CHAPTER 9

COMMANDING AND CONTROLLING NUCLEAR WEAPONS

Zia Mian

Nuclear weapons are unrelenting. Managing them has been a hard and costly task for the major nuclear weapons states. It has made building the bomb appear easy in comparison. History may show that managing the bomb is impossible in the political, military, institutional and technological environment that prevails in South Asia.

Efforts to manage nuclear arsenals have typically assumed that a government and its armed forces behave as if they were a single, coherent entity. Decision making powers are seen as concentrated in the hands of a few individuals who exercise their authority through a command and control system that extends down to the nuclear armed military unit, be it an aircraft or a silo-based, submarine-launched or mobile ballistic missile or cruise missile. This command and control system is often treated as an arrangement of human levers or cogs that will engage in an efficient, infallible, effectively mechanical activity guided by clear and precise rules and where everything will function as intended.

At a practical level, the problem of managing nuclear weapons in the real world can involve hundreds if not thousands of people at all levels, many acting under orders and in diverse settings with different powers, interacting with each other and with a variety of technical systems, with nuclear weapons only being a small part of this. What actually happens in any given situation will depend on all the elements of this system. A major study of nuclear weapons operations concluded that the viability of nuclear command and control depends on 'the unpredictability of circumstances and human behaviour' where 'the smallest details can assume central importance' and 'even the most advanced experts and the most experienced practitioners are narrowly and incompletely informed,' and where 'no one understands the whole.'[1]

According to General Lee Butler, who was Commander-in-Chief of the United States Strategic Air Command, and its successor the United States Strategic Command which had responsibility for all U.S. Air Force and Navy nuclear weapons, the people that run the nuclear enterprise have 'a sense of infallibility', even though in day to day reality, 'the capacity for human and mechanical failure, and for human misunderstandings, was limitless.'[2] As examples, General Butler narrates that, 'I have seen bombers crash during exercises designed to replicate, but which were inevitably far less stressful than, the actual conditions of nuclear war. I have seen human error lead to missiles exploding in their silos. I have read the circumstances of submarines going to the bottom of the sea laden with nuclear missiles and warheads because of mechanical flaws and human errors.'[3] Clearly, nuclear weapons are not immune to the rule that sooner or later everything will go wrong that can go wrong.

This chapter looks at the challenges of commanding and controlling nuclear weapons and what these challenges mean for India and Pakistan. It highlights the problems with the technologies and procedures for making sure that weapons are used only when such use is intended, and the difficulties of maintaining such control during a crisis and in case of a war.

POSITIVE AND NEGATIVE CONTROL

It is a normal requirement of every deployed military weapon that it should only be used when authorised by the appropriate authority and that the weapon will function as and when required (i.e., it should be both reliable and safe). With nuclear weapons these demands become especially important since unlike ordinary weapons, nuclear weapons have acquired an important diplomatic and political utility short of their use as an explosive. Only the highest political authorities should be able to authorise the use of nuclear weapons. Thus it is important to assure that possession of a nuclear weapon by a military unit should not equal the ability to use it: the unit that holds, moves, and fires the system cannot (as opposed to may not) use it without approval from higher authority.

One way to formulate this problem is in terms of positive control and negative control, or use-oriented command and control and restraint-oriented command and control.[4] Positive or use-oriented control describes a situation where weapons are used when authorised, while negative or restraint-oriented control reflects the requirement that weapons cannot be used unless authorised. Positive control can be seen as defining how the system should behave in wartime, while negative control is the more powerful constraint on command and control in peacetime.

Positive control involves a set of interlocked technological and administrative systems, with associated procedures and plans to ensure nuclear weapons can be used by a national authority when it decides to do so. These systems include the:[5] (a) early warning system; (b) procedures to assess the nature and extent of an attack that may be taking place; (c) command and decision centres; (d) communications between leaders and nuclear armed units; and (e) military units equipped with nuclear armed missiles or other delivery systems.

The operational viability of each component and the system as a whole is supported by training exercises and drills that work through the steps of the plans that have been developed for the possible use of nuclear weapons. But it is a commonplace in the design and execution of plans and exercises involving complex systems to assume that things will go as expected and that there will be no surprises. This confidence is based more on the lack of any alternative than on actual experience. It is hard if not impossible to foresee every eventuality. There is no way to prepare for every possible combination of events, including all the equipment malfunctions, human errors and misperceptions that may come into play.

Even where detailed procedures are put in place, there are problems. For instance, the U.S. found that for its SAGE (Semi-Automatic Ground Environment) warning and control system 'it was impossible to specify in advance all of the contingencies that could be faced in the course of actual operations. Reliance on formal written procedures proved impractical and unwritten work-arounds soon developed among the human operators.'[6] The larger lesson drawn in a study of this and other systems is that 'any nuclear command organization circumvents official procedures in order to carry out its assigned mission. Such rule short-cutting is likely to be oral and informal, and therefore invisible to outside observation except under the high-stress conditions of actual war or crisis.'[7]

The need for caution about the differences between the way command and control systems are supposed to work and the way they actually work is supported by growing evidence that demonstrates how complex systems that tightly integrate administrative procedures and technologies can fail unpredictably and catastrophically in the real world.[8] This has included major failures of systems involved in managing nuclear weapons.[9] These failures have all been in situations far more subdued than the crisis and chaos that would be associated with imminent nuclear war.

Military planners have traditionally ignored these acute, effectively insoluble problems. For them, the main threat to positive control is decapitation—a successful attack by an adversary that renders a nuclear arsenal unusable because the command and control system is destroyed. Their concern is that the orders to use nuclear weapons need to be communicated to the military units with custody of the weapons through the command and control system, and if this does not take place the order may become undeliverable. Among the specific issues that are raised include the need for early warning of an impending attack that may threaten the command and control system, protection of nuclear decision-makers, reliable communications systems and nuclear weapons that can survive an attack by a determined adversary.

There are a number of steps that have been taken by the nuclear weapon states to mitigate the possible loss of command. These include multiple early warning systems including ground based radar, and in the case of the United States and the Soviet Union the use of satellites; plans to preserve national leadership, including secure command posts, alternative command centres, alternative mobile command centres; multiple, hardened communications between leaders and the nuclear arsenal which are able to, for instance, withstand the electromagnetic pulse from detonation of nuclear weapons;[10] large nuclear arsenals and mobile ballistic missiles and submarines as the survivable core of such an arsenal.

These measures have all proved to be extraordinarily complex and costly. The United States spent approximately $400 billion on building and maintaining its nuclear arsenal between 1940 and 1990.[11] The planes, submarines and land-based missiles systems for these weapons cost in excess of a staggering $3000 billion.[12] It spent almost 200 billion dollars on its strategic command, control and communications system.[13] A cheaper way to overcome the possibility of decapitation is to disperse and delegate the authority and ability to use nuclear weapons in advance. This, however, increases the likelihood of unauthorised nuclear use.

The nuclear armed unit raises command and control issues of its own; it needs to be appropriately trained and should be in possession of weapons systems that are serviceable, reliable, and survivable.[14] Nuclear units assigned responsibility for assembling, maintaining, transporting, or storing nuclear weapons, their components and related equipment need to have adequate knowledge of the unique characteristics of nuclear weapons, and the safety and control features associated with these weapons. They need appropriate training and inspection to determine they are able to perform their assigned mission. Along with their specific technical skills, the individual members of the unit also need to be evaluated for their reliability, and their qualifications to have custody of, control access to, or have access to nuclear weapons. These Personnel Reliability Programs involve investigative and administrative checks of military personnel—between 1975 and 1990 the U.S. disqualified annually between 3–5 per cent of the military personnel it had previously cleared for working with nuclear weapons on the grounds of drug or alcohol problems, conviction for a serious crime, negligence, unreliability or aberrant behaviour, poor attitude, and behaviour suggesting problems with due law and authority, etc.[15]

Some requirements for positive control also figure in establishing negative control, i.e., in making sure that nuclear weapons are not used without authorisation. Negative control involves how nuclear weapons are deployed, military procedures associated with them, and the design of the weapons and their delivery systems. Among the most significant concerns about negative control are possible unauthorised access to the weapons and the safety of the weapons should there be an accident. More specifically, the weapons should be secure against efforts by people to gain unauthorised access to them or to detonate them, and the weapons should not detonate accidentally because of problems with maintenance or the malfunction of the delivery system, including severe situations such as a missile or plane crash.

There are several technical and procedural solutions that have been developed to deal with these concerns, including:

- combination or coded locks (Permissive Action Links, or PALs) which can block unauthorised use of a nuclear weapon.[16]
- safety design features of warheads, e.g., one-point-safe designs and insensitive high explosive that will reduce the risk of a warhead detonating if it catches fire or is otherwise damaged.[17]

The procedural components encompass:

- physical protection of the weapons (in manufacturing, storage, and transport) as well as the codes for unlocking nuclear weapons.
- the requirement that at every stage in the maintenance, deployment, and use of nuclear weapons at least two people

participate, each being capable of detecting incorrect or unauthorised procedures (the two-man rule).

NUCLEAR COMMAND AND CONTROL IN INDIA AND PAKISTAN

In the wake of their nuclear tests, India and Pakistan have begun to create command and control systems for their respective arsenals. From the earlier general discussion of such systems, it is possible to identify at least five important constraints that may be of significance in the effort by leaders in India and Pakistan to make sure they can use their nuclear weapons when their leaders want while ensuring the weapons remain safe in the meantime. First, there are nuclear arsenals and the pressures created by the limited numbers of weapons that are available and the characteristics of the delivery systems. Second, there are specific problems of early warning created by geography and technology in South Asia. Third, there are a number of strategic constraints that stem from a perceived need to be prepared to use nuclear weapons in a conflict and the kinds of military scenarios that are deemed plausible in South Asia. Fourth, ensuring proper safeguarding of the weapons raises important technical and institutional questions. And finally, there is the safety of the weapons and delivery systems India and Pakistan may be capable of fielding.

The creation of a formal command and control structure in India following the 1998 nuclear tests was initially slow and troubled.[18] Lacking a single dominant institution like the Pakistan Army to shape the process, India's efforts in this direction have been shaped by political, bureaucratic and military rivalries. In January 2003, the Indian Government's cabinet committee on national security published a brief official statement on nuclear doctrine and set up a command structure.[19] The doctrine commits India to 'building and maintaining a credible minimum deterrent,' capable of 'nuclear retaliation to a first strike [that] will be massive and designed to inflict unacceptable damage.'

Nuclear decision making was entrusted to a two-layered structure called the Nuclear Command Authority, which includes a Political

Council, chaired by the Prime Minister, and an Executive Council, chaired by the national security adviser to the Prime Minister. The Political Council is empowered to authorise the use of nuclear weapons, although ‘arrangements for alternate chains of command for retaliatory nuclear strikes in all eventualities’ are mentioned. This means that in some circumstances someone other than the prime minister may be able to order the use of nuclear weapons. The 2003 nuclear doctrine created a Strategic Forces Command to manage and administer India’s nuclear weapons. As of 2011, it is headed by Air Marshal K.J. Mathews.[20]

The 2003 statement formalized a more detailed 1999 draft nuclear doctrine.[21] The draft doctrine declared that India would seek to establish: (a) sufficient, survivable and operationally prepared nuclear forces; (b) a robust command and control system; (c) effective intelligence and early-warning capabilities; (d) planning and training for nuclear operations; and (e) the will to employ nuclear weapons. The nuclear forces are to be deployed on a triad of delivery vehicles of ‘aircraft, mobile land-based missiles and sea-based assets’ that are structured for ‘punitive retaliation’ so as to ‘inflict damage unacceptable to the aggressor’. The doctrine called for an ‘assured capability to shift from peacetime deployment to fully employable forces in the shortest possible time.’

Along with the aircraft that can carry nuclear bombs, India has built and tested a range of missiles. These include the 700 km *Agni-I* missile, the 2000 km range *Agni-II* missile and the 3500 km range *Agni-III* missile, which have been approved for deployment with the army.[22] India also has carried out an underwater launch of its 700 km range submarine-launched ballistic missile, *Sagarika*.[23] In 2009 India launched its first nuclear powered submarine.[24] It plans a fleet of three to five, each armed with 12 *Sagarika* ballistic missiles.[25] India also is working on a 5000-km range *Agni-V* missile, which it plans to test in late 2010 or early 2011, and may be developing multiple independently targetable re-entry vehicles for this missile.[26]

There are a few signs of early Indian thinking about a nuclear command and control system.[27] The system is envisaged to include a command post designed to withstand a direct nuclear strike, with the authority to order use of nuclear weapons conveyed by separate coded messages sent over independent communication systems, with all the messages required for authorisation. The physical control over the nuclear weapons was to be divided with the nuclear warhead stored separately and under a separate organization from the military unit in charge of the delivery system.

In Pakistan, a history of military coups and weak elected governments that abdicated national security policy to the military has ensured that the armed forces, in particular the army, have authority over the nuclear weapons program. After its 1998 nuclear tests carried out at the behest of Prime Minister Nawaz Sharif, Pakistan announced that, 'The final authority to use nuclear weapons will remain with the prime minister, but the CJCSC (Chairman of the Joint Chiefs of Staff Committee) will be the strategic commander of the nuclear force.'[28] The first person to hold this responsibility was General Pervez Musharraf, who staged a military coup in October 1999 overthrowing Nawaz Sharif.

In February 2000, General Musharraf established a National Command Authority (NCA) with responsibility for formulating policy and exercising control over the development and employment of Pakistan's strategic nuclear forces and associated organizations.[29] The NCA held its nineteenth meeting in July 2011.[30] The NCA comprises of three components: an Employment Control Committee, Development Control Committee, and the Strategic Plans Division. The Employment Control Committee is chaired by the head of the government and includes the ministers of foreign affairs, defense and interior, chairman of the CJCSC, military service chiefs, director-general of Strategic Plans Division (secretary) and technical advisors. This committee presumably is charged with making nuclear weapons policy, including the decision to use nuclear weapons.

The second part of the NCA, the Development Control Committee, manages the nuclear weapons complex and the development of nuclear weapons systems. It has the same military and technical members as the Employment Committee but lacks the cabinet ministers that represent the other parts of government. The Development Control Committee is chaired by the head of the government and includes the Chairman of the Joint Chiefs of Staff Committee (as deputy chairman of the Committee), military service chiefs, director-general of the Strategic Plans Division, and representatives of the weapons research, development and production organizations. These organizations include the A.Q. Khan Research Laboratory (Kahuta), National Development Complex, and the Pakistan Atomic Energy Commission.[31] It also includes the National Engineering and Scientific Commission, which was initially headed by Samar Mubarikmand (who was formerly the head of technical development at the Pakistan Atomic Energy Commission and led the team that conducted the nuclear weapons tests).[32]

The third arm of the NCA is the Strategic Plans Division (SPD). It was established in the Joint Services Headquarters under the CJCSC and since its creation has been headed by Lieutenant General Khalid Ahmed Kidwai, who continued in the past even after retiring from the army in 2007. This division acts as the secretariat for the NCA and has responsibility for planning and coordination and in particular, for establishing the lower tiers of the command and control system and its physical infrastructure. The SPD is said to have a security division of 9000–10,000 personnel responsible for the security of the nuclear weapons complex.[33]

Pakistan is believed to rely on its air force and its land-based mobile-missiles to deliver its nuclear weapons. Along with jet fighters, such as the U.S. supplied F-16, which can carry nuclear bombs, Pakistan has tested the 350 km range air-launched cruise missile, *Ra'ad*.[34] The Pakistan Army's Strategic Force Command has tested both short- and long-range missiles, including the *Ghaznavi* with a range of 290 km, the *Ghauri* (1300 km), and the *Babur* cruise missile (700 km). In 2008, the Pakistan Army's Strategic Force Command carried out a training launch of a 2000 km range missile, the *Shaheen II* that was said to have 'validated the operational readiness of a strategic missile group equipped with the *Shaheen II* missile.'[35] In 2011, Pakistan tested the 60 km *Nasr* missile that was claimed to be a tactical nuclear weapon delivery system for use on the battlefield and 'to add deterrence value to Pakistan's strategic weapons development program at shorter ranges.'[36] Pakistan has a naval Strategic Force Command, charged with 'exercise technical, training, and administrative control over the strategic delivery systems', but it is not known if this command has yet been issued any nuclear weapons.[37]

If, as seems likely, India and Pakistan continue to increase the size of their respective arsenals and move to increased reliance on mobile missiles and put nuclear weapons at sea, their problems of command and control will grow more complex. There will be more military units with nuclear weapons, some of which may need in a crisis to be dispersed and remain out of communications to become more difficult to detect and so enhance their survivability. With a large number of weapons distributed over many diverse delivery systems, deployed across large areas and in different environments, considerable independent authority over the use of the weapons may need to be handed over to low-level commanders. When to disperse forces and lessen direct central command authority in a crisis becomes an issue in its own right, as does the question of how to ensure central control over the weapons will be regained when a crisis is managed successfully.

THE COURSE OF WAR

The demands on a command and control system that it be appropriate in war-time require looking especially at how war may begin in South Asia. There are many scenarios of how a crisis may develop and escalate into war, perhaps without deliberate intent on either the part of India or Pakistan.[38] Most if not all hinge on Kashmir and the possibility that India may respond to Pakistani action in Kashmir by escalating the conflict and moving it to another area, namely by sending its conventional military forces across the southern desert or central plains into Pakistan.

Pakistan's long narrow geography, paralleling its contiguous border with India, makes all of its military facilities and cities easily within reach of Indian aircraft and missiles. There are few places for Pakistan to hide its nuclear facilities, weapons, or delivery systems. India does not face the same problem, with its southern tip well over a thousand kilometres from the border with Pakistan. Pakistan has also long feared and prepared to counter a pre-emptive attack on its nuclear arsenal and facilities.[39] These date back at least to December 1982—following the example of Israel's destruction of Iraq's Osirak reactor a year earlier—when it was reported that India considered plans for an attack on Pakistan's Kahuta uranium enrichment facility. (That such plans were considered and rejected has been confirmed.)[40] Similar fears were expressed by Pakistani officials again just before Pakistan's 1998 tests, and the air force was put on alert at both the nuclear test site and at Kahuta.[41]

The nature of the border and the pattern of deployment of armed forces close to it, which include frontline strike aircraft, make any significant early warning effectively impossible, especially for Pakistan. The problem will be worsened by the presence of ballistic missiles with ranges of over a thousand kilometres that put major cities, including the respective capital cities and business cities, within a few minutes flight time. (The problems of early warning are addressed separately in this book in the chapter: 'The Infeasibility of Early Warning'). These weapons systems and deployments ensure that policy makers in either country have in effect no time to think. With geography and technology combining to render any solution seemingly impossible, Pakistan may feel it should remain prepared to disperse its nuclear forces early in every crisis rather than risk losing them. But there are other graver risks that would follow.

India has much larger conventional military forces, and it is widely believed they would eventually overwhelm those of Pakistan. India's army chief, General Deepak Kapoor, in 2009 claimed that his forces were developing the ability to mobilize very rapidly and mount a decisive conventional attack on Pakistan. This Indian strategy has been dubbed 'Cold Start',' and has been the subject of extensive war games and military exercises. The 2006 *Sanghe Shakti* (Joint Power) exercise involved aircraft, tanks, and soldiers in a war game whose purpose was described by an Indian commander as 'to test our 2004 war doctrine to dismember a not-so-friendly nation effectively and at the shortest possible time.'[42]

Pakistani civilian and military leaders have repeatedly argued that the conventional forces imbalance is in fact a prime reason for Pakistan's nuclear weapons in the first place.[43] Taking such claims seriously suggests Pakistan may choose to follow the U.S. and NATO strategy in Europe of having three phases of nuclear weapons use. This consisted of a conventional non-nuclear war plan, where nuclear threats are issued once NATO forces were unable to contain a Soviet attack, to be followed by the planned use of nuclear weapons on the battlefield, and finally if the Soviets responded with nuclear forces there was the plan to use strategic nuclear weapons.

Israel apparently had a similar strategy when it prepared to use its nuclear weapons during the 1973 war. According to one description, 'Israeli forces on the Golan Heights were retreating in the face of a massive Syrian tank assault. At 10 p.m. on Oct. 8th, the Israeli Commander on the northern front, Major General Yitzhak Hoffi, told his superior: "I am not sure we can hold out much longer." After midnight, Defense Minister Moshe Dayan solemnly warned Premier Golda Meir: "This is the end of the third temple." Mrs Meir thereupon gave Dayan permission to activate Israel's Doomsday weapons. As each bomb was assembled, it was rushed off to waiting air force units. Before any triggers were set, however, the battle on both fronts turned in Israel's favour.'[44] A slightly different description of these events suggests: 'the nuclear missile launches at Hirbat Zachariah, as many as were ready, would be made operational, along with eight specially marked F-4s that were on twenty-four alert at Tel-Nof, the air force base.'[45]

Pakistan may follow Israel's policy in another way. It has been suggested Israeli strategy during the crisis when it called a nuclear alert and began arming its nuclear arsenal was aimed substantially 'to blackmail Washington into a major policy change . . . to begin an immediate and massive resupply of the Israeli military.'[46] Pakistan may seek to use the threat of nuclear weapons use as a way to incite intervention to terminate the war before it lost more ground. This could be done simply by moving some nuclear armed missiles into the open for U.S. satellites to be able to detect them. Failing appropriate intervention, it is imaginable that Pakistan would consider the battlefield use of nuclear weapons, against advancing Indian tanks for instance, as a way to signal its desperation. (The chapter: 'Pakistan's Battlefield Use of Nuclear Weapons' considers the consequences of Pakistan's use of its nuclear forces against a large-scale Indian conventional military attack.)

Indian military exercises show every indication that India anticipates Pakistan using battlefield nuclear weapons.[47] The *Poorna Vijay* (Complete Victory) exercises were aimed at testing equipment, troops and manoeuvres in a situation where nuclear weapons were used against them, with an Indian official confirming that, 'Drills and procedures to meet the challenges of a nuclear, chemical or biological strike are also being practised.'[48] Among the options worked through were a Pakistani nuclear attack on a bridgehead or bridge, armoured forces and troops.[49]

However, the exercises went further and suggest a more aggressive strategy aimed at putting pressure on, or perhaps even overwhelming, Pakistan's nuclear capability. The Indian Air Force sought to 'test its operational efficacy while underscoring the importance of advanced interception and detection methods in the wake of potential nuclear strikes from adversaries.'[50] The army aimed to rehearse 'deep armoured thrusts'.[51] These were to be combined with attacks by 'deep penetration strike aircraft' and helicopter borne special forces operations.[52]

In turn, Pakistani military planners may well seek to anticipate such Indian attempts to intercept Pakistani aircraft carrying nuclear weapons and perhaps to destroy or degrade Pakistan's nuclear weapons storage sites and delivery systems in the early stages of a conflict. This would pose important constraints on the kind of nuclear command and control system Pakistan may have established and would be a cause of additional possible dangers.

There are many instances of military forces in combat going beyond what had been ordered by senior military or political leaders; where nuclear forces are involved this can lead to what has been dubbed *inadvertent escalation*.[53] This can also result from the simple difficulty of knowing and controlling everything that is happening on a battlefield. The result in either case, and more likely still with both processes working, is the possibility of unforeseen contact between Indian conventional forces and Pakistan's nuclear weapons systems. In such a situation, Indian and Pakistani plans could lead to the use of nuclear weapons without either side having anticipated such an event.

Pakistan's situation is somewhat reminiscent of that faced by U.S. military planners in Europe in the late 1950s and early 1960s who saw themselves confronting overwhelming Soviet conventional forces. To protect their nuclear forces against being destroyed in a surprise attack they placed them on heightened alert. This required that nuclear bombs and warheads were to be loaded on planes and missiles and kept ready for launch within minutes. This option had been made possible by the development of 'sealed pit' weapons, in which a key component no longer needed to be manually or mechanically inserted into the centre of the bomb at the last moment—earlier weapons had been kept disassembled and were only put together as when considered necessary. The pressure for keeping some U.S. nuclear forces in Europe on hair trigger alert raised concerns about access to these weapons by U.S. allies, who were then being trained to operate them; including instances of non-U.S. aircraft loaded with armed U.S. nuclear weapons waiting on airstrips—ready to take off. These problems led to the development of coded arming switches to limit access and possible use of nuclear weapons only to those with the requisite authorisation (i.e., the codes), which have evolved into modern Permissive Action Links.[54]

Permissive Action Links (PALs) are electronic switches that serve to protect a nuclear weapon against all kinds of unauthorised use, and are meant to be effective even when the weapon is assembled, armed and mated to its delivery system and ready for use. They have to be built into the weapon in such a way that it is not accessible for tampering and cannot be bypassed. There are a variety of technical approaches to this, although, for obvious reasons the details are secret.[55] Recent PALs use a set of multiple, six-digit or twelve-digit codes with a limited try capability. Since these are electronic locks, the limited try capability stops any effort to keep trying codes until the correct one is determined.[56]

Both India and Pakistan have sought help with PAL systems. It has been reported that 'India . . . has tried, so far unsuccessfully, to acquire missile safeguards technology from Russia to allay the concerns of Indian political officials that weaponization of missiles could erode tight central control over their use.'[57] Pakistan, for its part, has sought help from the U.S. suggesting that, 'precautions against accidental or unauthorised launch of nuclear weapons are obviously imperative. . . . Cooperation of more experienced states should be solicited.'[58] Other former senior officials are more direct, they highlight the risk of accidental or unauthorised use and approvingly cite U.S. authors on the need for the U.S. to share command and control information with de-facto nuclear weapons states.[59]

In 2006, General Khalid Kidwai, head of the Strategic Plans Division (SPD), stated that Pakistan's nuclear weapons are secured with a system that is analogous to PALs, and Pakistan follows a 'two-man rule' to authenticate these codes for the release of weapons.[60] It is important to appreciate, however, that the efficacy of a technical system depends on the circumstances in which it is to function and the procedures that govern its use. In the case of PALs, there are significant political, military and institutional constraints that need to be kept in mind.

At first sight, by limiting unauthorised access to nuclear weapons PALs may seem as contributing to reducing possible dangers. However, the matter is more complex. The prospect of tight, assured control over nuclear forces that PALs appear to offer may tempt political leaders and military planners to be more forceful in using the alert status and deployment of their nuclear forces as instruments of diplomacy. This was in fact an early argument for PALs. Fred Ikle, described as the 'father' of PALs advocated in the late 1950s that such devices 'could permit substantial gains in readiness by replacing more time consuming operational safeguards and by making higher alert postures politically acceptable.'[61] Control through technology rather than relying on people is presented as making risks seem less daring and thus easier to rationalise.

This temptation may be particularly great in South Asia where both India and Pakistan believe that in a crisis the U.S. would use spy planes, satellites and electronic signals intelligence to closely monitor events, and may be incited into intervening. In the past, Pakistan, in particular, has sought to elicit such intervention through various kinds of military actions, most notably in the Kargil conflict of 1999. It is easy to imagine how in a crisis a perceived increase of control may lead to a greater willingness among Pakistani policy makers to alert their nuclear forces or begin deployment as a signal to the U.S. that they were serious about being prepared to use nuclear weapons unless the U.S. restrained India in some way.

The nature of the conflict between India and Pakistan may be one where nuclear weapons are in the theatre of a conventional conflict. In such a situation, it is recognised that PALs 'do nothing to alleviate the organizational and environmental pressures to decentralise and delegate control of most theatre nuclear weapons . . . if weapons were sent into battle while political authorities retained control of the codes needed to unlock them, there could be no guarantee, not even a likelihood, that all of the codes could be matched with their respective weapons in the confusion of a conventional (war). . . . The political command, or any centralised depository of the codes, could be attacked, thereby paralysing the military's ability to strike back. Practically speaking, a strong pressure exists to release any needed codes at the same time that the weapons are dispersed from their storage sites.'[62] In short, in the circumstances that are likely to prevail in the case of Pakistan, its compulsions to protect its nuclear weapons by dispersing them and to keep them usable could require loosening central authority to such an extent that PALs would be effectively neutralised as a crisis threatened to turn into war.

For PALs to serve as an effective technology of negative control, limiting normal access to nuclear weapons during peacetime, it is the day-to-day procedures of the military as an institution that become important. It is not just that the weapons themselves need to be properly protected; PALs are only effective if the codes for the locks are also kept secure. If anyone can have access to the codes then PALs offer little if any restraint as command and control devices. That this problem is real even where there are decades of experience is evident from the incident in December 1994 when the unlock codes for U.S. strategic forces were reportedly compromised aboard a U.S. Strategic Command airborne command centre.[63]

There are many examples of institutional failure caused by poor planning and procedures on the part of the armed forces, as with other institutions, in India and Pakistan. A useful set of examples to consider is the way that the respective armies have dealt with peacetime storage of their conventional ammunition and look for problems with planning and procedures associated with this.

In March 1988, there was an accidental fire at India's Central Ordnance Depot (claimed to be the largest in Asia), located at the Jabalpur Ordnance Factory and Ammunition Depot, which led to the ammunition stored in underground bunkers exploding over a period of several days and required the evacuation of nearby villages, and the closure of the airport 45 kilometres away.[64] The disaster, involving the destruction of munitions reportedly worth hundreds of millions of dollars, was attributed to 'negligence' on the part of the commandant by both, the workers in the depot and the local member of the state parliament.[65]

Despite warnings about the hazards at other Indian arms depots, the next decade saw more disasters.[66] In 1998, there was a fire at the magazine and ammunition store of the Proof and Experimental Establishment Centre near Balasore.[67] This facility is closely tied to the missile test grounds at the Interim Test Range, Chandipur, and few details were released of the accident. In April 2000, around 12,000 tonnes of ammunition, including surface-to-air missiles, anti-tank guided missiles, tank and artillery shells, were destroyed by a fire at the Bharatpur Field Ammunition Depot—this amounted to 30 to 40 per cent of the operational reserves of India's Southern Army Command.[68] A smaller subsequent fire at a storage site near Pathankot destroyed 400 tons of ammunition. Major General Himmat Singh Gill claimed that at the site residential development habitation had begun to cross the mandatory one kilometre exclusion zone around arms depots, compromising the security of the facility and putting people at risk.[69] Another fire in May 2001, at the Suratgarh Depot in Rajasthan which serves as the Indian Army's forward ammunition stores, consumed 8000 tons of tank and artillery ammunition.[70] The explanation that was offered by Vice Chief of Army Staff was that it was a 'pure accident', an 'act of God'.[71] Other military officials in private spoke of it to be the result of 'a crisis of casualness.'[72]

India is not alone in disasters involving a major weapons storage facility. On 10 April 1988, the Ojhri Ammunition Depot located close to the twin cities of Islamabad and Rawalpindi exploded; the official toll was approximately a hundred people killed and a thousand injured.[73] Other tallies suggested that between 6000 and 7000 people were killed and many thousands injured.[74] The official cause presented to Parliament by the Ministry of Defense was that an accidental fire broke out in an ammunition lorry which spread to the whole site.[75] Prime Minister Mohammad Khan Junejo announced that arms depots were to be shifted from populated areas.[76] Looking back a decade later, a former very senior military officer has claimed that the Ojhri accident case made it clear that, 'orders and instructions were grossly violated,' and noted that despite official claims no lessons had been learned from it about the siting of ammunition stores close to major population centres or establishing a crisis management system bringing together the military services and civilian authorities.[77]

These disasters highlight the effects of poor planning, lax procedures and limited oversight. There have been particular concerns voiced in the *Pakistan Army Journal* about training: 'The Army personnel and organizations (units, formations, institutions) have been overburdened by palpably unrealistic expectations and fruitless activity with the result that nearly all aspects of military life including training itself, discipline, administration, and morals and morale (both) have suffered.'[78] The crisis is traced to a profound mistake: 'To consider that army personnel, however, disciplined they may be, will behave like automatons is absolutely fallacious. Our planners and, with due respect, senior commanders have foundered on this account.' This raises important concerns about any nuclear Personnel Reliability Program that Pakistan may have put in place.

There is limited public information about the nuclear Personnel Reliability Program in Pakistan. The program is reported to examine the 'personal finances, political views and sexual histories' and 'degrees of religious fervour' of people in the weapons complex, with 'recruits . . . subject to a battery of background checks that can take up to a year [and] new employees are monitored for months before moving into sensitive areas. They may also be subjected to periodic psychological exams and reports from fellow workers.'[79] These procedures are however only as effective as the people who are charged with managing and implementing them.

In recent years, Pakistani military officers have been directly implicated in attacks on General Pervez Musharraf while he was Chief of Army Staff and President, and in the 2009 attack on the General Headquarters (GHQ) of the Pakistan Army in Rawalpindi. While insider knowledge may have played a role in the attacks on the offices in several cities of the Inter-Services Intelligence (ISI) Directorate, and in the 2011 attack on the PNS Mehran naval base near Karachi. A number of military officers and soldiers have been arrested and charged for ties to militant Islamist groups. Most recently, in 2011, a Brigadier serving in the GHQ was arrested and four other officers reported to be under investigation for contacts with the radical Islamic group Hizb-ut-Tahrir.[80] Taken together, this history suggests that the Pakistan Army is not reliably able to recognize and pre-empt at an early stage plots by officers and enlisted men with radical Islamist sympathies.

NUCLEAR WEAPONS DESIGN AND SAFETY

India and Pakistan have had limited experience with nuclear weapon design and testing and mating their weapons with delivery systems, both aircraft and missiles. Their armed forces have had even more limited experience with nuclear weapons in the field. One military analyst familiar with the Pakistan Army reports that even more than a decade after the formation (in 1989) of a 'Composite Missile Regiment' and exercises with nuclear missiles, the Pakistan Army's 'procedures are as yet by no means effective.'[81]

The United States began to tackle the risks of accidental detonation of its nuclear weapons in the mid- to late 1950s, once it had deployed nuclear weapons which were stored and placed on aircraft fully assembled. In simple nuclear weapons, a set of detonators are arranged uniformly around a shell of high explosive and set off simultaneously so as to detonate this shell, creating a shock wave that compresses the plutonium or highly enriched uranium until it undergoes a nuclear explosion. Weapons designers assumed that it would be very unlikely for several of the high explosive detonators on a bomb to be triggered simultaneously in an accident and sought to develop weapons that would be one-point safe, i.e., weapons that would not produce a nuclear yield if detonated at any single point. This has become a more or less common standard.

Recognising that an accident could trigger a warhead's electrical arming, fusing, and firing systems and lead to a nuclear explosion, other criteria were introduced that sought to reduce the chance of a weapon prematurely detonating in the normal course of its life (i.e., while in storage, transport, and at any stage in its combat use before it reached its assigned target), including during an accident or in other abnormal situations. As part of this effort, 'Enhanced Nuclear Detonation Safety Systems' were developed. Typically, they rely on a combination of a unique electrical signal and electronic data from sensors that assess whether the movements of the warhead correspond to what would be expected if it was going through its normal, assigned sequence on the way to its target. An unexpected pattern of acceleration, and other measures of the warhead path, should prevent the warhead from being armed and made ready to fire.

To limit the danger of plutonium dispersal from accidents, the U.S. sought to replace the high explosive in nuclear weapons, which was 94 per cent hexamine nitromene (HMX), with new insensitive high explosive (based on 2, 4, 6-tri-nitro-1, 3, 5-benzenetriamine, TATB) resistant to burning and detonation even under extreme conditions, as well as surrounding the uranium or plutonium with a shell of a refractory metal to produce a fire resistant pit that can withstand a jet fuel fire.[82] However, the refractory shell can be punctured or destroyed if the weapon is damaged in an aircraft crash or if the crash leads to a detonation of the high explosive. A fire resistant pit is also unlikely to be very effective if exposed to the much higher temperatures of a missile fuel fire.

The introduction of insensitive high explosive and a fire resistant shell add substantially to the size and weight of the bomb, as well as changing the way it behaves when it is detonated. The U.S. conducted numerous nuclear tests to validate the introduction of insensitive high explosives and fire resistant pits. Full three dimensional simulation of nuclear weapons detonations, which has been made possible by modern computers and use the accumulated data from previous nuclear tests and extensive laboratory experiments, have shown that earlier two-dimensional computer simulations were 'inadequate, and in some cases misleading, . . . in predicting how an actual explosion might be initiated and lead to dispersal of harmful radioactivity or even a nuclear yield.'[83] The U.S. is estimated to have carried out approximately 130 very low yield safety related tests, of which 62 are officially acknowledged as one-point safety tests.[84] For comparison, the USSR conducted about 100 hydronuclear tests, and 25 safety tests involving 42 weapons, between 1949 and 1990.[85] The

ENDS (Enhanced Nuclear Detonation Safety) system requires no additional nuclear tests since it does not affect the high explosive or nuclear fission parts of the weapon.

India conducted its first nuclear explosion in May 1974. By all accounts this was a crude, large, heavy, experimental plutonium-based implosion device, comparable to the first U.S. test in 1945. There are long standing questions about its yield.[86] It was in 1986 that India began to develop a bomb that could more easily and reliably be used from an aircraft, which involved 'a major effort to reduce the size of the bomb by using better quality explosives and lenses, making its detonators fail-safe, producing reliable high voltage capacitors and building in a series of electronic checks to ensure the bomb would go off only when the proper codes were fed in.'[87]

As part of these efforts, the Terminal Ballistic Research Laboratory at Chandigarh attempted to make the bomb lighter and smaller by using HMX as the high explosive (it has a very high detonation velocity).[88] This development in the early- to mid-1990s may been have the basis of the only nuclear weapon that was tested on 11 May 1998; according to a description of the tests by R. Chidambaram, then head of India's Department of Atomic Energy: 'The 15 kiloton device was a weapon which had been in the stockpile for several years. The others were weaponisable configurations.'[89] This would suggest that Indian nuclear weapons do not use insensitive high explosive, and given the compulsion to make the bomb as small and light as possible it may be that they also lack fire resistant pits since these also bring a weight and size penalty.

While Indian weapons scientists have made clear statements about the yields of their nuclear weapons, they have said nothing about safety. There has been no official mention that India's nuclear weapons are one-point safe. There has not even been a claim that nuclear weapons safety tests were conducted. The two small tests on 13 May 1998, claimed as sub-kiloton tests, were said to allow Indian nuclear weapon scientists to improve their computer simulations. There has been no suggestion that either of these were safety tests.

Despite what amounts to only one actual test, and with no evidence for one-point safety, and perhaps lacking modern safety features, India has prepared to deploy nuclear warheads on some of its planes and missiles. It is reported that as part of the 11 April 1999 *Agni-II* flight test, 'the bomb team secretly mounted on its warhead, a nuclear weapon assembly system minus the plutonium core to test whether all the systems including the safety locks would work.'[90] It had been discovered earlier that, 'when the warhead was subject to severe vibrations, a high voltage arching [*sic*] problem occurred that prematurely triggered the device'. *Agni-II* was tested again in January 2001 in what was called 'its final operational configuration.'[91]

Like their Indian peers, Pakistani nuclear weapons scientists have said nothing about the safety of their weapons. In building warheads to be delivered by aircraft and ballistic and cruise missiles and possibly for battlefield use, they face the constraints of minimising the size and weight of the weapons, and a very limited number of tests of both the weapons and the missile systems. This may make it unlikely that they have incorporated either insensitive high explosives or fire resistant pits as safety features. If they are deployed, there may be a risk of accidental detonation.

The experience of the other nuclear weapon states suggests accidents involving a nuclear weapon could be caused by any number of factors, including aircraft crashes, fires and missile explosions. Accidents can also happen in storage and during transport of nuclear weapons. The risks of an accident increase when the weapons are deployed on delivery vehicles (missiles, aeroplanes, etc.) and further increased where the weapons systems are kept on a high state of alert.

The consequences of an accident involving a nuclear weapon in South Asia could be severe. One possibility is if the high explosive detonates and converts the fissile material (the plutonium or highly enriched uranium) into an aerosol, but there is no nuclear yield. If the weapon relies on plutonium, an accidental explosion in a densely populated area (such as a large city) could lead to between 5000 and

20,000 fatalities from cancers caused by inhalation of the radioactive plutonium as it is spread by the wind.[92]

An even more serious possibility is where an accident causes the high explosive to detonate and triggers a nuclear explosion. In principle, the yield could be as large as the design yield of the weapon, i.e., it would have the same effects as the deliberate use of the weapon. It has been estimated that a nuclear explosion with a yield comparable to those claimed for their weapons by India and Pakistan could kill many hundreds of thousands of people.[93] A nuclear weapons accident could be a catastrophe.

CONCLUSION

The development of nuclear weapons by India and Pakistan and the efforts now being made by the respective governments to establish systems of nuclear command and control have created grave risks for the people of both countries. The history of nuclear weapons teaches that the effort to create a robust 'nuclear deterrent' requires creating military forces that are equipped, trained and able to use nuclear weapons. This history also shows how fallible people, institutions and technology can be. The destructive power of nuclear weapons, which has made them so attractive to India, Pakistan and a handful of other states, brings a potential for catastrophe.

The risk of an accident may increase through the action of numerous, often unpredictable factors. There are however some obvious lessons that can be learned from the experience of command and control of nuclear weapons over the past fifty years or so. The most important is that no system for nuclear command and control can be perfect, no matter how carefully it is designed; how carefully selected and well-trained the personnel; how sophisticated the technology; or how much money is spent. There are profound problems built into the task such a system is intended to perform, and these problems leave it open to failure and the possibility of disaster.

Having tested their weapons, both India and Pakistan are now struggling to operationalise their nuclear weapons capability. The nuclear arsenals are growing, delivery systems are under development, and structures of command and control are still in their infancy. There are great pressures on any possible system for nuclear command and control. The size of the arsenal is itself an issue; as arsenals grow and the delivery systems start to include aircraft and missiles, and perhaps eventually even submarines, there will be more bombs and more people in more places under more circumstances that require control, and more opportunities for things to go wrong.

While having fewer nuclear weapons obviously makes exercising control easier, it does not make it easy or simple. There are other factors at work over which there can be no control. The geography of South Asia ensures that for Pakistan in particular there can be no useful early warning of an Indian attack on its nuclear arsenal or facilities, nor are there many places to hide its weapons from such an attack. The history of India–Pakistan relations ensures that these fears shall not pass easily. The failures of the early warning systems of both have been exposed repeatedly. The weapons will always be seen as vulnerable and this fear will make command and control insecure. The temptation will be to disperse the nuclear weapons, and de-centralise control in the hope that some weapons would survive any possible attack. With this step, the risk of accidental or inadvertent use of nuclear weapons is increased, as is the possibility of an accident involving a weapon and its delivery system. Removing this fear will require changing the pattern of military forces on both sides so that no surprise attack is possible.

Even when there are no surprises, war brings pressures of its own. India's conventional military strength is a pressure that is pushing Pakistan to deploy nuclear weapons early in a crisis. Pakistan would seek to protect the weapons against attack, show its determination to escalate a conflict rather than concede, and seek to incite intervention from the international community. Nuclear and conventional forces may clash on the battlefield; India may seek to destroy Pakistan's nuclear weapons and Pakistan may use them for lack of a perceived alternative. With Indian military planners seemingly prepared to include this possibility in their war plans and to keep fighting, Pakistan's generals may feel even more acutely that they must use their nuclear weapons early and hopefully decisively or risk losing the option. Nuclear war in South Asia could result in possibly millions of deaths and injuries. Preventing this apocalypse should become the biggest challenge.

Maintaining command over nuclear weapons produces its own problems. Pakistan and India have both sought technology from other nuclear weapon states to ensure that only the highest political and military authorities are in the position to unleash nuclear weapons. In particular, they have sought to systems such as Permissive Action Links (PALs), the coded switches that seek to prevent unauthorised or accidental use. Unfortunately, experience suggests it is all too common for a simple minded faith in technology to produce a sense of control that slides into over-confidence. Feeling that the bomb is now safely in hand, politicians and generals may all too easily and publicly use the deployment and alert status of nuclear weapons as signals of resolve to adversaries, and to their own people. With time, a growing sense of confidence in control over nuclear weapons may push deployments and alert levels ever closer to the edge of being fully prepared for use at a moments' notice. The United States and the Soviet Union did just this. Nothing should be done, no technology sought, no procedures developed that can help create such dangerous confidence in South Asia.

However, in the fog and friction of war, the decision to unleash nuclear destruction may not be for South Asia's generals or prime ministers to make. Both India and Pakistan will disperse their weapons to protect them in a crisis. The codes to unlock them would also need to be dispersed, otherwise the weapons may become unusable through the countless minor circumstances which cannot properly be illustrated on paper but ensure that things do not turn out as planned. Things have gone dreadfully wrong with far simpler procedures to manage weapons even in peace time. With control of nuclear weapons and their codes in the hands of brigadiers, in the heat of battle, the chances of unauthorised use, misjudgement and accident are great. Again, the consequences would be devastating. There must be a determined search for ways to prevent and manage crises.

The critical first step is for India and Pakistan to not assemble and deploy their nuclear weapons. Even in peace time, assembly and deployment bring increased risk of accidents. There is a long record of accidents and near misses involving aircraft and missiles carrying nuclear weapons belonging to other nuclear weapons states. The safety record of India and Pakistan's military aircraft is poor: accidents are frequent; the causes many. With many of the air bases often located close to major cities, there would always be the risk of an aircraft crash involving a plane carrying a nuclear weapon, or a bomb accidentally falling from a plane. This may be enough to detonate the bomb. South Asian missiles are still at a seminal stage of development; tests have been few and missiles may harbour their own dangers. They may explode and trigger their nuclear warhead. Keeping the weapons disassembled and far from their delivery systems is the only sure protection.

It is not known how safe either India or Pakistan's nuclear weapons would be if they were involved in an accident. Neither state has revealed any information about conducting safety tests, or whether their weapons are safe against detonation if they are in a fire or if subjected to high impact. The limited number of tests they have carried out and the incentive to produce weapons that are as small and light as possible suggests neither country may have adopted either insensitive high explosive or fire resistant pits, both of which add to the size and weight of a weapon.

The consequences of an accident could be devastating. An explosion in which the high explosive is set off and converts the fissile material into an aerosol that can be spread by the wind and inhaled could kill between 5000 and 20,000 people if it involves plutonium and takes place close to a large city. An accident in which the bomb explodes with its full yield could potentially kill hundreds of thousands in a large South Asian city. There would be no warning, and no defense.

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