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

Paul Booker and Lisa Brown
Sandia National Laboratories, California
8 September 2004

Contact Information:

Paul Booker
Email: pmbooke@sandia.gov
Phone: 925.294.6076

Lisa Brown
Email: lmbrown@sandia.gov
Phone: 925.294.1299

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 9/11, 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 of the American people and policy makers about U.S. immunity from attack. Combating organized terrorist activities become 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 9/11, 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

---

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.

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 9/11.

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 secures nuclear weapons as 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 special nuclear material (SNM) produced by the U.S. Nuclear Weapons Complex (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

---

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).

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.

utilizing American resources warrants changes being made in order to make nuclear weapons infrastructure more responsive to modern threats. The precedence of U.S. nuclear materials as an attractive terrorist target is substantiated by two incidences complied 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]"

---

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 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 decrease the infrastructure and cost 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 it's 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.

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 was heating 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

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

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.

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.

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. Because of this joint mutual objective, it is important to evaluate the development of an integrated surety theme to address all threats instead of developing the safety theme and use

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

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. Using a surety lifecycle approach strives to keep all nuclear materials safe, secure and accounted for from cradle to grave.

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 1700 and 2200 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. 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

---

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

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.

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 11, 2001 terrorist attacks on the United States. During the Cold War nuclear weapons were optimized to provide the maximum yield for a given size and weight. In today's world it is imperative to shift away from that mindset and begin optimizing the stockpile for safety and security. 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 adoption of technological solutions to

---

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).

provide a lifecycle approach in creating an affordable safe and secure nuclear force appropriate for the post 9/11 threat environment.

Bibliography

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

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

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

Harvey, John R. *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.

National Nuclear Security Administration Act, Section 3221.b.2. March 11, 2004.

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

Schmid, Alex P. "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, 13-46. Austria: International Atomic Energy Association, August 2002.

Shuster, Mike. "National Security, Nonproliferation, and the War against Terrorism." In *After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation,* ed. Michael Barletta, 1-5. Monterey, California: Center for Nonproliferation Studies, 2002.

Spector, Leonard S. "The New Landscape of Nuclear Terrorism." In *After 9/11: Preventing Mass-Destruction Terrorism and Weapons Proliferation,* ed. Michael Barletta, 6-12. Monterey, California: Center for Nonproliferation Studies, 2002.

Talbot, Edward B. *NextWES Surety*. Sandia National Laboratories Presentation. 22 July 2004.

Warner, Edward L. 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.