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Reevaluating Nuclear Safety and Security in a Post 9/11 Era

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Changing Perspectives on Nuclear Safety and Security

The majority of active weapon systems in today's nuclear stockpile were designed and fielded during the 1970s and 1980s. Throughout that period, safety and security methodologies for protecting against unauthorized nuclear detonations were aimed at addressing Cold War threats. With the end of the Cold War and the increased focus on terrorism and rogue states following the September 11th terrorist attacks, the safety and security needs for a credible deterrent have evolved. While considering the reduction in stockpile numbers called for in the Nuclear Posture Review (NPR), nuclear safety and security methodologies must be modified as the characteristics of tomorrow's flexible deterrent are formulated.

The attacks on the continental United States on September 11, 2001 changed many perceptions held by the American people and policy makers about U.S. immunity from attack. Combating organized terrorist activities became a major focus of the nation. Terrorist groups did not suddenly appear, however nothing had previously captured America's attention like Al-Qa'ida. The attack on the World Trade Center and the Pentagon painfully demonstrated that terrorists could prove a formidable adversary when properly organized and equipped with available technology. Following September 11th, U.S. national security policy adapted to have an increased focus on homeland defense[1]. With protection of the American people in mind, preventing terrorist attacks with weapons of mass destruction became a principal mission for national security. Former U.S. Secretary of Defense William Perry stated, "Nuclear or biological weapons in the hands of terrorists or rogue states constitute the greatest single danger to American security - indeed to world security - and a threat that is becoming increasingly less remote."[2] Regardless of the nuclear threat posed by other nations, the United States will continue to maintain a credible nuclear deterrent as a component of its national security policy for the foreseeable future.[3] Assuming that the U.S. nuclear stockpile will continue to exist in some form, needed changes to the stockpile must be evaluated in light of the heightened perception of terrorism after September 11th.

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1. Mike Shuster, "National Security, Nonproliferation, and the War against Terrorism," in After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation, ed. Michael Barletta (Monterey, California: Center for Nonproliferation Studies, 2002), 1.

2. William J. Perry, "Preparing for the Next Attack," Foreign Affairs 80 (November/December 2001): 31-45.

3. Edward L. Warner III, "Statement of the Honorable Edward L. Warner III, Assistant Secretary of Defense for Strategy and Threat Reduction, Before the Senate Armed Services Subcommittee on Strategic Forces Hearing on Nuclear Deterrence April 14, 1999," (Washington, D.C.: Federal Document Clearing House, Inc., 1999).

Evolving Needs in a Post-9/11 Era

Nuclear safety and security methodologies must be modified as the characteristics of tomorrow's nuclear deterrent are formulated. Improvements in safety and security need to be evaluated while considering several factors that have emerged since the Cold War. Increased budgets for homeland security and the "Global War on Terror" mean that military funding for nuclear weapons will at best remain at its current level. Decreasing the cost to the military while providing needed capabilities is therefore a strong driver as we move forward and tradeoffs are evaluated. There is a demand for the Nuclear Weapons Complex (NWC) to become more flexible and responsive to evolving threats to the nation. The cost and infrastructure associated with becoming more responsive could be offset by a reduced stockpile called for by President Bush's administration while also reconsidering time to use. In the Cold War, it was necessary to have nuclear weapons in a state of readiness at all times so that the United States could respond to an attack at a moment's notice. Maintaining that state of alert is costly, and while it is necessary for some weapons to be ready at an instant, other weapons could be stored in a less costly configuration that would allow them to be ready for deployment over a longer time frame. It is also important to take a lifecycle approach to nuclear weapons. Instead of developing separate safety and security themes for the different phases of a nuclear weapon, the NWC needs to move toward developing an integrated surety theme that protects Special Nuclear Material (SNM) from "cradle to grave".

Nuclear Weapons: An Attractive Terrorist Target

Aside from target kill capabilities, nuclear weapons are unique because they are "unmatched as weapons of terror"[4]. This characteristic ensures that nuclear weapons will remain a cornerstone of U.S deterrence strategy, but also makes them attractive targets for terrorist organizations. Whether a nuclear weapon was detonated at full yield or a dirty bomb scattered radioactive material, the resulting public hysteria from a terrorist attack utilizing nuclear material has the potential to surpass that of 9/11. Public outrage would be severely intensified if terrorists had employed SNM produced by the U.S. NWC against Americans. The political ramifications of such an attack with U.S. nuclear materials would have a deep and lasting impact on the NWC, possibly even jeopardizing its very existence. The availability of less protected nuclear sources outside the United States, particularly nuclear materials in Russia[5], is much greater, but the implications of an attack utilizing American resources warrants changes being made in order to make the nuclear weapons infrastructure more responsive to modern threats. The precedence of U.S. nuclear materials as an attractive terrorist target is substantiated by two incidents compiled by Alex Schmid in his keynote address to the International Atomic Energy Agency conference in Stockholm, Sweden in May 2001,

> *"In the 1980s, a member of the German Red Army Faction recorded on camera the loading of nuclear weapons on military aircraft at the US air base near Aviano, Italy, apparently in an effort to explore opportunities for theft[6]....In April 1997 the director of security and safeguards of the Rocky Flats nuclear facility in Colorado, USA, resigned, claiming that he could no longer ensure the safety of the citizens of Denver who lived 15 miles from the facility in which large amounts of weapon-grade material was stored. He warned that the Montana Militia, a right-wing group, had tried to recruit members from among the plant's guards – an attempt which was not successful but indicative of the interest of US groups in nuclear or radiological weapons.[7]"*

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4. Glenn C. Buchan et al., Future Roles of U.S. Nuclear Forces: Implications for U.S. Strategy (Santa Monica, California: RAND Project Air Force, 2003), 39.

5. Leonard S. Spector, "The New Landscape of Nuclear Terrorism," in After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation, ed. Michael Barletta (Monterey, California: Center for Nonproliferation Studies, 2002), 7.

6. Terrorism Prevention Branch, Database on Significant Nuclear and Radiological Incident, Events, Threats and Hoaxes, (Vienna, TPB, May 2001), 2. Quoted in Alex P. Schmid, "Nuclear Terrorism: How Real is the Threat," in Measure to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radiation Sources, Proceedings from IAEA Conference held in Stockholm, Sweden (Austria: International Atomic Energy Association, August 2002), 28.

7. Jessica Stern, "The Ultimate Terrorists" (Cambridge, Mass: Harvard University Press, 1999), 58. Quoted in Alex P. Schmid, "Nuclear Terrorism: How Real is the Threat," in Measure to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radiation Sources, Proceedings from IAEA Conference held in Stockholm, Sweden (Austria: International Atomic Energy Association, August 2002), 29.

Although an attractive target, there have been no terrorist attacks with the purpose of obtaining U.S. SNM, primarily because the terrorist organizations perceive that their probability of success is quite low. As technology advances and terrorist groups acquire increasingly sophisticated means of attack, the perception of invulnerability could change. It is therefore imperative that the security of U.S. nuclear weapons remains substantially greater than any credible terrorist threat in order to deter terrorist groups from attacking and to reassure the American public. Thus, the United States would be remiss if did not take increased aggressive action to secure not only its nuclear stockpile, but all SNM associated with the weapon lifecycle to protect against terrorist threats. Such protective action, when leveraging modern technical solutions, has the potential not only to reduce the likelihood of a terrorist event utilizing U.S. special nuclear materials and the resulting political ramifications, but also decreases the infrastructure and costs associated with current physical protection of America's SNM. It is imperative that we focus on increased protection of SNM with technology, realizing that physical protection is costly and has its limitations.

The Case for Increased Safety

Nuclear safety has been a core mission of the NWC since the advent of nuclear weapons. Because of the unacceptable consequences of an accident, nuclear safety is critical. While safety visionaries laid out the basic foundations for an ideal nuclear safety theme decades ago, implementation has been constrained due to a combination of technological and political limitations. The NWC has a responsibility to the American public and to the world to ensure that U.S. nuclear weapons are as safe as feasible while remaining reliably usable. As a part of its stated mission, the National Nuclear Security Administration (NNSA) is required to "maintain and enhance the safety, reliability, and performance of the United States nuclear weapons stockpile, including the ability to design, produce, and test, in order to meet national security requirements."[8] In order to achieve that mission it is vital to persistently improve the safety of our weapons systems and make continued strides toward an ideal system as new technology has become available.

8. National Nuclear Security Administration Act, Section 3221.b.2, (11 March 2004), 6.

Evolution of Current Nuclear Weapons Safety and Security

In order to have a framework for future safety and security methodologies, it is important to have a good understanding of the stockpile's current approaches and their evolution. Maintaining a safe and secure nuclear stockpile has been a crucial component of the United States' nuclear weapons program since its inception. Early safety was implemented by keeping SNM and high explosives physically separate until ready for use, while early security measures consisted primarily of guards and guns. As the Cold War heated up, the military moved to a wooden bomb concept where nuclear weapons were ready to go at a moments notice and did not require additional assembly prior to use. This meant that weapons would be stored in operable conditions, forcing a new approach to safety. Three fundamental principles are currently used to ensure safety: isolation, incompatibility, and inoperability. The nuclear explosive package is isolated from unintended outside energy, arming signals are designed to be incompatible with commonly occurring signals, and the weapon is engineered to become inoperable before the safety system would fail in accident environments. Using these guiding principles, nuclear weapon safety themes have been developed to meet the criteria set forth in the "Walske Letter" of 1968, which specifies that in abnormal environments, the probability of an inadvertent nuclear detonation shall be less than 1 in 10^6 per exposure, and in normal environments, the probability of a premature nuclear detonation shall be less than 1 in 10^9 per warhead lifetime.[9]

With the advent of nuclear weapons being deployed outside of the continental U.S., the security of nuclear weapons was reexamined as well. It became apparent that additional measures were needed to ensure that only the President of the United States could authorize the release of one of the US nuclear weapons – no matter where that weapon was deployed. Today use control has evolved around the three guiding principles of deny, discriminate, and disable. Unauthorized energy is denied access to the explosive package, weapons discriminate between authorized and unauthorized actions, and weapons are engineered to disable upon detecting unauthorized actions.

9. J. Arlin Cooper, "Mathematical Aspects of Unique Signal Assessment," Sandia National Laboratories Report SAND2002-1306 (May 2002), 9.

Integrated Surety

Traditionally, threats that could result in unauthorized nuclear weapon detonation have been separated into two areas: random accidents, which are protected against with safety, and intelligent, malevolent forces, which are protected against with use control. Several factors influenced the separation of safety and use control. Although sharing similar requirements, safety and use control have traditionally taken different approaches in meeting those requirements, with safety relying on passive measures, and use control implementing active measures.

Political factors also played a key role in maintaining separation. By its nature, use control must be classified however there was a strong desire to keep safety unclassified. During airborne alert there were a handful of accidents involving nuclear weapons. It was important to reassure the American public as well as our NATO allies that although accidents may happen, the robust safety designed into the U.S. nuclear stockpile made it extremely unlikely for a detonation to result even in a severe accident scenario. An accidental detonation of a nuclear weapon, regardless of what country it came from, has always been deemed unacceptable. By keeping safety concepts unclassified, the U.S. was able to share its safety methodology with other nuclear nations, making the world safer as a whole. Unclassified safety also meant that more people were able to analyze a weapon's safety theme, resulting in increased scrutiny and a greater chance of identifying any flaws.

Even though safety and use control have evolved as separate subsystems on a nuclear weapon, they share a common overriding goal to prevent any unauthorized nuclear detonations. Safety and use control are more alike than different, sharing common underlying state transitions. In both systems they are stored in a reversibly inoperable state and by applying some sort of control, presidential authorization for use control and human intent for safety, they move to a reversibly operable state allowing for detonation to occur. If, however, the safety system detects an accident or the use control system is invoked, the weapon will become irreversibly inoperable. Because of the joint mutual objective of preventing unauthorized use, it is important to evaluate the development of an integrated surety theme to address all threats instead of developing the safety theme and use control theme in isolation from one another. This may not mean that all functionality is completely merged, and in some cases it should not be, but it does mean that artificial partitions should not be imposed upon protecting against unauthorized detonation.

Classification issues that drove a separation in the past are not as relevant in today's world. Ideal nuclear safety themes have already been shared therefore the details of new implementations do not need to be shared with other nuclear powers. Generalized safety themes could be kept unclassified and open to wide scrutiny while only certain specific design information would remain protected. Since a detailed analysis of a safety theme requires full access to a weapon design, the same number of people would be able to critique a combined surety theme as currently make a full safety assessment. It is vital that we do not make safety sacrifices solely to maintain an unclassified designation. Using a surety lifecycle approach strives to keep all nuclear materials safe, secure and accounted for from "cradle to grave".

The Role of Safety and Security in Enabling Responsiveness

The NWC must be able to rapidly respond to emerging threats and adapt quickly if new military characteristics are passed down. In the absence of having design work, there is a limit to how much preparation that can be done to make the NWC more responsive. Developing designs that are optimized for increased safety and security could play a critical role in enabling the infrastructure of the NWC to become more responsive. New work on safety and security could provide a politically palatable way to exercise the NWC, making necessary steps to increase responsiveness while ensuring that knowledge is preserved for the next generation of weapons designers.

Advances in Surety Technologies

President Bush and his administration have set forth a plan to "reduce our operationally deployed strategic nuclear warheads to a level of between 1,700 and 2,200 over the next decade."[10] A smaller stockpile presents the U.S. with technical opportunities that were not feasible during the height of the Cold War due to the large number of warheads required by the mutually assured destruction strategy and policies of brinksmanship. Implementing even minor changes to the huge stockpile at that time was prohibitive due to the cost and time required. With a reduced future stockpile, technical solutions can be rapidly implemented and the infrastructure required to maintain and secure warheads can be optimized for thousands of weapons instead of tens of thousands of weapons.

Command and control solutions with a reduced stockpile become increasingly feasible as well. Traditionally a "fire and forget" approach was used after presidential authorization was given to release a nuclear weapon because the survivability of the nuclear command and control system in Cold War scenarios could not be guaranteed and thus could not be relied upon to provide control after launch.[11] In today's post-Cold War world, however, limited nuclear strikes are a more realistic scenario for future exchanges making end-to-end command and control viable. The availability of communications greatly enhances safety and security of nuclear weapons. State of health information about the weapon can be reported back to mission operators and the weapon could be rendered unusable, if necessary. Intent safety signals can be delivered to the warhead in the near vicinity of the target, ensuring a higher level of safety for longer in the mission.

Other advanced technologies can provide enhanced nuclear surety as well. Traditional safety systems have relied upon intent signals and trajectory information to move the weapon into an enabled state. By including location information into that mix, it can be assured that the weapon will detonate when authorized by the president in the exact target region specified. Work has also been done investigating technologies to make nuclear weapons intrinsically safe and secure.

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10. George W. Bush, "Message to the Senate of the United States," (Washington D.C.: Office of the Press Secretary, 20 June 2002).

11. John R. Harvey, Seeking a Responsive Nuclear Weapons Infrastructure and Stockpile Transformation, presented to the National Academy of Science Symposium on Post-Cold War Nuclear Strategy: A Search for Technical and Policy Common Ground. (11 August 2004).

Reevaluating Safety and Security: A Necessity

The end of the Cold War has called for a reevaluation of the safety and security of the United States stockpile. Motivation for that review has been spurred on by the September 11th terrorist attacks on the United States. It is imperative to recognize that the world has changed and our approach to safety and security must adapt.

New technical solutions must be implemented to protect U.S. SNM and reduce the burden of physical security on the NWC and the Department of Defense. Modern drivers necessitate integration of weapon infrastructure and the adoption of technological solutions to provide a lifecycle approach for creating an affordable, safe, and secure nuclear force appropriate for the post-9/11 threat environment.

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