Nuclear Weapons Security and Control

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This study of nuclear weapons security and control focuses on the protection of U S nuclear weapons after the Department of Energy has transferred them to military custody This transfer is effected in accordance with a biennial, presidentially approved Nuclear Weapons Deployment Plan that allocates the weapons to strategic and nonstrategic nuclear forces.[1] The weapons treated in this study are those covered by the plan The specific focus is their protection while being stored or transported by the military or when operationally deployed from peacetime storage worldwide Special attention is paid to issues involved in protecting U S Navy nuclear weapons

Definitions

Given the terrorist context of this study, *protection* is defined broadly It applies not just to the threat of actual physical seizure of a weapon by unauthorized people and its detonation—or, more probably, its threatened detonation. Moreover, *unauthorized people* encompasses not just terrorists[2] but also military personnel, both U S and allied, particularly from member nations of the North Atlantic Treaty Organization (NATO) with which the United States has concluded Programs of Cooperation (POCs).[3]

The terms of reference for the discussion here are the U S nuclear weapons employment policy. It is contained in successive (and evolutionary) presidential directives on the subject—National Security Decision Memorandum 242, Presidential Directive 59, and National Security Decision Directive 13—which lay down the policy for planning the possible employment of U S nuclear weapons in support of U S national objectives The purpose of this planning is to deter to the fullest extent possible any conflict with the Soviet Union and its surrogates

All the directives affirm the concept of extended deterrence (that is, the threat to employ U S nuclear weapons, including first use, on behalf of U S allies threatened by the Soviet Union or its client states) The United States has chosen to further the principle of extended deterrence in the NATO context by the forward deployment or storage of U S weapons during peacetime at locations within the integrated U S and allied military command called Allied Command, Europe (ACE) Geographically ACE covers all the continental members of the NATO alliance and the United Kingdom Within the context of NATO strategy and policy, the presence of these weapons in Europe in part meets the requirement that ACE military forces be capable of escalation to combat a Warsaw Pact attack Moreover and most significant, within the context of NATO's strategic concept of a flexible response, the storage of these weapons and their delivery systems in Europe is viewed as coupling the conventional forces of the alliance to the U S strategic deterrence forces based outside Europe

In view of the significance of these forward deployed weapons to NATO, it is possible that terrorist organizations might well view activities directed against these weapons, even if they did not actually result in the seizure of one or more, as successful The mere fact of an attack using mortars or rockets without actually entering or penetrating the storage site could, for example, generate substantial publicity and/or create anxiety about a nation's participation in the NATO integrated military structure, with its explicit emphasis on shared risk and responsibility At the extreme, these anxieties could generate domestic political pressures to remove U S nuclear weapons from national territories and to make them more secure by storing them in the United States

Some would argue that the removal of U S nuclear weapons is precisely what should be done, even without the stimulus of a terrorist attack At the same time, there is a well-documented concern on the part of Europeans that the perception of coupling be maintained, a stance that was painfully evident during the ground-launched cruise missile (GLCM) and Pershing II deployments (Another indication is the current concern with what Europe views as the potentially decoupling effect of the Strategic Defense Initiative) U.S and other alliance decision makers see the removal of U S nuclear weapons as a step that might irretrievably destroy NATO cohesion Even the most sanguine person could hardly be optimistic that the present consensus over security in each alliance nation could be maintained or, at the extreme, that a credible new deterrent strategy could be agreed to if forward deployment were abandoned. These forces militate against removal of the weapons

The point of this study is not, however, to argue the merits of forward deployment but rather to argue that the protection of U S nuclear weapons against terrorists must include protection against the loss of their functional utility to U S policy There is a range of plausible scenarios to suggest that

terrorist acts other than seizing a U S nuclear weapon (or acts short of detonation such as nuclear blackmail in the event a weapon is seized) could precipitate that loss Regardless of whether all the scenarios are equally credible, the fact remains that senior alliance officials are concerned about the possibilities

Within the spectrum of terrorist actions, the theft and detonation of a U S nuclear weapon by terrorists (or by other people) must be considered the extreme case The mere fact of an attack on a nuclear storage site or of access by unauthorized people to U S weapons could have negative effects on the weapons' functional utility in a number of direct ways For example, unauthorized people could damage the weapons so that they could not be used or could cause a nonnuclear detonation that would still scatter the plutonium Even a chalked message on a weapon container symbolizing the possibility of further action, whether actually carried out or not, might have a serious impact in a country where the public was particularly agitated by the presence of the weapons

Approach

Specific information about the means and processes through which the security and official control over U S nuclear weapons are maintained is generally classified. Therefore the approach taken here is to state a set of principles that should govern protection I then show how the application of these principles would serve to realize the fundamental U S (and NATO) objective of preventing unauthorized persons, including terrorists, from gaining possession of U S weapons or using them in any way Here, *use* like *protection,* is defined broadly to mean direct actions such as detonation or indirect actions such as the generation of publicity for the terrorists' cause

It is also important to define the protective task Clearly it is to maintain the security of U S nuclear weapons It is far from clear, however, how the United States or NATO can dissuade terrorists from attacking nuclear weapons storage sites Thus it appears that the task is also to find ways to prevent a decision to attack from being made From a terrorist's point of view, the attainment of publicity means success, whatever the undertaking Generally (though not always) a successful undertaking has involved a hijacking and seizure of hostages, assassination of an industrialist, or bombing of a government installation An inability to achieve these results can have a variety of adverse results for terrorists, such as demonstrating that the government is effective and can protect its citizens and facilities, the implication being that the terrorists' cause is associated with failure, or losing a trained cadre Measures that make nuclear weapons storage sites overtly more difficult

targets could well compel terrorists to seek softer targets that offer a higher probability of success

A secondary reason for developing a framework of protective principles is to avoid too specific a discussion about the potential vulnerabilities of U S nuclear weapons This approach should preclude possibly useful information from being made available to terrorist groups

The principles I have outlined are derived from a variety of unclassified sources on U S policy, interests, and national objectives They include the Atomic Energy Act of 1946, as amended, various congressional hearings and reports, other official documents and policy statements, and a small but significant number of published books and articles [4] Although these principles are broadly applicable to both the strategic and nonstrategic components of the U S nuclear stockpile, clearly both the circumstances of peacetime and wartime storage and the requirements for their movement vary sharply They therefore pose somewhat different issues or problems with regard to how the principles should be applied in specific terms For example, strategic weapons would be delivered by strategic nuclear delivery vehicles, including Titan, Minuteman, and Peacekeeper (MX) intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and B-1 and B-52 bombers and cruise missile carriers In peacetime, these strategic weapons are located within the continental United States or at various places under the oceans, generally in one of three configurations or conditions mounted on their ICBMs and SLBMs, loaded aboard bombers standing alert at various Strategic Air Command bases, or stored at specially protected sites inside the general defenses of such bases, not too distant from the runways from which the bombers would take off

It would be imprudent to rule out the possibility of terrorist access to these strategic weapons, however, their location inherently limits the opportunities for successful access in comparison with the nonstrategic nuclear weapons that currently are or are planned to be deployed forward in potential theaters of operations outside the continental United States Because of the greater risk, the discussion here focuses on the nonstrategic nuclear weapons

Nonstrategic nuclear weapons employed by theater forces outside the United States would be delivered by systems whose range is less than intercontinental These systems vary between the so-called battlefield ones (nuclear-capable howitzers and Lance missile launchers) and the intermediate range GLCM and Pershing II missiles currently deployed in Europe The latter can strike targets just short of Moscow from bases in West Germany Deployment of these delivery systems and the storage of their warheads on the European continent is an integral element in NATO's strategic concept, which relies on the credible threat of their use to deter the Warsaw Pact

Peacetime forward deployment of U S nuclear weapons in Europe or in other locations outside the United States potentially places these weapons at

greater risk from terrorist actions The United States has acknowledged publicly not only that nuclear weapons are stored in Europe but also the quantity stored The location of the stored U S. weapons is dispersed but keyed to the peacetime positions of the national forces to which the weapons have been allocated The storage sites have also been chosen to further the principle of forward defense that is integral to NATO's strategic concept, as well as the General Defense Plan of the Supreme Allied Commander, Europe (SACEUR), that also supports forward defense

Although there has been a steady consolidation of storage sites to increase weapons security in recent years, some 4,600 U S nuclear weapons will still be located at various sites throughout Allied Command, Europe, in 1988, even after the 1,400 are withdrawn as directed by the alliance ministers of defense at Montebello, Canada, in October 1983 Operational requirements dictate that many of these sites be in the Federal Republic of Germany or nearby in other countries of NATO's Central Region These are the same locations where the German Red Army Faction and other terrorist groups have been active The Southern Region countries—Italy, Greece, and Turkey—have experienced similar problems, and the operational imperatives governing the peacetime storage of nuclear weapons there also apply In short, weapons storage in Europe must be responsive to the operational requirements that flow from NATO's military strategy In turn, these requirements constrain where peacetime storage sites can be located and require that they be dispersed to some degree The result is the creation of a set of potential targets that coincide with areas where terrorists, who are usually stridently anti-American, have been or are operating

U.S nuclear weapons stored during peacetime are not the only concern when it comes to terrorism or other acts by unauthorized people to seize, damage, or detonate the devices In times of crisis or international tension whose severity the alliance nations all recognize, NATO would probably implement its Formal Alert System This system, which applies to the NATO integrated military structure, comprises a set of actions, generally sequential, that the forces assigned to SACEUR commanders (that is, the Supreme Commander, Atlantic, and Commander-in-Chief, Channel) are to take as prudent preparations for possible conflict In view of the forward defense concept and given that in peacetime the national military ground forces that come under SACEUR's command are located rearward, one step in the Formal Alert System is to deploy U S nuclear weapons forward to their General Defense Plan positions, except for nuclear bombs, which must remain at or near the airbases from which NATO's aircraft operate Movement of the weapons to those locations means that they will be more dispersed, a situation that helps their survivability by increasing the number of targets that must be attacked

Once U S nuclear weapons are dispersed, they become more vulnerable to terrorist actions Because the weapons need to be reasonably near the

national military units that might be authorized to employ them, there would be more field storage sites (FSLs) than peacetime storage sites and therefore more potential targets to choose from Based on inferences drawn from current unclassified discussions, FSLs do not have elaborate protective structures Thus, dispersal combined with the conditions of field-type storage could present greater opportunities for terrorist action

The extent of the opportunities would depend on the degree to which civilian movement in the forward areas was controlled by West German territorial forces or inhibited by the presence of the defensive forces themselves On balance, it must be concluded that the threat of terrorism posed by dispersed U S weapons is slight In this circumstance, the greater threat is from Soviet special forces (SPETZNAZ) or U S or allied military personnel assigned to fulfill custodial, guard, or other protective functions but who might decide to act in an unauthorized manner These possibilities must also be considered when formulating principles of protection

Principles of Protection

Each of the principles is stated and then explored briefly The discussion contains information from unclassified sources regarding current practices that illustrate how each principle has been derived in light of the context described earlier

Principle 1: *The protection accorded U S nuclear weapons against terrorists or other people with similar intent should be provided by means of a multilayered system that encompasses technical means (equipment and other direct applications of technology to protect weapons physically or provide warning), procedures, personnel and structures, and other physical facilities.*

A multilayered protective system tends to create a synergistic effect whereby the protection provided by the whole is greater than the sum of its parts For example, technology that prevents physical access to weapons in peacetime storage for a specified period, when coupled with a guard force required and trained to respond within that period, provides greater protection than either a delay system or guards alone can provide Layers of protection also tend to ensure against the failure of one element and, presumably for a terrorist group, raise the level of uncertainty of a successful action against a peacetime storage site There are several U S -sponsored, alliance-funded NATO programs involving protective infrastructure that are either in the process of completion or have just been completed They do or will provide extra layers of protection

These programs were generated by concern over the security of weapons after the 1972 Munich Olympics and in the face of continuing terrorist activities These infrastructure programs include the Long-Range Security Program, by which the physical facilities at storage sites for U S nuclear weapons in Europe are upgraded (for example, through new fencing, buildings, and lighting that meet higher standards of security); the Weapons Access Delay System Program, under which physical barriers were erected that delay the access of unauthorized people to certain types of U S weapons, should the outer defenses protecting the actual storage igloos be breached; and the Intrusion Detection System Program, which provides sensors to warn custodians and guards of unauthorized activity directed against stored U S weapons

The newest layer or element of the system of protection will be the air force weapon storage vault, which provides for storage of air force nuclear bombs in such a way as to increase their survivability, security, and safety With respect to the problem of personnel contemplating unauthorized acts (insiders), whether U.S or allied, there is a two-man-rule that requires joint performance of certain key functions, as well as a system of overlapping elements—that is, one that includes different groups of personnel who may be either exclusively U S or multinational (U S personnel will always be present because of their custodial responsibilities) These measures also tend to lessen the threat from insiders The actual deterrence of insiders will depend on successful interaction among the different elements of the protective system Those elements include, at one extreme, protective features designed into the weapon itself or perhaps into its protective container

Principle 2: Protection should be an integral part of weapons design.

The core of the protection system should be the security features built into the weapon itself These can provide yet another layer of protection (and synergy) Of even greater importance, they can provide the most direct prevention against an unauthorized detonation Government officials in testimony before the U S Congress have repeatedly pointed to ongoing programs designed to increase the safety and security of U S. nuclear weapons and have emphasized that the latest of technologies are incorporated into new weapons as they are fielded. This point has been reflected in the annual arms control impact statements, and both the Congress and the executive branch have been lending important momentum to these programs since the early 1960s

The most significant technological development has been the permissive action link (PAL) systems integral to each weapon PAL systems are designed to preclude unauthorized detonation of a weapon by requiring the insertion of a proper digital code before the warhead can be armed The earliest PAL systems were mechanical combination locks, found on the older 8 inch and 155 mm nuclear artillery projectiles (designated, respectively, W33 and W48 by the Departments of Energy and Defense) still in the U.S. inventory and

currently deployed in Europe The PALs have now evolved into the electronically controlled category D and F PAL systems, with switches that can be individually coded so that only selected weapons can be unlocked These category D and F PAL systems also incorporate command disable systems that allow a nuclear weapon to be rendered incapable of a nuclear detonation through nonviolent means (that is, without using externally applied explosive devices) built into the weapon itself or its container. The new 8 inch (W79) and 155 mm (W82) weapons have category D PAL systems with this command disable feature

The command disable systems, at least those associated with the newer PAL systems, also incorporate the principle of automaticity After a limited number of attempts to unlock the weapon with an inaccurate code, the weapon automatically becomes incapable of nuclear detonation Clearly automaticity is preferable to other means that require action by U S custodial personnel (such as activating a switch or lever or, at the extreme, the actual physical destruction of the mechanism in the weapon that permits generation of the nuclear explosion), given that the worst case possibility is the incapacitation or death of U S custodians The combination of PAL and command disable systems is a powerful tool with which to prevent the unauthorized nuclear detonation of a U S weapon

The PAL systems alone, particularly the category D and F systems with their multiple code, coded switches, are also a powerful tool for helping ensure positive control of U S weapons Their status is regulated continuously and effectively, changing only as directed by authorized higher personnel Systems such as the PAL exemplify how technological means can provide an additional degree of certainty over that provided by the routine complex set of procedures, training, evaluation, and scrutiny by military personnel, all supported by basic military discipline, which are and will continue to be the primary means of ensuring positive control

A variety of other features that provide either greater safety or security (or both) to U S nuclear weapons also serve as obstacles to terrorists (The concept of overlapping protective measures is exemplified by the military's use of the term *nuclear surety* to mean nuclear security and safety) These other features include the use of insensitive high explosives (IHE) in modern weapons to make them resistant to chemical detonation that would produce a plutonium scatter One-point safe is another characteristic of the weapons. It ensures that in the event of a detonation initiated at any one point in the high explosive system, the probability of achieving a nuclear yield greater than the equivalent of 4 pounds of TNT will not exceed one in a million Weapons designed to function only when an insertible nuclear component (INC) is placed inside also inhibit terrorists or other unauthorized personnel from generating a nuclear detonation The degree of security here, however, depends on where and under what conditions the INCs themselves are stored,

arrangements that will have to reflect the operational requirements for employment of the weapon

Principle 3: *Protection systems must not be so cumbersome in either a figurative or literal sense (such as use of equipment or storage facilities that are deliberately designed to make rapid removal of U S nuclear weapons from peacetime storage impossible) that the weapons do not meet the operational requirements of military forces.*

Storage systems can be designed to impose deliberate time delays on either physical access to, or the removal of, U S nuclear weapons from peacetime storage The objective of the delays is to permit guards to respond to alarms or other indicators before the weapon can be damaged, stolen, or subjected to other unauthorized acts On the other hand, if authorized personnel have no way to circumvent the designed delay, the system will be biased toward physical security rather than operational responsiveness (for example, the capability to respond to directives to disperse the weapons for survivability or to move them forward that SACEUR might issue) General Bernard Rogers, the current SACEUR, has testified that weapons access delays, measured in minutes, are built into some current U S Army nuclear weapon storage sites in Europe through the weapons access delay system (WADS) and the new U S Air Force weapons storage vault for nuclear bombs Given the high degree of responsiveness required for forward deployed forces and the potentially short warning times of attack, given the proximity of the probable attackers, the delay times must be reasonably short and, it must be assumed, capable of being circumvented by authorized personnel This balance between security and operational responsiveness must be embodied in protection systems if U S nuclear weapons are to preserve their functional utility

This principle must also apply to elements of the protection system applied to U S weapons that have been removed from peacetime storage for dispersal and/or deployment forward Those elements should not inhibit the rapid transportation of U S weapons However, to the degree possible within the implicit limitations of space, weight, and size relative to the need for rapid movement, the elements of the protection system that pertain to weapons when they are moved should replicate those provided during peacetime storage While what might be construed as classic terrorism tends to be viewed as a peacetime phenomenon, recent indications relating to state-sponsored terrorist groups suggest that this presumption need not be true Given the greater range and size of resources available through governments, combined with the leverage this assistance gives terrorists in pursuing their objectives, conceivably terrorists with state sponsorship and guidance might seek to attack U S weapons during dispersal or even while located at some forward storage location. Admittedly this possibility seems remote because

of the difficulties that would constrain civilians from operating freely in a country mobilizing for defense In view of other threats (such as from SPETZNAZ) to U S weapons as they are going through the various phases of their operational deployment sequence (for example, in the case of ground-delivered weapons, removal from storage, transportation forward, establishment at field storage locations, and possible subsequent movement or employment of selected weapons), the need for such protection is conclusive, however

Principle 4: *Command and control elements and supporting communications systems must be incorporated into the weapons protection system to permit responsive action, including weapon movement, employment, and disablement by authorized personnel while precluding unauthorized personnel and terrorists the opportunity to detonate a weapon, should they acquire one Command and control elements or subsystems of the overall weapons protection system are seen as comprising military organizational structures, including all the appropriate authorities, technical means for supporting information flows among them, procedures, and other mechanisms, among them authentication systems and PALs and command disable or similar physical or technical systems that provide specific means of preventing the unauthorized detonation of a U S weapon.*

In military terms, the exercise of effective command and control over U S nuclear weapons by the National Command Authorities (the president and secretary of defense) and their subordinate military echelons is the mechanism through which positive control of U S nuclear weapons (including the maintenance of U S nuclear weapons in U S custody) is ensured, as required by U S law and the nature of the weapons themselves [5] Effective command and control must cover the possibility of hostile military forces overrunning locations where U S nuclear weapons are stored and employing them against U S or allied forces Terrorists and other people operating without authorization are the other principal threat to U S weapons with which the command and control elements or subsystems of the overall weapons protection systems must deal

In keeping with military organizational principles and as described in testimony and by various students of the subject, clear hierarchies and special channels exist through which directives regarding U S nuclear weapons are required to pass These directives start with the National Command Authorities and run down to the unified commander to whom nuclear-capable and conventional forces are allocated and then to the commanders of the nuclear-capable delivery forces through whatever intervening command levels have been established. These forces are the military means with which the unified commander executes the theater mission The command and control of the nuclear component of these forces are always handled separately and are

always dependent on authorizations and directives from the National Command Authorities

In Europe, SACEUR is the focal point of the command and control system for nuclear weapons deployed within (or specifically allocated to the support of) Allied Command, Europe, British as well as U S He identifies the levels at which requests for the release of nuclear weapons to be employed by his forces can originate and has the power to decide whether the requests (or requests originating at his level) are submitted to the National Command Authority or the British equivalent

For positive control, the flow of information among the elements of the hierarchy must be accurate, timely, and, most important, capable of validation as to the source cited in the message The familiar systems of message authentication employed by the U S military provide the last Typically these authentication systems require the inclusion in the message of special alphanumerics that can be compared to those designated for a given time and day as stated in the authentication tables distributed to the headquarters of the relevant commanders In the case of nuclear delivery units deployed forward and hence subject to the possibility of overrun, the potential acquisition of authentication tables by hostile forces poses the possibility that spurious messages could be generated, creating confusion and severe problems of positive control

The capability to validate directives from higher levels in the nuclear command and control structure, particularly at operational levels, is valuable chiefly in preventing hostile military forces from disrupting U S positive control In this regard, it is conceivable that terrorists or insiders might also seek to attain their objectives by generating messages containing valid authentication values but spurious directives intended to confuse or spoof the system The nuclear command and control structure, however, must be based on the far more serious potential for unauthorized persons securing the proper code with which to unlock and detonate U S nuclear weapons

U.S PAL systems are key elements in the exercise of effective command and control over U S weapons that are forward deployed on land in support of operational commanders Positive control requires that the code for unlocking U S nuclear weapons be provided to U S custodians of the weapons only at the time the president releases them for employment In operational terms, this requirement means that the code must be provided through messages directing the weapons' use For forward deployed weapons, logic suggests that these messages must originate at the unified or theater commander's level, since the forces deployed there are to support his mission and are under his command In Europe, the U S European Command supervises nuclear weapons storage and must provide the messages with the unlocking data to the custodians. During hostilities, the enemy, such as the Soviet Union, could conceivably intercept messages with sophisticated in-

tercept equipment and ascertain how to unlock the coding data with deencryption techniques In peacetime, however, terrorists and other unauthorized people would not have even this potential source of unlock codes to draw upon

An unauthorized person with access to a U S weapon with an operative PAL system but without the code to unlock it would try picking the lock That attempt would be foiled by the integral command disable systems A weapon in terrorist hands that required external activation (such as a switch thrown) that had been accomplished would still be useless If the system was of a limited-try type, a certain number of incorrect entries inserted in the PAL coded switch would automatically produce the same result This combination of an advanced PAL system with multiple code, coded switches, and an integral, non-violent command disable system that operates automatically appears to be the most effective means at present for both strict positive control of U S weapons and prevention of an unauthorized nuclear detonation

Navy nuclear weapons merit special discussion in the light of principles 2 and 4 Definitive unclassified data on the security systems associated with specific navy weapons are not available However, much testimony and other official information contained in the arms control impact statements provided by the executive branch to the Congress regarding various U S Navy nuclear weapons, together with information provided orally by former U S Navy officers, tend to confirm that navy nuclear weapons either have not been designed with integral PAL systems or, in the case of weapons used by the navy and other services that are known to incorporate PALs (such as most models of B-61 nuclear bombs), the weapons are stored unlocked, at least when on board ship Assuming this conclusion is true, the issue is whether principles 2 and 4 should be made applicable to U S Navy weapons [6] This issue is made all the more pointed by the fact that U S Air Force strategic nuclear missiles and air-delivered weapons are protected by PAL devices

Given the potential for terrorism or unauthorized acts by other people, including dissident U S Navy personnel, the issue must be considered from two perspectives (1) the possibility that such people could achieve their objectives by virtue of the possible presence of unlocked U S Navy weapons stored on land in the United States or its territories or on board U S Navy vessels in port anywhere in the world and (2) the possibility for unlocked weapons on board U S Navy vessels at sea being employed in unauthorized manner by the crew for whatever reason (such as the belief that the United States has been attacked on a massive scale and that nuclear retaliation is in order even without National Command Authority direction, a scenario that is the most salient concern of those who want U S Navy weapons to incorporate PAL systems)

As to the first possibility, it is generally analogous to the situation of forward deployed U S. Army and Air Force weapons in Europe In the absence

of PAL and associated command disable systems, the possibility that terrorists or other unauthorized people will achieve success—if success is measured by the potential to acquire a weapon that can be detonated and to produce the designed nuclear effects—is greater The ability of these people to gain access to a weapon in the first place will be determined largely by the effectiveness of the other elements of the multilayered protective system Conversely, whatever other use terrorists might be able to make of any weapon they acquire, at least an actual detonation would be precluded by a PAL and a command disable system

The potential for unlocked U S Navy weapons on board vessels at sea to be employed in unauthorized manner is the more serious concern, although it is a special case that, at least on the surface, has little to do with terrorism Fundamentally this possibility exists because of two factors the relatively greater difficulty of communicating with U S Navy vessels at sea, especially the submerged submarines (SSBNs) that carry the navy's strategic ballistic missiles, and the availability of unlocked nuclear weapons stored aboard essentially autonomous combat units that can only be communicated with via electronic means

With regard to the possible unauthorized launch of SLBMs, apparently authoritative U S Navy sources have described an intentionally complicated and (one must assume) lengthy process for launching these missiles The process can begin only upon specific National Command Authority direction and involves not only the two-man rule with respect to the authorizing message but also the performance of a large number of sequential actions by separate individuals (an unidentified senior navy official has estimated they number thirty) Ostensibly any participant in the launch process can stop it if he has reason to believe the launch is not truly authorized Thus the navy relies on the human factor rather than on physical and technical means (at least in the sense of a PAL system) to maintain the requisite positive control over its nuclear weapons, including SLBMs

Especially in the case of SLBMs, the navy obviously believes that it can ensure effective command and control by means of the extremely careful selection and monitoring procedures it has established for its submarine crews, their well-known discipline, and their frequent practice of procedures for launching (they include becoming familiar with the sound of the voices that would provide inputs to the launch procedure), particularly when this approach is coupled with the absolute requirement for a specific National Command Authority directive to launch

The navy's tactical nuclear weapons are subject to the same kinds of procedural checks and balances (or voting on a launch, as it has been described), although the human factor may be somewhat more problematical, since the crew of a surface vessel may not meet the standards required of submarine crews in entirety The implications of unauthorized employment

of tactical navy weapons are potentially somewhat less alarming, although the employment of any U S nuclear weapon must be viewed as producing a qualitative change in any ongoing hostilities, with consequences that are difficult to calculate Certainly the loss of a major Soviet fleet unit to a U.S Navy nuclear weapon, or even a Soviet SSBN, is hardly comparabale to the loss of a Soviet city from a U S bomber or ICBM attack However, the probability of a U S Navy commander's somehow employing a tactical nuclear weapon as a weapon of choice rather than a conventional weapon designed to perform the same mission (such as torpedoes or depth charges in antisubmarine warfare) seems low

In this regard, it is instructive to know that there appears to be a virtual lack of U S Navy doctrine on how to employ its tactical nuclear weapons, a situation that has been commented on critically by a number of national security analysts [7] These critics appear to have overlooked the fact that this gap implies a preference for conventional weapons with which to perform the same naval missions (for example, antisubmarine warfare, anti-air warfare, and antisurface warfare), for which carefully designed doctrine and tactics have been developed and are continuously exercised by U S. Navy vessels assigned these combat functions There is a concept, advanced recently by Desmond Ball, that a use-or-lose syndrome militates for use by the U.S Navy of tactical nuclear antisubmarine warfare weapons in a war at sea in which Soviet attacks were on the verge of destroying the navy's underwater sensor system for detecting Soviet submarines [8] The argument seems singularly unpersuasive when set in the context of tactical engagements at sea These events require extremely responsive weapons systems, and the uncertainty of securing timely NCA release of the navy's tactical nuclear weapons provides an additional reason why conventional weapons are indeed the navy's choice

This analysis of the potential for unauthorized employment of either strategic or tactical U S Navy nuclear weapons suggests that the trouble-free history of effective navy command and control can be extrapolated with confidence into possible future wartime situations However, integrating PAL systems into present and future U.S Navy nuclear weapons through retrofit or design has potential utility On balance, it may be desirable to put PAL systems with command disable features on these weapons PAL systems would provide the physical and technical means of raising to the maximum the already extremely high probability that effective command and control can be maintained over SLBMs in all situations, including during a communications loss Any cost in terms of time as a result of adding another step to the launch process, already deliberately designed to be complex, would be minimal and should have no significant impact on the responsiveness required of strategic weapons As to the tactical nuclear weapons carried on board a ship, PAL and command disable systems would provide another layer to their protection systems, an addition that would be particularly advantageous dur-

ing port visits anywhere in the world but especially in those areas where the visits are visible demonstrations of U S interest and power but where the potential for terrorist activities is high (as in the Middle East)

Principle 5: *Protection systems against terrorists or other persons with similar intent must be effective and reliable under a wide range of geographic and climatic conditions.*

The emphasis up to this point has been on U S nuclear weapons planned for or already forward deployed in Allied Command, Europe This focus is understandable because a great deal of unclassified information about U S weapons stored in various alliance countries is available It is important not to overlook the fact, however, that U S policy and worldwide force posture may require the forward deployment of U S nuclear weapons in other areas of the world where terrorist activities could be directed against U S weapons

The Republic of Korea is the one other geographic area in the world besides Europe that a U S secretary of defense has specifically discussed in the last ten years as a place where U S nuclear weapons might be employed in support of a U S. ally Thus it is possible that during a crisis U S. weapons might be deployed to the Korean peninsula, a place markedly different in many ways from Europe There are also other areas, notably the Middle East, where it is possible to conceive of U.S nuclear-capable forces being deployed

In the light of the differences of these areas, the various layers or elements of the multilayered protection system must be flexible enough to adapt to the specific conditions of each one, with the overall mix of layers providing the requisite level of protection For example, larger guard forces located at storage sites to respond to terrorist actions could conceivably be necessary for U S weapons stored in South Korea, given the rugged topography and potential for interdicting augmentation forces responding from other locations.

Principle 6: *Protection systems must include elements to facilitate the recovery of U.S. weapons that may have been removed successfully from peacetime storage by terrorists or other people with similar intent.*

One logical element in this regard should be specific additional bilateral agreements that address this contingency between the United States and those nations with which it has established programs of cooperation (POCs) covering U S. weapons forward deployed on their soil These agreements presumably would specify individual and mutual responsibilities for recovery actions, establish channels for bilateral and multilateral coordination of these efforts, and provide for external assistance as appropriate Given the relative propinquity of international borders in most of the known POC countries, the agreements might also cover hot pursuit and rules of engagement should the terrorists be brought to bay

The agreements would not be of direct assistance in locating a stolen U S nuclear weapon if original contact with the perpetrators of the theft was lost For this purpose, the U S has developed the Nuclear Emergency Search Team (NEST) The NEST was organized specifically as a means of dealing with possible nuclear terrorism It uses various sensors, including sensitive gamma ray detectors, to fulfill its functions, which include detecting stolen nuclear weapons, nuclear materials, or improvised nuclear devices, and it utilizes the technical skills, experience, and knowledge of senior scientific advisers, physicists, engineers, electronic specialists, computer analysts, and instrument specialists from the Los Alamos, Lawrence Livermore, and Sandia National Laboratories, as well as from supporting contractors

NEST's capabilities can be tailored to provide a graduated response appropriate to the nature of any incident, the number of people deemed necessary (which could range from 2 to 200), and the types of equipment required, whether airborne, handheld, or groundbased suitable for roadblock monitoring Given the basing of NEST in the continental United States, as currently structured it may not be entirely suitable for meeting the requirements of this protection principle It seems obvious that NEST capabilities would be most valuable in facilitating detection of a stolen U S nuclear weapon if its capabilities were applied within a very short time of the theft, ideally while the weapon was still being transported to its initial hiding place

Although NEST capabilities are configured to be moved by aircraft, the time necessary to traverse the distances between the United States and probable or known locations of forward deployed U S nuclear weapons throughout the world is still long It is certainly long enough to raise questions about how effectively NEST capabilities might be brought to bear upon a theft, particularly if it occurred in the highly urbanized areas of Western Europe where a variety of ways of shielding gamma radiation could be applied

Political and Cost Considerations

Political and cost considerations tend to merge in NATO, where common funding under the NATO infrastructure program is an intensely political issue The infrastructure program was created primarily to provide facilities and other special capabilities for the integrated military structure, with procurements subject to international competitive bidding in which national companies and multinational consortia drawn from the alliance nations participate The domestic political repercussions of infrastructure projects won or lost can sometimes have substantial impacts on the fortunes of alliance governments (including the United States) that usually work assiduously on behalf of their nationals' interests Moreover, alliance governments other than the United States have historically tried to keep the total NATO infrastructure

low in order to avoid domestic criticism of their budgets, which must include their proportionate share of the common NATO infrastructure annual budget

On the other hand, the U S government has generally sought to increase the level of infrastructure funding because of continuing concern about NATO's military posture and because of congressional pressure to get the other alliance members to bear at least part of the cost of improvements This congressional concern has also manifest itself in a general unwillingness to countenance U S prefinancing of infrastructure projects Prefinancing—that is, initial funding by a nation of a project thought to be eligible for NATO common funding—is an accepted way for a country to fund and procure items more quickly than is possible under standard infrastructure processes Prefinancing, however, involves a degree of risk, albeit generally slight, that the projects being prefinanced might not ultimately be accepted for common funding by the alliance as a whole There is also sometimes a substantial delay in recouping the funds expended by the prefinancing nation Historically, however, funding by NATO of projects related to improving the security of U S nuclear weapons has been relatively easy to obtain, and the U S Congress has tended to support prefinancing of these projects with less difficulty

This pattern does not mean that funding for new security improvements will be either timely or as easy in the future The three large security-related infrastructure projects—the Long-range Security Program, the Weapons Access Delay System, and the Intrusion Detection System Program—have involved substantial expenditures that are still ongoing It can be anticipated that U S initiatives for new infrastructure programs specifically designated to improve security will be scrutinized closely by U S allies The reason is that such initiatives tend to raise questions about the need and value of the earlier security programs that have not yet all been completed.

An additional factor on the NATO side that may well generate resistance to new security initiatives, at least in the near term, is the fact that the six-year NATO infrastructure program approved by the alliance ministers in December 1984 represented a substantial increase in funding over previous programs sought by the United States It was approved only after hard bargaining and considerable U S pressure On the U S side, in spite of a record of good congressional support for NATO security programs, including their prefinancing, the intense pressure to cut the defense budget stemming from the Gramm-Rudman-Hollings legislation may generate much weaker support than in the past Congress may also question why anything new is needed when large security programs for Europe have been funded already and partially executed

More purely political considerations with regard to improvements in security may arise from the nature of specific security improvement programs developed in accordance with the principles presented in this study For example, programs that seem to reflect a lesser emphasis on security in favor

of the operational utility of U S weapons might generate alliance opposition They might be construed as proof of a long-standing Soviet assertion that the United States would rather fight a nuclear war with theater weapons on European soil than deter a conflict through the threatened use of U S strategic systems Additionally, it is probably true that some European political opposition might be based on a fear that, in the absence of a clear terrorist threat to nuclear weapons that would militate for funding, overt attention to weapons security might actually precipitate terrorist activities against them

Recommendations

This study of U S nuclear weapons security and control has quite consciously not approached the subject from a rigorous analytical perspective To do so would have required the use of classified information that, even if it were available, would have been inappropriate A comprehensive data base would have been required, including descriptions of current facilities, procedures, and processes for protecting U S nuclear weapons against terrorists, and the status of the various upgrade programs. If this data base had been available, it might have been appropriate to make a basic recommendation that the principles presented in this study be used to assess the degree to which the baseline (including upgrade programs) adheres to these principles This assessment, in turn, could have provided a basis for recommended changes to ensure greater future consistency with the principles

Absent a detailed data base, the most appropriate basic recommendation is that the approach of this study—that is, the use of a broad set of protection principles—be considered by responsible U S government officials with access to the necessary classified information as a possible basis for evaluating the actual baseline U S unified commanders generate and submit to the Joint Chiefs of Staff documents called required operational capabilities that identify the additional capabilities (for example, survivable Command, Control and Communications systems) needed by the theater commander to perform his mission It appears that no parallel effort has been directed specifically at the subset of security relating to terrorism

Three specific recommendations flow from the discussion of the principles stated here

First, programmed modernization of U S nuclear weapons should be accelerated as a matter of the highest priority in order to ensure that these weapons, especially the ones that may be planned for forward deployment, incorporate the latest PAL and, as appropriate, command disable technology The latter should encompass the principle of automaticity to preclude the possibility of an unauthorized unlocking of a usable U S weapon Barring the possibility of retrofit, implementing this recommendation should involve, at

a minimum, the accelerated production and forward deployment of the new W79 and W82 weapons (presumably without their enhanced radiation capability) to replace the older W33 and W48 weapons

Second, U S. Navy nuclear weapons requirements should be reevaluated with regard to the technical, cost, and operational feasibility of incorporating modern PAL systems and, where appropriate, command disable systems into the weapons Although the various scenarios advanced by critics of U S Navy policy regarding PAL systems are not necessarily persuasive, the marginal increase in positive control that the systems might provide would remove a continuing source of criticism and might yield an additional element of stability of the perceived U S -Soviet strategic balance PAL and command disable systems could provide additional flexibility and better security for the deployments of certain U.S Navy tactical weapons This gain could be especially valuable for possible contingent deployments of air-delivered nuclear ASW weapons on foreign soil

Third, ongoing research and development programs must emphasize ways to prevent unauthorized access to U S nuclear weapons, as must the continual monitoring by officials of proposals to improve weapons security. The potential impact on alliance public opinion and governments that would result from a terrorist's merely gaining physical access to a U S weapon is such that finding ways to decrease the probability of that event is essential Assuming that weapons modernization with the objective of putting in place the most advanced PAL and command disable systems has taken place, these measures should provide sufficient guarantees against the possibility of an actual terrorist detonation of a stolen weapon

Notes

1 The term *nuclear weapons* is used throughout this report to denote nuclear bombs and nuclear warheads for missiles and artillery rounds, whether or not the warheads are mated with their associated missile bodies or artillery shells

2 The word *terrorist* as used here denotes individuals or groups such as the Red Army Faction, Red Brigades, and Fighting Communist Cells An interesting discussion of how else the term might be defined is contained in Thomas C Schelling, "Thinking about Nuclear Terrorism," *International Security* 6 (Spring 1982) 61–77

3 These POCs comprise a set of bilateral agreements concluded in accordance with the Atomic Energy Act of 1946 that establish the conditions and mutual and individual responsibilities of the signatory nations with regard to U S nuclear weapons provided for possible employment by allied military forces

4 These are listed in the chapter Bibliography They also constitute the sources for the data used in the discussions that follow These sources have not been footnoted in the text to avoid breaking the flow

5 As early as the August 1968 version, the governing Department of Defense directive, number 5210 41, "Security Criteria and Standards for Protecting Nuclear

Weapons," was explicit that "nuclear weapons require special protection because of their political and military importance, their destructiveness, and the attendant consequences of an unauthorized detonation" (August 14, 1968, p 3)

6 Principle 2 states that protective capabilities against terrorists or the acts of other unauthorized people should be an integral part of weapons design Principle 4 states that command and control systems for nuclear weapons should incorporate physical and technical systems to prevent the unauthorized detonation of U S nuclear weapons

7 The latest is Desmond Ball "Nuclear War at Sea," *International Security* 10 (Winter 1985–1986) 3–31

8 Ibid

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