place since 2000. This NCA was established by the military government led by President and General Pervez Musharraf. The NCA of Pakistan is

[11] Michael M. May, and John R. Harvey, "Nuclear Operations and Arms Control" in *Managing Nuclear Operations*, edited by Ashton B. Carter, John D. Steinbruner, and Charles A. Zrakert (The Brookings Institution, Washington, D.C., 1987).

[12] Bracken, Paul, *The Command and Control of Nuclear Forces*, (Yale University Press, New Haven, USA, 1983), p. 64.

described in a flow chart published on the web site of the Pakistani Ministry of Foreign Affairs.[13] The NCA is responsible for policy formulation and will exercise employment and development control over all strategic forces and strategic organizations. The NCA is made up of an Employment Control Committee, a Development Control Committee, and a Strategic Plans Division (SPD).

The head of the Pakistani government chairs the Employment Control Committee. Other members include the Ministers of Foreign Affairs, Defense, Interior; the Chairman of the Joint Chiefs of Staff Committee; the three service chiefs; the Director-General of the SPD, and technical advisors as required. Only this Committee is authorized to make a decision on the employment of nuclear weapons.

The head of the Pakistani government also chairs the Development Control Committee. Other members include the Chairman of the Joint Chiefs of Staff Committee; the three service chiefs; the Director-General of the SPD; and representatives of strategic organizations and the scientific community. The Development Control Committee develops the strategic assets required to carry out the employment orders issued by the Employment Control Committee.

The SPD acts as the secretariat for the NCA. The SPD is located in the Joint Services Headquarters and is led by a two/three-star General, who is traditionally from the Army.

Major General (ret.) Mahmud Durrani has discussed the broad features of Pakistan's nuclear doctrine and command and control structures in an Occasional Paper published by the Cooperative Monitoring Centre at Sandia National Laboratories.[14] The description of Pakistan's doctrine is based on an analysis of public statements and interviews of key Pakistani officials. As described by General Durrani, deterrence is the cornerstone of Pakistan's doctrine:

> The central theme of Pakistan's nuclear policy is to act in a responsible manner and exercise maximum restraint in the conduct of its deterrence policy. Some of the salient elements are as follows: Pakistan's nuclear capability is solely for the purpose of deterrence of aggression and defense of sovereignty….

Although eschewing a policy of "No First Use", public statements by Pakistani leaders have in the main stressed that Pakistan would use nuclear weapons only as a last resort and only if the very survival of Pakistan was at stake. In this regard, an interview of General Khalid Kidwai, the Director of Pakistan's SPD, reported by the Landau Institute, an Italian arms control institution, is extremely illustrative. The Landau report says, "Asked if Pakistan has prepared something like a ladder of nuclear escalation, General Kidwai answered that of course there were options available in the nuclear response."[15]

The fact that Pakistan is ready, at least in principle, to employ its nuclear weapons in a war-fighting and possibly escalating mode results in India having to face the prospect, however unlikely, of deterrence failure; and to begin planning for the use of nuclear weapons – that is, to begin viewing nuclear weapons (at least partially) as capable of being used and not simply as a political hedge against coercion, never to be used, and sufficient simply by their very existence to deter an adversary.

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[13] Pakistan Ministry of Foreign Affairs, Organization of Pakistan's National Command Authority. Available at <http://www.forisb.org/NCA.html>.

[14] Major General (ret.) Mahmud Durrani, "Pakistan's Strategic Thinking and the Role of Nuclear Weapons" Occasional Paper No. 37, Cooperative Monitoring Centre, Sandia National Laboratories, Albuquerque, NM, USA, 2004.

[15] *Nuclear safety, nuclear stability and nuclear strategy in Pakistan*, a report of a visit by Landau Network-Centro Volta; Como (Italy). Available at <http://www.mi.infn.it/~landnet>.

India's NCA is made up of two Councils: Political and Executive. The Prime Minister chairs the Political Council. This is the sole body that can authorize the use of nuclear weapons. The National Security Advisor chairs the Executive Council. The Executive Council provides inputs for decision-making by the NCA and executes the directives given to it by the Political Council.

In January 2003, India created its Strategic Forces Command (SFC), taking another step towards the greater operational integration of its nuclear forces with its military. The Commander-in-Chief of the SFC reports to the Chiefs of Staff Committee (COSC) that reports to the NCA. The Cabinet Committee on Security (CCS) appointed the Commander-in-Chief of the SFC. In the official press release of this appointment, the role of the SFC is described as being one "to manage and administer all Strategic Forces".[16] Official statements have also been made that the SFC will have "operational control" of India's strategic assets. Uday Bhaskar, the Deputy Director of the Institute of Defence Studies and Analyses, a government-funded think-tank in New Delhi, has described the connection between the SFC, the COSC, and the Executive Council of the NCA as follows:

> [The SFC] will function under the Chairman of the Chiefs of Staff Committee that in turn will provide inputs to the Executive Council that reports to the Political Council for the final decision-making in the hopefully unlikely exigency of having to use nuclear weapons.[17]

As a crisis develops, and strategic units become operational, control of these assets is expected to pass to the SFC. The delivery systems include aircraft, and Prithvi and Agni missiles. These systems will presumably stay with the respective forces (currently the Army and Air Force) in times of peace, but move into the control of the SFC as a crisis develops.

In October of 2001, India created the Integrated Defence Staff (IDS) that began to serve as the principal secretariat to the COSC. An analysis of the charter of duties of the IDS establishes that one of the IDS's roles is the "management of war fighting". In his "Report on the first year of existence by the Chief of Integrated Defence Staff to the Chairman Chiefs of Staff Committee", Lt. General P.C. Joshi in his description of the activities of the Operations Branch of the IDS described an activity with nuclear relevance:[18]

> Nuclear Issues. I am not at liberty to disclose here the full extent to which work has been done in this field. However, considerable work has been done and is progressing.

It is clear that the Indian military is studying the role of nuclear weapons in war-fighting.

If we juxtapose the IDS's role in preparing management plans for war-fighting with this reference to nuclear weapons, it is clear that the Indian military is studying the role of nuclear weapons in war-fighting. In this regard, certain military exercises and technologies being practised and developed

16 Press Release, "Cabinet Committee on Security reviews progress in operationalizing India's nuclear doctrine", Press Information Bureau, Government of India, 4 January 2003.

17 Bhaskar, Uday, "A Credible Minimum Deterrent, Silicon India", *Daily Byte*, 6 January 2003.

18 Report available at <http://ids.nic.in/reportfirst.htm>.

within India are significant. In May 2000, for example, the Indian Army in collaboration with the Indian Air Force, conducted a number of training exercises, collectively known as *Poorna Vijay* or 'complete victory', "to evaluate concepts and practice battle procedures during offensive and defensive operations on the future battlefield, with a nuclear backdrop."[19] The Defence Research and Development Organization (DRDO) has developed and transferred to the Indian military an Integrated Field Shelter that provides

> collective personnel protection from NBC[20] agents in a nuclear warfare scenario. The shelter has multifarious usage and apart from living can be used as [a] Command Post, Observation Post, Regimental Aid Center, and Communication Center. The shelter can also be utilized for storage of food, fuel, medical supplies, etc.[21]

These facts, that Indian war plans and exercises have simulated Indian troops entering a radiological hazard area (using T-90 tanks that have filters against NBC hazards), and that the DRDO has developed portable fall-out shelters, point to a recognition within India's military at least that nuclear weapons are capable of being used on a battlefield.[22]

On 4 January 2003, the Indian Prime Minister's Office distributed the press release that described conclusions reached by the CCS on operationalizing India's nuclear doctrine.[23] This press release says, "The CCS reviewed the existing command and control structures, the state of readiness, the targeting strategy for a retaliatory attack, and operating procedures for various stages of alert and launch." This press release on India's official nuclear doctrine is scanty in details. In contrast, in 1999, India's National Security Advisory Board (NSAB) prepared a report for India's National Security Council that dealt with options for India to consider in creating a nuclear doctrine. The document is called the "Report of the National Security Advisory Board on the Draft Indian Nuclear Doctrine."[24] The report was widely circulated by the government to generate dialogue and discussion, and came to be known as India's draft nuclear doctrine. This draft doctrine, however, was never officially accepted; and has been superseded by the official pronouncement of 4 January 2003. Though not as doctrine, the NSAB report can be interpreted as a statement of intent, representing the opinions of influential security advisors to the government.

The NSAB report does address the issue of the command and control of nuclear weapons. The doctrine makes it clear that India's command and control structure and nuclear forces must be able to survive repeated attacks of attrition. The exact words in the doctrine in section 4.3 are –

> (i) India's nuclear forces and their command and control shall be organized for very high survivability against surprise attacks and for rapid punitive response. They shall be designed and deployed to ensure survival against a first

[19] Sainik Samachar, Ministry of Defence, Government of India, June 2000.
[20] NBC = nuclear, biological, chemical.
[21] Available at <http://www.drdo.com/pub/techfocus/apr02/Collective Protection.htm>.
[22] US newspapers have often published reports of desk exercises carried out by US military officers that model the outbreak of a conventional war between India and Pakistan. See, for example, Sam Gardiner, "It Doesn't Start in Kashmir and It Doesn't End Well," *Washington Post*, 20 January 2002. These exercises are reported to predict India gaining an advantage and Pakistan turning to tactical nuclear weapons to try and stop an Indian mechanized advance. Indian war-planners may have conducted similar simulation exercises with comparable results.
[23] See <http://pib.nic.in/archieve/lreleng/lyr2003/rjan2003/04012003/r040120033.html>.
[24] See <http://www.indianembassy.org/policy/CTBT/nuclear_doctrine_aug_17_1999.html>.

> strike and to endure repetitive attrition attempts with adequate retaliatory capabilities for a punishing strike which would be unacceptable to the aggressor. (ii) Procedures for the continuity of nuclear command and control shall ensure a continuing capability to effectively employ nuclear weapons.

Section 5.2 of the NSAB report further states that, "An effective and survivable command and control system with requisite flexibility and responsiveness shall be in place. An integrated operational plan, or a series of sequential plans, predicated on strategic objectives and a targeting policy shall form part of the system." The requirement for a series of sequential plans lends credence to the fact that the NSAB report envisages a series of repeated, perhaps escalating, attacks; to which India would respond through its series of plans, presumably having suffered damage to its command and control structure. The flexibility and the series of attacks discussed in the doctrine are based on assumptions that the first attack India suffers may not be one that creates total destruction – rather it could be the first of a series of steadily escalating attacks, to each of which India may respond with its sequential plans and targeting policy. The implication here is of weapons either used in an escalating manner, or of a variety of weapons of varying yields being used. The principal assumption of a scenario in which repeated attacks occur is that the first attack and its response are not of such intensity that no further attacks are either needed or possible. The command and control system is assumed to function through a series of attacks, directing and employing appropriate responses.

A further indication that the Indian doctrine encompasses some issues related to the war-fighting use of nuclear weapons is that Article 5.5 states, "The Indian defense forces shall be in a position to execute operations in an NBC environment with minimal degradation." The fact that this issue of operations in an NBC environment has been recognized does give credence to the fact that the use of weapons is being thought about.

Ashley Tellis identified three main reasons for India's current refusal to treat nuclear weapons as military tools[25]: one, a tradition of liberal and idealistic thought that sees nuclear weapons as inherently abhorrent; two, a system that enshrines the primacy of civil over military institutions, and that fears the strengthening of the military in civil-military relations through the greater military control over nuclear weapons required by a nuclear war fighting posture; and, three, an aversion to paying the increased costs associated with a nuclear posture that may require nuclear weapons to be in a more ready state of alertness and of greater number and variety. For these reasons, a delayed yet assured retaliation for punishment against countervalue targets is, therefore, the main nuclear-use policy being currently followed by India for deterrence. Until further changes in existing conditions, at the level of declaratory policy India will attempt to avoid viewing nuclear weapons as having utility as war fighting implements. However, as India's nuclear posture evolves, at an operational policy level the future will likely see a trend towards what Ashley Tellis has called a "countervalue plus" targeting strategy. As Tellis points out,

> It is reasonable to expect that India's nuclear doctrine will eventually incorporate a…. targeting orientation that still presupposes mutual assured vulnerability at bottom but integrates the capacity for more flexible responses in order to ensure that punishment, whenever inflicted, can be proportionate and lead eventually to speedy conflict termination at the most minimal cost to India.

[25] Ashley Tellis, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal*, pp. 280-292.

It is not clear, however, that Indian and Pakistani analysts have given much consideration to the changes required in their command and control systems by the future adoption of nuclear war-fighting strategies. Such strategies will require a major rethinking of India and Pakistan's command and control systems. A command and control system that must simply give a single order for a massive retaliation will be quite different from one that must coordinate a steadily escalating strategy under nuclear attack. In the first case, the system can disintegrate after it gives its single command without a loss of function; in the second case, the system must survive repeated nuclear attacks.

As pointed out by Shaun Gregory, India and Pakistan have to be greatly concerned about

> command and control issues around the deployment and operation of nuclear weapons. The dynamics of taking nuclear weapons from their recessed postures, mating warheads to delivery systems, deploying weapons in the field, and meeting the requirements of command and control through possible conventional and perhaps even nuclear engagement are immensely demanding and risk-prone."[26]

What are the command and control issues that are particularly and uniquely made complex by India and Pakistan's possession of disassembled forces? And what are the steps being implemented to optimize the command and control structures and minimize any negative consequences arising from this state of possessing disassembled forces?

These are the hard questions related to their command and control structures that both countries still need to answer and make transparent to each other without excessively exposing vulnerabilities.

One of the key issues, apart from surviving a preemptive attack, for India and Pakistan's command and control systems will be to move the separate components of their nuclear forces and reconstitute them, even under attack. Let us consider the risks involved in such movement.

[26] Shaun Gregory, "Rethinking Strategic Stability in South Asia," SASSU Research Report No. 3, South Asia Strategic Stability Unit, University of Bradford, September 2005, p. 19.

6. Risks of Transport Accidents

To reiterate, the deployment status of India and Pakistan's nuclear forces is currently understood as a state in which warheads are stored separately from delivery systems and the warheads may be stored as disassembled components. As a crisis develops, the readiness posture of nuclear weapons is expected to progressively change, moving through stages until a nuclear-armed delivery system reaches a ready-to-use state.

Zia Mian, M.V. Ramana, and R. Rajaraman have assessed the risks and consequences from the dispersal of plutonium into the atmosphere and consequent biological hazards from nuclear weapon accidents in South Asia.[27] They state that such accidents involving nuclear weapons could be caused, for example, by missile and jet fuel fires and explosions – and point out that many such accidents have occurred to US nuclear weapons, as well as to those possessed by other nuclear powers. As pointed out in this paper, "prudence would dictate that India and Pakistan not deploy nuclear weapons or store them close to aircraft or ballistic missiles. Keeping the weapons disassembled would further reduce the risk of accidental detonation." Other studies have also reviewed and assessed nuclear weapons accidents for the US and other countries.[28] Shaun Gregory, for example, has described some extremely serious accidents involving nuclear weapons, including one in which fuel leaked into the silo of a Soviet nuclear-armed missile and exploded.[29]

As the components of India and Pakistan's nuclear forces begin to move, there will be increased risks of transport accidents. Feroz H. Khan has pointed out the harsh physical conditions under which such movement will occur in South Asia:

> Conditions for armored and infantry mobility are harsh and compounded by heat and dust. Missile deployment is logistically challenging. Strategic missile types encompass both liquid- and solid-fueled technologies, each having its own unique problems of handling and safety in movement.[30]

To understand these safety risks of movement quantitatively, we can use data on accident rates based on numbers and types of vehicles involved and distances moved.[31] We can then assume certain

[27] Zia Mian, M. V. Ramana and R. Rajaraman, "Risks and Consequences of Nuclear Weapons Accidents in South Asia", Center for Energy and Environmental Studies, Princeton University, PU/CEES Report No. 326, Princeton, NJ, USA, September 2000.

[28] See, for example, Jaya Tiwari and Cleve J. Gray, "U.S. Nuclear Weapons Accidents." Available at <http://www.cdi.org/Issues/NukeAccidents/accidents.htm>.

[29] Shaun Gregory, *The Hidden Cost of Deterrence: Nuclear Weapons Accidents* (London: Brassey's, 1990), pp. 184-190.

[30] Feroz Hassan Khan, "Nuclear Signaling, Missiles, and Escalation Control in South Asia", Chapter 4, in Escalation Control and the Nuclear Option in South Asia, Michael Krepon, Rodney W. Jones, and Ziad Haider (eds.), (Stimson Center, Washington D.C.) Available at <http://www.stimson.org/southasia/pdf/ESCCONTROLCHAPTER4.pdf>.

[31] We assume that the risks of accidents are uniform over the distances and/or times that vehicles move. This is a simplifying assumption to aid in determining bounds on magnitudes of accident risks for various modes of transport. Then given the number of accidents, A, for a number, N, of vehicle-kilometers or vehicle-hours of operation, we can calculate through a simple proportion the number of vehicle-kilometers or vehicle-hours for at least one accident to

numbers and types of vehicles and distances moved for the mating of the nuclear components of a recessed force. Data from India on transport accident rates are more readily available, and so they are used in the analysis presented here, with the assumption that accident rates for Pakistan would be similar. In the case of helicopter accident rates, data from the United States are used as such data from India and Pakistan are not readily available.

When nuclear weapons or materials are moved, extraordinary precautions will be taken. However, some insight is still provided by using civilian transport accident rates. Using civilian transport accident rates provides an upper bound on likely accident rates involving the movement of nuclear weapons or materials, assuming that the accident rates for the movement of specialized materials (such as nuclear weapons) are lower than for general civilian transport.

Helicopter accident data from 1999 for the US indicate that 8.4 accidents can be expected for every 100,000 hours of flight.[32] These data include all manner of accidents, even relatively minor ones. Therefore, the US data may still provide an upper (or representative) estimate of risks for Indian and Pakistani helicopter transport, as the US data are not simply for significant accidents. Let us assume, for example, that in moving fissile cores and warheads, India or Pakistan will need 10 helicopters that will move for 10 hours each. In such a case, the probability of at least one accident occurring is 0.0084. However, if 100 helicopters carrying nuclear components move for 100 hours each, then the probability of at least one accident occurring will be 0.84. Therefore, when a number of fissile cores and warheads are moved by helicopters, the probability of an accident increases quite significantly with increasing numbers and travel time.

A similar calculation is possible for transport by trains. Indian train accidents occur at about 0.55 per million train-kilometers.[33] Therefore, if we assume that movement of the forces involves 10 trains moving 1000 kilometers each,[34] we get a total of 10000 train-kilometers, and the probability of an accident is 0.0055. A train accident involving nuclear forces is, therefore, a low probability event. However, it would be an event of very serious consequence.

Globally, train accidents involving nuclear materials have been known to occur. In the UK, for example, a train carrying spent nuclear fuel flasks, and travelling at a very low speed, derailed as it arrived at a power station.[35] The accident occurred outside the Torness power station near Dunbar, East Lothian. In the case of India and Pakistan, a train accident involving components of nuclear forces could have serious consequences if it does occur, even if no nuclear material is released. If sabotage were suspected, the political ramifications would be very troubling.

In 2002, major Indian road accidents were of the order of 400,000, with approximately 58,863,000 registered motor vehicles.[36] If

occur as N/A; then the probability of at least one accident occurring, p_a, for a specific number, n, of vehicle-kilometers or vehicle-hours actually moved or operated is, $p_a = n/(N/A)$, or $p_a = A * (n/N)$. Thus, if n, the vehicle-kilometers or vehicle-hours moved, is equal to N/A, then p_a will be unity.

32 Annual Review of Aircraft Accident Data, U.S. General Aviation, Calendar Year 1999, NTSB report. Available at <http://www.ntsb.gov/publictn/2003/ARG0302.pdf>.

33 Statistics provided by the Indian Railways. Available at <http://www.indianrailways.gov.in/railway/whitepaper/chap-1.htm>.

34 These numbers are posited for the purposes of bounding calculations, and not directly based on locating possible Indian and Pakistani bases and determining the distances to potential points at which the constitution of nuclear forces might occur..

35 Details of this accident are available at <http://danger-ahead.railfan.net/reports/rep2001/dunbar20010302.html >.

36 Motor Transport Statistics, Indian Ministry of Road Transport and Highways. Available at <http://morth.nic.in/mts.htm>.

we assume that each of these vehicles moves approximately 10,000 kilometers annually[37], we get an accident rate of 400,000 per 580 billion vehicle-kilometers; or, approximately, 1 major road accident per 1.5 million vehicle-kilometers. Therefore, if 100 trucks will move 1000 kilometers each during the constitution of distributed forces, the probability of an accident would be 0.066. This is also a low probability event – but, again, with potentially serious consequences if it does occur.

From the above numbers, it is clear that if warheads or other nuclear weapon components are moved by land transport the risks will not be as significant as for the case when warheads are moved by air, such as via helicopters. However, it will be in India's and Pakistan's interests to minimize the numbers moved, and the distances and durations involved, if distributed and hidden nuclear forces are ever mobilized.

[37] This estimate of 10,000 km moved annually on average by Indian road vehicles is an assumption used primarily to create a bounding calculation of road transport risks, and should be treated as such by the reader.

7. Difficulties of Safety and Reliability Analyses for Disassembled Forces

For a nuclear weapon, a principal safety concern is to "prevent electrical energy from reaching the nuclear package."[38] For this type of failure to occur, certain links have to fail (such as a switch that fails to stay open) and other links have to stay intact in order to complete the required electric circuit. Safety analyses have to take into account the possibility of failure of various critical components, as well as the survival of other components. The reactions of such components to catastrophic or slow fires and other extreme environmental conditions have to be analyzed, as well as the effects of aging of sub-systems and components.

With distributed and disassembled forces, components are exposed to differing environments. Complete systems may not be easily available for regular testing. This could complicate safety and reliability analyses. Let us assume that a component gets exposed temporarily to a higher than design level of temperature. Engineers now will have to resolve whether this component will still work when mated with the entire assembly. This may not be a trivial exercise of their skills. Further, all measurements have errors. For components stored separately, errors in measuring the temperatures that different components are exposed to could get compounded – one set of components could be registered by sensors as being exposed to a spuriously higher temperature than the components are exposed to in actuality, and another set of components could be measured as being exposed to a slightly lower temperature. These inaccurate readings could be within the normal errors of the temperature measuring sensors. As thermal radiation effects might need to be modelled, and thermal radiation varies as the fourth power of temperature, errors in assessing internal stress levels of components could be compounded. Such errors would further complicate modelling the aging of components in disparate environments.

A far worse scenario is that an incident might occur at a facility in which some components are exposed to off-design environmental conditions, but the personnel at that facility do not report the incident deeming it not of sufficient concern. Engineers tasked with the constitution of an entire assembly from the separately stored components would never be able to take into account in their analyses the off-design exposures of some components, as these off-design exposures would remain unknown.

For all of these reasons, the Indian and Pakistani militaries may not be supremely confident about the efficacy of their own rapidly assembled nuclear weapons; and have equal doubts about the other's forces. Their lack of confidence in their own weapons would lead to greater circumspection, but their doubts about the other's weapons could lead to contemplation of more adventurous strategies. Could such contemplations involve preemptive and damage-limiting strikes?

[38] Allan S. Benjamin, 1996, Comparison of Methodologies for Assessing the Risks from Nuclear Weapons and Nuclear Reactors, Proceedings, Probabilistic Safety Analysis 96, American Nuclear Society, Park City Utah, 1996.

8. Minimizing the Risks from Inadvertent or Deliberate Attacks

Fortunately, at this time, neither India nor Pakistan has the capability to carry out a “splendid” strike (a term popularized by Herman Kahn) and sufficiently destroy the other’s nuclear arsenal that damage to itself can be dramatically reduced by having struck first. A probabilistic assessment of the current Indian and Pakistani capabilities to destroy a significant proportion of the other’s mobile missile launchers is available in a separate paper by the author. [39] The analysis presented in this paper establishes that, using tactical nuclear weapons and short-range missiles, Indian or Pakistani attacks against the other’s mobile missile launchers would have a negligibly small probability of successfully destroying all launchers out of a force of 50 launchers, even for a very high probability, p, (p=0.9, for example) of successfully destroying any one launcher.

However, a troubling possibility driven by a high probability of success against an adversary’s opposing systems, is that a military commander with decision power to launch strikes may not be interested in destroying a very large number of opposing launchers – he may simply want to create a high enough attrition rate that an imminent attack gets blunted or stopped. In this case, the commander may be interested in reaching the attrition point at which the enemy’s launchers would be pulled out of battle. The actual consequence of these actions may be to escalate the exchange with devastating consequences – while the military logic may have simply been to try to limit damage or quickly reach the adversary’s break point.

The break point for ground forces (percent attrition at which a unit is pulled out of battle) is often assumed as 30 – 50 %, as described by Davis, Hillestad and Crawford in a study of US capabilities to intervene and stop a major regional conflict.[40] If we assume that an attrition of 30 percent would stop an attack, that is, if at least 15 out a force of 50 or at least 30 out of a force of 100 launchers could be destroyed, the probabilities of success for various values of p (=0.1, 0.5 and 0.9) are displayed in Table 1. Here, N is the total number of launchers, and the total numbers of launchers to be destroyed is greater than or equal to a number L.

Table 1 presents the overall probability of success, P, of destroying launchers for a range of values of p, N, and L

Here we see that the probability of destroying 30 percent of the launchers (that is, L=15 for N=50, or L=30 for N=100) for a p=0.5 is very high. Therefore, with a high p,

[39]“Strategic Stability in South Asia: The Need for Restraint in Targeting Technologies”, *Disarmament Forum*, India and Pakistan: Peace by Piece, 2004, Number 2, pp 41-50.

[40] Davis, Paul K., Richard Hillestad, and Natalie Crawford, “Capabilities for Major Regional Conflicts,” chapter in David Ochmanek and Zalmay Khalilzad, Strategic Appraisal 1997, RAND, 1997. Available at <http://www.rand.org/contact/personal/pdavis/chapters/MR826.ch6.html>.

	L = 15, N=50	L=25, N=50	L = 30, N=100	L=50, N=100
p=0.1	0.000074	~ 0	~ 0	~ 0
p=0.5	0.998699	0.556138	0.99984	0.539795
p=0.9	~ 1	~ 1	~ 1	~ 1

Table 1: Overall probability of success P for different values of p, N, and L, where p is the probability of destroying a single launcher, N is the total number of launchers, and L is the least number of launchers that are sought to be destroyed

a military commander may be tempted to consider an attack that destroys 30 percent of the adversary's launchers in the hope that this would blunt or stop an imminent attack. However, if p is very low (p=0.1 for example), the commander has no possibility of succeeding in such an attack. Crisis stability in such a case is much more enhanced.

8.1 A Possible Restraint Regime

Clearly, if India and Pakistan establish a restraint regime, and do not continually upgrade their ability to detect, search, track and destroy targets, a smaller number of launchers could provide a higher level of comfort of survivability. Ideally, if both countries cannot detect, search and track even one of the other side's launchers with a high probability of success, the probability of destroying a significant fraction of the other side's launchers becomes very low. This then allows each side to have a smaller number of launchers with a higher level of confidence in the survivability of the force. This is a more stable situation. Decreasing the ability to find and target launchers makes the probability of destroying even a small fraction so close to zero that no first strike against the launchers could ever be contemplated.

8.1.1 Restraining growth in sensors

A possible restraint regime for India and Pakistan to consider could be against developing or purchasing the sensors and related communication and analytical infrastructure required to detect, search, and track small, individual mobile targets to such an extent that they feel that their mobile missile launchers could become vulnerable. Recently, India has purchased the Israeli Phalcon radar system for monitoring multiple air targets. This system has a capability to track ground targets. This has created alarm in Pakistan, and Pakistan's perceived vulnerability of its mobile missile launchers has undoubtedly increased. Pakistan may feel compelled to increase the size of its missile forces, and adopt a more aggressive launch posture. If Pakistan upgrades its capability to track ground targets, India will feel more vulnerable and may increase the size of its nuclear forces, and change its posture. In either case, crisis stability could be threatened.

Limiting improvements in missile accuracy

India and Pakistan could also limit improvements in the accuracies of their missiles. This could involve placing limits on the numbers of missile tests they undertake. Reduced accuracy would decrease the temptation to consider the use of missiles against counterforce targets.

Eliminate short-range missiles

Finally, realizing that short-range missiles are possibly vulnerable targets, as the area over which they are based is smaller than for longer-range systems, India and Pakistan could eliminate their short-range systems altogether. A precedent for such an agreement exists in the Intermediate Nuclear Forces treaty between the US and the former Soviet Union.

9. The Issue of Non-deployment

As a step towards the elimination of short-range missile systems, a non-deployment agreement is also a possibility. However, such an agreement could require intrusive monitoring. In such a case, monitoring the systems at their storage or other non-threatening base locations to ensure that the systems have not been moved out and into a restricted area would be required. The use of ground-based sensors could be an optimal approach. Enhancing aerial and remote monitoring technologies could create a risk that either side's capabilities could be switched from a compliance verification mode to a more offensive application. An option for monitoring non-deployment that would not increase vulnerabilities is presented here.

Verifying that missile non-deployment is being implemented requires a balance of opacity and transparency regarding operational status. Deterrence depends on the survivability of the missile forces. Full transparency in missile deployment could actually reduce deterrence stability because each side gains targeting information that might tempt a counterforce strike by missiles, conventionally armed aircraft, and/or special operations forces. Therefore, only selected information should be shared. Monitoring must provide information that is geographically and temporally specific enough to provide assurance that the parties are complying with the agreement, yet not so specific that it creates strategic vulnerabilities.

9.1 A Non-intrusive Strategy for Monitoring Non-deployment

This section outlines a statistically-based approach to transparency in missile deployment that combines a high certainty of compliance with the preservation of deterrence stability.[41]

A limited deployment zone (LDZ) could, for example, exclude missiles from designated zones, require basing only within certain defined zones, restrict them to garrisons, or require them to be in storage. Figure 1 depicts a hypothetical situation in which India excludes a certain class of missiles from a zone close to its border with Pakistan and restricts them to a LDZ that keeps them far outside the range of any potential targets in Pakistan. The case for India is used primarily as an example. Similar arguments apply for Pakistan. It may appear that Pakistan is restricted in its choices for LDZs, given its lack of strategic space. However, for short-range missiles (with ranges of the order of 300 km), there would be numerous locations within Pakistan that would make these missiles out of the range of any significant Indian targets. Long-range

[41] This concept was first presented by the author as a joint paper at the 46th Annual Meeting of the Institute of Nuclear Materials Management in Phoenix, AZ, along with Michael G. Vannoni: "A Strategy for Verifying the Non-deployment of Nuclear Delivery Systems," Proceedings, Annual Meeting, Institute of Nuclear Materials Management, Phoenix, AZ, July 2005. The concept was also presented as an invited paper to a workshop organized by the Naval Postgraduate School's Center for Contemporary Conflict on "Strategic Stability in South Asia", July 2005, Monterey, CA.

missiles could, of course, be based anywhere within a country and still potentially impact an adversary's significant targets.

There are several benefits from creating missile LDZs:

- This is an advanced form of cooperation that builds and sustains confidence.
- Restricting deployment of missiles from specific geographic locations moves them away from preferred launching points and greatly reduces the risk of a sudden crippling attack.
- In a crisis, LDZs delay any attempted use or alerting of missile forces – providing additional time for crisis resolution.

The exact number of missiles that India and Pakistan possess is highly sensitive information that neither may wish to share with the other. However, the number of Transporter-Erector-Launchers (TEL) each side has is more widely known based on the organization of missile units that each country has created. Therefore, the monitoring of TELs may be more acceptable to each country than monitoring the missiles themselves.

A possible verification strategy presented here would use a combination of tagged declared items, statistically-based sampling, tamper-protection devices, time delays, and managed access during on-site inspections to create a form of on-site inspection with relatively low intrusiveness.

It is well known that the attributes of an entire population can be inferred from a randomly selected representative sample. If the missiles/TELs have been declared and tagged in a suitable manner, only a small sub-set of the missile force has to be polled (inspected) to determine whether any missiles have moved out of the LDZs. Since only a sub-set of the missile force is to be inspected, the exact location of the inspected missiles can be provided to the other side without risking the survivability of the entire missile force. The remaining missiles are held in dispersed and secure locations.

The steps in the verification strategy are as follows:

1. The parties agree to declare and tag missiles and/or their TELs and to restrict their locations to defined LDZs.
2. Each party has the right to call a short-notice inspection of a subset of the missiles covered by the agreement to

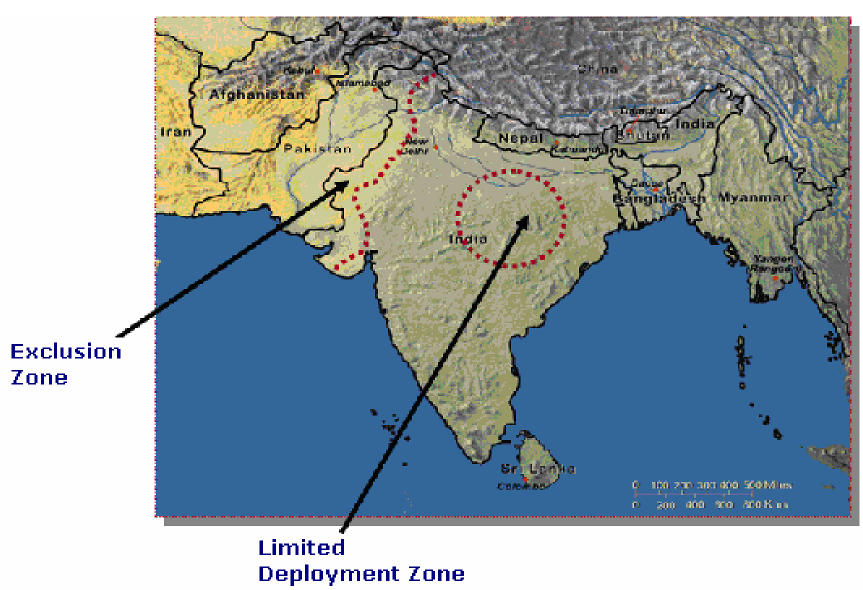

Figure 1: A Hypothetical Depiction of Missile Limited Deployment Zones in India

confirm that they are still in permitted locations. The missiles to be inspected are identified by identification numbers and the emplaced tags.

3. The inspecting party issues a tamper-indicating sealed camera to the inspected party to photograph the tags placed earlier on the missiles/TELs. The sealed camera could be stored and maintained at the embassy of the inspecting party and transferred to the inspected country's Ministry of Foreign Affairs or Defense when a short-notice inspection is called.

4. The inspected party has a set period of time to photograph the tags on the specified missiles/TELs. The inspecting party will not be present during the photography process.

5. The camera system includes a GPS receiver that superimposes the geographical coordinates and date/time onto the digital image whenever a photograph is taken. Analysis of the image would then show that the specified missile/TEL was present at a known location at a known time. This means that a party could not move a missile/TEL farther from a limited deployment zone than it would take to return in time for a short-notice inspection. The verification system thus becomes a "leash" on the movements of individual missiles/TELs.

6. The tags also report tampering to the camera system. Tampering could be detected visually in the image in the same way as a traditional on-site inspection. Alternatively, a more sophisticated tag could transmit a state of health message when it receives a short-range radio frequency message from the camera system.

7. After the photography process, the inspecting party receives the sealed camera system, verifies the system's integrity, and analyzes the photographs to determine the identity, location, and tamper status of the specified tags. There is a time lag from the time the picture is taken to the time the inspecting party receives the camera system. As the missile/TEL is permitted to move after the photograph is taken, the inspecting party does not receive information that is so geographically and temporally specific that the inspected missiles/TELs could be precisely targeted.

8. The agreement defines the total number and frequency of short-notice inspections during a year.

The key question for verification is whether polling a statistically valid, appropriately chosen sample size can provide enough information about the entire population to conclude that the commitment for limited deployment is being met. The probability of finding an errant missile (i.e., one outside of the permitted deployment zone) by polling any single missile in the force at random if Z missiles out of a force of N have been moved illicitly out of the LDZ is Z/N, defined as p. The probability of finding x errant missiles out of N missiles (defined as P(x)) can be modeled as a Bernoulli trial problem, and a simple mathematical approach can be used to calculate the probabilities of success of finding errant missiles.[42]

[42] The probability of finding an errant missile (i.e., one outside of the permitted deployment zone) by polling any single missile in the force at random if Z missiles out of a force of N have been moved illicitly out of the LDZ is Z/N, defined as p. We assume that, after inspection, the inspected missile/TEL is again a part of the population that can be polled, keeping p constant for each inspection. This precludes the possibility that after inspection the system could enter an exclusionary zone, as it could be recalled for another inspection. The probability of finding x errant missiles out of N missiles [defined as P(x)] is then a Bernoulli trial problem, where, $P(x) = \{N! / (x! (N-x)!)\} p^{x} (1-p)^{N-x}$ The probability of finding one or more errant missiles in a sample size, L, can then be found by a summation of P(x) over $1 <= x <= L$.

Figure 2 presents graphs that describe the probabilities of success in finding errant missiles for various sample sizes and numbers of missiles in violation, in a missile force of 50 units. The graphs show that polling to determine the locations of even a small number of missiles/TELs (selected at random) results in acceptably high confidence that a large number of missiles have not moved out of the limited deployment zone.

If a large number of missiles/TELs were moved out of the limited deployment zone, polling a sample as small as three randomly selected units gives a high probability of detecting the violation. If a small number of missiles/TELs are moved out and escape detection by virtue of a small sample size being polled, the inspections still preclude the possibility of a large preemptive attack being assembled. Therefore, crisis stability can be strengthened by a small number of short-notice inspections.

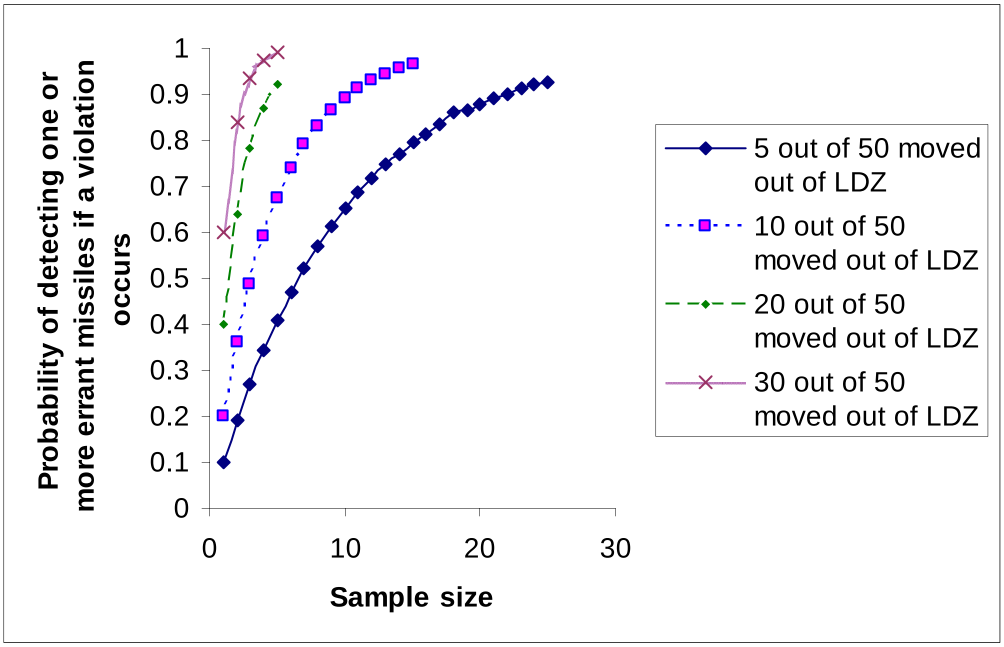

Figure 2: The Effectiveness of a Verification Strategy Based on Statistical Sampling of the Monitored Missile Population

10. Conclusion

There is a need for India and Pakistan to strengthen the stability of their nuclear stand-off. The posture of a force-in-being does not by its adoption create an inherently stable situation. During crises, each side could take precautionary moves that might be misinterpreted and result in undesired escalation.

India and Pakistan should assure each other that their nuclear weapon systems are safe, undergo regular safety checks, and that constitution will not occur routinely or even if a crisis is beginning to escalate – only as a matter of last resort. Further, given the concerns regarding limited and complicated safety tests, and the risks of transport accidents, both sides may wish to reassure each other that transport of nuclear weapons, when it does occur, will take place with the nuclear package not mated with the warhead. This would ensure that if a transport or other accident did occur during movement, the risks of an accidental nuclear explosion would be minimized.

India and Pakistan can exercise restraint in the growth of their targeting technologies, and/or eliminate certain classes of their more destabilizing short-range missile systems.

In short, these are some of the steps India and Pakistan could undertake to make their state of recessed deterrence more stable:

- Minimize the numbers, distance and duration of any move of force components.
- Provide assurances that if such movement does occur it will only occur with the nuclear package not mated with the warhead.
- Affirm that constitution of weapons will only occur at a very late stage in a crisis when an attack seems imminent.

This last point does not prevent Pakistan from deterring an Indian conventional attack by leaving open the threat of exercising its nuclear option even in the early stages of a conventional attack. What it does is reassure each other that signals will not be misread and forces constituted and moved frequently and in a crisis' early stages.

Simultaneously, by assuring each other that their deterrence is credible, and *will* be constituted when a crisis reaches close to the stage of a conventional war, they can both work to avoid ever reaching such a stage – while having negated the need for bellicose statements through the public media.

To minimize the risks of inadvertently or deliberately targeting the other's missile launchers and other nuclear delivery systems, India and Pakistan can exercise restraint in the growth of their targeting technologies, and/or eliminate certain classes of their more destabilizing short-range missile systems. If short-range missiles are eliminated, India and Pakistan's deterrent forces would consist of long-range missiles hidden over a much larger territory. Longer-range missiles generally are less accurate, and are more expensive to build and maintain. These systems are less likely to be considered for use as battlefield weapons. They would also be less likely to be inadvertently attacked during the border skirmish phases of a beginning armed conflict, as they would be located well away from the border.

Monitoring technologies can facilitate the establishment of limited and non-deployment zones for missiles/TELs. A verification strategy that polls a sub-set of a tagged population of restricted items has been presented.

In this strategy, a camera system takes an image of the tag and also records the time and coordinates of the image's location. This approach avoids creating vulnerabilities by providing too much information about the locations of the missiles/TELs.

Recent moves toward peace by India and Pakistan provide an opportunity to consider taking steps to make their nuclear stand-off more stable. Steps proposed here include agreements on restraints on the movement of nuclear forces during crises, establishing some restraint measures on technologies for targeting mobile nuclear launch systems, and establishing limited deployment zone for mobile missiles.