Radiological Events in the Homeland

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The leadership of al Qaeda has issued fatwas justifying the use of nuclear weapons to bring destruction to the American homeland, and its campaign to recruit those who have expertise and access to radiological weapons is underpinned by ample resources. This reality, combined with the diffusion and increasing amount of radiological materials in the world, creates the fear that the Nation has a radiological rendezvous in its future. Government at all levels is working to anticipate, deter, detect, and defeat this threat.

But what if the enemy is successful? When the baby boomers were children, they passed signs every day for fallout shelters and stocks of water and food to be used in the event of a nuclear attack. While we may not need such drastic measures at present, we should take steps to prepare for a radiological event in the homeland. We need to relearn what we knew during the Cold War. We need to reacquaint ourselves with the radiological effects that could occur and how to mitigate the threat.

The radiological threat can come in various forms, from a highly technical nuclear device to a rudimentary improvised explosive device (IED) with radiological material thrown in to create a form of dirty bomb. A terrorist attack on a nuclear power plant to create a meltdown is another possibility. A nuclear strike on the homeland was a theme in the television show *24*, where a nuclear device went off, killing 12,000 people; but the

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true effects of the weapon were clearly glossed over. Recently, the Federal Government, combined with various state and local governments, exercised how to respond to such an attack. During these exercises, there was much high velocity learning for governmental teams at all levels. This article is a primer for policymakers and decisionmakers on some of the issues they need to consider in planning for and responding to a nuclear detonation. It is imperative that leaders learn and understand these issues because, rest assured, our enemies are working at this moment to bring this terror to reality.

High-end Nuclear Devices

A nuclear bomb is not easy to build. It requires not only a significant understanding of nuclear physics, bombmaking, and engineering, but also state sponsorship to provide weaponized uranium, materials, and state-of-the-art laboratories for constructing a device that will produce a nuclear yield. The need for state sponsorship is why there is so much fear about the expansion of the nuclear club to countries that espouse the destruction of the United States or its allies. North Korea's possession of nuclear technology, for instance, has become a major concern for Washington. In addition, Iran's unabashed effort at pursuing the ability to develop nuclear weapons is a similar concern because of the intent of Iran's current president to "wipe Israel off the map," as he stated during his inauguration in August 2005.

Airman checks simulated suspicious packages with radiation detection equipment during operational readiness inspection

355th Communications Squadron (Alesia Goosic)

Because construction of a nuclear device is so difficult, possibly the best way for a terrorist group to obtain one is to either purchase or steal an already constructed device along with the know-how to set it off. Thus, the suspect sources quickly grow to any nation that has a nuclear arsenal or the ability or desire to obtain one. They range everywhere from the original five members of the nuclear club—the United States, United Kingdom, Russia, France, and China, all of whom have dedicated security and protection measures for their arsenals, along with over 50 years of experience in handling these devices—to the newer members of the club, such as India, Pakistan, and North Korea—all of whom have their own security challenges in the handling of nuclear materials. The threat of the wrong parties purchasing a device is naturally highest where the financial needs and the security challenges of the seller are greatest. Recently, the Pakistani government initiated a public campaign to recover lost nuclear material.[1] While it is praiseworthy that the government would mount such a campaign, the need for it is nevertheless alarming.

Dirty Bombs

A "dirty bomb" is a poor man's nuclear device. If a terrorist group falls short of the ability to make a device or to get access to an already constructed weapon, then its most likely course of action is to construct a bomb with radioactive materials mixed in that will be dispersed during the blast and create radiological effects. The mere measurement of radioactive presence that is significantly over background radioactivity could create massive panic and impose strategic psychological effects on the victim nation. Consider the effects on the world stage of Russian defector Alexander Litvinenko, who died publicly and painfully in a London hospital in November 2006 due to ingested alpha particles from Polonium 210. Just the trace trail of Polonium 210 across the city and in the airplane that carried it from Russia to London was enough to create public health concerns.[2] One can only imagine this tragedy playing out in multiple hospitals from a dirty bomb incident.

In the summer of 2006, a man in Ukraine attempted to sell radiological materials[3] and claimed to have access to more. Fortunately, he was selling his materials to state agents. But his activity confirms fears that radiological material is available on the world market and that a dirty bomb is the greatest radiological likelihood when considering nuclear threats to the homeland. In fact, there are ample sources of nuclear material in the United States alone. Medical and some photographic equipment utilizes radiological materials that, if stolen in sufficient amounts, could comprise a radiological component of a dirty bomb.

While the laws of nuclear physics can clearly predict the radiological effects of a nuclear device, the effects of a dirty bomb could be due more to luck and circumstance. Genius bombmaker Ramzi Yousef is now in a "supermax" prison serving several life sentences for his bomb attack on the World Trade Center in February 1993. He was also the architect of the 1995 al Qaeda plans to kill Pope John Paul II and President Bill Clinton and to simultaneously bring down 11 U.S. jetliners in the Bojinka plot. At the World Trade Center, Yousef placed sodium cyanide in the Ryder rental truck carrying the bomb in an effort to create a toxic cloud that would kill survivors and first responders alike. However, in spite of being an expert bombmaker, he overlooked the effects of the initial flash in the confined spaces of the parking garage, and the fireball consumed the sodium cyanide rather than dispersing it. Similar miscues can happen when creating a dirty bomb.

United Nations investigators reported in 1996 that they had evidence that the Iraqi regime conducted state-level tests with dirty bombs in 1987.[4] The desired endstate was to create a lethal dose of 200 REM (roentgen equivalent in man—a unit of radiation dose; acute radiation disease occurs around the 75 REM rate) out to a distance of 12 kilometers. To do this, the Iraqis used irradiated zirconium oxide from a nuclear research reactor mixed in an aerial type bomb. The tests failed to achieve any of their desired radiological effects other than minor contamination of the ground and air near the explosions. The results were measured as having basically the same annual effect as an average X-ray technician receives in a full year of work. In all cases, the normal blast effects of the explosives were far greater than the radiological effects. However, with the right materials, some radiological effects will occur. In particular, as the radiological material is dispersed, it can be expected to create an alpha particle threat that, at the minimum, would incur significant cleanup costs and could have cascading effects on public confidence if the government does not effectively measure the dose rate and define the hazard area as well as the expected results. Indeed, public information will be among the first munitions in countering the effects of a radiological attack. Leaders need to understand the possible impact *before* an incident occurs rather than fall victim to misinformation or, worse yet, become vectors themselves for misinformation.

Nuclear Effects

There are three major effects from a nuclear device: thermal, blast, and radiological. There is also a fourth effect, which is the electromagnetic pulse (EMP). All of these effects are influenced, for example, by whether a nuclear detonation occurs in the air, on the surface, on the subsurface, or in a well-constructed building. When any bomb goes off, an initial flash, fireball, and thermal effect take place, followed immediately by the blast effects of explosive force that propel shrapnel and debris. The same things occur with a nuclear detonation, but on an entirely different scale. A fireball of incredible intensity launches out in advance of the blast, incinerating fuel in its path close to the blast and causing lesser burns farther from the detonation. In a 14-kiloton blast (the equivalent of 14,000 tons of dynamite), which is the rough magnitude of the bomb dropped on Hiroshima, Japan, near the end of World War II, thermal effects are felt as far as 2,500 meters, and the blast effects are seen at more than 3,000 meters.

The initial devastation of a nuclear attack will always be felt in thermal wave and blast. The pictures of devastation at Hiroshima are testimony to these effects, but one should remember that the quality of construction there was considerably beneath that in a major Western city today. The devastation would be severe, but perhaps not as severe as in Hiroshima or Nagasaki.

One of the first two radiological effects of a nuclear detonation is gamma rays, which pass through most materials, instantly radiating those within reach. For example, in a 10-kiloton detonation, gamma rays would be expected to extend out to approximately 1,700 meters in all directions. Gamma rays generally pass one time from the source of the detonation forward. There is, however, the phenomenon known as "ground shine gamma," in which inanimate objects that have been radiated by a large blast can emanate residual gamma rays. This is not an immediate hazard due to the light dose rates of ground shine gamma, but it is a significant cleanup and disposal issue that needs to be considered. All gamma rays can be measured by simple radiological detection equipment, such as an old ANPDR/27 that looks similar to a Geiger counter.

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Alpha and beta radiation are the more commonly understood forms of radiation in a nuclear blast. Alpha particles have an extremely limited range in air, have little ability to penetrate the skin, and are of minor significance unless they are inhaled or ingested. Beta particles are much less penetrating than gamma rays but can be extremely harmful if a beta-emitting substance is ingested or deposited on the skin.

The second immediate radiological effect is a one-time EMP that destroys or disrupts electrical circuitry within its blast area. Less is known about EMP than the other effects of a nuclear blast. It occurs when gamma radiation collides with atoms/objects in the air. Electrons are stripped from the atoms, and the freed electrons move, causing strong electromagnetic fields. This would have the effect of immediately making in-flight helicopters inoperable and destroying cell phone towers and repeaters as well as supervisory control and data acquisition–type electronic controls. Moreover, if the weapon is detonated on or near the ground, the range of EMP damage is expected to be limited to the immediate blast area. For example, with a 10-kiloton device, the expected EMP blast radius would range from 5,000 meters (temporary disruption) to 30 kilometers (possible temporary interference).

Radiological Effects

When the Chernobyl nuclear meltdown occurred in April 1986, firefighters courageously fought the fires with little time to be concerned with radiological effects. The Chernobyl accident caused many severe radiation effects almost immediately. Of 600 workers on the site, 134 received high exposures (ranging from 50–1,340 radium absorbed doses [rad]) and suffered from radiation sickness. Of these, 28 died in the first 3 months, and 19 died from 1987 to 2004 of various causes not necessarily associated with radiation exposure. In addition, according to the 2000 report of the United Nations Scientific Committee on the Effects of Atomic Radiation,[5] during 1986 and 1987, about 450,000 recovery operation workers received doses between 1 and 100 rad. Acute radiological sickness is expected to occur in healthy 20-year-old males around an accumulated

Vehicles outside Murrah Federal Building destroyed by bombing

U.S. Air Force (Preston Chasteen)

exposure of 75 rad, a dose that will cause the onset of symptoms within 1 hour to 2 days.

To deal with a radiological threat area, operational exposure guidance is established by the principal Federal officer or lead official to ensure that the proper standards are applied for first responders and response personnel to preserve life and health. Generally, an emergency immediate dose rate of 25 rad is the maximum allowed and then only for saving the lives of afflicted personnel. Five rad is the level at which responders are normally to be evacuated from an affected area, and to ensure their protection they are not allowed to return. Sheltering in place is an option for those personnel in an area where remaining inside will only incur a dose rate of 1 rad. A maximum annual dose rate that an X-ray technician is allowed to receive is 5 rad, and a single X-ray carries a dose rate of 0.02 rad. A normal average annual overall dose is 0.36 rad. This helps provide an understanding of the acceptable levels of radiation exposure.

Judging from the poor effects of Iraqi attempts at creating radiological effects with state-sponsored dirty bombs, it is likely that a dirty bomb may create a major cleanup problem which could limit access to the affected areas, but it will not likely cause radiological sickness or death. Protective equipment such as thin disposable Tyvek suits and respirator masks is necessary for those working in affected areas. Given these precautions, residual radiological effects can be mitigated.

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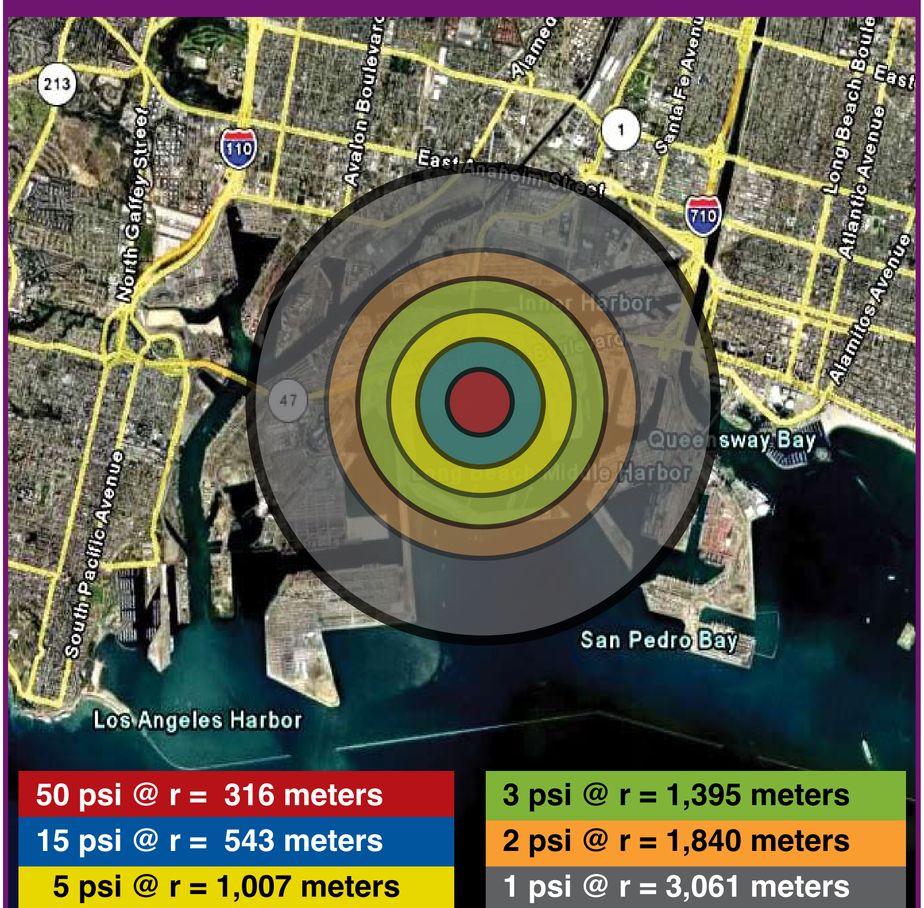
Deterrence through Response

Since the 1950s, the strategy of deterrence has encompassed various concepts, such as massive retaliation and mutual assured destruction. In all cases, the foundation of deterrence relied on threatening to destroy a nation-state's ability to wage war and survive. With respect to nation-states, this strategy continues to be successful. However, subsequent to the attacks of September 11, 2001, a different threat came to be seen as more likely than that from hostile nation-states. A new deterrence calculus was needed to respond to the threat from terrorists and nonstate actors, as well as to maintain the traditional deterrent architecture to address nation-states. This calculus presumes that a terrorist may be successful in a nuclear or radiological attack against the United States or its interests.

In "Deterring a Nuclear 9/11," Caitlin Talmadge describes various nuclear deterrence theories.[6] One theory, "deterrence by punishment," includes the threat to impose unacceptable costs on an enemy for any hostile action. With respect to terrorist and nonstate actors using weapons of mass destruction (WMD), this theory has evolved into national policy that includes the prospect of an overwhelming response to such an attack. However, an effective response to a WMD attack from terrorists or nonstate actors requires a rapid identification of the source and perpetrator through attribution—that is, "the rapid fusion of technical forensic data with intelligence and law enforcement information."[7] Talmadge concludes that "nuclear forensics is the linchpin of any attempt at deterrence by punishment." An essential ingredient of attribution, and therefore nuclear forensics, is the fact that the U.S. ability to identify the source of the material is public and well known.

The science of nuclear forensics involves the tracing of unique radiological isotopes and material from devices or bombs to their source. It is a multilayered, deductive process requiring analysis and interpretation of a range of information, including material, physical, chemical, and isotopic traits. The results of this analysis will provide indicators not only of the source of the material involved, but also of whose material it is not. Nuclear forensics, involving rad-chemical analysis, modeling, and use of sets of data, is a documented process that is bound by the laws of physics and the actual processes needed to conduct the analysis. Its foundation lies in capabilities developed during the Cold War and is well documented and understood. The results of this analysis, when combined with national intelligence and classic law enforcement activities, may provide the identity of the

Radiation Blast Effects



perpetrator and the information needed by national decisionmakers for response.

In October 2006, the Department of Homeland Security established a National Technical Nuclear Forensic Center (NTNFC). In conjunction with the Departments of Defense, Energy, and State, 10 national laboratories, and the Federal Bureau of Investigation, the NTNFC is responsible for developing the national architecture for conducting nuclear forensics essential to implementation of the new deterrent policy. The center is also charged with developing advanced nuclear forensics capabilities for pre- and postdetonation radiological material. The postdetonation mission is new for the United States, a result of the calculus of the deterrent policy that presumes an attack might be successful.

First Response/Mitigation

The first responders at an incident site will likely be exposed to significant levels of radiation. Once radiation is detected, however, the area can be cordoned off and a shelter-in-place order can be issued for the areas adjacent to the site. Evacuation and decontamination of the injured become the top priorities of the immediate responders. Simultaneously, identifying the extent/limits of contamination becomes extremely important in preventing the spread of radioactive contamination. Understanding proper shelter-in-place procedures can significantly reduce unnecessary exposure.

Decontaminating a large, densely populated urban area will be the biggest issue facing the restoration and remediation effort. Having the appropriate decontamination techniques established and long-term plans in place before an incident occurs will improve the government's ability to recover from a radiological dispersal device attack. In some cases, decontamination of buildings and other infrastructure to safe levels will not be an option and the assets will need to be destroyed and removed.

The process of decontamination creates many other challenges as well. For example, when using fresh water wash-down techniques to decontaminate workers or material, the water mixes with the removed alpha particles and becomes a contaminant itself. The volume of contaminated water can become massive, so planning for storage and mitigation is needed.

The United States faces an increasing threat from a radiological terrorist attack involving either a radiological or nuclear device. Recently, the Federal Government worked collectively with various state and local governments to exercise their response to this sort of attack. In addition to training events, it is apparent that leaders at all levels need to study and plan for the mitigation of radiological effects in case the Nation is faced with a radiological event in the homeland. These forms of attack pose a significant challenge, not only because of their destructive power but also because of the inevitable psychological impact they would cause. Understanding and anticipating the challenges of these effects are first steps to mitigating the unacceptable levels of risk posed by this sort of attack. While prevention remains the first priority, it is important to be prepared to respond if that fails. First responders must be trained, equipped, and exercised. Collaboration, communication, and engagement are the fundamental cornerstones for every aspect of response operations. **JFQ**

NOTES

[1] "Pakistan downplays radioactive ad," BBC News, May 2, 2007, available at <http://news.bbc.co.uk/2/hi/south_asia/6616225.stm>.

[2] "Sophistication behind spy's poisoning," BBC News, November 28, 2006, available at <http://news.bbc.co.uk/2/hi/science/nature/6190144.stm>.

[3] "Another Russian arrested in Ukraine for attempt to sell radioactive substance," Nuclear Threat Initiative, Abstract 20020500, September 21, 2002, available at <http://www.nti.org/db/nistraff/2002/20020500.htm>.

[4] United Nations, 1st Report under United Nations Security Council Resolution 1051 (S/1996/258), April 11, 1996, available at <www.iraqwatch.org/un/UNSCOM/1051/s-res-1996-258.htm>.

[5] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "UNSCEAR assessments of the Chernobyl accident," available at <www.unscear.org/unscear/en/chernobyl.html#UNSCEAR>.

[6] Caitlan Talmadge, "Deterring a Nuclear 9/11," *The Washington Quarterly*, Spring 2007, 21–34.

[7] George W. Bush, *National Strategy for Combating Terrorism* (Washington, DC: The White House, September 2006), 15.

Part of Shinto shrine remained standing after atomic bomb was dropped on Nagasaki, October 1945

U.S. Marine Corps (R.J. Battersby)