STRATEGY FOR THE LONG HAUL

CSBA

Nuclear Terrorism

Assessing the Threat, Developing a Response

BY EVAN BRADEN MONTGOMERY

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NUCLEAR TERRORISM:
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2009

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EXECUTIVE SUMMARY

Over the past several years, the prospect of a terrorist group armed with a nuclear weapon has frequently been cited as a genuine and overriding threat to the security of the United States. Although the likelihood of a nuclear terrorist attack may be relatively low, the consequences of such an attack would obviously be enormous. There is, therefore, widespread agreement regarding the severity of this threat. Despite this consensus, a number of important questions remain open to debate: How real is the risk that a terrorist group could acquire or construct a functional nuclear device, and how might it attempt to do so? Which group poses the greatest threat in this regard, how has that threat changed over time, and is it currently growing or abating? What existing and prospective measures will prove most effective in preventing terrorists from obtaining a nuclear weapon, stopping them from delivering and detonating a weapon if prevention fails, and responding both at home and abroad in the event that an attack succeeds? The purpose of this report is to examine these critical issues.

SOURCES OF THE NUCLEAR TERRORIST THREAT

There are two major dimensions of the nuclear terrorist threat: the "supply" side of nuclear proliferation and the "demand" side of violent Islamist extremism. Over the past decade, longstanding concerns over proliferation have become increasingly acute in light of a number of worrisome developments, including the status of India and Pakistan as overt nuclear weapon states, North Korea's test of a nuclear weapon, the international community's failure to restrain Iran's nuclear ambitions, and the fear that an Iranian nuclear weapons program could spark further proliferation throughout the Middle East. Ultimately, while existing nuclear arsenals and stockpiles of fissile material represent the most immediate concern, the spread of nuclear weapons and material has increased the probability that terrorists might be able to acquire or construct a nuclear device. At the same time that nuclear proliferation has become a growing concern, terrorism has also been elevated from a secondary to a primary threat to US security because of the emergence of groups that have few inhibitions on inflicting mass casualties by means of chemical, biological, and even nuclear weapons. Today, for example, the threat of nuclear terrorism is primarily associated with Osama bin Laden and his followers, who have not only pursued these weapons for some time, but have expressed their willingness to use them against their enemies.

Since the US invasion of Afghanistan in 2001, however, al Qaeda has lost a key sanctuary and much of its original senior leadership. Does it still hope to acquire and use weapons of mass destruction? Is it capable of obtaining or building a nuclear weapon? The answer to the first question appears to be "yes." Publicly available information leaves little doubt that the group's intentions remain unchanged. Nevertheless, al Qaeda appears to be much less capable of conducting a major attack against the United States, and especially a catastrophic attack using a nuclear weapon, than it was when it had a base of operations in Afghanistan. After the downfall of the Taliban regime, al Qaeda evolved into an increasingly decentralized organization. Moreover, as the influence and capabilities of its central leadership have waned, the source of the terrorist threat has shifted toward regional groups affiliated with al Qaeda and homegrown extremists inspired by it, neither of which are likely to possess the knowledge, skills, resources, or discipline necessary to plan and successfully carry out a nuclear attack. Unfortunately, numerous accounts suggest that al Qaeda's core leadership is regaining its strength, reasserting and even expanding control over its far-flung network of allies and sympathizers, and reestablishing its ability to organize and execute major attacks, developments that would not be possible without the sanctuary it has established in remote areas of Pakistan. To the extent that this sanctuary allows al Qaeda's leadership to plan future operations, the likelihood that the group might be able to conduct a catastrophic attack at some point in the future appears to be increasing once again.

An analysis of the supply and demand sides of the nuclear terrorist threat suggests two major conclusions. First, limiting and preferably stopping any further proliferation of nuclear weapons and the technology to produce nuclear material is and will remain an important goal. At present, this goal hinges largely on Iran—if Tehran does pursue and develop nuclear weapons, this could be the catalyst for a wave of proliferation in the Middle East. Yet stopping Iran from becoming a nuclear weapon state, while certainly desirable, may not be feasible through diplomacy, economic sanctions, or military action. The United States must, therefore, work to develop a comprehensive strategy to prevent further proliferation in the region if and when Iran does become a full-fledged nuclear power. Second, because there is a very strong probability that any credible plot to conduct a nuclear terrorist attack will originate with al Qaeda's central leadership, a critical component of a broader strategy to prevent such an attack will involve measures directed at weakening al Qaeda's leaders and eliminating—or at the very least restricting—their sanctuary in Pakistan.

TERRORIST ACQUISITION OF NUCLEAR WEAPONS: HOW, AND HOW LIKELY?

If a terrorist group like al Qaeda was determined to "go nuclear," how might it attempt to do so and what obstacles would it face? There are four main alternatives that prospective nuclear terrorists might pursue. First, terrorists could attempt to manufacture the fissile material needed to fuel a nuclear weapon (either highly enriched uranium or plutonium) and then use that material to construct a nuclear device. Of all the scenarios, this is by far the most ambitious, most difficult, and least likely. Producing fissile material is both the most crucial and the most challenging aspect of developing nuclear weapons, and is the step that has in the past prevented aspiring nuclear powers such as Libya and Iraq from becoming nuclear-weapon states. Thus, the knowledge, infrastructure, and finances needed to undertake this step with any realistic prospect of success very likely outstrip the resources that even a well-funded terrorist group might possess.

A second possibility is that a terrorist group might seek out a state sponsor, in particular a rogue nation that already possessed nuclear weapons and might provide the group with this capability. While the direct transfer of a nuclear weapon would certainly be the easiest route from a terrorist group's perspective, several factors suggest that it is also highly unlikely. First, nuclear weapons are an extraordinarily valuable commodity that any state would be reluctant to part with. Second, any state that deliberately provided a terrorist group with a nuclear weapon would run the risk of being discovered and suffering the consequences. Third, it is also unlikely that a regime would willingly entrust a terrorist group with such a powerful weapon, since there would be no way to ensure that the group would carry out an attack against the intended target rather than another state or even the sponsoring regime itself.

A third possibility is the theft of an intact nuclear weapon, although this would hardly be an easy task. Most nuclear weapons are heavily guarded, and, even if terrorists did manage to acquire a weapon, they would still have to overcome any security features that render a weapon inoperable without the proper arming codes. Despites these factors, fears of "loose" nuclear weapons persist and are warranted, especially in the cases of Russia and Pakistan. For example, while efforts to help the Russian government reduce, consolidate, and secure its nuclear arsenal have been underway for more than a decade, the sheer size of that arsenal, the incomplete accounting of Russia's weapon stockpiles, and limited or problematic safety measures at its nuclear facilities have contributed to lingering questions over Moscow's ability to safeguard its weapons. In Pakistan, ongoing political instability and popular unrest, as well as suspicions that members of Pakistan's military, intelligence, and scientific establishments continue to sympathize with and perhaps even support violent Islamist groups, have exacerbated fears that Pakistan's nuclear weapons may be vulnerable.

Finally, there is the possibility that a group could purchase fissile material on the black market or steal it from a military or civilian facility and then use that material to construct an improvised nuclear device. In recent years, analysts have increasingly come to view this scenario as the most plausible route for terrorists seeking nuclear weapons, for two main reasons. First, large stockpiles of fissile material can be found throughout the world in military as well as civilian facilities, some of which are inadequately monitored and protected. Second, building a crude nuclear device once a sufficient amount of this material has been obtained, although not an easy task, is certainly within the realm of possibility. Here, the principal challenge for terrorists would involve the tradeoff between the quantity of fissile material required for a weapon and the type of weapon that could be built. That is to say, while a gun-type nuclear weapon would be relatively easy to build, it requires a significant amount of highly enriched uranium; conversely, far less uranium or a very small amount of plutonium would be needed to fuel an implosion weapon, but building this device would prove extremely difficult. Nevertheless, this threat remains particularly salient.

DEVELOPING A RESPONSE

At the most basic level, a comprehensive strategy for addressing the threat of nuclear terrorism should be structured around three core objectives: preventing terrorists from acquiring nuclear weapons or fissile material; stopping terrorists from delivering a nuclear weapon to their intended target should prevention fail; and being prepared to respond as quickly and effectively as possible, both at home and abroad, in the event that terrorists succeed in detonating a nuclear weapon inside the United States.

Keeping Terrorists from the Bomb

The first and most important way to avert a nuclear terrorist attack is to prevent terrorists from acquiring an intact weapon or from collecting a sufficient amount of fissile material to build a nuclear device. If terrorists do succeed in either of these endeavors, thwarting an attack will ultimately depend on locating any missing fissile material before a weapon can be assembled or intercepting a device before it can be delivered to the target and detonated. These are extremely challenging tasks that cannot be relied upon as a primary line of defense. Achieving this objective requires adopting a multi-dimensional approach that significantly decreases the prospects that terrorists will succeed at each major stage in their plot—obtaining a nuclear weapon, transporting the weapon to the target, and enjoying the benefits they anticipate will follow if they conduct a nuclear attack. Not only will such an approach increase the likelihood that prospective nuclear terrorists will fail in their efforts, it could as a result dissuade terrorists from seriously pursuing the nuclear option at all. There are three main areas that can contribute to dissuasion: delegitimizing the killing of civilians generally and the use of nuclear weapons specifically, reducing stockpiles of highly enriched uranium and plutonium and securing existing weapons and fissile material, and developing and deploying radiation monitors and other detection systems.

First, efforts must be made to foster the perception among terrorists that an act of nuclear terrorism will not help them to achieve their aims, but will instead prove counterproductive by causing sympathizers and potential supporters to turn away from them rather than rally to their side. If terrorists can be convinced that a successful catastrophic attack will ultimately backfire, they may grow reluctant to pursue this type of attack in favor of more "acceptable" forms of violence. Al Qaeda, for example, has recently displayed some concern over the increasingly widespread criticism of its violent tactics, particularly the murder of Muslim civilians. The US government should therefore work through intermediaries to publicize as widely as possible al Qaeda's acts of violence and their immediate and longer-term effects on those who have suffered from them. It should also seek to support individuals and organizations throughout the Muslim world that not only eschew violence, but can publicly and credibly challenge al Qaeda by arguing that the large-scale killing of civilians and the use of nuclear weapons are immoral, religiously impermissible, and unlikely to help the situation of those whom al Qaeda claims to be fighting for.

Second, if terrorists cannot be persuaded to abandon the idea of nuclear terrorism, the next best thing would be to convince them that it is not a realistic option. Specifically, if a terrorist group concludes that it cannot acquire a nuclear weapon or enough fissile material to make one on its own, or that any attempt to do so would require enormous human and material resources and would still have only a very small chance of succeeding, it will likely devote most of those resources elsewhere. Continuing and, where possible, accelerating and expanding efforts to eliminate or secure potentially vulnerable nuclear weapons and material can therefore thwart determined terrorists from obtaining these items and dissuade prospective nuclear terrorists from attempting to do so in the first place. Moreover, as individual nations and international organizations work to secure loose weapons and material, a corresponding effort should also be made to publicize their successes and ensure that these actions are exploited for their dissuasive value.

Finally, detection systems can also play an important role in preventing a nuclear terrorist attack, not only by stopping a group from successfully transporting a nuclear weapon or material to its target, but also by dissuading terrorists from pursuing the nuclear option. In concert with the other recommendations discussed above, the deployment of radiation monitors and other detection systems can increase the prospect that potential nuclear terrorists will judge the possibility of success as too low to merit the effort required. It is important, however, to ensure that the presence of these systems influences terrorists' calculations in the expected way—i.e., that they discourage terrorists from pursuing nuclear weapons and material as opposed to providing a roadmap for which routes, ports, or border crossings should be avoided. In addition to "red teaming" how terrorists might attempt to sneak a weapon or fissile material into the United States, analyses should be undertaken to determine how to convince terrorists that they will be unable to circumvent existing defenses, which may depend as much on publicizing (and possibly exaggerating) existing capabilities as developing new ones.

Stopping Terrorists from Delivering a Weapon

Although preventing terrorists from acquiring nuclear weapons and material is the best, safest, and most feasible way to avoid a catastrophic attack, prudence demands that the US Government be as well prepared as possible to locate and intercept a terrorist group that obtains these items before it can deliver a weapon to its intended target. Two areas in particular are likely to play a crucial role in these efforts: human intelligence and Special Operations Forces

Given the inherent difficulty of detecting nuclear weapons and material, especially from any significant distance, locating and stopping terrorists who are in possession of these items may depend first and foremost on knowing where to look. Yet terrorist groups are often reluctant to use electronic forms of communication that could be monitored, and al Qaeda is notoriously difficult to penetrate through the cultivation of human sources. Therefore, resources might be better spent on the comparatively easier task of developing assets within the military and/or scientific establishments of nations that are the most probable sources of loose nuclear weapons and material, especially if individuals working in particularly high-risk facilities or more senior individuals who would be among the first to learn of any missing items can be identified in advance.

If terrorists obtain stolen nuclear material or a nuclear weapon and have been located by human intelligence sources or some other means, Special Operations Forces will likely be tasked with interdicting and securing these items. Ideally, special operations personnel trained to render safe a nuclear device would be capable of responding quickly to a potential nuclear terrorist threat. In reality, however, the small number of personnel qualified for this mission, the high demand for those personnel in support of ongoing operations, the inherent uncertainty over where a nuclear terrorist threat might materialize, and the constraints imposed by geography all make the ideal response capability difficult to realize. Despite these problems, a number of measures could be taken to enable qualified personnel to respond to a nuclear terrorist threat in relatively short order, for example training select allies and partners in render-safe procedures, prepositioning necessary equipment overseas at bases or operating sites centrally located to various known smuggling routes and/or terrorist sanctuaries, and forward-deploying a small, dedicated response team in Europe or Central Asia.

Responding to an Attack

The aftermath of a terrorist attack would involve response efforts both at home and abroad. Response efforts at home would primarily focus on consequence management—limiting the damage caused by an attack. Improving consequence management capabilities will require continued investment in a number of areas, for example training first responders, prepositioning stockpiles of medication to treat radiation sickness, ensuring that various federal as well as state agencies have clearly defined and well understood areas of responsibility in the event of an attack, developing public communication strategies that can quickly and effectively instruct citizens on how to respond to an attack, and improving capabilities for decontaminating large areas that have been exposed to radiation.

Although the government's immediate focus will be on mitigating the consequences of an attack, it will quickly shift its attention toward identifying those responsible and retaliating against the perpetrators. As a first step, scientists would be tasked with analyzing the radioactive debris from a nuclear explosion in order to gain as much information as possible on the weapon and material used, in order to determine their origin—a field that has received increased attention and funding in recent years. An effective nuclear attribution capability could also help to prevent an attack in the first place by ensuring that state sponsors would not be able to retain anonymity. In fact, a number of analysts have advocated a strategy of deterring nuclear terrorism by threatening potential state sponsors with retaliation if they are identified as the source of a nuclear weapon or material used in an attack.

Nuclear attribution is an important capability that deserves the increased attention and funding it has received. The US Government should continue to invest in this area, and may even want to publicly exaggerate its capabilities to encourage the belief that state sponsors will not be able to remain anonymous. At the same time, policymakers should also exercise caution when contemplating public declarations regarding who will be held responsible for an attack and what type of response will follow. Ambiguous warnings that do not explicitly call for a military reprisal could be useful by reinforcing the notion that governments may be culpable for the actions of a terrorist group. While declarations that overtly threaten a military reprisal will certainly capture a state's attention, these threats may not prove credible or particularly effective in the most important cases, and could even risk doing more harm than good.

INTRODUCTION

> Weapons of mass destruction . . . in the possession of hostile states and terrorists represent one of the greatest security challenges facing the United States.[1]
>
> —*National Strategy to Combat Weapons of Mass Destruction* (2002)

> The proliferation of nuclear weapons poses the greatest threat to our national security. Nuclear weapons are unique in their capacity to inflict instant loss of life on a massive scale. For this reason, nuclear weapons hold special appeal to rogue states and terrorists.[2]
>
> —*National Security Strategy of the United States of America* (2006)

Over the past several years, the prospect of a terrorist group armed with nuclear weapons has frequently been cited as a genuine and overriding threat to the security of the United States.[3] The Bush administration, for example, repeatedly argued that the nexus between terrorism and weapons of mass destruction (WMD), particularly nuclear weapons, represents one of the greatest dangers of the twenty-first century.[4] Although the previous administration's efforts to prevent this threat from material-

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1 *National Strategy to Combat Weapons of Mass Destruction* (Washington, DC: White House, December 2002), p. 1, accessed at http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf on September 9, 2008.

2 *The National Security Strategy of the United States of America* (Washington, DC: White House, March 2006), p. 19, accessed at http://www.whitehouse.gov/nsc/nss/2006/nss2006.pdf on September 9, 2008.

3 The threat of a nuclear terrorist attack has been examined in a number of recent studies. See, for example, Graham Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe* (New York: Henry Holt, 2005); Charles D. Ferguson and William C. Potter, *The Four Faces of Nuclear Terrorism* (New York: Routledge, 2005); Matthew Bunn, *Securing the Bomb 2007*, Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard University, September 2007; and Michael Levi, *On Nuclear Terrorism* (Cambridge, Mass.: Harvard University Press, 2007).

4 The term "weapons of mass destruction" generally refers to chemical, biological, radiological, and nuclear weapons.

izing were hardly immune from criticism, few argued that its underlying concerns were misplaced. Critics were far more likely to argue that the administration devoted too little attention to this issue rather than too much, or that it focused its efforts in the wrong place by emphasizing the possibility of a rogue state transferring a nuclear weapon to a terrorist group as opposed to other, more plausible scenarios.[5]

There is clearly widespread agreement that the possibility of a nuclear terrorist attack is and will likely remain one the most significant threats facing the United States. Yet, a number of important questions remain open to debate: How serious is the risk that a terrorist group could acquire or construct a functional nuclear device, and how might it attempt to do so? Which group poses the greatest threat in this regard, how has that threat changed over time, and is it currently growing or abating? What existing and prospective measures will prove most effective in preventing terrorists from obtaining a nuclear weapon, stopping them from delivering and detonating a weapon if prevention fails, and responding both at home and abroad in the event of an attack? The purpose of this report is to examine these critical issues.

There is widespread agreement that the possibility of a nuclear terrorist attack is and will likely remain one the most significant threats facing the United States.

AN EMERGING CONSENSUS

In September 2004, near the conclusion of an otherwise contentious political debate, President George W. Bush and Senator John Kerry displayed a brief moment of agreement in response to perhaps the most important question of the evening. When asked to name the single greatest threat to the security of the United States, both candidates unequivocally cited the proliferation of nuclear weapons and material, and the possibility that either might fall into the hands of terrorists who would not hesitate to use them.[6] Four years later this consensus appears to remain firmly intact, as the recent presidential election saw both major party candidates identify the nuclear terrorist threat as one of their chief concerns.

While delivering a foreign policy speech on the subject of nuclear weapons in May 2008, Senator John McCain called on the United States and Russia to "redouble our common efforts to reduce the risk that nuclear, chemical, or biological weapons may fall into the hands of terrorists or unfriendly governments." Emphasizing the danger of nuclear terrorism in particular, McCain declared, "No problem we face poses a greater threat to us and the world than nuclear proliferation. In a time when followers of a hateful and remorseless ideology are willing to destroy themselves to destroy us, the threat of suicide bombers with the means to wreak incomprehensible devastation

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[5] Daniel Byman, "Do Counterproliferation and Counterterrorism Go Together?" *Political Science Quarterly*, Spring 2007, p. 32.

[6] Transcript: First Presidential Debate, September 30, 2004, from Coral Gables, Florida, accessed at http://www.washingtonpost.com/wp-srv/politics/debatereferee/debate_0930.html on July 29, 2008.

should call the entire world to action."[7] Several weeks later, Senator Barack Obama delivered a major speech on national security issues. Joined by former Senator Sam Nunn, a co-sponsor of legislation in 1991 to secure nuclear weapons and material in the former Soviet Union, Obama called the prospect of nuclear terrorism "the gravest threat we face." He went on to observe that today's most pressing dangers now revolve around the existence of unsecured nuclear material, the risk of a breakdown in the nuclear nonproliferation regime and, most of all, the possibility of "a rogue state or nuclear scientist transferring the world's deadliest weapons to the world's most dangerous people: terrorists who won't think twice about killing themselves and hundreds of thousands in Tel Aviv or Moscow, in London or New York."[8]

These statements reflect the broad agreement that now exists among policymakers, academics, and security analysts regarding this frightening possibility. For example, while serving as Director of the Office of Homeland Security in 2002, former Pennsylvania governor Tom Ridge was asked by reporters what scenario worried him most. He responded with a single word: "nuclear."[9] Thomas Kean and Lee Hamilton, respectively the Chair and Vice-Chair of the 9/11 Commission, have admitted to having "no greater fear than a terrorist who is inside the United States with nuclear weapons."[10] Upon reviewing al Qaeda's longstanding interest in and efforts to acquire weapons of mass destruction in his memoir, former Director of Central Intelligence George Tenet ominously concluded, "One mushroom cloud would change history. My deepest fear is that this is exactly what they intend."[11] In a 2005 survey of eighty-five national security experts conducted under the direction of Senator Richard Lugar, more than 60 percent of the respondents believed that the chance of a nuclear attack somewhere in the world over the following decade stood between 10 and 50 percent. More remarkably, nearly 80 percent of those surveyed believed that if a nuclear attack did occur within this timeframe, it would most likely be the act of a terrorist group

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7 Transcript: McCain Remarks on Nuclear Security, May 27, 2008, accessed at http://www.washingtonpost.com/wp-dyn/content/article/2008/05/27/AR2008052701367.html on July 29, 2008.

8 Transcript: Obama Remarks on Confronting Terrorist Threats, July 16, 2008, accessed at http://www.washingtonpost.com/wp-dyn/content/article/2008/07/16/AR2008071601474_pf.html on July 29, 2008; and Josh Meyer and Peter Nicholas, "Obama Unveils Plan to Protect U.S. from 21st Century Threats," *Los Angeles Times,* July 17, 2008.

9 Quoted in Bill Keller, "Nuclear Nightmares," *New York Times Magazine*, May 26, 2002.

10 Opening Remarks of Thomas H. Kean and Lee H. Hamilton, Chair and Vice Chair of the 9/11 Public Discourse Project, November 14, 2005, "Report on the Status of 9/11 Commission Recommendations Part III: Foreign Policy, Public Diplomacy and Non-Proliferation," pp. 1–2, accessed at http://www.9-11pdp.org/press/2005-11-14_remarks.pdf on August 4, 2008.

11 George Tenet, *At the Center of the Storm: The CIA during America's Time of Crisis* (New York: Harper Perennial, 2008), p. 280.

rather than that of a government.[12] Finally, Sam Nunn recently warned that "The risk of a nuclear weapon being used today . . . is growing and not receding."[13]

NUCLEAR TERRORISM: HAZARD OR HYPE?

By demonstrating that some terrorist groups will go to extraordinary lengths to inflict mass casualties against their enemies, the 9/11 attacks radically altered how low-probability, high-consequence threats would be perceived in the future.

It is hardly surprising that the threat of nuclear terrorism has preoccupied many individuals both inside and outside of government, especially over the past several years. Thankfully, despite the apparent willingness of some terrorist groups to use WMD, the likelihood that a terrorist cell could somehow obtain a nuclear weapon from an existing stockpile or acquire the fissile material needed to build one and then successfully construct an improvised nuclear device (IND) remains far smaller than the probability of an attack using conventional explosives. As the former Director of the Central Intelligence Agency (CIA), Michael Hayden, recently commented, "We are fortunate that those with the clearest intent to acquire and use weapons of mass destruction are also the least capable of developing them."[14] Nevertheless, the prospect of a nuclear weapon being detonated in an American city understandably evokes tremendous fear. Moreover, by demonstrating that some terrorist groups will go to extraordinary lengths to inflict mass casualties against their enemies, the 9/11 attacks radically altered how low-probability, high-consequence threats would be perceived in the future. As terrorism analyst Brian Michael Jenkins has observed, those attacks "redefined plausibility." In their aftermath, "scenarios previously considered far-fetched suddenly became operative presumptions."[15]

Yet the possibility of a nuclear terrorist attack is not only small compared to the likelihood of a conventional attack, it is also the least likely form of WMD terrorism. As discussed in greater detail in Chapter 3, while there are several ways that terrorists might acquire a nuclear device, one of the more plausible scenarios involves a group building a weapon itself. Doing so, however, depends entirely on having access to a sufficient amount of highly enriched uranium (HEU) or separated plutonium, the primary materials used to fuel nuclear weapons. Without this material — most of which is monitored and guarded, though not necessarily well enough — it is impossible to construct a nuclear device.

By comparison, chemical, biological, and radiological weapons are easier and less expensive to produce. For example, many of the precursor agents needed to develop chemical weapons have commercial applications, as does the equipment used to

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12 Senator Richard G. Lugar, *The Lugar Survey on Proliferation Threats and Responses*, June 2005, pp. 14–15, accessed at http://lugar.senate.gov/reports/NPSurvey.pdf on August 4, 2008.

13 CNN, "Nuclear Threat from Terrorists Rising, Ex-Senator Says," September 10, 2008, accessed at http://www.cnn.com/2008/POLITICS/09/10/wmd.congress/ on October 16, 2008.

14 Remarks by Central Intelligence Agency Director Michael Hayden at the Los Angeles World Affairs Council, September 16, 2008, accessed at https://www.cia.gov/news-information/speeches-testimony/directors-remarks-at-lawac.html on October 5, 2008.

15 Brian Michael Jenkins, "Nuclear Terror: How Real?" *Washington Times*, May 13, 2007.

manufacture them. Similarly, much of the equipment that could be used to create a biological weapon is also classified as "dual use."[16] The easiest unconventional weapon to develop and use, however, would almost certainly be a crude chemical weapon — for example, one that used chlorine or hydrogen cyanide — or a radiological dispersal device (RDD), often referred to as a "dirty bomb." As one analyst notes, "a crude chemical attack is within the reach of any reasonably professional terrorist group."[17] A very basic RDD, moreover, would be relatively simple to construct, and might consist of little more than a modest amount of conventional explosives mixed with some quantity of radioactive material, including a number of isotopes that are widely used in commercial and medical applications. If terrorists were to use a chemical, biological or radiological weapon, the consequences would obviously be grave and, depending on the specific weapon used, perhaps catastrophic.

If attacks using other so-called weapons of mass destruction are more plausible than a nuclear terrorist attack, why focus on the comparatively unlikely threat of nuclear terrorism? Quite simply, the potential consequences of a nuclear terrorist attack are so devastating as to outweigh the very low probability of such an event. Nuclear weapons remain unique in their ability to kill and injure large numbers of people, damage and destroy infrastructure, and contaminate wide areas with radiation, to say nothing of the psychological effects that a nuclear explosion would have on the targeted population as well as the broader international political repercussions of a nuclear attack after more than half a century of non-use.[18] As the Congressionally-appointed Gilmore Commission noted in its initial report on threats to the US homeland, "the only certain way for terrorists to achieve bona fide mass destruction would be to use a nuclear weapon."[19]

The potential consequences of a nuclear terrorist attack are so devastating as to outweigh the very low probability of such an event.

Although other forms of WMD terrorism merit concern, only biological weapons pose a danger comparable to nuclear weapons.[20] Because they are living organisms

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[16] US Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks* (Washington, DC: Government Printing Office, 1993), pp. 6, 38, accessed at http://www.princeton.edu/~ota/ns20/topic_f.html on August 15, 2008. Despite the comparative ease of developing certain chemical and biological agents in comparison to nuclear weapons, effectively disseminating either would still pose significant challenges for a terrorist group. In order to kill large numbers of people, both types of agents would have to be dispersed over a wide area in the form of a low altitude aerosol cloud. This is technically difficult to achieve, especially for biological weapons, which need to be inhaled and infect a victim through the lungs, and must therefore be distributed as microscopic particles ranging in size from approximately one to five microns (millionths of a meter) in diameter. See Jonathan B. Tucker, "Introduction," in Tucker, ed., *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge, Mass: MIT Press, 2000), pp. 6–8.

[17] Jeffery M. Bale, as quoted in Joby Warrick, "An Easier, but Less Deadly, Recipe for Terror," *Washington Post*, December 31, 2004.

[18] These effects are discussed in greater detail in Chapter 2.

[19] Advisory Panel to Assess Domestic Response Capabilities for Terrorism Using Weapons of Mass Destruction, *First Annual Report to the President and the Congress: Assessing the Threat* (Washington, DC: RAND Corporation, December 15, 1999), p. 29, accessed at http://www.rand.org/nsrd/terrpanel/terror.pdf on August 17, 2008.

[20] Ashton Carter, "How to Counter WMD," *Foreign Affairs*, September/October 2004, p. 73.

RDDs are frequently characterized as weapons of mass *disruption* rather than weapons of mass *destruction*.

and reproduce once inside a host, biological agents can be extraordinarily lethal, even in very small doses.[21] According to a report from the now defunct Office of Technology Assessment (OTA), while "nuclear weapons remain the most massively destructive weapons that can be built . . . biological weapons efficiently delivered under the right condition against unprotected populations would, pound-for-pound, exceed the killing power of nuclear weapons."[22] This is particularly true if the agent used is contagious as well as infectious.[23] The effects of biological weapons are, however, generally considered to be more unpredictable than those of nuclear weapons (although the consequences of a nuclear attack would also be difficult to calculate in advance given uncertainty over the weapon's yield). With advance warning or early detection, the effects of many biological agents could be mitigated through a number of measures, including the use of protective masks, the distribution of vaccinations and antibiotics, and the establishment of quarantines. These weapons are also very susceptible to ultraviolet radiation from sunlight, weather conditions such as rain and wind, and even terrain, all of which could blunt their effects.[24]

In comparison to either nuclear or biological weapons, chemical agents are much less deadly, and massive quantities — possibly many tons — would be required to kill large numbers of people. For this reason, the same OTA report also notes, "it may not even be appropriate to consider them weapons of mass destruction."[25] Finally, an RDD would generate panic and could inflict a significant amount of economic damage due to the costs of evacuating and decontaminating the affected area, but it is unlikely that many people would actually die as the result of prompt radiation exposure; instead, most if not all of the fatalities would be caused by the blast from the conventional explosive rather than the spread of radioactive material, as those not immediately killed or incapacitated could (presumably) leave the area surrounding the explosion before being exposed to a lethal dose of radiation. RDDs, therefore, are frequently characterized as weapons of mass *disruption* rather than weapons of mass *destruction*.[26]

Nuclear terrorism thus remains the most serious, although not the most likely, form of WMD terrorism. Moreover, while the probability of an attack is relatively low, the threat itself is unfortunately not ephemeral. Presently, the greatest source

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21 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction* (Washington, DC: Government Printing Office, 1993), pp. 72–73, accessed at http://www.princeton.edu/~ota/disk1/1993/9344/9344.PDF on August 21, 2008

22 US Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction*, p. 52.

23 Richard L. Garwin, "The Technology of Megaterror," *Technology Review,* September 2002.

24 US Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction*, p. 8–9, 48–49; Tucker, "Introduction," pp. 8-9; and Gregory Koblentz, "Pathogens as Weapons: The International Security Implications of Biological Warfare," *International Security*, Winter 2003/04, pp. 91–92.

25 US Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction*, p. 9.

26 On radiological weapons, see Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, chap 6; and Peter D. Zimmerman with Cheryl Loeb, "Dirty Bombs: The Threat Revisited," *Defense Horizons*, January 2004.

of concern with regard to terrorist use of unconventional weapons in general and nuclear weapons in particular stems from al Qaeda and its affiliates. Not only have Osama bin Laden and his followers sought these weapons for years, but conventional wisdom holds that they would be unlikely to show restraint if they acquired them. Although states can be deterred, a religiously-motivated, transnational terrorist organization like al Qaeda is far less likely to be discouraged from using WMD—including nuclear weapons—by the prospect of overwhelming retaliation. With no "return address" or fixed assets to hold at risk, a determination to inflict mass casualties against its enemies, and a readiness to use suicide operations in order to achieve its goals, traditional notions of deterrence that guided US strategy successfully during the Cold War would seem to offer a much lower chance of success in this case.[27]

It is important to note, however, that the prospect of a nuclear terrorist attack was a growing concern before al Qaeda was identified as the central threat to US security, and it is likely to remain a danger even after al Qaeda is discredited and defeated. As Rolf Mowatt-Larssen, former Director of the Department of Energy's (DOE) Office of Intelligence and Counterintelligence, has argued:

> It would be a mistake . . . to view nuclear terrorism strictly through the prism of the threat posed by al-Qaeda today . . . the sober reality is that the threat posed by nuclear terrorism is much broader than the aspiration of any single terrorist group. We live in a world of escalating levels of asymmetric vulnerabilities. Increasing numbers of disaffected groups are turning to violence to achieve their goals . . . The extremes of 20 years ago are no longer extreme, and we must guard against any conventional thinking that places limits on the art of the possible for terrorist action. It is precisely the potential to surprise, along with the asymmetric impact of weapons of mass destruction that makes them appealing to the desperate designs of terrorists.[28]

In short, because it is rooted in a number of trends—several of which are discussed below—that are likely to persist for some time, it appears that the danger of nuclear terrorism, while small, will nonetheless remain an enduring feature of the security environment.

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STRUCTURE OF THE REPORT

This report is comprised of four substantive chapters. Chapter 1 describes some of the key trends influencing the nuclear terrorist threat, where these trends stand today, and their implications for US foreign and defense policy. Chapter 2 summarizes the likely effects of a nuclear detonation in a major city, including both the initial effects

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[27] Richard Betts, "The Soft Underbelly of American Primacy: Tactical Advantages of Terror," *Political Science Quarterly*, Spring 2002, pg. 31.

[28] Rolf Mowatt-Larssen, "The Strategic Threat of Nuclear Terrorism," Prepared Remarks for a Speech to the Washington Institute of Near East Policy, June 16, 2008, accessed at http://www.washingtoninstitute.org/print.php?template=C07&CID=404 on August 12, 2008.

of the explosion and the secondary effects that would become evident in aftermath of an attack. Chapter 3 analyzes the main routes by which a terrorist group might attempt to acquire a nuclear weapon, and assesses which pathways are most plausible. Building on this analysis, Chapter 4 presents a framework and recommendations directed at addressing the nuclear terrorist threat.

CHAPTER 1 > SOURCES OF THE NUCLEAR TERRORIST THREAT

The 9/11 attacks immediately elevated the possibility of nuclear terrorism from a serious but secondary concern to a principal one.[29] While the heightened anxiety over this threat may be due in large part to the jarring effect of those attacks, the threat itself is rooted in and influenced by the core strategic challenges that define the current security environment, specifically the nexus of violent Islamist extremism (and possibly other sources of religiously inspired or apocalyptic terrorism) and nuclear proliferation, or what the 2002 *National Security Strategy* referred to as "the crossroads of radicalism and technology."[30] Certain terrorist groups—particularly al Qaeda and its various affiliates—have sought and appear willing to use weapons of mass destruction, including nuclear weapons, in order to carry out catastrophic attacks against the United States, its allies, and possibly other nations.[31] At the same time, while existing nuclear arsenals and stockpiles of fissile material represent the most immediate concern, the spread of nuclear weapons and material could increase the probability that terrorists will be able to acquire or construct a nuclear device, especially if any future nuclear powers fail to properly secure these items. In short, proliferation and extremism represent the "supply" and "demand" sides of the nuclear terrorist threat, respectively.

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[29] Concerns over WMD terrorism obviously predate the 9/11 attacks. See, for example, Richard Betts, "The New Threat of Mass Destruction," *Foreign Affairs*, January/February 1998; and Ashton Carter, John Deutch, and Philip Zelikow, "Catastrophic Terrorism: Tackling the New Danger," *Foreign Affairs*, November/December 1998.

[30] *The National Security Strategy of the United States of America* (Washington, DC: White House, 2002), accessed at http://www.whitehouse.gov/nsc/nss.pdf on August 11, 2008. For an assessment of the core strategic challenges facing the United States, see Andrew Krepinevich, Robert Martinage and Robert Work, *The Challenges to US National Security* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008).

[31] For example, in November 2006 British intelligence officials publicly stated that al Qaeda was determined to attack Britain with a nuclear weapon. See Vikram Dodd, "Al-Qaida Plotting Nuclear Attack on UK, Officials Warn," *Guardian*, November 14, 2006.

THE SUPPLY SIDE: NUCLEAR PROLIFERATION

The spread of nuclear weapons has been a major source of concern ever since the United States enjoyed its short-lived atomic monopoly in the aftermath of World War II. This unilateral US advantage quickly eroded as the Soviet Union tested its first nuclear weapon in 1949, followed by Britain and France. Although these developments raised the specter of wider proliferation in the decades ahead, it was China's test of an atomic weapon in 1964 that gave credence to this possibility and sparked fears that states throughout Asia, the Middle East, Europe, and Latin America would pursue their own nuclear weapons programs.[32] After the Nuclear Non-Proliferation Treaty (NPT) entered into force in 1970, the fear that nuclear weapons would spread beyond the five nuclear-weapon states recognized by the treaty (the United States, Britain, France, the Soviet Union (later Russia), and China) persisted, though arguably at a diminished level. With the end of the Cold War, however, nuclear proliferation once again became a core security challenge, as policymakers and analysts shifted their focus away from traditional great power politics and toward regional conflicts, terrorism, and the threat posed by "rogue" nations such as Iran, Iraq, Syria, and North Korea. In fact, several prominent analysts have even warned of an emerging "second nuclear age" characterized by the widespread proliferation of nuclear weapons, as well as other weapons of mass destruction and the means to deliver them, to a number of nations and perhaps even non-state actors such as terrorist groups.[33]

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Concerns over proliferation have become particularly acute in the past decade in light of a series of worrisome developments, including:

> The status of India and Pakistan as overt nuclear weapon states, as well as the conflicts between these longtime rivals in 1999 and again in 2001–2002 that raised the possibility of the first nuclear exchange between two nations to dangerously high levels;[34]

> The revelation that Pakistani scientist Abdul Qadeer (AQ) Khan, the individual most responsible for the success of Pakistan's nuclear weapons program, not only sold sensitive information and technology to several aspiring nuclear powers

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32 Joseph Cirincione, *Bomb Scare: The History & Future of Nuclear Weapons* (New York: Columbia University Press, 2007), pp. 27–34; and Francis J. Gavin, "Blasts from the Past: Proliferation Lessons from the 1960s," *International Security*, Winter 2004–2005, pp. 104–107.

33 See, for example, Fred Charles Iklé, "The Second Coming of the Nuclear Age," *Foreign Affairs*, January/February 1996; and Paul Bracken, "The Second Nuclear Age," *Foreign Affairs*, January/February 2000.

34 For a concise overview of the Indian and Pakistani nuclear weapons programs, see Bruce Riedel, "South Asia's Nuclear Decade," *Survival,* April/May 2008.

(including North Korea, Iran, and Libya), but may have done so with at least the tacit permission of the Pakistani government;[35]

> North Korea's decision to withdrawal from the NPT in 2003 and its test of a nuclear weapon in October 2006;[36]

> A September 2007 military strike by the Israeli Air Force against a target near the town of al Kibar in the Syrian desert, which US intelligence officials later revealed was a covert graphite-moderated nuclear reactor designed to produce plutonium;[37]

> The recent approval of the US-India nuclear deal, which will allow India to purchase nuclear fuel and equipment from the United States in exchange for permitting the International Atomic Energy Agency (IAEA) increased access to its civilian nuclear facilities, but which critics argue could ultimately benefit India's nuclear weapons program and further undermine the existing non-proliferation regime;[38] and

> Iran's continuing development of an indigenous uranium enrichment capability, along with unanswered questions regarding its possible efforts to create a nuclear weapons program.[39]

The controversy surrounding the nature of Iran's nuclear program and the debate over its implications are also indicative of two additional although still nascent

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35 See Adrian Levy and Catherine Scott-Clark, *Deception: Pakistan, the United States, and the Secret Trade in Nuclear Weapons* (New York: Walker and Company, 2007); Wiliam Langewiesche, "The Wrath of Khan," *The Atlantic Monthly,* November 2005; and Langewiesche, "The Point of No Return," *The Atlantic Monthly*, January/February 2006.

36 As the result of the six-party talks that began after North Korea's withdrawal from the NPT, the United States removed North Korea from the State Department's list of state sponsors of terrorism in October 2008 in exchange for a declaration of its plutonium production. See Helene Cooper, "Bush Rebuffs Hard-Liners to Ease North Korean Curbs," *New York Times*, June 27, 2008; and Cooper, "U.S. Declares North Korea Off Terror List," *New York Times*, October 12, 2008.

37 "Background Briefing with Senior U.S. Officials on Syria's Covert Nuclear Reactor and North Korea's Involvement," April 24, 2008, accessed at http://dni.gov/interviews/20080424_interview.pdf on October 5, 2008. See also Richard Weitz, "New Insights About 2007 Israeli Air Strike in Syria," *WMD Insights*, June 2008, accessed at http://www.wmdinsights.com/I25/I25_ME2_NewInsights.htm on October 5, 2008.

38 For a brief summary of these developments and some of the concerns surrounding them, see Esther Pan and Jayshree Bajoria, "The U.S.-India Nuclear Deal," Council on Foreign Relations Backgrounder, updated October 2, 2008, accessed at http://www.cfr.org/publication/9663/ on October 22, 2008.

39 In November 2007 a US National Intelligence Estimate (NIE) judged that Iran had halted its nuclear weapons program in the fall of 2003, although considerable skepticism still exists regarding Iran's intentions. Office of the Director of National Intelligence, *Iran: Nuclear Intentions and Capabilities*, November 2007, accessed at http://www.dni.gov/press_releases/20071203_release.pdf on July 11, 2008. For an overview of Iran's nuclear program, see David Albright and Jacqueline Shire, "A Witches' Brew? Evaluating Iran's Uranium-Enrichment Progress," *Arms Control Today*, November 2007; and Paul K. Kerr, "Iran's Nuclear Program: Status," Congressional Research Service, June 23, 3008.

A number of nations in the Middle East and North Africa have recently shown a renewed interest in pursuing a nuclear power capability.

trends, both of which represent a growing source of concern. First, like Iran, a number of other nations in the Middle East and North Africa have recently shown a renewed interest in pursuing a nuclear power capability. According to King Abdullah II of Jordan, "The rules have changed. Everybody's going for nuclear programs."[40] While the fuel needed to operate nuclear power *reactors* cannot be used in nuclear *weapons*, this development raises concerns because the NPT does not bar members states from developing the sensitive technology required to produce nuclear fuel, i.e., the capability to enrich natural uranium and separate plutonium from spent nuclear fuel. Yet enrichment and reprocessing are key steps that a state would need to master in order to amass enough HEU and/or plutonium to fuel nuclear weapons. Civilian nuclear programs that possess these capabilities are therefore inherently dual-use, and can double as an essential element of a nuclear "breakout" capability or a "hedging" strategy—developing the infrastructure and raw material necessary to produce a nuclear weapon on relatively short notice.[41] This possibility has been highlighted by Mohamed El-Baradei, the Director-General of the IAEA:

> Under NPT rules, there is nothing illegal about any state having enrichment or reprocessing technology…even though these operations can also produce highly enriched uranium or plutonium that can be used in a nuclear weapon. An increasing number of countries have sought to master these parts of the 'nuclear fuel cycle', both for economic reasons and, in some cases, as a good insurance policy for a rainy day—a situation that would enable them to develop at least a crude nuclear weapon in a short span of time, should their security outlook change. Whatever the reason, this know-how essentially transforms them into a 'latent' nuclear-weapon state.[42]

The second trend that may be on the horizon is directly related to the first, insofar as it helps to explain why several nations have demonstrated a renewed interest in nuclear power. This is the possibility of proliferation acting as a catalyst for further proliferation. In 2003, for example, George Tenet emphasized the possibility of a "nuclear chain reaction" in response to the spread of nuclear weapons, warning the United States Senate intelligence committee, "The 'domino theory' of the 21st century may well be nuclear."[43] In fact, even defensively-motivated proliferation could trigger an intensified security dilemma between nations wary of one another's true inten-

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40 Quoted in William J. Broad and David E. Sanger, "With an Eye on Iran, Rivals Also Want Nuclear Power," *New York Times*, April 15, 2007.

41 Ariel E. Levite, "Never Say Never Again: Nuclear Reversal Revisited," *International Security*, Winter 2002/2003. For example, recent reports indicate that Iran has accumulated enough low enriched uranium—the type of uranium used to fuel nuclear power reactors—for a single nuclear weapon, if that uranium is further enriched into HEU. William J. Broad and David E. Sanger, "Iran Said to Have Nuclear Fuel for One Weapon," *New York Times*, November 20, 2008.

42 Quoted in Dalia El-Sheikh, "Nuclear Dynamics," *Al-Ahram*, April 2006, accessed at http://weekly.ahram.org.eg/2006/789/in4.htm on September 1, 2008.

43 Walter Pincus, "CIA Head Predicts Nuclear Race," *Washington Post*, February 12, 2003. See also James Sterngold, "Second-Tier Powers Join Arms Race," *San Francisco Chronicle*, August 1, 2005.

tions; because most states are likely to become increasingly fearful if their neighbors and especially their adversaries acquire nuclear weapons or a breakout capability, they may feel compelled to respond in kind.[44] It therefore comes as no surprise that several nations in the Middle East, many of which have long felt threatened by the regime in Tehran, have recently expressed an interest in developing their own nuclear capability. The danger, of course, is that uncertainty over Iran's intentions and the insecurity this fosters could spark a new wave of nuclear proliferation in the region.[45]

The spread of nuclear capabilities and particularly nuclear weapons poses a number of challenges for the United States, to include dramatically raising the cost of projecting power against a nuclear-armed regional opponent. Perhaps the most important consequence of nuclear proliferation, however, is the effect it could have on the prospects of a nuclear terrorist attack. If more and more nations acquire the means to produce fissile material and especially if they develop nuclear weapons, the likelihood that a terrorist group like al Qaeda could fulfill its ambitions and obtain the means to carry out a catastrophic attack would increase markedly. As discussed in Chapter 3, this could occur a number of different ways, including the deliberate transfer of nuclear weapons, material, or expertise from a government to a terrorist group; the theft of a nuclear weapon from a nation's arsenal; the onset of severe domestic instability that places the security of a nation's nuclear weapons in jeopardy; and, perhaps most likely, the purchase or theft by a terrorist group of enough fissile material to fuel a nuclear weapon, which could then be used to construct an improvised nuclear device. Ultimately, the key point is well made by Sam Nunn: "The more countries that have this fissile material, the more likely the risk of a diversion or theft of fissile material becomes."[46]

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THE DEMAND SIDE: RELIGIOUSLY MOTIVATED TERRORISM

At the same time that nuclear proliferation has become a growing security concern, both terrorists and terrorism have changed in ways that have made this longstanding threat far more dangerous than it once was. Throughout the latter half of the twentieth century and until the end of the Cold War, terrorism was primarily associated with two types of groups: ethno-nationalist/separatist groups fighting for greater autonomy or independence, and ideologically motivated groups, including various left-wing Marxist-Leninist organizations. By and large, the actions of both groups,

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44 The concept of the security dilemma holds that one state's efforts to increase its security, often by expanding its military capabilities, may incorrectly indicate that it possesses hostile intentions, leading other states to respond in kind and increasing the possibility of an unwanted conflict.

45 Broad and Sanger, "With an Eye on Iran, Rivals Also Want Nuclear Power"; and Joby Warrick, "Spread of Nuclear Capability is Feared," *Washington Post*, May 12, 2008.

46 Quoted in Michael Crowley, "The Stuff Sam Nunn's Nightmares are Made Of," *New York Times Magazine*, February 5, 2007.

while certainly violent, tended to reaffirm the conventional wisdom that terrorists were more interested in drawing attention to their respective causes than killing large numbers of people. Consequently, these groups demonstrated little interest in acquiring or using chemical, biological, and nuclear weapons.[47]

In the 1980s and throughout the 1990s, observers witnessed the advent of what is often referred to as the "new terrorism": religiously-inspired or apocalyptic groups and movements willing to inflict mass casualties against civilians.

Although the 9/11 attacks obviously shattered this conventional wisdom, it had already been shaken in the 1980s and especially throughout the 1990s, as observers witnessed the advent of what is often referred to as the "new terrorism": religiously-inspired or apocalyptic groups and movements willing to inflict mass casualties against civilians.[48] As two prominent analysts have noted, "These groups, unlike their secular counterparts, want a lot of people watching *and* a lot of people dead."[49] Particularly ominous was the Japanese spiritual cult Aum Shinrikyo's 1995 attack on Tokyo's subway system with Sarin nerve gas. In the aftermath of the attack, it was discovered that the group had not only accumulated large stockpiles of Sarin, it had also developed or was in the process of developing chemical and biological agents such as VX gas, mustard gas, and Q-fever, and may have attempted to acquire samples of the deadly Ebola virus in Africa.[50]

Nor was Aum alone in its aspirations to conduct a WMD attack. In December 1999, Jordanian security forces interrupted a plot by a group with ties to Osama bin Laden which intended to conduct a series of attacks on New Year's Eve. One of the planned attacks would have dispersed hydrogen cyanide in an Amman movie theater.[51] More recently, in early 2003, an al Qaeda affiliated group apparently planned to release hydrogen cyanide in the New York City subway using a homemade dispersal mechanism, but during the final stages the operation was called off by bin Laden's deputy, Ayman al-Zawahiri, possibly because it was considered an insufficient follow-up to the 9/11 attacks.[52] Finally, in April 2004 the Jordanian government announced that it had disrupted another potential WMD terrorism plot—a planned attack against the headquarters of its intelligence agency, the prime minister's office, and the United States Embassy. The government claimed that it seized twenty tons of blistering agents and nerve gas, and blamed the attack on Abu Musab al-Zarqawi, the future

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47 Bruce Hoffman, *Inside Terrorism*, revised and expanded edition (New York: Columbia University Press, 2006), pp. 269–271.

48 Ibid., pp. 88–89.

49 Steven Simon and Daniel Benjamin, "American and the New Terrorism," *Survival*, Spring 2000, p. 71 (emphasis in original).

50 In addition, it was later revealed that Aum members had in fact engaged in approximately twenty biological and chemical attacks between 1990 and 1995, including nine failed attempts to disperse either botulinum toxin or anthrax between 1990 and 1993, and a successful attack using Sarin nerve gas in June 1994—nearly a year before the Tokyo subway attack—that killed seven people. Hoffman, *Inside Terrorism*, pp. 124–125, 277; and David E. Kaplan, "Aum Shinrikyo (1995)," in Tucker, ed., *Toxic Terror*, pp. 207, 213, 216–128.

51 Tenet, *At The Center of The Storm*, pp. 125.

52 Ibid. pp. 273–274; and Ron Suskind, *The One Percent Doctrine: Deep Inside America's Pursuit of its Enemies Since 9/11* (New York: Simon & Schuster, 2006), pp. 217–220.

head of al Qaeda in Iraq (AQI), who was subsequently convicted and sentenced to death in absentia.[53] These and other incidents fit with the changing patterns of terrorism, as groups that deliberately seek to inflict mass casualties will almost certainly use WMD if they have the ability to do so; at the very least, these new terrorist groups are far more likely to conduct attacks with unconventional weapons than were an earlier generation of terrorists.[54]

The Proximate Threat: Al Qaeda's Pursuit of WMD

Given the events of the past several years, it is hardly surprising that, at present, the threat of WMD terrorism in general and nuclear terrorism in particular comes primarily from Osama bin Laden and his followers, who have not only expressed a willingness to use WMD against their enemies, but who have also made repeated—although largely unsuccessful—efforts to acquire unconventional weapons.

Al Qaeda's pursuit of weapons of mass destruction has been well documented in recent years, as evidenced by a number of highly publicized incidents, including the purchase of a container believed to contain uranium (but which was in fact counterfeit) by a bin Laden representative in Sudan;[55] bin Laden's own reference to the acquisition of weapons of mass destruction as a "religious duty;"[56] his success at prompting a well-known Saudi cleric to issue a fatwa (or religious opinion) sanctioning mass murder with WMD;[57] the group's claim to have purchased several so-called suitcase nuclear weapons from former Soviet scientists;[58] intelligence reports over a period of several months in 2002 and 2003 indicating that al Qaeda was negotiating the purchase of three Russian nuclear weapons;[59] and a meeting that took place between bin

Osama bin Laden and his followers have not only expressed a willingness to use WMD against their enemies, but have also made repeated efforts to acquire unconventional weapons.

[53] Craig Whitlock, "Al-Zarqawi's Biography," *Washington Post*, June 8, 2006; CNN, "Jordan Says Major al Qaeda Plot Disrupted," April 26, 2004, accessed at http://www.cnn.com/2004/WORLD/meast/04/26/jordan.terror/ on October 18, 2008; and Associated Press, "Jordan Sentences Zarqawi, in Absentia, to Death in Chemical Plot, *New York Times*, February 16, 2006. There have also been suggestions that the perpetrators of the 1993 World Trade Center bombing unsuccessfully attempted to incorporate sodium cyanide into the bomb used in the attack, in the hope that it would combine with sulfuric acid to produce a deadly cloud of hydrogen cyanide gas. While this particular accusation appears to be incorrect, Ramzi Yousef, the mastermind behind the attack, admitted to considering this option but apparently found it too difficult to implement, and may have also considered using hydrogen cyanide in a follow-on attack. See John V. Parachini, "The World Trade Center Bombers (1993)," in Tucker, ed., *Toxic Terror*.

[54] Bruce Hoffman, "Terrorism and WMD: Some Preliminary Hypotheses," *The Nonproliferation Review*, Spring/Summer 1997; and Simon and Benjamin, "America and the New Terrorism," pp. 70–71.

[55] Lawrence Wright, *The Looming Tower: Al-Qaeda and the Road to 9/11* (New York: Alfred A. Knopf, 2007), pp. 190–191.

[56] Cited in Sammy Salama and Lydia Hansell, "Does Intent Equal Capability? Al-Qaeda and Weapons of Mass Destruction," *The Nonproliferation Review*, November 2005, p. 624.

[57] Ibid., pp. 627–628.

[58] Anna Badkhen, "Al Qaeda Bluffing About Having Suitcase Nukes, Experts Say," *San Francisco Chronicle*, March 23, 2004.

[59] See Tenet, *At the Center of the Storm*, pp. 272–273.

Laden, Zawahiri, and two high ranking Pakistani nuclear scientists who "appear to have provided Al Qaeda a road map to building nuclear weapons."[60]

Initially, the group's interest in WMD appears to have been driven by the hope of deterring the United States from invading its sanctuary in Afghanistan by acquiring several nuclear weapons, smuggling them into the United States, and using them to retaliate in the event of an American attack.[61] Over time this view changed, however, and the group began to consider unconventional weapons as something that should be used in a first strike against its enemies.[62] Bin Laden in particular was and perhaps remains focused primarily on acquiring nuclear weapons, which have apparently been the subject of his attention since at least 1992.[63] Journalist Steve Coll describes how these weapons fit within bin Laden's worldview:

> Since the late 1980s and certainly since 1991, bin Laden has seen the United States as the principal invader of the Muslim world because of its support for the Saudi Royal family, Israel and other Middle Eastern governments he labels apostate. In often tedious debates with comrades during the 1990s, he has argued that only by attacking distant America could al Qaeda hope to mortally wound the Middle East's frontline authoritarian governments. His inspiration, repeatedly cited in his writings and interviews, is the American atomic bombing of Hiroshima and Nagasaki, which he says shocked Japan's fading imperial government into a surrender it might not otherwise have contemplated. Bin Laden has said several times that he is seeking to acquire and use nuclear weapons not only because it is God's will, but because he wants to do to American foreign policy what the United States did to Japanese imperial surrender policy.[64]

By contrast, bin Laden's deputy, Ayman al-Zawahiri, has displayed a greater interest in fabricating chemical and biological weapons, which he has previously described as both easier to develop than nuclear weapons and equally lethal.[65] Zawahiri personally oversaw al Qaeda's efforts in this area, including the development of laboratories in Afghanistan that were used to conduct experiments with nerve gas and weaponize anthrax.[66]

Before the loss of its sanctuary as a result of Operation Enduring Freedom, al Qaeda not only had a program underway to develop chemical and biological agents, it was

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60 David Albright and Holly Higgins, "A Bomb for the Ummah," *Bulletin of Atomic Scientists*, March/April 2003. See also Suskind, *The One Percent Doctrine*, pp. 27, 47, 70; and Tenet, *At the Center of the Storm,* pp. 264, 268.

61 Salama and Hansell, "Does Intent Equal Capability?" pp. 625–626; and Robert Wesley, "Al-Qaeda's WMD Strategy Prior to the U.S. Intervention in Afghanistan," *Terrorism Monitor*, October 7, 2005.

62 Salama and Hansell, "Does Intent Equal Capability?" pp. 626–627.

63 Hoffman, Inside Terrorism, p. 273; and Michael Scheuer, "New York Subway Plot and al-Qaeda's WMD Strategy," *Terrorism Focus*, June 20, 2006, p. 6.

64 Steve Coll, "What Bin Laden Sees in Hiroshima," *The Washington Post*, February 6, 2005.

65 Hofmann, *Inside Terrorism*, pp. 275–276.

66 Tenet, *At the Center of the Storm*, p. 260; Wright, *The Looming Tower,* pp. 303–304; and Suskind, *The One Percent Doctrine*, p. 71.

also investigating the option of pursuing nuclear weapons, although it appears that its efforts were relatively primitive. Documents discovered in Afghanistan following the Coalition invasion provide a glimpse into these efforts. According to David Albright, these documents did not suggest that al Qaeda had acquired any fissile material, and showed that the group had attained only a very limited ability to construct a weapon itself. At the same time, however, the documents also indicated that "al Qaeda was intensifying its long-term goal to acquire nuclear weapons and would have likely succeeded, if it had remained powerful in Afghanistan for several more years."[67]

Al Qaeda Today: Intentions and Capabilities

Since the US invasion of Afghanistan, al Qaeda has lost a key sanctuary and much of its original senior leadership. Does it still hope to acquire and use weapons of mass destruction? Is it capable of obtaining or building a nuclear weapon? The answer to the former question appears to be "yes": publicly available information gives little doubt that the group's intentions remain unchanged. According to the unclassified key judgments of a July 2007 National Intelligence Estimate, "al-Qa'ida will continue to try to acquire and employ chemical, biological, radiological, or nuclear material in attacks and would not hesitate to use them if it develops what it deems is sufficient capability." Similarly, in March 2008 then-Director of National Intelligence J. Michael McConnell testified that while the US intelligence community still believed that an attack using conventional explosives was the most likely scenario, "al-Qaida and other terrorist groups are attempting to acquire chemical, biological, radiological, and nuclear weapons . . . and will continue to try to acquire and employ these weapons and material."[68] To cite one recent example of this continuing interest, in September 2006 Zarqawi's successor as the head of AQI, Abu Hamza al-Muhajir, released an audio recording soliciting help in developing unconventional weapons:

> To people of distinguished skills and high levels of expertise of the sciences of chemistry, physics, management, electronics, media, and all other specializations that require depth of knowledge, and particularly the nuclear scientists and explosives engineers, we call on you to tell you that we are in need of you. . . . The battlefield will accommodate

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[67] David Albright, "Al Qaeda's Nuclear Program: Through the Window of Seized Documents," The Nautilus Institute, Policy Forum 47, November 6, 2002, accessed at http://www.nautilus.org/archives/fora/Special-Policy-Forum/47_Albright.html on August 26, 2008.

[68] National Intelligence Estimate, *The Terrorist Threat to the US Homeland*, July 2007, accessed at http://www.dni.gov/press_releases/20070717_release.pdf on August 26, 2008; and Statement for the Record of J. Michael McConnell, Director of National Intelligence, Annual Threat Assessment of the Intelligence Community for the House Permanent Select Committee on Intelligence, February 7, 2008, p. 6, accessed at http://www.dni.gov/testimonies/20080207_testimony.pdf on August 26, 2008.

> your scientific aspirations.... The vast areas in the American camps will be the best test site for your unconventional bombs, of the so-called germ or dirty variety.[69]

Although al Qaeda's intentions seem to be clear, its current capabilities are much harder to discern.[70] This is due in part to the limits of publicly available information, but it is also the result of the significant changes the group has undergone over the past several years, as well as the changes it continues to experience. In the aftermath of the US invasion of Afghanistan, al Qaeda began to evolve from the hierarchical, centralized, and bureaucratic organization that trained thousands of fighters and conducted a series of high profile attacks into something that can best be described as a hybrid, one that includes elements of the terrorist group that al Qaeda once was, along with a network of diverse but likeminded terrorist groups spread across the globe, and a broader ideology.

Although al Qaeda's intentions seem to be clear, its current capabilities are much harder to discern.

Specifically, al Qaeda now appears to be comprised of at least three main elements:

> The group's original leaders and its current senior managers, including bin Laden, Zawahiri, and their key lieutenants;

> A number of affiliated groups or "franchises," including terrorist organizations in the Arabian peninsula, Central and Southeast Asia, North Africa, and elsewhere that support or have pledged their loyalty to bin Laden; and

> A wider social movement made up of "homegrown" terrorists as well as ideological sympathizers, who look to bin Laden and al Qaeda as a source of inspiration, but have little if any direct connection to the core leadership or other al-Qaeda affiliated groups.[71]

This evolution has had a significant effect on how the group operates and the nature of the threat that it poses. According to Bruce Riedel, al Qaeda is now "more diffuse, and its components operate more independently." While bin Laden may still set the general direction, "overall the movement is more loosely structured, which leaves

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69 Cited in Sammy Salama and Gina Cabrera-Farraj, "New Leader of al-Qaeda in Iraq Calls for Use of Unconventional Weapons Against U.S. Forces; Possible Poisoning of Iraqi Security Forces at Central Iraq Base," *WMD Insights*, November 2006, p. 2; accessed at http://www.wmdinsights.org/PDF/FP_NovIssue.pdf on October 29, 2008.

70 Nevertheless, for a recent overview of the relative strength of al Qaeda and its various affiliates, see Robert Martinage, *The Global War on Terrorism: An Assessment* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008).

71 Ibid., pp. 18–30; Hofmann, *Inside Terrorism*, pp. 285–290; Hoffman, "The Changing Face of Al Qaeda and the Global War on Terrorism," *Studies in Conflict and Terrorism*," November/December 2004; Bruce Riedel, "The Return of the Knights: al-Qaeda and the Fruits of Middle East Disorder," *Survival*, Autumn 2007; and Reid Sawyer and Michael Foster, "The Resurgent and Persistent Threat of al Qaeda," *Annals of the American Academy of Political and Social Science*, July 2008.

more room for independent and copycat terrorist operations."[72] Moreover, as significant elements of the core leadership have been hunted, captured, and killed, and as its control over global operations has waned as a result, the main source of danger appears to have shifted toward the independent and quasi-independent franchises as well as local extremists.[73]

As a result of this shift, al Qaeda has paradoxically managed to become both more dangerous and less dangerous. On the one hand, the declining influence of al Qaeda's central leadership has provided an opening for the various groups and individuals that comprise the broader movement to act more independently, take the initiative, and engage in more regular attacks. In addition, al Qaeda arguably represents a more enduring threat today than it did before the 9/11 attacks and Operation Enduring Freedom in Afghanistan. Not only is an amorphous, decentralized movement less susceptible to disruption or decapitation than a top-heavy and rigidly hierarchical organization, but the evolution of al Qaeda into a source of inspiration and emulation suggests that the violent ideology it advocates will be perpetuated in some capacity for many years to come. On the other hand, while the danger posed by various al Qaeda affiliates and homegrown extremists may have grown over the past several years, the likelihood of a major attack against the US homeland and especially a catastrophic attack using WMD has in all probability declined. This is because these groups and individuals are unlikely to possess the knowledge, skills, resources, or discipline necessary to plan and successfully carry out an operation of such magnitude.[74] Put simply, "Leaderless organizations can't mount spectacular operations . . . which require years of planning and training."[75]

Al Qaeda has paradoxically managed to become both more dangerous and less dangerous.

Yet it would be premature to dismiss the possibility of such an attack in the future, as this trend already appears to be in the process of reversing itself. As Peter Bergen has recently argued, "al-Qaeda continues to gather strength, both as a terrorist/insurgent organization . . . and as an ongoing model for violent Islamists around the globe."[76] The reason for its growing strength as an organization can be traced in large part to the support it retains in several parts of Pakistan and, most importantly, the sanctuary it has established in that country's Federally Administered Tribal Areas (FATA) — a largely autonomous region that borders Afghanistan and is nominally under the control of Islamabad but is not fully integrated into Pakistan's government or society.

As a result of this development, the primary terrorist threat appears to be shifting yet again, only this time it is moving away from the local extremists and back toward

72 Bruce Riedel, "Al Qaeda Strikes Back," *Foreign Affairs*, May/June 2007, p. 35.

73 Rohan Gunaratna, "The Post-Madrid Face of Al Qaeda," *The Washington Quarterly*, Summer 2004.

74 Salama and Hansell, "Does Intent Equal Capability?" p. 629; Tiina Tarvaien, "Al-Qaeda and WMD: A Primer," *Terrorism Monitor*, June 2, 2005, pp. 8–9; and Martinage, *The Global War on Terrorism*, p. 71.

75 Peter Bergen, "Al Qaeda at 20 . . . . . . Dead or Alive?" *Washington Post*, August 17, 2008.

76 Ibid.

Al Qaeda has apparently been able to reconstitute some of its research and development efforts involving unconventional weapons.

al Qaeda's core leadership, which, according to numerous accounts, is regaining its influence, reasserting and even expanding control over its far-flung network of allies and sympathizers, and reestablishing its ability to organize and execute major attacks.[77] According to the 2007 NIE cited above, al Qaeda "has protected or regenerated key elements of its Homeland attack capability, including: a safehaven in Pakistan's Federally Administered Tribal Areas (FATA), operational lieutenants, and its top leadership."[78] In his March 2008 testimony, then-Director of National Intelligence McConnell reaffirmed these conclusions, noting that al Qaeda's sanctuary in the FATA "provides the organization many of the advantages it once derived from its base across the border in Afghanistan, albeit on a smaller and less secure scale." As a direct consequence, the group "has been able to maintain a cadre of skilled lieutenants capable of directing the organization's operations around the globe."[79]

Even more worrisome, however, is the fact that al Qaeda has apparently been able to reconstitute some of its research and development efforts involving unconventional weapons.[80] Of course, this does not mean that the group is on the verge of conducting an act of WMD terrorism, or that it is likely to acquire or construct a nuclear weapon in the near future. In fact, terrorists' knowledge of nuclear weapons and material appears to be quite rudimentary. According to the testimony of Charles Allen, then-Under Secretary for Intelligence and Analysis at the Department of Homeland Security (DHS), documents available on the Internet indicate that terrorists do not have "a sophisticated or detailed understanding of nuclear principles and technologies," although he qualified this assessment by noting that an actual nuclear capability "may not be advertised."[81] Perhaps most significantly, al Qaeda's short-term prospects for developing WMD suffered a notable setback in July 2008, when Abu Khabab al-Masri—one of the group's key lieutenants and the individual in charge of its reconstituted WMD program—was killed in a US airstrike.[82] Nevertheless, what does seem increasingly clear is that al Qaeda not only retains the intent to conduct a

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77 Mark Mazzetti and David Rohde, "Terror Officials See Al Qaeda Chiefs Regaining Power," *New York Times*, February 19, 2007; Greg Miller, "Bin Laden Hunt Finds Al Qaeda Influx in Pakistan," *Los Angeles Times,* May 20, 2007; Craig Whitlock, "The New Al-Qaeda Central," *Washington Post*, September 9, 2007; Josh Meyer, "Al Qaeda Grows by Adding Affiliates," *Los Angeles Times,* September 16, 2007; and Mark Mazzetti, "U.S. Analyst Depicts Al Qaeda as Secure in Pakistan and More Potent Than Last Year," *New York Times*, August 13, 2008.

78 National Intelligence Estimate, "The Terrorist Threat to the US Homeland."

79 Statement for the Record of J. Michael McConnell, p. 5. The State Department's most recent assessment of the terrorist threat also reaches the same conclusions. See United States Department of State, Office of the Coordinator for Counterterrorism, Country *Reports on Terrorism 2007*, April 2008, p. 7, accessed at http://www.state.gov/documents/organization/105904.pdf on August 28, 2008.

80 Josh Meyer, "Al Qaeda is Said to Focus Again on WMD," *Los Angeles Times*, February 3, 2008.

81 Quoted in Calvin Biesecker, "Terrorist Intent to Develop Nuclear Weapons Remains But Capabilities Unclear, DHS' Allen Says," *Defense Daily*, April 4, 2008.

82 Joby Warrick and Dan Eggen, "U.S. Strike May Have Killed Al-Qaeda Aide," *Washington Post*, July 29, 2008; and Simon Jeffrey, "Al-Qaida Confirms Death of Poisons Expert in Pakistan," *Guardian*, August 3, 2008.

catastrophic attack, but it is also in the processing of regaining capabilities that it had previously lost.

IMPLICATIONS

There are two key implications to be drawn from the discussion in this chapter. The first involves the supply side of the nuclear terrorist threat. Namely, limiting or preferably stopping any further proliferation of nuclear weapons material, the technology needed to produce this material, and especially nuclear weapons themselves, is an important goal, even if this only reduces the number of opportunities for terrorists to gain access to these items. As Thomas Schelling noted over twenty-five years ago, "there is at least one principle that I think is undeniable: the best way to keep [nuclear] weapons and weapons-material out of the hands of non-governmental entities is to keep them out of the hands of national governments."[83] More recently, Graham Allison has argued that halting the spread of enrichment and reprocessing technologies and preventing the emergence of additional nuclear-weapon states are key pillars of a broader strategy to prevent nuclear terrorism.[84]

Limiting or preferably stopping any further proliferation of nuclear weapons material and especially nuclear weapons themselves, is an important goal, even if this only reduces the number of opportunities for terrorists to gain access to these items.

Of course, both goals fall squarely into the category of "easier said than done." Over the past several years the United States, several other nations, and even a private non-governmental organization have put forward proposals designed to guarantee the supply of nuclear fuel to nations with power reactors in the hope that this might alleviate their fear of supply disruptions and thus discourage them from developing indigenous fuel cycle capabilities. These proposals face a number of obstacles, however, and whether or not they can succeed remains an open question.[85] Precluding the further spread of nuclear weapons is even more pressing, and it may also be even more problematic. At present, this goal hinges largely on Iran, which may or may not intend to develop these weapons. Yet stopping Iran from becoming a nuclear weapon state, while certainly desirable, may not be feasible through diplomacy and economic sanctions alone. At the same time, a preventive military strike against Iran's nuclear facilities could achieve little more than a temporary delay of its nuclear program due to the hardening of those facilities, the possibility of additional facilities in unknown locations, and Iran's ability to stockpile and disperse key components and material in advance of an attack.[86]

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83 Thomas C. Schelling, "Thinking about Nuclear Terrorism," *International Security*, Spring 1982, p. 76.

84 Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, pp. 156–171.

85 For an overview of these proposals, see Mary Beth Nikitin, et al, "Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power," Congressional Research Service, updated March 7, 2008, pp. 20–37; and Fiona Simpson, "Reforming the Nuclear Fuel Cycle: Time is Running Out," *Arms Control Today*, September 2008.

86 David Albright and Jacqueline Shire, "Why a Military Attack is Not an Option," *Arms Control Today*, November 2007.

Regardless of how the United States and the rest of the international community address Iran's nuclear aspirations in the coming months and years, ongoing debates over the value of diplomacy versus military force should not distract the United States from preparing for the worst over the long-term. As discussed above, one of the key dangers of an Iranian nuclear weapons program is the possibility that it could trigger further proliferation throughout the region, as states like Saudi Arabia, Egypt, Jordan, Turkey, Algeria and perhaps others might seek to develop or otherwise acquire a nuclear capability to bolster their security. In a region as volatile as the Middle East, this outcome has the potential to be extremely destabilizing in a number of different ways. Perhaps most importantly, it would increase the probability of a terrorist group eventually obtaining either a nuclear weapon or the material needed to build one; all else being equal, the more states that possess these items, the more likely it is that they will fall into the wrong hands. Thus, if Iran does build a nuclear arsenal, and especially if it becomes increasingly aggressive behind its newfound military strength, the United States may have to dissuade surrounding nations from developing nuclear weapons or a nuclear "hedge" of their own.

If Iran does build a nuclear arsenal, the United States may have to dissuade surrounding nations from developing nuclear weapons or a nuclear "hedge" of their own.

Although some analysts paint this task as a relatively simple one,[87] it could become quite complicated. To provide just one example, the US Government might determine that the most effective (or the only) way to halt further proliferation in the region is by publicly committing to retaliate against Iran for an attack on its neighbors, if, in return, the latter promise not to pursue nuclear weapons.[88] Yet this decision would raise a host of difficult questions: Which nations would receive this extended deterrence commitment and which ones would be excluded? Would the United States commit to retaliating with conventional or nuclear weapons? Would the commitment apply to irregular and conventional attacks as well as nuclear attacks? Retaliation for an attack below the nuclear threshold may not be desirable, but could a commitment to respond only to a nuclear attack actually encourage lower-level forms of aggression? If Iran were to conduct a significant irregular attack, could the United States even prove its culpability? How could deterrent commitments be made credible in these circumstances? Would the United States need to deploy a substantial number of troops to threatened countries to serve as a "tripwire" as it did in Europe and Asia during the Cold War? If so, how might this affect US efforts to prosecute the war on terrorism or improve its standing in the region? Given the complexity of these issues, an ad hoc or poorly conceived response could do more harm than good. Clearly, developing a comprehensive plan to prevent further proliferation in the region if Iran

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87 See, for example, Barry Posen, "We Can Live with a Nuclear Iran," *New York Times*, February 27, 2006.

88 In fact, this option was explicitly advocated by one major party presidential candidate, Senator Hillary Clinton, during a democratic primary debate. "Transcript: Democratic Debate in Philadelphia," April 16, 2008, accessed at http://www.nytimes.com/2008/04/16/us/politics/16text-debate.html on October 5, 2008.

does indeed become a nuclear-armed state should not be put off until it already has a weapon in hand.

The second major implication addresses the demand side of the threat. Specifically, a critical component of a broader strategy to prevent a nuclear terrorist attack will involve measures directed at weakening al Qaeda's leaders and eliminating—or at the very least restricting—their sanctuary in the FATA. Because obtaining or building a nuclear device and delivering it to a target would be a difficult and expensive operation,[89] it is highly likely that any credible plot will originate with al Qaeda's central leadership, whether its operatives attempt to carry out such an attack on their own or instead finance, organize, and coordinate the efforts of one or more affiliates. By themselves, al Qaeda's various franchises and especially local extremists would likely find an attack of this scale beyond their abilities. In fact, the group's franchises might not even be tasked to help with such a large and important operation, beyond providing limited logistical support. According to Bruce Hoffman, "high value, 'spectacular' attacks are entrusted only to al Qaeda's professional cadre: the most dedicated, committed, and absolutely reliable elements of the movement."[90] Therefore, to the extent that its sanctuary in the FATA has allowed al Qaeda's leadership to regain its strength and plan future operations, the probability that the group might be able to conduct a catastrophic attack at some point in the future has correspondingly increased.

A critical component of a broader strategy to prevent a nuclear terrorist attack will involve measures directed at weakening al Qaeda's leaders and eliminating their sanctuary in the FATA.

Unfortunately, efforts to diminish al Qaeda's presence in Pakistan so far have met with only limited success. On the positive side, the United States has increased its use of unmanned aerial vehicles (UAVs) to launch airstrikes, which have killed a number of prominent al Qaeda figures.[91] Between 2002 and 2007, however, the United States provided nearly $6 billion dollars of assistance to the Pakistani government to help it combat terrorist groups in the FATA.[92] Yet during this period al Qaeda's strength grew substantially. Moreover, within the US Government there has been a great deal of uncertainty and debate over a number of thorny issues, including: how much the United States can pressure Pakistan's government to take action in the FATA without undermining its stability, provoking a backlash, or both; the extent to which the United States should rely on efforts to train, advise, and equip indigenous forces such as Pakistan's paramilitary Frontier Corps, which can then combat local terrorist and insurgent groups largely on their own; whether increased emphasis should be placed

89 The challenges involved in acquiring or building a nuclear device are discussed below in chapter 4.

90 Bruce Hoffman, "The Global Terrorist Threat: Is al-Qaeda on the Run or on the March?" *Middle East Policy,* Summer 2007, p. 46.

91 Warrick and Eggen, "U.S. Strike May Have Killed Al-Qaeda Aide"; Joby Warrick, "U.S. Cites Big Gains Against Al-Qaeda," *Washington Post*, May 30, 2008; Greg Miller and Julian E. Barnes, "Higher-Tech Predators Targeting Pakistan," *Los Angeles Times*, September 12, 2008; and Jane Perlez and Ismail Kahn, "20 Reported Dead in U.S. Drone Attack in Pakistan," October 27, 2008.

92 US Government Accountability Office, "Combating Terrorism: The United States Lacks a Comprehensive Plan to Destroy the Terrorist Threat and Close the Safe Haven in Pakistan's Federally Administered Tribal Areas," April 2008, p. 3.

on non-military solutions, in particular addressing the underlying political and socio-economic ills that afflict this part of Pakistan; and whether or not to expand covert operations and the use of US Special Operations Forces (SOF) inside Pakistan to capture or eliminate key targets.[93] While there are no easy answers to these dilemmas, developing a plan to eliminate or restrict al Qaeda's FATA sanctuary will be a crucial task for the new administration.

93 Griff Witte, "Pakistan Seen Losing Fight Against Taliban and Al-Qaeda," *Washington Post*, October 3, 2007; Eric Schmitt, Mark Mazzetti, and Carlotta Gal, "U.S Hope to Use Pakistani Tribes Against Al Qaeda," *New York Times*, November 19, 2007; Steven Lee Myers, David E. Sanger, and Eric Schmitt, "U.S. Considers New Covert Push Within Pakistan," *New York Times*, January 6, 2008; Eric Schmitt and Thom Shanker, "U.S. Plans Widens Role of Training Pakistani Forces in Qaeda Battle," *New York Times*, March 2, 2008; Mark Mazzetti and David Rohde, "Amid Policy Disputes, Qaeda Grows in Pakistan," *New York Times*, June 30, 2008; and Craig Whitlock, "In Hunt for Bin Laden, a New Approach," *Washington Post*, September 10, 2008. According to one recent report, in July 2008 President Bush signed an order allowing SOF to carry out ground raids inside Pakistan against al Qaeda targets without the approval of the Pakistani government. See Eric Schmitt and Mark Mazzetti, "Bush Said to Give Orders Allowing Raids in Pakistan," *New York Times*, September 10, 2008.

CHAPTER 2 > THE POTENTIAL CONSEQUENCES OF A NUCLEAR TERRORIST ATTACK

In order to assess a threat, two critical elements must be considered: the potential consequences of that threat, and its likelihood. Although the consequences of a successful nuclear terrorist attack — the human toll in deaths and injuries, the direct economic costs stemming from damaged or destroyed infrastructure, and the psychological repercussions among the general population — may seem obvious, it is important to have a thorough understanding of these effects in order to truly appreciate the significance of the threat. Toward that end, this chapter provides a brief overview of one possible nuclear attack scenario, including the direct effects of the attack itself as well as the secondary effects that would likely materialize in the days, weeks, and months to follow. Because the effectiveness of nuclear weapons and the outcome of a nuclear exchange were frequently examined subjects during the Cold War, the direct effects of a detonation are fairly well understood. While the secondary effects are much more speculative and context dependent, the aftermath of the 9/11 attacks provides some indication of what might take place following a nuclear explosion, though the scale of such an attack would almost certainly be orders of magnitude greater than the attacks of September 2001.

THE IMMEDIATE EFFECTS OF A NUCLEAR DETONATION

The precise effects of a nuclear terrorist attack would depend greatly on a number of variables, most importantly the yield of the weapon used, but also whether the attack took place in the heart of a major city or in a less densely populated area, whether the detonation took place during a busy workday when the population of most urban areas is highest, the extent to which buildings and other structures shield bystanders from blast and radiation effects, wind patterns that would influence the distribution of radioactive fallout, and several other factors. Nevertheless, a surface level nuclear explosion in a major urban area, even one with a relatively low yield, could result in

In October 2001, the US intelligence community received information that al Qaeda had acquired a 10-kiloton Russian nuclear weapon.

tens or even hundreds of thousands of casualties, if not more. For example, in October 2001, only a few weeks after the 9/11 attacks, the US intelligence community received information from a foreign agent claiming that al Qaeda had acquired a 10-kiloton Russian nuclear weapon, which it was planning to smuggle into New York City.[94] Thankfully, this report proved to be a false alarm; had it been accurate, the results could have been devastating.

A nuclear explosion generates both immediate effects (principally thermal radiation, blast, and prompt ionizing radiation) and delayed effects (notably radioactive fallout), which together are responsible for most of the damage and casualties caused by nuclear weapons.[95] At the moment of detonation, a 10-kiloton nuclear weapon would release a massive amount of thermal radiation, immediately producing temperatures in the tens of millions of degrees. This in turn would create a fireball of superheated gas and debris that would destroy everything for 200 meters in all directions. The intense light and heat radiating from the fireball would also ignite clothing as far away as 1,100 meters from the epicenter and cause second-degree burns to exposed skin out to 1,700 meters. In addition to the effects of thermal radiation, the explosion would generate an outwardly moving shockwave of overpressure (a sudden increase in air pressure) capable of crushing heavy objects, and extremely high velocity winds of several hundred miles per hour. This shockwave would impact objects within 500 meters of ground zero with a force equivalent to 15 pounds per square inch (psi), which could destroy steel reinforced concrete buildings; out to 1,000 meters, the blast-wave overpressure would measure at 5 psi, which is strong enough to destroy wood-frame buildings and homes.[96] While thermal radiation and blast damage would cause much of the immediate destruction, the explosion would also release gamma rays and neutrons, delivering a prompt dose of ionizing radiation to bystanders over a wide area. Within 1,500 meters of the point of detonation, anyone who was not in some form of shelter when the

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94 Massimo Calabresi and Romesh Ratnesar, "Can We Stop the Next Attack?" *Time*, March 11, 2002, accessed at http://www.time.com/time/covers/1101020311/story.html on August 1, 2008. A 10-kiloton nuclear weapon would release an amount of energy equivalent to 10,000 tons of the conventional explosive trinitrotoluene, or TNT. While this would certainly be a massive detonation, it would still be smaller than the earliest nuclear weapons. For example, the nuclear bombs that were dropped on Hiroshima and Nagasaki in 1945 had yields of approximately 13 kilotons and 21 kilotons, respectively. The figure of 10 kilotons is often cited as a yield that terrorists might be able to achieve with an improvised nuclear device. It is important to note, however, that if a nuclear weapon was acquired from an existing arsenal, it could conceivably have a far greater yield and would therefore cause immensely more damage. For example, even some Russian tactical nuclear weapons—which are designed for battlefield use, rather than targeting large populations across significant distances—may have yields as a high as several hundred kilotons. See Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 53, 112.

95 Federation of American Scientists, "Nuclear Weapons Effects," accessed at http://www.fas.org/nuke/intro/nuke/effects.htm August 7, 2008; and US Congress, Office of Technology Assessment, *The Effects of Nuclear War* (Washington, DC: Government Printing Office, 1979), chap. 2, accessed at http://www.fas.org/nuke/intro/nuke/7906/index.html on August 2, 2008.

96 These figures are cited in John Holdren and Matthew Bunn, "Blocking the Terrorist Pathway to the Bomb: Nuclear-Weapons Effects," Nuclear Threat Initiative, updated on November 25, 2002, accessed at http://www.nti.org/e_research/cnwm/overview/technical3.asp on August 1, 2008.

detonation occurred would immediately receive a 500 rem[97] dose of radiation, which would prove lethal to half of those exposed within thirty days.[98]

Finally, a nuclear explosion would also lead to widespread and deadly contamination. While an air-burst (a nuclear detonation that occurs high enough above the surface that the fireball does not make contact with the ground) generates comparatively little radioactive debris, a surface-level explosion would cause a significant amount of material to be vaporized and carried up into the atmosphere, only to return to the ground and cover a large area in fallout. For a 10-kiloton explosion, an area of approximately 30 square kilometers would be covered with enough radioactive material that anyone who did not evacuate immediately or find adequate shelter would also receive a 500 rem dose of radiation within 48 hours.[99]

A recent assessment paints a less abstract, and far more chilling, portrait of a nuclear explosion of this magnitude in a major city:

> The downtown area, about one mile in radius, would be obliterated. Just outside the area leveled by blast, people wounded by flying debris, fires, and intense radiation would stand little chance of survival. Emergency workers would not get to them because of the intense radiation, and in any event, their burns and acute radiation exposure would require sophisticated and intensive medical care to offer any chance of survival. Further downwind from the detonation point, a plume of radioactive debris would spread. Its shape and size would depend on wind and rain conditions, but within one day, people within five to 10 square miles who did not find shelter or flee within hours would receive lethal radiation doses.[100]

One self-described "conservative" estimate suggests that if the October 2001 intelligence report had been correct and a 10-kiloton nuclear weapon had detonated at Grand Central Station in New York City during a typical workday, the explosion would have killed more than half a million people almost immediately, wounded several hundred thousand more, and inflicted significantly more than $1 trillion in direct economic costs.[101] Two government studies produced in 2003 and 2004

One estimate suggests that if a 10-kiloton nuclear weapon had detonated at Grand Central Station in New York City, the explosion would have killed more than half a million people almost immediately.

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97 The unit Roentgen equivalent man (rem) is a measure of the risk of suffering negative health effects from exposure to ionizing radiation.

98 Holdren and Bunn, "Nuclear-Weapons Effects."

99 Alternatively, if a 10-kiloton nuclear weapon "fizzled," or detonated with a much lower than expected yield due to improper design, poor construction, or some other factor (which would be quite possible in the case of a terrorist-built IND), these effects would be much smaller, although still highly destructive. For example, a one-kiloton explosion would produce a fireball extending 75 meters from ground zero in every direction, generate overpressure of five psi at 500 meters, and would deliver a prompt dose of 500 rem to unprotected bystanders out to 1,100 meters. See Holdren and Bunn, "Nuclear-Weapons Effects."

100 Ashton B. Carter, Michael M. May, and William J. Perry, "The Day After: Action Following a Nuclear Blast in a U.S. City," *The Washington Quarterly*, Autumn 2007, pp. 21-22.

101 Matthew Bunn, Anthony Weir, and John P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard University, March 2003, pp. 15–18, accessed at http://www.nti.org/e_research/cnwm/cnwm.pdf on July 31, 2008.

also examined the potential effects of a 10-kiloton nuclear detonation, this time in Washington, DC, and estimated the number of deaths at somewhere between 99,000 and 300,000, depending on factors such as the direction of wind and the success of evacuation efforts.[102]

SECONDARY COSTS AND CONSEQUENCES

In the wake of a nuclear explosion, both the government and the general public would be preoccupied with the possibility that additional attacks might occur.

These figures are sobering, but they are hardly the only costs or consequences that would follow a nuclear terrorist attack. In the immediate aftermath of an attack, federal, state, and local emergency responders would very likely be overwhelmed by the demands placed upon them, which could include rescuing survivors from heavily damaged and contaminated areas, containing widespread fires that would break out as the result of thermal radiation igniting combustible material and blast damage to fuel sources such as gas lines and electrical circuits, and coordinating the evacuation of locations near the point of detonation. Meanwhile, any medical facilities spared by the explosion would be inundated with victims, and would have to be supported by military field hospitals.[103] In the weeks and months to follow, economic costs would mount, as areas that were not destroyed by the initial blast would have to be decontaminated. Moreover, if ports and border entry points were closed for an extended period of time in an effort to prevent any additional weapons from entering the country, supply chains would be severely disrupted and the economic effects of the explosion would ripple throughout the nation and the globe. This could in turn lead stock markets worldwide to plummet.[104]

In the wake of a nuclear explosion, both the government and the general public would also be preoccupied with the possibility that additional attacks might occur, much as they were in the aftermath of 9/11. Indeed, this fear might be quite justified; as Ashton Carter has argued, "If one bomb goes off, there are likely to be more to follow."[105] Given the difficulty of acquiring even a single intact nuclear weapon or the fissile material necessary to build one, this is not a foregone conclusion. What can almost certainly be expected, however, are multiple claims of responsibility and threats of future attacks.[106] Unfortunately, even fictitious claims and false alarms can have significant, and extremely costly, effects. While some threats might easily be

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102 John Mintz, "U.S. Called Unprepared for Nuclear Terrorism," *Washington Post*, May 3, 2005.

103 Zachary Coile, "Planning for the Unthinkable—Nuclear Attack," *San Francisco Chronicle*, June 27, 2008.

104 Charles Meade and Roger C. Molander, *Considering the Effects of a Catastrophic Terrorist Attack* (Santa Monica, CA: RAND Corporation, 2006), pp. 9–10.

105 Quoted in James Sterngold, "Contingencies for Nuclear Terrorist Attack," *San Francisco Chronicle,* May 11, 2007.

106 As Sam Nunn has warned, "If a nuclear bomb went off in Moscow or New York City or Jerusalem, any number of groups would claim they have another." Quoted in Crowley, "The Stuff Sam Nunn's Nightmares are Made Of." See also Carter, May, and Perry, "The Day After," p. 27.

dismissed as apocryphal, the grave consequences of ignoring these claims and being proven incorrect would require many and perhaps all of them to be investigated. Doing so, however, would further tax government agencies already occupied with preventing subsequent attacks, determining who was responsible for the attack, and formulating a response both at home and abroad. Moreover, the heightened possibility of follow-on attacks also increases the likelihood that preemptive emergency measures such as evacuations would be taken in cities throughout the country, which would in turn require additional time, effort, and resources on the part of a severely overstretched government.[107]

To these concerns, one can also add the possible psychological, strategic, and political consequences of a nuclear explosion. The very idea of a nuclear attack on American soil, along with the graphic images such an attack would produce, could lead to widespread panic and a tremendous loss of confidence in government, especially if response efforts were handled poorly.[108]

There is also the possibility that a nuclear terrorist attack could paralyze the operation of government.

The public reaction to an attack could also include emotional demands for retaliation that might be ill advised, given that a recurring goal for terrorists generally and al Qaeda and its affiliates in particular is to incite a reprisal, or even to spark a wider interstate war between their enemies. For example, one of the key goals bin Laden hoped to achieve with the 9/11 attacks was to provoke an American invasion of Afghanistan, which he calculated would be as protracted and draining for the United States as it had been for the Soviet Union two decades earlier.[109] Another al Qaeda plot — one that was never carried out — envisioned recruiting pilots from the Saudi Royal Air Force to steal their own fighter jets and conduct a rogue attack against Israel, in the hope that this would instigate another Arab-Israeli war.[110] Should a nuclear terrorist attack ever occur, the perpetrators could have similar motives.

Finally, there is also the possibility that a nuclear terrorist attack directed against the nation's political leadership and institutions could paralyze the operation of government. This possibility, which might seem like an anachronistic vestige of the Cold War and fears of a US-Soviet nuclear exchange, suddenly became very real on September 11, 2001, when Vice President Richard Cheney directed Congressional

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107 Carter, May, and Perry, "The Day After," pp. 27–28.

108 A classified document prepared for the Department of Homeland Security in 2006 also warned that "mass psychological illness" could occur among fearful population in the aftermath of a chemical, biological, or nuclear attack, especially if the government's emergency communications efforts were not handled appropriately. United Press International, "Post-Terror Illness Often Just in Mind," *Washington Times,* September 24, 2008.

109 Wright, *The Looming Tower*, p. 331.

110 Riedel, "The Return of the Knights," p. 112. Similarly, in the aftermath of a terrorist attack on India's parliament by fighters from the disputed province of Kashmir in December 2001, Steve Coll observed that these insurgent groups, which have ties to al Qaeda, "seem to have developed their own nuclear-weapons doctrine, based not on the acquisition of nuclear devices…but on carrying out spectacular strikes in India — attacks that might draw India and Pakistan into a major war." Coll, "The Stand-Off," *The New Yorker*, February 13, 2006.

leaders to be taken outside the city to 1950s-era nuclear bunkers.[111] Since 9/11, the fear of a nuclear terrorist attack has prompted renewed efforts to ensure continuity of government should the unthinkable occur.[112]

111 James Mann, *Rise of the Vulcans: The History of Bush's War Cabinet* (Viking: New York, 2004), pp. 295–296.

112 Barton Gellman and Susan Schmidt, "Shadow Government is at Work in Secret," *Washington Post*, March 1, 2002; and Spencer S. Hsu, "Bush Changes Continuity Plan," *Washington Post,* May 10, 2007.


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238.0289
6,5,4,3,2
4404
1408
18.95
94
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3505
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Plutonium
$^{238}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} \longrightarrow ^{239}_{92}\mathrm{U} \xrightarrow[23.5\ \mathrm{min}]{\beta^-} ^{239}_{93}\mathrm{Np} \xrightarrow[2.3565\ \mathrm{d}]{\beta^-} ^{239}_{94}\mathrm{Pu}$
2069

CHAPTER 3 > TERRORIST ACQUISITION OF NUCLEAR WEAPONS: HOW, AND HOW LIKELY?

One of the most difficult problems encountered when assessing the threat of nuclear terrorism and determining how best to confront it is the inherent uncertainty that exists regarding the likelihood of a future attack. As discussed above, the consequences of a successful attack, although dependent on a number of factors, can be estimated with some level of confidence and would undoubtedly be profound. Yet the probability of a nuclear terrorist attack actually taking place is impossible to predict.[113] While it is certainly much lower than almost any other form of attack, it is still greater than zero, but just how much greater is unknown. Moreover, even though the most likely culprits—the members of al Qaeda's central leadership—can be identified in advance, and though it seems clear that they are gaining strength, this says nothing about how they or any other terrorist group might try to acquire (or fabricate) a nuclear weapon and what their prospects for success would be. Despite this considerable uncertainty, the remainder of this chapter attempts to provide a more detailed assessment of the threat in order to better understand how realistic it actually is.

If a terrorist group was determined to "go nuclear," how might it attempt to do so and what obstacles would it face? Although it is possible to imagine any number of scenarios, some more plausible than others, there are four main alternatives that prospective nuclear terrorists might choose to pursue: manufacturing fissile material on their own for use in a nuclear weapon, finding a state sponsor that could provide a weapon or the material and expertise required to build one, stealing an intact nuclear weapon from a nation's arsenal, and stealing or purchasing the necessary fissile material and then constructing an improvised nuclear device. These pathways are described below from least to most likely. It is necessary to note, though, that this

113 Some analysts have offered their predictions, however. For example, Graham Allison estimates that, "on the current trend line, the chances of a nuclear terrorist attack in the next decade are greater than 50 percent." Allison, "Apocalypse When?" *The National Interest*, November/December 2007, p. 13.

is only an assessment of relative probability—while some of these pathways may be more or less likely than others, this does not mean than any one pathway is either extremely likely or impossible.

BACKGROUND: FISSILE MATERIAL AND NUCLEAR WEAPONS

Before discussing how terrorists might attempt to acquire nuclear weapons, it is necessary to provide a brief overview of (1) the primary fissile materials used to fuel these weapons, and (2) the basic principles behind first-generation weapons, which terrorists attempting to construct an improvised nuclear device would seek to replicate.[114]

Fueling a Nuclear Weapon: HEU and Plutonium

The immense energy unleashed by nuclear weapons is produced when the atoms in the weapon's core undergo a rapid series of fission reactions—the division of heavy nuclei into smaller elements. Although fission occurs spontaneously in some materials, in others it can be induced when an atom is bombarded by neutrons, absorbs a neutron, and then splits, which releases a large amount of energy as well as free neutrons that can go on to cause additional fission reactions in surrounding atoms.[115] When each fission event causes an average of one additional nucleus to undergo fission, a self-sustaining chain reaction—one that is characterized by a constant rate of fission—is achieved. A supercritical chain reaction that powers a nuclear weapon occurs when the neutrons released by each fission event cause more than one additional nucleus to fission, so that both the rate of fission and the amount of energy released increase exponentially over time.

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[114] The basic information that is included in this section can be found in numerous sources. Useful overviews of the issues briefly summarized here include the following: US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, chap. 4; Owen R. Coté, "A Primer on Fissile Materials and Nuclear Weapon Design," in Graham T. Allison, Coté, Richard A. Falkenrath, and Steven E. Miller, *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (Cambridge, Mass: MIT Press, 1996); John Holdren and Matthew Bunn, "Blocking the Terrorist Pathway to the Bomb: Nuclear Basics," Nuclear Threat Initiative, last updated on November 25, 2002, accessed at http://www.nti.org/e_research/cnwm/overview/technical1.asp on September 8, 2008; and Holdren and Bunn, "Blocking the Terrorist Pathway to the Bomb: Nuclear Weapons Design & Materials," Nuclear Threat Initiative, updated on November 25, 2002, accessed at http://www.nti.org/e_research/cnwm/overview/technical2.asp on September 8, 2008.

[115] By contrast, in more advanced and more powerful thermonuclear weapons much of the energy that is released is generated by fusion, which occurs when very light nuclei are joined together as the result of extreme temperature or pressure.

The two primary materials used to fuel nuclear weapons are isotopes of the elements uranium (U) and plutonium (Pu): U-235 and Pu-239.[116] While naturally occurring uranium consists primarily of the non-fissile isotope U-238, approximately 0.7 percent of natural uranium is made up of the isotope U-235, which fissions almost every time it absorbs a neutron. *Highly enriched uranium* is uranium in which the concentration of U-235 has been increased to at least 20 percent, although this often refers to uranium with U-235 concentrations greater than 80 percent. *Low enriched uranium* (LEU) refers to uranium in which the concentration of U-235 has been increased to less than 20 percent, usually somewhere between 2-5 percent. All uranium classified as HEU can technically be used to power a nuclear weapon (LEU cannot be used in nuclear weapons, but is commonly used as fuel for light water-moderated nuclear power reactors.). Nevertheless, the amount of material that constitutes a critical mass—the smallest mass capable of supporting a chain reaction—increases significantly as the concentration of U-235 declines, making lower levels of HEU impractical for use in weapons. The type of HEU that is generally used in nuclear weapons contains more than 90 percent U-235, and is referred to as weapon-grade HEU.

In contrast to uranium, the element plutonium essentially does not occur in nature: it is produced in nuclear reactors when the U-238 in reactor fuel captures a neutron to become U-239, then decays twice by emitting an electron to become Pu-239. In order to be used in a nuclear weapon, the plutonium must be removed from the reactor and chemically separated from the remaining uranium as well as the other extremely radioactive fission byproducts that are present in the spent fuel. Although Pu-239 is created when the uranium in a reactor is irradiated for only a short period of time, if it remains in the reactor it will also absorb neutrons, leading to a buildup of other plutonium isotopes (Pu-240, Pu-241, and Pu-242, as well as Pu-238). Weapon-grade plutonium contains approximately 90 percent or more of the isotope Pu-239. By contrast, reactor-grade plutonium contains 20 percent or more of the isotopes Pu-240 and Pu-242, and only 60 to 70 percent Pu-239. Although virtually any isotopic mixture of plutonium can be used to power a nuclear weapon, weapon-grade plutonium is preferred because isotopes other than Pu-239 have high rates of spontaneous fission and emit a large number of neutrons. Consequently, if used in a weapon, plutonium with a lower concentration of Pu-239 has an increased likelihood of experiencing predetonation (the initiation of a supercritical chain reaction sooner than is optimal), which could result in decreased reliability as well as decreased yield.

While both weapon-grade plutonium and weapon-grade HEU are used in nuclear weapons, the former is generally preferred because Pu-239 is more likely to undergo fission when struck by a neutron, and it also releases a larger number of free neutrons

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116 Different chemical elements are distinguished from one another by the number of protons in their nucleus, referred to as their atomic number. An individual element may have several isotopes, however, based on the number of neutrons in an atom's nucleus. An isotope of a particular element is indicated by its atomic mass, or the total number of protons and neutrons in its nucleus.

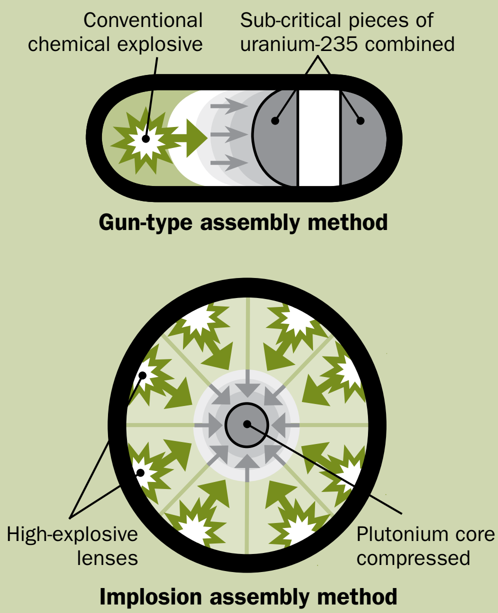
after undergoing fission. As a result, Pu-239 has a critical mass that is several times lower than U-235, meaning that less material is needed to sustain a fission chain reaction. The critical mass for a bare plutonium sphere in its alpha phase containing more than 90 percent Pu-239 is approximately 10 kilograms (or 22 pounds), as opposed to 52 kilograms (114.5 pounds) for a uranium sphere containing more than 90 percent U-235.[117] In addition, the critical mass of reactor-grade plutonium is roughly 25 to 35 percent larger than the critical mass of weapon-grade plutonium.

First Generation Nuclear Weapon Designs

The central challenge of a nuclear weapon is to assemble a supercritical mass quickly enough that a sufficient portion of the explosive material fissions and releases its energy before the chain reaction stops and the material blows itself apart. Achieving

[117] Plutonium metal has several different allotropic phases of different crystal structures and densities. The alpha phase is very dense and is stable at room temperature, but is also very brittle and difficult to machine. Delta phase plutonium is not as dense—its critical mass is 60 percent greater—but is more malleable. Nuclear weapons generally use delta phase plutonium that has been stabilized by alloying it with a small percentage of another metal, for example gallium or aluminum. Because delta phase plutonium undergoes a phase transition to the alpha phase at low pressures, the shockwave used to compress plutonium in an implosion device will cause it to transform to the more dense alpha phase, allowing it to become supercritical more easily and with less mass.

FIGURE 1. **BASIC NUCLEAR WEAPON DESIGNS**



this fast reaction depends on the composition of the fissile material (the percentage of either U-235 or Pu-239) and the method of assembling the supercritical mass. There are two basic methods for initiating an explosive nuclear chain reaction: the gun-type design and the implosion design (illustrated in Figure 1).

In the gun-type design, a propellant charge is used to drive one subcritical piece of HEU down a gun barrel-like cylinder into a second subcritical piece of HEU; these pieces form a supercritical mass and generate a nuclear explosion if they can be brought together quickly enough. In the implosion design, precisely shaped chemical explosives surrounding a subcritical mass of fissile material are detonated nearly simultaneously at multiple points, creating a uniform shockwave that quickly compresses the HEU or plutonium in the core. This decreases its volume, increases its density, and forms a supercritical mass.[118] Because of these alternative methods of assembling a supercritical mass, there are three other important differences between gun-type and implosion weapons.

An implosion device can use either HEU or plutonium, whereas a gun-type device can only use HEU.

First, an implosion device can use either HEU or plutonium, whereas a gun-type device can only use HEU. Compared to HEU, isotopes of plutonium have high rates of spontaneous fission and are thus strong neutron emitters. This is particularly the case for isotopes such as Pu-240, which will always be present to some degree in weapon-grade plutonium. Because a critical mass is assembled in the gun design relatively slowly, there is a high probability that these neutron emissions would prematurely trigger a chain reaction as the two pieces of plutonium approached one another, blowing the weapon apart. In an implosion device, compression occurs far more rapidly, making it possible to use plutonium as well as HEU.

Second, an implosion device requires less fissile material than a gun-type device, and not only because it is capable of using plutonium with its smaller critical mass. When fissile material is compressed its density increases, and atoms within the material are pushed closer together. As a result, every free neutron has a greater likelihood of striking another nucleus and generating an additional fission event before escaping the nuclear material, decreasing the amount needed for a critical mass. Moreover, an implosion device is much more efficient than a gun-type device, which only fissions a small fraction of its fissile material. Because it increases the density of the fissile material in its core, an implosion device allows more HEU or plutonium to undergo fission before the weapon blows apart, which in turn allows smaller amounts of material to produce larger yields.

Third, an implosion device is more technically complex and difficult to construct than a gun-type device. To successfully assemble a critical mass via the implosion method, the surrounding explosives must detonate nearly simultaneously in order

118 Modern implosion weapons use the process of boosting to further decrease size and weight while maintaining yield. Boosting involves placing a small amount of deuterium and tritium gas in the core of the fission device. The gas undergoes fusion as the fission chain reaction gets underway, and releases an intense burst of neutrons that more completely fissions the surrounding fissile material. This level of sophistication is beyond what a terrorist group constructing an IND could achieve, however.

to generate a uniform shockwave that will compress the nuclear material to a super-critical density. If some of the explosives detonate before others, the material will be flattened and a nuclear explosion will not be achieved. This requires specially shaped explosive lenses that are symmetrically arranged around the material, detonators that are inserted into the lenses such that the distance between each detonator and the nuclear material is uniform, and electronics sufficient to deliver a high-current pulse to those detonators almost simultaneously. An implosion device also requires (and a reliable gun-type device should have) a neutron generator that initiates a blast of neutrons at the optimal moment (the point of maximum compression for an implosion device or the point of full assembly in a gun-type device) to start the chain reaction.[119]

One way for terrorists to obtain a weapon would be to manufacture the necessary fissile material on their own.

ALTERNATIVE 1: MANUFACTURING FISSILE MATERIAL

One way for terrorists to obtain a weapon would be to start at the source, that is, to manufacture the necessary fissile material on their own and then use that material to construct a nuclear device. Of all the different scenarios, this is far and away the most ambitious, most difficult, and least likely. To develop enough highly enriched uranium for one or more nuclear weapons, it would be necessary to mine tens of thousands of tons of uranium ore (which contains only a very small percentage of natural uranium), then use milling facilities to crush the ore and extract the uranium concentrate, a process that yields what is often called yellowcake. The yellowcake would then need to be converted into a precursor that could be used as the feedstock in one of several complex processes designed to enrich the concentration of the fissile uranium isotope U-235 to a level sufficient for use in a nuclear weapon (for example, uranium hexafluoride if the gaseous diffusion method were used). To develop plutonium instead, uranium fuel would need to be irradiated in a nuclear reactor, removed, and then chemically separated from the rest of the very radioactive and dangerous-to-handle spent fuel.[120] After all of this — which has proven to be too great a hurdle for a number aspiring nuclear powers — the terrorist group would in all likelihood have to convert the HEU or plutonium into a metal, fabricate the fissile material into the appropriate size and shape, and then construct the weapon itself. Although these tasks are hardly

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[119] In both designs, a tamper of heavy metal surrounding the fissile material may be used to keep the material assembled for several additional microseconds before it blows apart, allowing more material to be fissioned and increasing the weapon's yield. In addition, the fissile material in the weapon may also be surrounded by a neutron reflector, which can decrease critical mass requirements by a factor of two or three by reflecting neutrons that would otherwise escape back into the fissile material. Depending on the type of material used, the tamper and the neutron reflector can be the same component.

[120] For a discussion of these steps, see US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, pp. 120–122, 137–139, 155-157; and John Holdren and Matthew Bunn, "Blocking the Terrorist Pathway to the Bomb: Production of Nuclear Materials," Nuclear Threat Initiative, Updated on November 25, 2002, accessed at http://www.nti.org/e_research/cnwm/overview/technical4.asp on August 21, 2008.

simple, actually developing the fissile material for weapons is the most difficult part of the entire process.[121]

Given the size and complexity of this endeavor, it is not surprising that the costs associated with it are enormous, and far exceed the cost of building the actual weapon. For example, of the $1.9 billion (in then-year dollars) spent on the Manhattan project between 1942 and 1945, $1.2 billion was spent on uranium enrichment and another $390 million on plutonium production.[122] One report provides some indication of the resources that would be required for a state undertaking a similar path today:

> Producing nuclear weapon materials indigenously would require at least a modest technological infrastructure and hundreds of millions of dollars to carry out. The costs of a full-scale indigenous program, however, especially if clandestine and lacking outside nuclear-weapon expertise, can be as much as 10 to 50 times higher than for a program aimed at producing just one or two bombs and largely carried out in the open or with outside technical assistance.[123]

The knowledge, infrastructure, and finances needed to undertake this series of steps very likely outstrip the resources of even a well-funded terrorist group.

In short, the knowledge, infrastructure, and finances needed to undertake this series of steps with any realistic prospect of success very likely outstrip the resources of even a well-funded terrorist group.[124] Moreover, an effort of this scale would produce a number of highly observable signatures that would almost certainly be discovered by attentive intelligence agencies.

While this scenario may appear farfetched, it should be noted that one terrorist group did attempt to manufacture its own fissile material for a nuclear device, albeit unsuccessfully. The Japanese cult Aum Shinrikyo possessed huge financial resources, a membership that included a large number of technical experts from various fields, and had a serious interest in nuclear weapons. Not only did Aum recruit two nuclear scientists to its cause, it even purchased a large piece of land in Western Australia where it intended to mine uranium, which would then be shipped back to Japan for enrichment by Aum's scientists.[125]

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121 Peter D. Zimmerman, "Technical Barriers to Nuclear Proliferation," *Security Studies,* Spring/Summer 1993, p. 353.

122 Kevin O'Neill, "Building the Bomb," in Stephen I. Schwartz, ed., *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940* (Washington, DC: Brookings Institution Press, 1998), pp. 58-59.

123 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 126.

124 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 119–120; and Bunn, *Securing the Bomb 2007*, p. 2.

125 See Hoffman, *Inside Terrorism*, pp. 122–124.

ALTERNATIVE 2: STATE SPONSORSHIP

A second possibility is that a terrorist group might seek out a state sponsor, in particular a rogue nation that already possessed nuclear weapons and might provide the group with this capability, presuming the two shared a common enemy. Indeed, this particular scenario has been cited frequently in recent years by policymakers and commentators, most notably during the months preceding Operation Iraqi Freedom in 2003, when Saddam Hussein's presumed efforts to reconstitute Iraq's nuclear weapons program and ties to various terrorist organizations were both central to the rationale for war. Today, this scenario is once again receiving significant attention due to Iran's ongoing nuclear program and its close and longstanding relationship with the terrorist group Hezbollah.

Any state that deliberately provided a terrorist group with a nuclear weapon would run the risk of being discovered and suffering the consequences.

While the direct transfer of a nuclear weapon would certainly be the easiest route to the bomb from a terrorist's perspective and is therefore a serious concern, several mutually reinforcing factors suggest that it is also highly unlikely. First, nuclear weapons are obviously an extraordinarily valuable commodity which any state would be reluctant to part with. Not only do they bolster a nation's military power and provide it with an enhanced deterrent, they also confer no small amount of prestige domestically and, in some corners, internationally. Moreover, as noted above, developing an indigenous capability to safely produce reliable nuclear weapons requires an enormous investment of time, effort, and money. The notion that a state — especially a relatively new nuclear weapon state with only a small arsenal — would willingly give away such an important asset is difficult to imagine, although not impossible.[126]

Second, any state that deliberately provided a terrorist group with a nuclear weapon would run the risk of being discovered and suffering the consequences.[127] In general, state sponsorship of terrorism occurs because it offers a relatively safe and inexpensive way to impose costs on an adversary: because terrorism generally causes less damage than conventional military attacks, and because sponsors can retain a degree of plausible deniability by claiming that terrorist groups operate independently, pressure can be brought to bear on an adversary with a decreased risk of precipitating a full-scale war. In fact, sponsors are generally more conservative than their clients, who must often be restrained from taking overly aggressive actions that could provoke forceful and costly reprisals. As a result, state sponsorship arguably makes it less likely that a terrorist group will use any type of WMD — if it were revealed (or even

[126] As the size of a nation's nuclear arsenal grows, however, the possibility that it could transfer a weapon but retain its nuclear deterrent would correspondingly increase.

[127] The fear of discovery may decrease if more nations acquire nuclear weapons, however, due to the increased difficulty of determining the original source of the weapon.

strongly suspected) that a state knowingly provided a terrorist group with a nuclear weapon, it would almost certainly suffer devastating retaliation.[128]

Third, it is also unlikely that a regime would be confident enough in its relationship with a terrorist group to willingly entrust it with such a powerful weapon, even if that regime did not fear or did not expect retaliation. Because terrorist groups have interests that are often quite different from those of their sponsors, and because they also have been known to turn against their patrons, a sponsor could hardly be certain that the group would carry out an attack against the intended target rather than against another state or even the sponsoring regime itself.[129]

Although the deliberate transfer of a nuclear weapon by a government may be unlikely, there are two other related possibilities that merit brief discussion. First, a state might choose to assist a terrorist group in a more limited way, by providing the fissile material, weapon components, and/or scientific and engineering knowledge that would allow the group to construct a nuclear device on its own, in the belief that these actions would be more likely to go undetected than transferring an entire nuclear weapon.[130] Second, members of government, military officers, or scientists in a nuclear weapon state who have access to these items could provide or sell them to a terrorist group without the direct sanction of the state's leadership, either out of ideological sympathy or simply for profit. This possibility in particular has been the subject of considerable attention and concern in the wake of the AQ Kahn affair.

On their face, both of these scenarios seem more plausible than the direct transfer of a weapon by a state's leadership. At the same time, neither seems very likely, at least compared to the two other alternatives discussed below. For example, while the transfer of fissile material or weapon components might be more difficult to detect either before a weapon was used or even after an attack took place, the risk of detection and retaliation would still remain. Any government that deliberately adopted this policy would therefore have to be extremely risk-acceptant. Moreover, that government would also have to be willing to share or part with extremely valuable commodities, and would still need to trust that its terrorist partner would ultimately use a weapon that it constructed in a way that conformed to the sponsor's interests. In short, most of the constraints listed above would still apply, although perhaps not quite as strongly. Alternatively, the possibility that rogue elements within a state's government, military, or scientific establishment might transfer sensitive materials on their own is a more serious danger. It is worth noting, however, that AQ Khan's

The possibility that rogue elements within a state's government, military, or scientific establishment might transfer sensitive materials on their own is a more serious danger.

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[128] Daniel Byman, *Deadly Connections: States that Sponsor Terrorism* (New York: Cambridge University Press, 2005), pp. 50–52; and Byman, "Do Counterproliferation and Counterterrorism Go Together?" pp. 32–33.

[129] Byman, *Deadly Connections*, p. 6; Byman, "Do Counterpoliferation and Counterterrorism Go Together?" p. 33; and Walter Laqueur, "Postmodern Terrorism," *Foreign Affairs*," September/October 1996, p. 34.

[130] This possibility is suggested in Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 118–119

sale of nuclear technology to other nations appears to have had at least the tacit consent of the Pakistani government. If this is true, it implies that the government could have stopped his activities earlier but chose not to, which in turn suggests that the danger of rogue actors within a state independently trafficking in nuclear weapons technology may not be as high as it has recently been portrayed.

While several factors suggest that the transfer of nuclear weapons, material, and/or expertise is unlikely, the proliferation of nuclear weapons and material to known state sponsors of terrorism is still a dangerous and destabilizing possibility. During the Cold War, for example, the relative strategic stability of mutually assured destruction — the knowledge that both the United States and the Soviet Union were capable of absorbing a nuclear first strike and retaliating in kind — was tempered by a dynamic referred to as the "stability instability paradox."[131] According to this perspective, a full-scale nuclear war would be so devastating for both sides that nuclear retaliation for anything short of a nuclear attack was not a credible proposition. Therefore, the Soviet Union might be tempted to engage in lower-level forms of aggression — either a conventional war in Europe or proxy wars in the developing world — because it would not fear escalation to the nuclear level.

Despite major differences between the US-Soviet rivalry during the Cold War and today's strategic environment, the proliferation of nuclear weapons to states that sponsor terrorism could have the similar effect of encouraging aggression. Specifically, rather than arm a terrorist group with a nuclear weapon, possession of these weapons might encourage a state to provide increased military and logistical support to terrorist or insurgent groups engaging in more traditional methods of attack such as bombings, raids, and assassinations, confident that its nuclear deterrent will prevent any significant retaliation by the targets of these attacks (an assumption that would clearly fail to apply if that support included providing a nuclear weapon or the material necessary to make one). Pakistan, for example, was encouraged by its own nuclear capability to begin arming insurgents in the disputed province of Kashmir as part of an effort to draw its Indian adversary into a costly irregular conflict. The Pakistani government was willing to pursue this strategy in part because it calculated that India would refrain from engaging in a large-scale reprisal for fear that the conflict might escalate out of control.[132] Today, a prospective nuclear power like Iran may not be willing to provide a nuclear weapon to a terrorist group for the reasons

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[131] Robert Jervis, *The Illogic of American Nuclear Strategy* (Ithaca, N.Y.: Cornell University Press, 1984), pp. 29–34

[132] International Crisis Group, *Kashmir: Confrontation and Miscalculation*, Asia Report No. 35, July 11, 2002, pp. 9–10; S. Paul Kapur, "Nuclear Proliferation, the Kargil Conflict, and South Asian Security, *Security Studies*, Autumn 2003; and Guarav Kampani, "Placing the Indo-Pakistani Standoff in Perspective," Center for Nonproliferation Studies, Monterey Institute of International Studies, n.d., p. 4, accessed at http://cns.miis.edu/pubs/reports/pdfs/indopak.pdf on July 11, 2008. This logic was apparently reinforced after the 1998 nuclear tests: according to Steve Coll, "even as the deployment of nuclear weapons made a conventional war on the subcontinent more risky…Pakistan's generals seemed to find their covert war in Kashmir more plausible." Coll, "The Stand-Off."

cited above. Nevertheless, the possibility that a nuclear deterrent would make the regime in Tehran more willing to support or encourage aggressive behavior by these groups, although hardly guaranteed, is certainly very real.[133]

ALTERNATIVE 3: STEALING A WEAPON

If terrorists cannot manufacture their own fissile material or find a state that is both willing and able to provide them with an intact nuclear weapon, could they steal one instead? The fear of stolen nuclear weapons is not new. As the Cold War came to an end concerns emerged regarding the safety of the Soviet nuclear arsenal, which had been dispersed across the republics of the Soviet Union and the Warsaw Pact nations of Central and Eastern Europe. Of particular concern were the tens of thousands of tactical nuclear weapons (including artillery shells, mines, gravity bombs, and warheads for air defense systems as well as ballistic and cruise missiles with ranges of less than 500 kilometers), many of which were forward-deployed outside of Russia's borders.[134] These fears were magnified in 1997, when former Russian National Security Adviser Alexander Lebed claimed that the Russian military could not account for over one hundred so-called "suitcase" nuclear weapons, although the existence of these weapons, let alone their status, has never been definitively confirmed.[135]

The possibility of a nuclear weapon being stolen and falling into the hands of terrorists remains a serious concern.

Today, the possibility of a nuclear weapon being stolen and falling into the hands of terrorists remains a serious concern. As the 2006 Quadrennial Defense Review (QDR) noted, "The prospect that a nuclear-capable state may lose control of some of its weapons to terrorists is one of the greatest dangers the United States and its allies face."[136] Although the total number of nuclear weapons in the world has decreased by more than half since reaching a Cold War peak of approximately 65,000 warheads,[137] there are still more than 10,000 operational nuclear warheads in the inventories of the nine nuclear-weapon states, with another 15,000 warheads either held in reserve or scheduled to be dismantled by the United States and Russia (see Table 1).

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133 Michael Eisenstadt, "Deter and Contain: Dealing with a Nuclear Iran," in Henry Sokolski and Patrick Clawson, eds., *Getting Ready for a Nuclear-Ready Iran* (Carlisle, PA: Strategic Studies Institute, 2005), pp. 231–232.

134 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 48; and David Filipov, "Russia's Scattered Tactical Arms a Temptation for Terrorists," *Boston Globe*, June 18, 2002. Soviet tactical warheads deployed in the former Soviet states were returned to Russia by July 1992. US Congress, Office of Technology Assessment, *Proliferation and the Former Soviet Union* (Washington, DC: Government Printing Office, 1994), pp. 20–21, accessed at http://www.princeton.edu/~ota/disk1/1994/9426/9426.PDF on October 18, 2008.

135 Katherine Shrader, Associated Press, "Suitcase Nukes Said Unlikely to Exist," *Boston Globe*, November 10, 2007.

136 *Quadrennial Defense Review Report* (Washington, DC: Department of Defense, February 6, 2006), p. 32.

137 Cirincione, *Bomb Scare,* p. 126.

Despite this large number of weapons, acquiring and then using one would hardly be an easy task. Not surprisingly, most nuclear weapons are heavily guarded. To steal one, a terrorist group would almost certainly require help from one or more individuals working at a weapons storage site or transfer point in order to quickly locate a weapon, bypass or disable alarm systems or other passive security measures, and avoid on-site security personnel. Absent this support, stealing a weapon would be all but impossible. As one report argues, "A terrorist organization planning to seize a nuclear weapon without insider assistance would need to invest in training and arming a force able to defeat all security measures protecting the weapons, including the intervention of guard and response teams . . . The task would be so daunting in most settings, unless security at the facility is sufficiently lax, as to appear more the stuff of fiction than a practicable approach for a terrorist organization."[138]

Even if terrorists did manage to acquire a weapon, actually using it would pose a number of significant challenges. For example, most and in some cases all operational

[138] Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 59.

TABLE 1. **WORLD NUCLEAR ARSENALS***

Country	Strategic Warheads	Non-Strategic Warheads	Total
United States	3,575	500	4,075 (+ 1260 warheads held in reserve and 5100 scheduled to be dismantled)
Russia	3,113	2,076	5,189 (+8800 warheads held in reserve or scheduled to be dismantled)
Britain	185		185
France	348		348
China	161	15	176
India			60–70
Pakistan			60
Israel			80
North Korea			5–12
			~10,195 (~25, 355 if warheads held in reserve and those scheduled to be dismantled are included)

* Source: Shannon N. Kile, Vitaly Fedchenko, and Hans M. Kristensen, "Appendix 8A. World Nuclear Forces, 2008," *SIRPI Yearbook 2008: Armaments, Disarmament, and International Security* (New York: Oxford University Press, 2008), p. 367. Although the total number of nuclear weapons produced by North Korea is unknown, the estimate of 5–12 weapons is based on the amount of weapon-grade plutonium Pyongyang is believed to have produced. See Center for Defense Information, "The World's Nuclear Arsenals: Updated July 30, 2008," accessed at http://www.cdi.org/friendlyversion/printversion.cfm?documentID=2972&from_page=../program/document.cfm on October 14, 2008.

nuclear weapons held by the United States, Britain, France, and Russia are believed to be equipped with security measures called permissive action links (PALs), which would make it very difficult for unauthorized users to activate and detonate them.[139] PALs were first employed on some US nuclear weapons in the early 1960s, and consisted of relatively simple, five-digit locks on warhead containers. Modern PALs are integrated directly into the warheads themselves, require the input of dual six- or twelve-digit numeric codes (the "two man" rule), and may also include "limited try" features that disable the weapon if the incorrect code is entered too many times, sensors that can detect unauthorized entry attempts into the weapon or the PAL system and then render the entire device inoperable, and command codes that can be used to disable a weapon if its security is in jeopardy. Modern weapons may also be equipped with environment sensing devices (ESDs) that prevent them from being armed until specific environmental conditions matching their intended delivery method—for example, changes in altitude or acceleration—are detected.[140]

It might be possible for a terrorist group to overcome these security measures given enough time, especially if it obtained the assistance of experts, or if a weapon was equipped with older, less complex PALs.[141] Nevertheless, if a weapon was stolen and a massive recovery effort was launched, the time needed to overcome any built-in security measures would increase the probability that the terrorist group would be discovered before it could transport the weapon to its intended target and detonate it. Alternatively, a group could attempt to remove the fissile material from a stolen weapon and then use that material to construct its own improved nuclear device, a possibility that is discussed in greater detail below. Doing so would, however, risk setting off the weapon's conventional explosives.[142] Moreover, modern nuclear weapons may not have enough fissile material in their core to fuel a crude IND.[143]

These factors suggest that the possibility of terrorists stealing and then using an intact nuclear weapon, although real, is relatively small. Nevertheless, fears of "loose" nuclear weapons persist, especially with regard to Russia and Pakistan. Russia, for example, remains a source of concern for a number of reasons. While efforts to help the Russian government reduce, consolidate, and secure its nuclear arsenal have been underway for more than a decade, the sheer size of that arsenal, incomplete accounting of Russian's weapon stockpiles, and limited or problematic safety measures at

The possibility of terrorists stealing and then using an intact nuclear weapon, although real, is relatively small.

139 Ibid., p. 62.

140 Ibid., pp. 61–62; and Gregory F. Giles, "Safeguarding the Undeclared Nuclear Arsenals," *The Washington Quarterly*, Spring 1993.

141 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 128.

142 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 63.

143 Matthew Bunn and Anthony Weir, "The Seven Myths of Nuclear Terrorism," *Current History*, April 2005, p. 156. Even if a stolen weapon contained enough fissile material for an IND, if that material was plutonium terrorists would have to construct an implosion-type nuclear device, which is significantly more complex than a gun-type nuclear device.

its nuclear facilities have contributed to lingering questions over Moscow's ability to safeguard its weapons, even with US assistance.[144] In addition, Russian nuclear weapons have a much shorter shelf life than US weapons, and must be remanufactured every eight to twelve years. This requires them to be transported, during which time they are more vulnerable to potential attackers.[145] Finally, older Russian tactical nuclear weapons — some of which may still be deployed — are not believed to incorporate PALs or other modern safeguards.[146] These weapons remain a significant source of concern; as Secretary of Defense Robert Gates has recently remarked, "I have fairly high confidence that no strategic or modern tactical nuclear weapons have leaked [from Russia]. What worries me are the tens of thousands of old nuclear mines, nuclear artillery shells and so on, because the reality is the Russians themselves probably don't have any idea how many of those they have or, potentially, where they are."[147]

Older Russian tactical nuclear weapons are not believed to incorporate PALs or other modern safeguards.

While concerns over the status of Russia's nuclear weapons date to the end of the Cold War, the security of Pakistan's weapons quickly became a pressing issue for the United States Government in the aftermath of the 9/11 attacks and the subsequent revelation of bin Laden's meeting with two Pakistani nuclear scientists. Both of these events led the United States to pressure then-President Pervez Musharraf to address potential vulnerabilities in his nation's nuclear arsenal.[148] Since that time, ongoing political instability and popular unrest, the details of AQ Kahn's proliferation network, multiple failed assassination attempts on Musharraf and the murder of former Prime Minister Benazir Bhutto, and lingering suspicions that members of the Pakistani Army and the Inter-Services Intelligence continue to sympathize with and perhaps even support violent Islamist groups have intensified fears that Pakistan's nuclear weapons may not be safe. The most worrisome developments, however, have been the growing influence of al Qaeda in Pakistan, its alliance with a resurgent Taliban, and their joint efforts to destabilize the country, which have raised fears that the state could collapse.[149] Not surprisingly, Pakistani officials have repeatedly sought to reassure outsiders that its command-and-control arrangements prevent its weapons from being used without proper authorization, and that the security of its nuclear facilities

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[144] Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 72.

[145] Bruce G. Blair, "The Wrong Deterrence: The Threat of Loose Nukes is One of Our Own Making," *The Defense Monitor*, September/October 2004, p. 1; and Tom Z. Collina and Jon B. Wolfsthal, "Nuclear Terrorism and Warhead Control in Russia," *Arms Control Today*, April 2002.

[146] Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 62; Bunn and Weir, "The Seven Myths of Nuclear Terrorism," p. 157; and US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 128.

[147] Secretary Robert Gates, US Department of Defense, "Nuclear Weapons and Deterrence in the 21st Century," Remarks to the Carnegie Endowment for International Peace, October 28, 2008, accessed at http://carnegieendowment.org/files/1028_transcrip_gates_checked.pdf on October 31, 2008.

[148] Michael Isikoff and Mark Hosenball, "Guarding Pakistan's Nukes," *Newsweek Web Exclusive*, November 7, 2007, accessed at http://www.newsweek.com/id/68890 on October 20, 2008.

[149] Bruce Riedel, "Al-Qa'ida's Resurgence in Pakistan," *CTC Sentinel*, December 2007, pp. 8–10.

is sufficiently robust.[150] Nevertheless, the possibility of a terrorist group stealing a nuclear weapon with or perhaps even without insider assistance appears particularly acute in Pakistan given its continuing instability.

Several factors do suggest that Pakistan's nuclear weapons remain secure, although the onset of a massive civil disturbance or full-scale internal conflict could obviously render the effectiveness of any security measures questionable. In recent years, the Pakistani government appears to have undertaken a number of important steps, including the implementation of a more rigorous personal reliability program—one targeted at rooting out religious extremists—for members of its nuclear program and the development of its own PALs, which were apparently absent from its nuclear weapons several years ago.[151] The United States has assisted in some of these efforts, spending nearly $100 million to train and equip Pakistani security personnel and bolster physical security at nuclear facilities.[152] Perhaps most important, however, is that Pakistan reportedly keeps the fissile cores of its weapons separate from their non-nuclear detonators, which would make it extremely difficult for terrorists to steal an entire nuclear weapon.[153] Ultimately, even in the wake of Benazir Bhutto's assassination and the upheaval that followed, the US intelligence community concluded that "the ongoing political uncertainty in Pakistan has not seriously threatened the military's control of the nuclear arsenal, but vulnerabilities exist . . . we judge that the Army's management of nuclear policy issues—to include physical security—has not been degraded by Pakistan's political crisis."[154]

The possibility of a terrorist group stealing a nuclear weapon appears particularly acute in Pakistan given its continuing instability.

ALTERNATIVE 4: BUILDING AN IMPROVISED NUCLEAR DEVICE

Of the various pathways by which terrorists might attempt to acquire a nuclear weapon, including those discussed above, perhaps none has been the subject of as much attention and concern in recent years as the possibility of a group constructing its own improvised nuclear device, either entirely on its own or with the assistance of any

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[150] See, for example, John Glionna, "Pakistan Says its Nuclear Arsenal is Secure," *Los Angeles Times*, January 27, 2008; and Peter Crail, "Pakistan Defends Nuke Security Amid Instability," *Arms Control Today,* March 2008.

[151] Peter Wonacott, "Inside Pakistan's Drive to Guard it's A-Bombs," *Wall Street Journal,* November 29, 2007; Kenneth N. Luongo and Brig. Gen. (Ret.) Naeem Salik, "Building Confidence in Pakistan's Nuclear Security," *Arms Control Today*, December 2007; and Gordon Corera, "How Secure Is Pakistan's Bomb?" *BBC News*, February 4, 2008, accessed at http://news.bbc.co.uk/2/hi/south_asia/7225175.stm on October 20, 2008.

[152] David E. Sanger and William J. Broad, "U.S. Secretly Aids Pakistan in Guarding Nuclear Arms," *New York Times*, November 18, 2007.

[153] Luongo and Salik, "Building Confidence in Pakistan's Nuclear Security"; Corera, "How Security Is Pakistan's Bomb?"; Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 79; and Joby Warrick, "Pakistan Nuclear Security Questioned," *Washington Post,* November 11, 2007.

[154] McConnell, Annual Threat Assessment of the Intelligence Community, p. 15.

A crude, gun-type IND would require somewhere between 50 and 100 kilograms of weapon-grade HEU, while an implosion device would require 25 kilograms or less of weapon-grade HEU, or between five and eight kilograms of weapon-grade plutonium.

experts who could be persuaded, bribed, or coerced to provide technical assistance. In fact, analysts have increasingly come to view this scenario not only as a plausible threat but also as the most feasible route for terrorists seeking nuclear weapons, for two main reasons: the large stockpiles of fissile material that can be found throughout the world in military as well as civilian facilities, some of which are inadequately monitored and protected; and the relative ease of building a crude nuclear device once a sufficient amount of this material has been obtained. As the report issued by the Baker-Cutler Task Force described the threat, "In a worst-case scenario, a nuclear engineer graduate with a grapefruit-sized lump of HEU or an orange-sized lump of plutonium, together with material otherwise readily available in commercial markets, could fashion a nuclear device that would fit in a van like the one . . . parked in the World Trade Center in 1993."[155]

Acquiring Fissile Material

How much HEU or plutonium would a terrorist group have to accumulate if it was attempting to construct its own fission weapon, and where might it obtain this material? The amount needed would depend on several factors, including the isotopic composition of the HEU or plutonium, the presence or absence of weapon components such as a neutron reflector that could significantly reduce the quantity of fissile material that would be required, and most importantly the design of the weapon itself.

As described above, a gun-type device assembles a supercritical mass relatively slowly, and therefore cannot use plutonium as its fuel; it requires HEU, which has a larger critical mass. Moreover, because it compresses the fissile material in its core, an implosion device using HEU would require significantly less material than a gun-type weapon. Based on these boundary conditions, as well as the likely technical sophistication of a terrorist group (or lack thereof), most estimates suggest that a crude, gun-type IND would require somewhere between 50 and 100 kilograms of weapon-grade HEU, while an implosion device would require on the order of 25 kilograms or less of weapon-grade HEU, or between five and eight kilograms of weapon-grade plutonium.[156]

These estimates could vary significantly, however, due to several factors. For example, if a terrorist group attempted to build a gun-type weapon and was somehow able to fashion a neutron reflector from beryllium, then the amount of material required

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155 US Department of Energy, The Secretary of Energy Advisory Board, *A Report Card on the Department of Energy's Nonproliferation Programs with Russia*, Howard Baker and Lloyd Cutler, Co-Chairs, Russia Task Force, January 10, 2001, p. vi.

156 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 132, 135; Matthew Bunn, *Securing the Bomb 2007*, pp. 2, 19; Levi, *On Nuclear Terrorism*, p. 35; and Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman, and Jacob Weechsler, "Can Terrorists Build Nuclear Weapons?" Paper Prepared for the International Task Force on the Prevention of Nuclear Terrorism, 1987, accessed at http://www.nci.org/k-m/makeab.htm on October 13, 2008.

could be reduced considerably, perhaps by as much as 50 percent.[157] If, on the other hand, terrorists acquired HEU enriched to substantially less than 90 percent U-235, or reactor-grade plutonium that contained significantly less than 90 percent Pu-239, then the amount of material needed would increase, particularly in the case of HEU. Finally, in most cases the amount of fissile material that would have to be acquired would exceed the amount needed to build a weapon, perhaps by a significant margin, because processing the fuel into a pure metallic form and then casting and machining the HEU or plutonium into the appropriate shape (or shapes) would likely result in the loss of some material.[158]

In most cases the amount of fissile material that would have to be acquired would exceed the amount needed to build a weapon, perhaps by a significant margin.

Where could a terrorist group potentially gain access to a sufficient amount of fissile material? There are several areas of concern. One is the possibility that terrorists could make a black market purchase of material that had previously been stolen or diverted, perhaps from Russia's large stockpiles during the tumult of the 1990s. According to George Tenet, in 2002 President Bush asked Russian President Vladimir Putin whether all Russian nuclear material was accounted for. Putin responded that he could only account for this material during his tenure, implying that some material may have gone missing during Boris Yeltsin's presidency.[159] In 2004, the US National Intelligence Council concluded that "undetected smuggling has occurred [in Russia], and we are concerned about the amount of material that could have been diverted or stolen in the last 13 years."[160]

The black market is, however, opaque by nature. The IAEA's Illicit Trafficking Database does contain 1,340 confirmed incidents "involving unauthorized acquisition (e.g., by theft), provision, possession, use, transfer, or disposal" of nuclear explosive and radioactive materials between 1993 and 2007, including 303 incidents of "unauthorized possession and related criminal activity," such as attempts to illicitly buy or sell these materials. Only eighteen of these incidents involved either HEU or plutonium, however, and in most cases the total quantity of material amounted to only a few dozen grams; none of the reported incidents involved more than three kilograms of HEU or plutonium.[161] Although this is far less than what is required to build a nuclear

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157 Ferguson and Potter, *The Four Faces of Nuclear* Terrorism, p. 132. Beryllium is closely regulated, however, and using it would require specialized tools, further complicating terrorists' efforts to build their own weapon. Ibid., p. 132; and Anna M. Pluta and Peter D. Zimmerman, "Nuclear Terrorism: A Disheartening Dissent," *Survival*, Summer 2006, p. 64.

158 Morten Bremer Maerli, Annette Schaper, and Frank Barnaby, "The Characteristics of Nuclear Terrorist Weapons," *American Behavioral Scientist*, February 2003, p. 736; and Mark, et al., "Can Terrorists Build Nuclear Weapons?"

159 Tenet, *At the Center of the Storm*, p. 272.

160 US National Intelligence Council, *Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces*, (December 2004), p. 3, accessed at http://www.dni.gov/nic/PDF_GIF_otherprod/russiannuke04.pdf on October 18, 2008.

161 International Atomic Energy Agency, Office of Nuclear Security, "IAEA Illicit Trafficking Database (ITDB) Factsheet," accessed at http://www.iaea.org/NewsCenter/Features/RadSources/PDF/fact_figures2007.pdf on October 13, 2008.

weapon, the database is limited by the fact that it primarily includes incidents that were reported by nations that voluntarily participate in the program. There is also the possibility that the small amounts of material discovered were merely samples. Finally, the database can obviously include only those instances in which traffickers were actually caught by the authorities. Whether other, more successful transactions involving larger quantities of fissile material have occurred is unknown.

Irrespective of what may or may not have found its way onto the black market in the past, there are still some 1,900 metric tons of HEU and separated plutonium in the world's fissile material stockpiles according to the most recent estimates (the breakdown of these figures by type of fissile material and country is summarized in Table 2). These materials can be found in different forms, but a terrorist group hoping to construct a nuclear weapon would certainly prefer to acquire HEU or plutonium in its metallic form, which could be used to fuel a weapon without additional chemical processing.

TABLE 2. **GLOBAL STOCKPILES OF FISSILE MATERIAL** (METRIC TONS)*

Country	National Stockpiles of HEU (93% enriched equivalent)	Military Stockpiles of Separated Plutonium	Civilian Stockpiles of Separated Plutonium
United States	508 (actual tons of HEU)	92 (53.9 declared excess)	
Russia	770 +/-300	145 (34-50 declared excess)	42.4
China	20 +/- 4	4	
Britain	23.4	7.9 (4.4 declared excess)	81.3
France	36.4 +/- 6	5 +/- 1	52.4
India	.2 +/- .1	.65 +/- .13	5.4
Pakistan	1.4 +/- .3	.08 +/- .016	
North Korea		.035 +/- .078	
Israel		.45 +/- .11	
Belgium			3.7
Germany			15 in France, Germany, and the UK
Japan			6.7 in Japan, 38 in France and the UK
Non-nuclear weapon states	10		
Total	~1370	~255 +/- 27 (≤100 declared excess)	244.9

* Source: Harold Feiveson, Alexander Glaser, Zia Mian, and Frank von Hippel, "Appendix 8B. Global Stockpiles of Fissile Materials, 2007," *SIRPI Yearbook 2008*, pp. 399–401.

Metallic fissile material would most likely be located in the weapons production, assembly, or disassembly facilities of a nuclear-weapon state, or at a reprocessing plant that produced weapon-grade plutonium for military use.[162] Although ideal for terrorists, this material is also likely to be the most securely guarded and difficult to obtain; doing so would necessitate either significant insider assistance, a large and well-armed group to overwhelm a facility's on-site and backup security forces, or both. Of course, this does not mean that these facilities are completely secure. For example, the US Departments of Energy and Defense have worked for more than a decade to improve security at facilities in Russia and other former Soviet republics. There have even been concerns regarding the potential vulnerability of US nuclear facilities and the adequacy of their security measures.[163] These concerns, along with costs associated with maintaining a high level of security at multiple facilities, have prompted the removal of fissile material from some of the national weapons laboratories and their subsequent consolidation at a smaller number of sites.[164]

Metallic fissile material would most likely be located in the weapons production, assembly, or disassembly facilities of a nuclear-weapon state.

Given the difficulties of acquiring metallic fissile material directly, a terrorist group could pursue other options. For example, separated plutonium might be found at civilian reprocessing facilities or mixed oxide (MOX) fuel fabrication plants, but this material would likely be in the form of an oxide powder.[165] If a terrorist group managed to steal plutonium from either facility, or during transport from the former to the latter,[166] there is a strong possibility that it would attempt to reduce the plutonium to its metallic form and alloy it with another metal to make it easier to work with; although plutonium oxide could be used directly in an implosion device, this would increase both the amount of material that was required and the probability that the weapon would fizzle, or achieve a lower than expected yield when detonated.[167] Processing the material into a metal would further complicate the task of

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[162] Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 120–121.

[163] See, for example, Mark Hertsgaard, "Nuclear Insecurity," *Vanity Fair*, November 2003.

[164] National Nuclear Security Administration (NNSA), "Press Release: NNSA Approves Final Analysis of Plan to Transform and Downsize Nuclear Weapons Complex," October 9, 2008, accessed at http://nnsa.energy.gov/news/2175.htm on October 15, 2008.

[165] Potter and Ferguson, *The Four Faces of Nuclear Terrorism*, p. 121. MOX reactor fuel contains approximately four to seven percent plutonium oxide (which plays the same role as U-235 in LEU reactor fuel) combined with depleted uranium oxide (uranium that has had most of its U-235 removed during the enrichment process and consists almost entirely of U-238).

[166] Fissile materials are particularly vulnerable when transported. According one estimate, over the next 15 years there will be an average of 100 commercial shipments per year worldwide containing approximately 300 kilograms of civilian plutonium. International Panel on Fissile Materials, *Global Fissile Material Report 2007: Developing the Technical Basis for Policy Initiatives to Secure and Irreversibly Reduce Stocks of Nuclear Weapons and Fissile Materials*, October 2007, p. 17, accessed at http://www.fissilematerials.org/ipfm/site_down/gfmr07.pdf on October 23, 2008.

[167] Mark, et al., "Can Terrorists Build Nuclear Weapons?"; Maerli, et al, "The Characteristics of Nuclear Terrorist Weapons," p. 733; and Levi, *On Nuclear Terrorism*, pp. 77–79. Because of its lower density, the critical mass for plutonium oxide is significantly larger than that of plutonium metal.

producing a weapon, though the ability to do so "could certainly be within the reach of a dedicated technical team."[168]

In theory, terrorists could also pursue an even more difficult route — stealing spent power reactor fuel or fresh (unirradiated) MOX fuel, both of which would need to have their plutonium chemically extracted. While separating the plutonium could be done with appropriate equipment, neither scenario poses much of a danger. Nuclear fuel assemblies are not only quite large, they are also extremely radioactive — emitting enough radiation to give thieves a lethal dose almost immediately — and are therefore considered "self-protecting" for decades after they are removed from a reactor. Moreover, because plutonium comprises only 1 percent of spent nuclear fuel, approximately one metric ton would be needed to obtain a sufficient amount of plutonium for a weapon. In addition, while MOX fuel is not very radioactive, it also contains only a small portion of plutonium, and between 150 and 250 kilograms would therefore be required to obtain enough plutonium for a weapon.[169]

One of the greatest sources of concern at present involves civilian research reactors, many of which use HEU containing 90–93 percent U-235 as their fuel.

While the aforementioned routes to acquiring fissile material all present significant difficulties for terrorists, one of the greatest sources of concern at present involves civilian research reactors, many of which use HEU containing 90–93 percent U-235 as their fuel. According to recent estimates, there are approximately 140 such reactors operating in forty countries, which between them have more than 50 metric tons of HEU. A number of these facilities do not have enough HEU on site to build a weapon, meaning that terrorists might have to target multiple locations to obtain enough material. Nevertheless, there are 128 facilities with at least 20 kilograms of HEU, which could be enough to construct an implosion device (although more than 20 kilograms would be required for a gun-type device).[170]

Despite the limited and dispersed quantities of HEU in civilian facilities, the danger posed by research reactors stems largely from the small size of their fuel elements in comparison to the large fuel rods and assemblies found in power reactors, and, most importantly, their weak security and high vulnerability in comparison to military facilities.[171] For example, the Department of Energy's (DOE) National Nuclear Security Administration (NNSA) recently assisted in the transport of 341 pounds of irradiated HEU — in theory enough material for six nuclear weapons — from a research reactor in Budapest, Hungary, to a storage facility in Russia. When asked about the security at

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168 Mark, et al., "Can Terrorists Build Nuclear Weapons?"

169 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 122–124; and George Bunn and Chaim Braun, "Terrorism Potential for Research Reactors Compared With Power Reactors: Nuclear Weapons, 'Dirty Bombs,' and Truck Bombs," *American Behavioral Scientist*, February 2003, p. 718.

170 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 135; Bunn, *Securing the Bomb 2007*, pp. 9, 32–33; Bunn and Braun, p. 717; and Alexander Glaser and Frank N. von Hippel, "Thwarting Nuclear Terrorism," *Scientific American*, February 2006, p. 58.

171 Bunn, *Securing the Bomb 2007*, p. 13. In addition, spent HEU fuel from a research reactor may be only lightly irradiated, and would therefore retain a high concentration of U-235 and be much less radioactive then spent fuel from a power reactor. See ibid., p. 34.

the research reactor site, an NNSA official noted, "they had a fence and a guard."[172] If a terrorist group did manage to steal enough research reactor fuel to build a weapon, they would have to take the step of processing the fuel elements to separate the uranium from the aluminum that it is often alloyed with and then reduce it to a metallic form, but this would not be a particularly difficult task.[173] As one assessment notes, "the chemical processing required is less sophisticated than some of the processing criminals routinely do in the illegal drug industry."[174]

Constructing a Weapon

Presuming that terrorists did manage to acquire enough fissile material to fuel a weapon and were able to process it into metal and then cast and machine it into the appropriate size and shape, could they construct a functional IND? Unfortunately, there is widespread agreement that acquiring the fissile material is in fact more difficult than building a device, especially in the case of a gun-type weapon.[175] Consequently, most assessments of this question conclude that a determined and well-funded terrorist group could, in a relatively short period of time and even without the assistance of scientists or engineers, build a crude nuclear weapon that would have a significant chance of producing a yield somewhere between one and possibly as many as 20 kilotons.

Most assessments conclude that a determined and well-funded terrorist group could build a crude nuclear weapon.

Several factors suggest that the knowledge, skills, and technology required to build an improvised nuclear device are not necessarily beyond the reach of a well-funded terrorist group. For example, while blueprints for nuclear weapons are highly classified, and producing detailed specifications for a weapon would take no small amount of time and effort,[176] the basic principles of nuclear weapons—particularly first generation gun-type and implosion designs—are no secret, and the equipment needed to produce them is over half a century old. According to one government assessment, "Although successfully designing a nuclear explosive device requires individuals with expertise in metallurgy, chemistry, physics, electronics, and explosives, the required technology dates back to the 1940s, and the basic concepts of nuclear bombs have been widely known for some time. Much of the relevant physics for a workable design is available in published sources."[177] Moreover, as the State Department's most recent report on terrorism also notes, this information continues to be disseminated widely

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172 H. Josef Hebert, "Official Describes Secret Uranium Shipment," Associated Press, October 22, 2008, accessed at http://ap.google.com/article/ALeqM5iz6IB135r62eNRzhSAnVsaA90VPwD93VR6QO0 on October 22, 2008.

173 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 136.

174 Bunn, *Securing the Bomb 2007*, p. 6.

175 Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 116.

176 Mark, et al., "Can Terrorists Build Nuclear Weapons."

177 US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, p. 149.

through the Internet and is only becoming more accessible, increasing the prospects that a terrorist group could successfully build an IND.[178]

In addition, despite having fewer resources than a state, a terrorist group seeking to construct a nuclear weapon would have a much more modest goal. Whereas a state would be interested in developing an arsenal of safe, reliable devices that were small and sturdy enough to be delivered by a plane or missile, a terrorist group would likely be willing to settle for something far easier to produce—a crude, inefficient weapon that would only need to fit into a cargo container or a small truck, and which might not achieve its intended yield but would nonetheless cause significant damage and tremendous fear, even if it failed to detonate as expected.[179] For these reasons, a report by the Office of Technology Assessment concluded more than three decades ago that if a sufficient amount of fissile material was acquired,

A terrorist group would likely be willing to settle for a crude, inefficient weapon that would only need to fit into a cargo container or a small truck.

> ...a small group of people, none of whom have ever had access to the classified literature, could possibly design and build a crude nuclear device. They would not necessarily require a great deal of technological equipment or have to undertake any experiments. Only modest machine-shop facilities that could be contracted for without arousing suspicion would be required...The group would have to include, at a minimum, a person capable of searching and understanding the technical literature in several fields and a jack-of-all-trades technician...The small non-national group described above would probably not be able to develop an accurate prediction of the yield of their device...However, there is a clear possibility that a clever and competent group could design and construct a device which would produce a significant nuclear yield...[180]

The difficulty of producing a nuclear weapon would, however, depend on the type of device that a terrorist group was attempting to construct. For example, if terrorists acquired either plutonium or an insufficient amount of HEU to fuel the simpler gun-type weapon, they would be forced to construct a more technically complex implosion device. In that case, designing and constructing a firing system capable of generating a uniform shockwave that will compress the fissile core without flattening it, testing the firing system with non-nuclear materials to determine whether or not it will achieve the necessary amount of compression and function effectively, acquiring the large amounts of chemical explosives that would be needed to conduct those tests, and developing a neutron initiator that could start the chain reaction at the appropriate moment would all pose significant challenges.[181] The difficulties associated with building an implosion device would be even greater if a terrorist group

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[178] US Department of State, *Country Reports on Terrorism 2007*, p. 179.

[179] Bunn and Weir, "The Seven Myths of Nuclear Terrorism," p. 7; Pluta and Zimmerman, "Nuclear Terrorism: A Disheartening Dissent," p. 61; Maerli, et al., "The Characteristics of Nuclear Terrorist Weapons," p. 731–732; and Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, p. 97.

[180] US Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (Washington, DC: Government Printing Office, June 1977), pp. 140–141, accessed at http://www.princeton.edu/~ota/ns20/topic_f.html on October 13, 2008.

[181] Bunn and Holdren, "Nuclear Weapons Design & Materials."

acquired reactor-grade plutonium for a weapon. Not only would the higher neutron emission rate from plutonium isotopes other than Pu-239 make building the weapon more complex, but the increased heat and radioactivity would also make handling the material more difficult and could adversely affect the weapon's non-nuclear components.[182] These challenges would not, however, be insurmountable for a determined and well-funded terrorist group, especially one that counted scientists and/or engineers among its members or was able to recruit outside support. According to one analysis, "An implosion-type bomb does not . . . require as extreme a level of sophistication as is sometimes imagined. Today, with the knowledge that it can be done and substantial unclassified literature on the underlying physics, materials properties, and explosives . . . the challenge, though still significant, would be less than during the Manhattan Project."[183]

By comparison, if terrorists acquired an adequate amount of HEU to build a gun-type weapon, their task would be considerably easier; as Charles Ferguson, William Potter, and their coauthors note, "Because of the inherent simplicity of a gun-type device, designing and constructing it would be relatively straightforward." In fact, this design was not even tested before being used for the first time over Hiroshima in 1945, due in large part to the confidence its designers had that it would function properly.[184] According to one recent estimate, a gun-type device could potentially be built in as little as two months, while an implosion device would take closer to a year to complete.[185] Another, more detailed analysis concludes that constructing a gun-type device would take approximately one year, cost roughly two million dollars (not including the cost of acquiring HEU on the black market), and would produce a weapon that could fit inside a van or a small truck.[186]

The relative ease of building this type of device is a particular concern given the types of individuals that al Qaeda has managed to recruit in the past. According to Peter Bergen, "The terrorists who have succeeded in carrying out spectacular attacks against Western targets in the past have been college-educated, technically proficient men who are capable of manufacturing and deploying chemical, radiological, and biological weapons. At some point they could also assemble a crude 'gun-type' nuclear

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[182] However, because of its high rate of spontaneous fission, an implosion weapon built with reactor-grade plutonium might not require a neutron generator, which would simplify building the device. Potter and Ferguson, *The Four Faces of Nuclear Terrorism*, p. 136.

[183] Matthew Bunn and Anthony Weir, "Terrorist Nuclear Weapon Construction: How Difficult?" *Annals of the American Academy of Political and Social Science*, September 2006, p. 142. See also Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, pp. 136–137; and Zimmerman, "Technical Barriers to Nuclear Proliferation," pp. 346–347.

[184] Ferguson and Potter, *The Four Faces of Nuclear Terrorism*, p. 134.

[185] Pluta and Zimmerman, "Nuclear Terrorism: A Disheartening Dissent," p. 64.

[186] Peter D. Zimmerman and Jeffrey G. Lewis, "The Bomb in the Back Yard," *Foreign Policy*, November/December 2006.

device and detonate it in a European city." In short, "Al Qaeda attracts the kind of highly educated men who one day might be able to pull off such an attack."[187]

SUMMARY

The possibility that a terrorist group such as al Qaeda could one day obtain a nuclear weapon is real, and the extraordinary consequences of a nuclear terrorist attack—even one using a crude and inefficient improvised nuclear device—dictate that preventing this threat from ever materializing should be a priority for the United States Government. At the same time, it is important not to exaggerate the likelihood of an attack; any terrorist group that chose to pursue the nuclear option would confront a host of obstacles, regardless of which path it followed.

For all intents and purposes, the prospect of terrorists manufacturing their own fissile material for use in a weapon can be discounted; this task has proven too difficult for a number of states, and the knowledge, resources, and infrastructure it would require far exceed what a terrorist group could accumulate, let alone in secret. The possibility of a terrorist group receiving a nuclear weapon from a state sponsor, while certainly greater than the possibility of a group creating its own HEU or plutonium, is also quite small. Of course, there is always a chance that an irrational, malevolent, or extremely risk-acceptant government could provide a nuclear weapon to a terrorist client if it sought to attack the United States indirectly or had no other means of delivery. While this scenario cannot be ignored, neither should it be a focus of US efforts to prevent nuclear terrorism, especially if addressing this one comparatively remote possibility comes at the expense of addressing more plausible alternatives. The prospect of a rogue element within a state's military or its scientific community providing a nuclear weapon, fissile material, and/or expertise to a terrorist group is more conceivable.

A somewhat more likely scenario involves stealing an intact nuclear weapon—perhaps with insider assistance—from a state like Russia or Pakistan. While the former has a large arsenal, parts of which may not be sufficiently well protected or accounted for and thus vulnerable to theft, the latter has a small and closely guarded arsenal, but one that could quickly become vulnerable if the country experiences widespread civil conflict or state failure. Even in these cases, however, the presence of various safety measures on most weapons suggests that the prospect of a terrorist group acquiring an intact weapon that it could actually use is fairly low. Finally, the most significant threat centers on the possibility of a group purchasing fissile material on the black market or stealing it from a military or civilian facility and then using it to construct an IND. Here, the principal challenge for terrorists is that while a gun-type

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[187] Peter Bergen, "Al Qaeda, the Organization: A Five Year Forecast," *Annals of the American Academy of Political and Social Science*, July 2008, p. 26. See also Michael Scheuer, "Al-Qaeda's Next Generation: Less Visible and More Lethal," *Terrorism Focus*, October 4, 2005, p. 5.

weapon would be relatively easy to build, it requires a significant amount of HEU, perhaps more than could be stolen from a single research reactor—the most vulnerable potential target. At the same time, less HEU and a very small amount of plutonium would be needed to fuel an implosion weapon, but building this device would prove extremely difficult. Nevertheless, the existence of inadequately secured fissile material, the possibility that terrorists could indeed build an implosion weapon, and the widespread consensus that building a gun-type device would not be an insurmountable challenge for a determined and well-funded terrorist group if it acquired enough HEU all make this threat particularly salient.


JOINT SPECIAL OPERATIONS

CHAPTER 4 > **DEVELOPING A RESPONSE**

There is no uniform solution to the danger of nuclear terrorism. Rather, any strategy that attempts to address this threat should include a number of different elements, such as efforts to improve the security of existing nuclear weapons and material; diplomatic, economic, and perhaps even military policies directed at halting or at least limiting the further proliferation of nuclear weapons, fissile material, and the technology and infrastructure needed to produce the latter; a counterterrorism campaign to weaken terrorist groups and disrupt their plans; the continued deployment of radiation sensors at domestic and international ports and border crossings to detect a smuggled weapon or nuclear-explosive material; intelligence-sharing measures such as the Proliferation Security Initiative; and many others. At the most basic level, however, a comprehensive strategy should be structured around three core objectives:

1) Preventing terrorists from acquiring nuclear weapons or fissile material;

2) Stopping terrorists from delivering a nuclear weapon to their intended target should prevention fail; and

3) Being prepared to respond as quickly and effectively as possible, both at home and abroad, in the event that terrorists succeed in detonating one or more nuclear weapons.

Attempting to develop a comprehensive strategy that encompasses all three objectives is a formidable task, one that goes beyond the scope of this report. Nevertheless, the remainder of this chapter examines each of these objectives in greater detail and suggests options for achieving them. The primary focus, however, is on ensuring that terrorists do not obtain nuclear weapons or material, preferably by taking steps that will discourage them from pursuing these items in the first place.

KEEPING TERRORISTS FROM THE BOMB

The first and most important way to prevent a nuclear terrorist attack is to make certain that terrorists do not acquire an intact weapon or a sufficient amount of fissile material to build one on their own. Once either of these steps has been achieved, thwarting an attack by a determined terrorist group will ultimately depend on locating any missing fissile material before a weapon can be assembled or intercepting a device before it can be delivered to the target and detonated, both of which are extremely challenging tasks that cannot be relied upon as a primary line of defense.[188] Achieving this objective requires adopting a multi-dimensional approach that significantly decreases the prospect that terrorists will succeed at each major stage in their plot — obtaining a nuclear weapon, transporting the weapon to their target, and enjoying the benefits they anticipate will result from a nuclear attack. Not only will such an approach increase the likelihood that prospective nuclear terrorists will fail in their efforts (or decrease the possibility that they can succeed at an acceptable or feasible cost), it could also dissuade terrorists from seriously pursuing the nuclear option at all.[189]

Deterrence versus Dissuasion

It has become a widely accepted proposition that terrorist groups like al Qaeda cannot be deterred from conducting an attack — including an attack using nuclear weapons if they manage to acquire them — because their willingness to die for their cause, along with the relative anonymity that comes from having no clear "return address" that can be targeted in response to an attack, makes them immune to the prospect of retaliation.[190] This view was expressed in the 2002 *National Security Strategy,* which noted, "Traditional concepts of deterrence will not work against a terrorist enemy whose avowed tactics are wanton destruction and the targeting of innocents; whose so-called soldiers seek martyrdom in death and whose most potent protection is statelessness."[191]

The implication often drawn from this assessment is that only proactive, offensive measures stand any real chance of preventing future terrorist attacks. For example, while the 2006 *National Security Strategy* presented a more qualified criticism of deterrence than its precursor, it still maintained that the United States "can no longer

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188 The issue of detecting nuclear weapons and material is addressed in greater detail below.

189 In more general terms, dissuasion involves taking actions that alter a target's cost/benefit calculation and discourage it from developing or otherwise acquiring a threatening military capability. See Andrew F. Krepinevich and Robert C. Martinage, *Dissuasion Strategy* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008).

190 There are debates, however, over whether or not this is in fact the case. See, for example, Robert F. Trager and Dessislava P. Zagorcheva, "Deterring Terrorism: It Can Be Done," *International Security*, Winter 2005/06.

191 *The National Security Strategy of the United States of America* (2002), p. 15.

simply rely on deterrence to keep the terrorists at bay or defensive measures to thwart them at the last moment. The fight must be taken to the enemy, to keep them on the run."[192] Not surprisingly, efforts to capture and kill key terrorist operatives have arguably been the focus of the US Government's efforts against al Qaeda and other violent groups since 9/11.[193] Yet this approach has its limitations as well, which have been demonstrated over the past several years. As noted in Chapter 1, despite the relentless pressure that has succeeded in killing and capturing a number of mid- and upper-level al Qaeda operatives, the group has proven quite adept at regenerating precisely these elements of its organizational structure.[194] Therefore, while measures to weaken al Qaeda will undoubtedly play a crucial role in averting future mass casualty attacks by removing key operatives and applying the continuous pressure that inhibits terrorists' ability to plan, organize, and conduct large scale operations, these efforts may not be sufficient to prevent or disrupt a nuclear terrorist plot.

Despite the problems associated with deterring terrorists, it may be possible to dissuade them from devoting substantial time, effort, and resources toward obtaining nuclear weapons.

Yet offensive measures, while important, are not the only alternative (or complement) to traditional methods of deterrence. Despite the problems associated with deterring terrorists, it may be possible to dissuade them from devoting substantial time, effort, and resources toward obtaining nuclear weapons in the first place. In other words, if steps can be taken to convince terrorists that they cannot purchase or steal nuclear weapons or material (or that the costs of doing so are too high and the difficulties are too great), that even if they do obtain these items it will be extremely difficult to smuggle them into the United States and deliver them to their target without being discovered, and that a successful attack will ultimately prove counterproductive to their underlying objectives, then they may choose to abandon their nuclear aspirations and turn their attention elsewhere.[195]

The importance of dissuasion has already been recognized in a number of key strategic documents over the past several years. For example, the 2006 *National Security Strategy* notes that the United States will endeavor to "convince our adversaries that they cannot achieve their goals with WMD, and thus deter and dissuade them from

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[192] *The National Security Strategy of the United States of America* (2006), p. 8.

[193] See, for example, Tenet, *At the Center of the Storm*, pp. 239–240.

[194] Hoffman, *Inside Terrorism*, p. 284.

[195] A strategy of dissuading terrorist groups from pursuing nuclear weapons also overlaps with a strategy of deterrence by denial—building defensive capabilities robust enough to convince an adversary that it will be unable to succeed in its attack and achieve its goals at an acceptable price—insofar as measures which decrease the likelihood that terrorists will be able to employ a nuclear weapon successfully (for example, by deploying detection systems capable of locating a weapon before it is delivered to its target) should also decrease the likelihood that a terrorist group will attempt to acquire nuclear weapons in the first place (or should reduce the level of effort the group devotes toward this end versus other methods of attack). For applications of deterrence by denial to the threat of terrorism, see Joseph Lepgold, "Hypotheses on Vulnerability: Are Terrorists and Drug Traffickers Coerceable?" in Lawrence Freedman, ed., *Strategic Coercion: Concepts and Cases* (New York: Oxford University Press, 1998); Wyn Q. Bowen, "Deterrence and Asymmetry: Non-State Actors and Mass Casualty Terrorism," *Contemporary Security Policy*, April 2004; and David P. Auerswald, "Deterring Nonstate WMD Attacks," *Political Science Quarterly*, Winter 2006.

Despite its interest in nuclear weapons, the majority of al Qaeda's time and resources have been devoted to supporting more plausible types of attacks.

attempting to use or even acquire these weapons in the first place."[196] Can terrorist groups like al Qaeda be dissuaded from pursuing nuclear weapons? While it is impossible to say for certain, it appears to be a distinct possibility. Although al Qaeda undoubtedly would like to possess these weapons, it would be a mistake to assume that the group and its members will devote significant and scarce human and material resources to acquiring them if the prospects for doing so are extremely low, if the chances they can transport them undetected to their intended target are extremely small, or if they calculate that a nuclear attack may not in fact serve their larger strategic interests—a smaller possibility, but one that should not be discounted entirely.[197] Instead, most indicators suggest that despite its interest in nuclear weapons, the majority of al Qaeda's time and resources have been devoted to supporting more plausible types of attacks, whether conventional explosives, hijacked commercial aircraft, or even other weapons of mass destruction.

For instance, as noted earlier in this report, bin Laden's deputy Zawahiri emphasized the pursuit of chemical and biological weapons rather than nuclear weapons, in large part because he determined that they were easier to develop. This calculus appears to have prevailed among his cohorts. In 2004, then-Undersecretary of State for Arms Control and International Security John Bolton noted that in terms of al Qaeda's pursuit of WMD, "the overwhelming bulk of the evidence we have is that their efforts are focused on biological and chemical" weapons, because "the technology for bio and chem is comparatively so much easier that that's where their efforts are concentrating."[198] In addition, al Qaeda's own ideological idiosyncrasies may actually facilitate dissuasion and help steer the group away from pursuing nuclear weapons as this option becomes increasingly infeasible. According to Brian Michael Jenkins,

> ...jihadists believe that God's will is expressed in success and failure. To succeed is to have God's support. Failure signals God's disapproval...Catastrophic attacks with unconventional weapons remain jihadist ambitions, but determined fighters with conventional explosives remain the most reliable weapons. Multiple attacks increase death and destruction, but operations with too many moving parts risk failure. Jihadist planners continue to think big but execute conservatively.[199]

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196 *The National Security Strategy of the United States of America (2006)*, p. 18.

197 When discussing dissuasion (as well as deterrence by denial) US strategic documents suggest that consequence management—the ability to contain and minimize the damage caused by an attack—can prevent terrorist from pursuing or using WMD. While consequence management is undoubtedly important, its utility for dissuasion in this case is doubtful. If terrorists are intent on conducting a catastrophic attack, it is difficult to imagine that they could be disabused of the notion that a successfully detonated nuclear weapon would inflict massive devastation, no matter how substantial local, state, and federal consequence management capabilities are.

198 Quoted in Dafna Linzer, "Nuclear Capabilities May Elude Terrorists, Experts Say," *Washington Post,* December 29, 2004.

199 Brian Michael Jenkins, *Unconquerable Nation: Knowing Our Enemy, Strengthening Ourselves* (Santa Monica, CA: Rand Corporation, 2006), p. 81.

Therefore, measures that decrease the prospects for success at each stage of a nuclear terrorist plot will not only yield the direct benefits of thwarting terrorists that attempt to obtain nuclear weapons and material, possibly intercepting these items before they can be used, and reducing the benefits that accrue to the perpetrators of an attack, they may also decrease the probability that a terrorist group will devote significant time and effort toward the pursuit of nuclear weapons and material. The remainder of this section focuses on three specific areas that, individually and especially together, can contribute to dissuasion:

> Delegitimizing the killing of civilians generally and the use of nuclear weapons and other WMD specifically;

> Reducing stockpiles of HEU and plutonium and securing existing weapons and fissile material; and

> Developing and deploying radiation monitors and other detection systems.

Before proceeding, however, it is necessary to mention an important qualification, namely, that successfully dissuading terrorists from pursuing nuclear weapons, while a major accomplishment, could have pernicious second-order consequences. Just as the hardening of government and military facilities led terrorists to shift their focus to so-called "soft" targets that were much more vulnerable, if they also choose to abandon any serious efforts to acquire nuclear weapons and conduct a nuclear attack, they will almost certainly redirect those efforts and the human and material resources that supported them to other, more viable methods of attack, whether convention or unconventional.[200] The United States could, therefore, become a victim of its own success. This point is symptomatic of a larger issue. To the extent that preventing nuclear terrorism is a focus for US foreign and defense policy and draws attention — and perhaps resources as well — away from addressing other aspects of the terrorist threat, the danger posed by more likely types of attacks may grow. This concern is not new, as a number of prominent terrorism analysts have warned against an excessive focus on low-probability WMD scenarios that might inhibit the ability of the US Government to prepare for and defend against more realistic dangers.[201] If one believes that the prospect of a catastrophic attack is what truly makes terrorism an overriding threat, then this potential tradeoff may be acceptable, but there is of course no easy answer to this dilemma.

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[200] Auerswald, "Deterring Nonstate WMD Attacks," p. 554.

[201] See, for example, Hoffman, *Inside Terrorism*, pp. 280–281; Paul R. Pillar, *Terrorism and U.S. Foreign Policy* (Washington, DC: Brookings Institution Press, 2001), pp. 3–5; and John Parachini, "Putting WMD Terrorism into Perspective," *The Washington Quarterly*, pp. 47–48.

Delegitimizing Nuclear Terrorism

Prevailing in the war of ideas can help to prevent future catastrophic terrorist attacks, including acts of nuclear terrorism.

The 2006 National Security Strategy emphasized that "the War on Terror has been both a battle of arms and a battle of ideas...for it is ideas that can turn the disenchanted into murderers willing to kill innocent victims."[202] This theme—that the United States and violent Islamist extremist groups are locked in an ideological competition in which both sides are vying for the sympathy and support of the world's Muslim population—has not only been echoed by a number of experts, it has also been identified as one the most important components of a broader strategy against al Qaeda, its affiliates, and the individuals they inspire, especially in the long run. According to one analysis, "Cutting off the supply of recruits to this movement, eliminating its financial support networks, and preventing it from metastasizing into new regions will...require a campaign to undermine its ideological appeal."[203] Yet the US Government's attempt to fight the "war of ideas" has frequently been singled out as one of the least effective elements of the war on terrorism.[204] As one recent assessment notes, "By any measure, U.S. efforts at communicating with Muslim-majority nations since 9/11 have not been successful. They have lacked energy, focus, and an overarching strategy."[205] In 2006, then-Secretary of Defense Donald Rumsfeld even admitted that the US government had earned poor marks in this area, and only deserved "a 'D' or a 'D plus' as a country as to how well we're doing in the battle of ideas that's taking place in the world today."[206]

Yet improving this situation is critical, because prevailing in the war of ideas can help to prevent future catastrophic terrorist attacks, including acts of nuclear terrorism. Specifically, one way to discourage terrorists from pursuing (or using) nuclear weapons is to take steps that delegitimize their actions in the eyes of their supporters as well as those they are attempting to impress and recruit to their cause.[207] The central goal is to convince terrorists that certain actions—for example, an act of nuclear terrorism—will not help them achieve their aims, but will instead prove counter-

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[202] *The National Security Strategy of the United States of America* (2006), p. 9.

[203] William Rosenau, "Waging the 'War of Ideas'," in David G. Kamien, ed., *McGraw-Hill Homeland Security Handbook* (New York: McGraw-Hill, 2006), p. 1132.

[204] At the same time, al Qaeda's propaganda arm, al-Sahab, has produced a growing number of videos with higher production quality in recent years, posting these videos directly to the Internet in order to disseminate its message. See Bergen, "Return of al Qaeda," *The New Republic*, January 29, 2007; and Whitlock, "The New Al-Qaeda Central."

[205] Hady Amr and P.W. Singer, "To Win the 'War on Terror,' We Must First Win the 'War of Ideas': Here's How," *Annals of the American Academy of Political and Social Science*, July 2008, p. 213. See also Stephen Van Evera, "Assessing U.S. Strategy in the War on Terror," *Annals of the American Academy of Political and Social Science*, September 2006, pp. 15–20; and Rosenau, "Waging the 'War of Ideas'," p. 1132.

[206] Associated Press, "Rumsfeld: U.S. Losing War of Ideas," March 27, 2006, accessed at http://www.cbsnews.com/stories/2006/03/27/terror/main1442811.shtml on September 16, 2008.

[207] Lepgold, "Hypotheses on Vulnerability," p. 144. Efforts can also be made to delegitimize terrorists' broader objectives and thus their very existence, but this is certain to be a more difficult task.

productive by causing these audiences to turn away from them rather than rally to their side. If terrorists can be convinced that a successful catastrophic attack will ultimately backfire, they may grow reluctant to pursue this type of attack in favor of more "acceptable" forms of violence. Due in large part to the inherent difficulties of operationalizing traditional notions of deterrence against transnational terrorist groups, there is now a growing recognition that efforts along these lines can indeed play an important role in preventing future attacks. For example, President Bush's National Security Advisor, Stephen Hadley, acknowledged that "Many terrorists value the perception of popular or theological legitimacy for their actions. By encouraging debate about the moral legitimacy of using weapons of mass destruction, we can try to affect the strategic calculus of the terrorists."[208]

If terrorists can be convinced that a successful catastrophic attack will ultimately backfire, they may grow reluctant to pursue this type of attack.

The fear of alienating existing or potential supporters is one factor that has prevented ideologically and politically motivated terrorists groups from undertaking mass casualty attacks and pursuing WMD in the past. Are al Qaeda and similar groups inhibited in this way, and if not, could they be encouraged to exercise self-restraint? Although the conventional wisdom suggests that religiously motivated terrorists are unlikely to be affected by these kinds of calculations, the difference between "old" and "new" terrorists in this respect may not be quite as large as it seems. For example, one study notes that despite their commitment to violence generally, al Qaeda and its supporters disagree over the strategic value and religious permissibility of different *forms* of violence: "Even the most fanatic . . . debate the acceptability of collateral Muslim casualties. They argue about whether Shia Muslims are potential allies or apostates, and, if the latter, whether they are legitimate targets of violence. They wonder aloud whether tactics such as kidnapping or taking children hostage . . . are counterproductive."[209]

Several developments in particular indicate that al Qaeda is indeed concerned about how it is perceived among the world's Muslim population, and does fear that certain acts might diminish its standing among this audience. One notable example is the central leadership's response to the actions taken by the Jordanian militant Abu Musab al–Zarqawi, who, before he was killed in a US airstrike in June 2006, was the head of AQI. Zarqawi's immediate strategy in Iraq was to isolate the United States by driving out non-US foreign forces and non-governmental organizations, and to precipitate a civil war between Iraq's Sunni and Shiite communities.[210] His brutal methods included indiscriminately killing Shiite civilians with suicide car bombings that often left dozens dead, and murdering hostages and releasing graphic videos of their executions. This earned him a rebuke from bin Laden's chief lieutenant, Zawahiri. In a July 2005 letter, Zawahiri wrote that if al Qaeda and its allies hoped to drive the

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[208] Quoted in Erich Schmitt and Thom Shanker, "U.S. Adapts Cold-War Idea to Fight Terrorists," *New York Times*, March 28, 2008.

[209] Jenkins, *Unconquerable Nation*, p. 84.

[210] Riedel, "Al Qaeda Strikes Back," pp. 27–28.

United States out of Iraq and establish an Islamic regime or the beginnings of a wider caliphate there,

> ...we will see that the strongest weapon which the mujahedeen enjoy...is popular support from the Muslim masses in Iraq, and the surrounding Muslim countries. So, we must maintain this support as best we can, and we should strive to increase it...the mujahed movement must avoid any action that the masses do not understand or approve...[211]

He then gently chastised Zarqawi for his brutality, noting, "the things which the feelings of the Muslim populace who love you and support you will never find palatable...are the scenes of slaughtering the hostages." Ultimately, Zawahiri lectured, "we are in a battle, and...more than half of that battle is taking place in the battlefield of the media...we are in a media battle in a race for the hearts and minds of our Umma [i.e., the wider Islamic community]."[212]

More recently, al Qaeda's popularity has declined in several parts of the world, a development that has been attributed to widespread disgust over the large number of Muslim civilians that have died in attacks conducted by the group and its affiliates in Iraq, North Africa, Pakistan, and elsewhere. It has also been forced to contend with public denunciations by several former supporters and fellow extremists, including Sayyid Imam al-Sharif (also known as Dr. Fadl), once a leading figure in Egyptian Islamic Jihad who has been described as the "ideological godfather" of al Qaeda for his role in articulating the doctrine of takfir (declaring fellow Muslims apostates) and providing the theological justification for killing civilians who did not support armed jihad against the apostate rulers of Middle Eastern nations such as Egypt.[213] These developments appear to have been taken very seriously by al Qaeda's leadership. According to Ted Gistaro, the US National Intelligence Officer for transnational threats,

> ...even as al-Qaeda attempts to push its propaganda in the West, its support has suffered several setbacks among its key constituents. Al-Qaeda's brutal attacks against Muslim civilians are tarnishing its image among both mainstream and extremist Muslims... Al-Qaeda senior leaders in 2008 have devoted nearly half their airtime to defending the group's legitimacy. This defensive tone continues a trend observed since at least last summer and reflects concern over allegations by militant leaders and religious scholars that al-Qaeda and its affiliates have violated the Islamic laws of war, particularly in Iraq and North Africa.[214]

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211 "Letter from al-Zawahiri to al-Zarqawi," dated July 9, 2005 and released by the Office of the Director of National Intelligence on October 11, 2005, accessed at http://www.globalsecurity.org/security/library/report/2005/zawahiri-zarqawi-letter_9jul2005.htm on September 16, 2008.

212 Ibid.

213 Lawrence Wright, "The Rebellion Within," *The New Yorker*, June 2, 2008; and Peter Bergen and Paul Cruickshank, "The Unraveling," *The New Republic*, June 11, 2008. The reference to Fadl as al Qaeda's "ideological godfather" is from Bergen and Cruickshank, "The Unraveling."

214 Ted Gistaro, "Assessing the Fight against al-Qaeda," Prepared Remarks for a Speech to the Washington Institute for Near East Policy, August 12, 2008, accessed at http://www.washingtoninstitute.org/templateC07.php?CID=414 on September 12, 2008.

This preoccupation with public relations was demonstrated in April 2008, when Zawahiri issued a lengthy response to questions that had been posted on Internet forums, which he himself had solicited the previous December. A number of these questions dealt with the moral legitimacy of targeting civilians, and according to an analysis of his responses, Zawahiri "revealed deep-seated worries about the controversies created by al-Qa'ida's killing of innocents."[215]

These developments suggest that al Qaeda may not be so quick to pursue or use a nuclear weapon, given the amount of devastation this would cause, the number of civilians—including Muslims—who would die as a result of such an attack, and the possibility that both of these factors could trigger a significant backlash among its sympathizers and potential followers. As one report notes, "nuclear use does have the potential of provoking revulsion among the very communities that bin Laden is seeking to rally to his restored Muslim Caliphate."[216] In fact, during the earliest debates among al Qaeda's leadership on the value of pursuing WMD, there were some members who cautioned that the use of these weapons would only diminish sympathy for the group's cause and the cause of Muslims generally.[217]

The US Government should work through intermediaries to publicize as widely as possible al Qaeda's acts of violence and their immediate and longer-term effects on civilians.

The US Government should therefore take steps to persuade al Qaeda that mass casualty and catastrophic attacks would hinder rather than advance its long-term interests. Already it appears that some positive steps have been taken, as the United States' strategy for winning the war of ideas seems to have shifted away from an earlier focus on improving perceptions of the United States abroad and toward the more feasible goal of supporting and promoting elements within the Muslim world that offer a non-violent alternative to al Qaeda's brand of extremism. This shift was recently described by James Glassman, who was at the time the State Department's Undersecretary for Public Diplomacy and Public Affairs: "the aim of the war of ideas is *not* to persuade foreign populations to adopt more favorable views of the United states and its policies . . . our main role is to support constructive alternatives to violent extremism. Our priority is not to promote our brand but to help destroy theirs."[218]

In this vein, the US Government should work through intermediaries to publicize as widely as possible al Qaeda's acts of violence and their immediate and longer-term effects on civilians. It should also seek to support individuals and organizations throughout the Muslim world—especially those that have at least some minimal level of grass roots support—that not only eschew violence, but that can publicly and cred-

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215 Jarret Brachman, Brian Fishman, and Joseph Felter, "The Power of Truth? Questions for Ayman al-Zawahiri," Combating Terrorism Center, United States Military Academy, 21 April 2008, p. 25.

216 Lewis A. Dunn, "Can al Qaeda be Deterred from Using Nuclear Weapons," Occasional Paper No. 3, Center for the Study of Weapons of Mass Destruction, National Defense University, July 2005, p. 11.

217 Wright, *The Looming Tower*, p. 304.

218 James Glassman, "Winning the War of Ideas," Prepared Remarks for a Speech to the Washington Institute of Near East Policy, July 8, 2008, accessed at http://www.washingtoninstitute.org/templateC07.php?CID=408 on September 15, 2008. For an overview of this shift in focus, see David E. Kaplan, "Hearts, Minds, and Dollars," *U.S. News and World Report*, April 17, 2005.

ibly challenge al Qaeda by arguing that the killing of civilians and the use of WMD (including and especially nuclear weapons) are immoral, religiously impermissible, and unlikely to help the situation of those whom al Qaeda claims to be fighting for. In addition, it is crucial that these efforts be effectively promoted and publicized; it is important to remember that the goal is not to affect a change of heart among al Qaeda's core members, but rather a change of strategy. By making it clear to them that their actions are alienating far more people than they are inspiring, they might become less likely to view a catastrophic attack as a strategically viable option.

Securing Nuclear Weapons and Material

If terrorists cannot be persuaded to abandon the idea of nuclear terrorism, the next best thing is to convince them that it is not a realistic option.

Although the prospect of delegitimizing nuclear terrorism may be appealing, actually convincing terrorists that using a nuclear weapon will erode if not eliminate their base of support and prevent them from achieving their ultimate objectives may not be possible. For example, the terrorists who are most likely to attempt a nuclear attack — the core members of al Qaeda — may also be the least susceptible to this message given their commitment to their cause as well as their apparent desire to conduct increasingly spectacular attacks. If terrorists cannot be persuaded to abandon the idea of nuclear terrorism, the next best thing is to convince them that it is not a realistic option. In other words, if a terrorist group concludes that it cannot acquire a nuclear weapon or enough fissile material to make one on its own, or that any attempt to do so would require enormous human and material resources and would still have only a very small chance of succeeding, it will likely devote most of those resources elsewhere. Continuing and, where possible, accelerating and expanding efforts to eliminate or secure potentially vulnerable nuclear weapons and material can therefore thwart determined terrorists from obtaining these items and dissuade prospective nuclear terrorists from attempting to do so. As one senior US official has observed, "If terrorists believe that it will be extremely risky, or impossible, to acquire [nuclear] weapons or materials, they may seek other avenues of attack."[219]

Reducing stockpiles of nuclear weapons and material, while improving security for what remains, is generally regarded as the single most important measure that can be taken to prevent a nuclear terrorist attack. Because terrorists will probably not attempt to manufacture fissile material on their own, and because it is also highly unlikely that a nuclear-armed state would transfer a weapon to a nonstate actor, preventing these groups from illicitly obtaining either item is the logical focus for preventive efforts. As Graham Allison has argued:

> The first goal in the plan to prevent nuclear terrorism must be to ensure that there is no place in the world where terrorists can acquire nuclear weapons or the materials

[219] Joseph Krol, Associate Administrator, NNSA, "The Threat of Nuclear Terrorism," Presented at the International Atomic Energy Agency (IAEA), May 30, 2008, accessed at http://nnsa.energy.gov/news/2039.htm on November 1, 2008.

> from which such weapons can be made. To this end, every nuclear nation must be persuaded to lock down all weapons and fissile material to a new "gold standard"—and to do so on the fastest feasible timetable. Material that cannot reasonably be secured to this standard, particularly at research reactors in developing and transitional countries, must be removed.[220]

In addition, improving the security of vulnerable nuclear weapons and material is not only prudent because it addresses the most likely routes by which terrorists might attempt to pursue a nuclear bomb, it is also the most feasible defense against the nuclear terrorist threat (in comparison, for instance, to relying primarily on detecting and interdicting nuclear weapons and material once they have been stolen and are in transit).[221] According to a report by the National Academies:

> Nuclear weapons and SNM [special nuclear material, i.e., HEU and plutonium] can most effectively protected, controlled, and accounted for at their sources, which are relatively few in number compared with the many potential points of transit across national borders and are protected by state-run security infrastructures. Therefore, the first line of homeland defense against nuclear and radiological terrorism is a robust system for protecting, controlling, and accounting for nuclear weapons and SNM at their sources.[222]

Improving the security of vulnerable nuclear weapons and material is the most feasible defense against the nuclear terrorist threat.

At present, there are a number of efforts underway that address these issues.[223] For example, the US Government runs a host of programs through the Departments of Defense, Energy, and State that seek to reduce the threat posed by nuclear weapons and material, in addition to other WMD, in Russia and the former Soviet republics. Since fiscal year 1992, these programs have received $10 billion in appropriations.[224] One of the most important is the Department of Defense's (DoD) Cooperative Threat Reduction (CTR) program, which works to destroy nuclear weapons and delivery vehicles, secure warhead storage sites, and increase the security of nuclear weapons and material in transit. Table 3 lists some of the major accomplishments of this program to date.

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[220] Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, p. 143.

[221] Bunn and Wier, "The Seven Myths of Nuclear Terrorism," p. 159.

[222] National Research Council, Committee on Science and Technology for Countering Terrorism, *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism* (Washington, DC: National Academies Press, 2002), p. 52.

[223] A comprehensive overview of current efforts to reduce and secure nuclear weapons and material globally can be found in Bunn, *Securing the Bomb 2007*, chapter 2. For a brief history of efforts to address the threat posed by Russian nuclear weapons and material after the end of the Cold War, see Bunn, "Cooperation to Secure Nuclear Stockpiles: A Case of Constrained Innovation." *Innovations*, Winter 2006.

[224] Amy W. Woolf, "Nonproliferation and Threat Reduction Assistance: U.S. Programs in the Former Soviet Union," Congressional Research Service, Updated January 3, 2008, p. 1. Originally, these programs focused primarily on assisting Russia, Ukraine, Belarus, and Kazakhstan with the transport, storage, and dismantlement of strategic nuclear warheads in the aftermath of the Cold War, but have since been expanded to other areas, including the destruction of chemical and biological weapons. Ibid., p. 7.

Through what was previously known as its Material Protection, Control, and Accounting (MPC&A) program, DoE also works to enhance accounting procedures and physical security at various nuclear sites in Russia, in addition to consolidating civilian nuclear material at a smaller number of less vulnerable locations. DoE was scheduled to complete security upgrades at 210 buildings containing weapon-usable nuclear material by the end of 2008, while DoE and DoD together planned to complete security upgrades at ninety-seven nuclear warhead storage sites — including forty-one permanent storage sites and fifty-six temporary sites such as rail transfer points — by the same deadline.[225]

In addition to securing nuclear weapons and material, the United States has also worked to reduce stockpiles of plutonium and especially HEU.

In addition to securing nuclear weapons and material, the United States has also worked to reduce stockpiles of plutonium and especially HEU, which poses a unique danger because it can be used to fuel a relatively simple gun-type weapon. For example, in 1993 the United States and Russia signed an agreement that committed the latter to eliminate 500 metric tons of HEU from dismantled nuclear warheads through downblending (the process of mixing HEU with uranium consisting primarily of U-238 to convert it to LEU). That LEU is then sold to the United States for use in its power reactors, and provides approximately 10 percent of the United States' total electrical power per year. So far, the program, sometimes dubbed "megatons to megawatts," has converted 322 tons of HEU, and is scheduled to proceed at a rate of 30 tons per year until 2013, when the 500-ton mark will be reached.[226] The NNSA also recently announced that a separate program aimed at eliminating non-weapon fissile material has succeeded in downblending 10 tons of Russian HEU.[227] Current plans under this program call for the elimination of 17 tons of HEU by 2012,[228] a rate that some analysts suggest should be doubled.[229]

Efforts to reduce vulnerable sources of HEU have also been expanded beyond the former Soviet Union to include civilian facilities world-wide — in particular research reactors that received HEU fuel from either the United States or the Soviet Union during

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225 Government Accountability Office, "Nuclear Nonproliferation: Progress Made in Improving Security at Russian Nuclear Sites, but the Long-term Sustainability of U.S.-Funded Security Upgrades Remains Unclear," February 2007, pp. 16–17; and Bunn, *Securing the Bomb 2007*, p. 68. The State Department, meanwhile, has helped fund Russian scientists who had previously worked on WMD-related programs to ensure that they do not sell their expertise to rogue nations or terrorist groups, and has worked to prevent illicit trafficking in WMD and related materials by helping states develop or improve export controls and by providing them with equipment and training for the detection and interdiction of smuggling. Woolf, "Nonproliferation and Threat Reduction Assistance," pp. 25–29.

226 NNSA Press Release, "NNSA Announces Nearly 13,000 Nuclear Weapons-Worth of Russian Uranium Converted to Peaceful Use," February 20, 2008, accessed at http://nnsa.energy.gov/news/1789.htm on November 1, 2008.

227 NNSA, Press Release, "U.S. and Russia Cooperate to Eliminate Dangerous Nuclear Material," April 24, 2008, accessed at http://nnsa.energy.gov/news/1987.htm on November 1, 2008.

228 Woolf, "Nonproliferation and Threat Reduction Assistance," p. 35.

229 See, for example, Matthew Bunn, "Reducing Excess Stockpiles: U.S.-Russia HEU Purchase Agreement," Nuclear Threat Initiative, last updated march 3, 2003, accessed at http://www.nti.org/e_research/cnwm/reducing/heudeal.asp on November 1, 2008.

the Cold War—through the DoE's Global Threat Reduction Initiative (GTRI). The goals of this program include converting research reactors fueled with HEU to run on LEU instead, shutting down vulnerable HEU-fueled reactors that cannot be converted, and returning US and Soviet-origin HEU.[230] In recent years, growing fears of nuclear terrorism have also spawned a number of international efforts, including the Group of Eight

[230] NNSA Factsheet, "GTRI: More Than Three Years of Reducing Nuclear Threats," October 2008, accessed at http://nnsa.energy.gov/news/793.htm November 1, 2008. DOE began converting foreign research reactors using US-supplied HEU to LEU in 1978 under its Reduced Enrichment for Research and Test Reactors program. Glaser and Von Hippel, "Thwarting Nuclear Terrorism," p. 58.

TABLE 3. **CTR PROGRAM ACCOMPLISHMENTS THROUGH 2008***

Category	CTR Baseline	Fiscal Year 2007 Reductions	Current Cumulative Reductions	CY 2012 Reduction Targets
Warheads Deactivated	13,300	267	7,504	9,222
Intercontinental Ballistic Missiles (ICBMs) Destroyed	1,473	30	742	1,078
ICMB Silos Eliminated	831	0	496	645
ICBM Mobile Launchers Destroyed	442	31	143	267
Bombers Eliminated	233	0	155	155
Nuclear Air-to-Surface Missiles Destroyed	906	0	906	906
Submarine-Launched Ballistic Missile (SLBM) Launchers Eliminated	728	20	476	564
SLBMs Eliminated	936	20	633	691
Nuclear Powered Ballistic Missile Submarines Destroyed	48	0	31	35
Nuclear Test Tunnels/Holes Sealed	194	0	194	194

	CTR Baseline	Fiscal Year 2007 Activities Completed	Current Activities Completed	CY 2012 Activities Targets
Nuclear Weapons Transport Train Shipments	N/A	47	422	620
Nuclear Weapons Storage Site Security Upgrades	N/A		24	24

* Sources: Press Release of Senator Lugar, "Nunn-Lugar Program Destroys Hundreds of WMD in 2008," January 23, 2009, accessed at http://lugar.senate.gov/press/record.cfm?id=307173&& on January 27, 2009; and Department of Defense, "Cooperative Threat Reduction Annual Report to Congress, Fiscal Year 2009, p. 2, accessed at http://www.dtra.mil/documents/oe/ctr/FY09%20CTR%20Annual%20Report%20to%20Congress.pdf on November 1, 2008.

Global Partnership against the Spread of Weapons and Material of Mass Destruction, the Global Initiative to Combat Nuclear Terrorism, and United Nations Security Council Resolution 1540, which prohibits member states from helping nonstate actors acquire WMD or delivery mechanisms, and requires members to secure WMD and related materials and to enact legislation criminalizing proliferation activities.

Limiting, consolidating, and securing nuclear weapons and fissile material is without a doubt the most important step that can be taken to prevent nuclear terrorism. Making weapons or material harder to steal will reduce the number of opportunities for aspiring nuclear terrorists to obtain these items, reducing the likelihood of a nuclear attack. Efforts to achieve this goal can also play an important role in discouraging terrorists from pursuing the nuclear option in the first place, if they can be convinced that doing so will be prohibitively costly, excessively dangerous, and stand little chance of success. Therefore, as individual nations and international organizations work to secure loose weapons and material, a corresponding effort should also be made to publicize their successes and ensure that these actions are exploited for their dissuasive value. Ultimately, no system of safeguards will ever be foolproof. If those safeguards can function as a credible element of a broader strategy of dissuasion, however, they may convince terrorists to abandon or at least scale back their efforts to bypass or overcome them.

As individual nations and international organizations work to secure loose weapons and material, a corresponding effort should also be made to publicize their successes and ensure that these actions are exploited for their dissuasive value.

Deploying Detection Systems

In the aftermath of the 9/11 attacks, fears of nuclear terrorism prompted the United States Government to undertake a broad deployment of radiation detectors in an effort to prevent a nuclear weapon (or the material needed to make one) from being smuggled into the country or into the heart of a major American city.[231] Unlike efforts to secure nuclear weapons and material, however, the role of detection in preventing a nuclear terrorist attack has been and continues to be the subject of much debate. On the one hand, there are those who are extremely skeptical of any large-scale efforts to deploy detection systems due to a host of factors, including the immense length of US borders, the ability of clever terrorists to avoid entry points that are likely to be well defended, and perhaps most importantly the difficulties associated with the detection of fissile material. As two skeptics note, "The physics of nuclear materials and nuclear weapons, the geography of the huge and complex American borders, and the economics of the global flow of people and goods conspire to make the terrorists' job easy and the defenders' job very difficult. Once stolen, the nuclear material for a bomb could be anywhere, and it is very difficult to detect, especially if shielding is used to limit radiation emissions."[232] On the other hand, there are those who view detection systems

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[231] Barton Gellman, "Fears Prompt U.S. to Beef Up Nuclear Terror Detection," *Washington Post*, March 3, 2002

[232] Bunn and Weir, "The Seven Myths of Nuclear Terrorism," p. 158.

as a crucial defensive measure against the threat of nuclear terrorism, with some advocating for significantly expanded government efforts not unlike the Manhattan or Apollo projects to research and develop new generations of detection systems capable of locating nuclear material with much greater accuracy and at far greater ranges than are currently feasible.[233] Both sides make a valid point, although they overstate the limitations as well as the potential value of this approach. Detection systems can play an important role in preventing, deterring, and perhaps even dissuading a nuclear terrorist plot. Nevertheless, the inherent limitations of this line of defense suggest that further study is warranted before devoting significant increases in resources.

Detection systems can play an important role in preventing, deterring, and perhaps even dissuading a nuclear terrorist plot.

Detecting nuclear weapons and material is a technically challenging task under most operating conditions. In the 1950s, Robert Oppenheimer was asked in a closed Senate session whether a small group of men could smuggle nuclear weapons into New York and detonate them. "Of course it could be done," Oppenheimer replied, "and people could destroy New York." He was then asked what instrument might be used to find weapons that had been hidden in a large city. "A screwdriver," he responded.[234] Although technology has obviously improved over the past half century, many of the fundamental difficulties remain.[235]

Three general methods exist to detect nuclear weapons and material: passive detection of the radiation emitted by nuclear material; active detection of dense objects within a package or container (for example through the use of x-rays or gamma radiography to discover hidden nuclear material or any shielding surrounding it); and active interrogation, which involves irradiating objects in order to induce fission reactions that will generate increased emissions of neutrons or gamma rays, which can then be detected.

Passive detection of radiation is currently the principal method available for locating a smuggled nuclear device or fissile material. For a number of reasons, however, passive detection of plutonium and especially HEU is problematic. Radioactive decay is the process by which an unstable isotope undergoes a spontaneous nuclear transmission via the emission of excess energy in the form of subatomic particles and electromagnetic waves, and is replaced by a different isotope or element. At the atomic

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233 See, for example, Fred Charles Iklé, *Annihilation from Within: The Ultimate Threat to Nations* (New York: Columbia University Press, 2006), pp. 86–89; and Garwin, "The Technology of Megaterror," p. 68.

234 Quoted in Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Vintage Books, 2005), p. 349.

235 For overviews of this issue, see Steve Fetter, Valery A. Frolov, Marvin Miller, Robert Mozley, Oleg F. Prilutsky, Stanislav N. Rodionov, and Ronald Z. Sagdeev, "Detecting Nuclear Warheads," *Science and Global Security*, 1990; Gary W. Phillips, David J. Nagl, and Timothy Coffey, *A Primer on the Detection of Nuclear and Radiological Weapons* (Washington, DC: National Defense University, Center for Technology and National Security Policy, 2005), pp. 3-4, accessed at http://www.ndu.edu/ctnsp/Def_Tech/DTP%2013%20Primer%20on%20Detection.pdf on September 12, 2008; and John Holdren and Matthew Bunn, "A Tutorial on Nuclear Weapons and Nuclear-Explosive Materials: Weapons & Material Detection & Protection," Nuclear Threat Initiative, updated November 25, 2002, accessed at http://www.nti.org/e_research/cnwm/overview/technical5.asp on October 24, 2008.

level radioactive decay is a random process, but decay rates can be predicted for a large number of atoms. Half-life is the time it takes for one half of a given quantity of similar atoms to decay. Generally, a short half-life indicates that an isotope is intensely radioactive for a relatively short period of time, while a long half-life indicates that an isotope is only weakly radioactive for a longer period of time. Neither U-235 nor Pu-239 is especially radioactive, however. By comparison, isotopes that might be used in a dirty bomb are far more radioactive and would therefore be easier to detect. Table 4 lists the half-life of these two fissile isotopes as well as four other radioactive isotopes that are often cited as candidates for use in a RDD.

Radiation monitors locate nuclear materials by detecting either neutrons generated primarily by spontaneous fission or gamma rays—the two primary observables that emanate from the decay of radioactive isotopes in fissile material. Both emissions have mean free paths of approximately a hundred meters in the air, meaning they cannot be detected by high-flying aircraft.[236] The ability to detect HEU or plutonium within this range is also affected by distance from the material, the presence of naturally occurring and man-made background radiation, and the interaction between the two. Specifically, the signal emitted by a point source of either neutrons or gamma rays decreases inversely with the square of the distance from that source, while the level of background radiation remains constant. As a result, the greater the distance from nuclear weapons or materials, the more difficult it is to distinguish HEU or plutonium from background radiation.[237] Given these inherent limitations and the state of existing passive detection technologies, lightweight portable detectors are only really useful within several meters of a strong point source, and large-area detectors

[236] Phillips, Nagl, and Coffey, *A Primer on the Detection of Nuclear and Radiological Weapons*, pp. 3–4.

[237] Ibid., p. 4; and Fetter, et al., pp. 232–233.

TABLE 4. **HALF-LIFE OF SELECT FISSILE AND OTHER RADIOACTIVE ISOTOPES***

Isotope		Half-Life (in years)
Fissile Isotopes	Uranium-235	700,000,000
	Plutonium-239	24,100
Other Radioactive Isotopes	Americium-241	432.7
	Cesium-137	30
	Strontium-90	29.1
	Cobalt-60	8.27

* Half-life figures are taken from the United States Environmental Protection Agency website, accessed at http://www.epa.gov/radiation/radionuclides/index.html on September 17, 2008.

may only be able to locate unshielded nuclear materials within a range of several dozen meters.[238]

Although both HEU and plutonium are significantly more difficult to detect than other radiological materials, detecting the former is much more challenging than detecting the latter. Plutonium is a strong emitter of neutrons that cannot be easily shielded. By contrast, HEU emits very few neutrons. Instead, its primary observable emission is a low energy gamma ray that can be shielded by as little as a few millimeters of lead.[239] Detection of HEU or plutonium is also dependent on the precise nature of the material and, in the case of an actual nuclear weapon, the presence or absence of certain components. For example, the neutrons generated by plutonium emanate primarily from the isotope Pu-240, which has a higher spontaneous fission rate than Pu-239. Reactor-grade plutonium, with its higher Pu-240 content, would therefore be easier to detect than weapon-grade plutonium. In the case of HEU, uranium that had previously been used in a reactor would contain small quantities of the isotope U-232, which has decay products that emit strong and more easily detectable gamma rays. Both materials would also be significantly easier to detect in their oxide form. A crude nuclear weapon may also contain a relatively large amount of fissile material and would therefore be easier to detect, although terrorists might attempt to smuggle HEU or plutonium in small amounts—especially if the material they acquired was not already in metallic form—and build the actual weapon once they were closer to their target. Finally, if a nuclear weapon used depleted uranium (a byproduct of the enrichment process that is predominantly composed of U-238) as a tamper, this material would also emit a strong gamma ray that is difficult to shield.[240]

Although both HEU and plutonium are significantly more difficult to detect than other radiological materials, detecting the former is much more challenging than detecting the latter.

Despite these qualifications, passive detection of plutonium and HEU remains difficult. While hand-held detectors are useful only at extremely close ranges, larger radiation detectors are capable of detecting unshielded or lightly shielded plutonium devices in cargo containers, in moving vehicles, and in vehicles at portals.[241] There is a general consensus, however, that available radiation portal monitoring equipment—installed in the United States and around the world—would be unable to detect HEU or an HEU-based device if shielding was used.[242] Active detection

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[238] Phillips, Nagl, and Coffey, *A Primer on the Detection of Nuclear and Radiological Weapons,* pp. 4, 52.

[239] Ibid., pp. 8–10. The difficultly of detecting nuclear materials could also be increased if those materials were surrounded by quantities of slightly radioactive but otherwise benign materials such as fertilizer, kitty litter, or television sets. Richard T. Kouzes, "Detecting Illicit Nuclear Materials," *American Scientist*, Vol. 93, No. 5 (September-October 2005).

[240] Holdren and Bunn, "Weapons & Material Detection and Protection"; Levi, *On Nuclear Terrorism*, p. 83–84; Phillips, Nagl, and Coffey, *A Primer on the Detection of Nuclear and Radiological Weapons*, pp. 8–12; and Fetter, et al., pp. 236–238.

[241] Roger C. Byrd, Joel M. Moss, William C. Priedhorsky, Carolyn A. Pura, Gary W. Richter, Kevin J. Saeger, W. Robert Scarlett, Sara C. Scott, and Richard L. Wagner, "Nuclear Detection to Prevent or Defeat Clandestine Nuclear Attack," *IEEE Sensors Journal*, Vol. 5, No. 4 (August 2005)," p. 14.

[242] Matthew Bunn and Anthony Weir, *Securing the Bomb 2006* (Cambridge, Mass.: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard University, 2006), p. 3.

through radiography is available and in use, but also has limits; according to one study, "Commercially available radiography has serious limitations . . . when searching for comparatively small quantities of SNM imbedded in containers of complex cargo."[243] There are, however, new technologies in development that may be able to more effectively image vehicles and cargo containers. Active interrogation, although not yet widely available, is potentially the most effective way to detect nuclear materials, particularly shielded HEU. Nevertheless, this method is controversial due to the potential health risks it could pose to those its vicinity.

Although reliably detecting nuclear weapons and material poses a significant challenge, the organization in charge of coordinating these efforts is moving forward with its plan to develop a global nuclear detection architecture.

Although reliably detecting nuclear weapons and material poses a significant challenge, the organization in charge of coordinating these efforts — DHS's Domestic Nuclear Detection Office (DNDO) — is moving forward with its plan to develop a global nuclear detection architecture, which has been described as "a multilayered detection framework of radiation detection equipment and interdiction activities to combat nuclear smuggling in foreign countries, at the U.S. border, and inside the United States."[244] This architecture encompasses programs run through DHS, DOE, and the State Department, and includes or will soon include the deployment of radiation monitors at border crossings and major ports overseas, the United States' northern and southern borders, truck inspection stations within the country, and tool booths, bridges, and tunnels surrounding major US cities.[245] The central premise behind these programs is to create a layered defense that will increase the probability that smuggled nuclear weapons or material will be detected somewhere along the journey from their point of origin to their target.[246]

These efforts have not been free of controversy. Perhaps the most well-publicized difficulties have surrounded the government's plans to purchase next-generation radiation detection systems, known as Advanced Spectroscopic Portal (ASP) monitors. These devices are intended to supplement or replace first-generation radiation portal monitors that are incapable of discriminating between radiation emitted by a benign source and emissions from threatening materials, which leads to an extremely high number of false alarms that must then be subjected to secondary inspections.[247] ASP

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243 Byrd, et al., "Nuclear Detection to Prevent or Defeat Clandestine Nuclear Attack," p. 4.

244 US Government Accountability Office, Statement of David C. Maurer, Nuclear Detection: Preliminary Observations on the Domestic Nuclear Detection Office's Efforts to Develop a Global Nuclear Detection Architecture," Testimony Before the Committee on Homeland Security and Governmental Affairs, U.S. Senate, July 16, 2008, p. 6.

245 For overviews of the various programs responsible for deploying radiation monitors and other detection systems in the US and abroad, see ibid., and Dana A. Shea, "The Global Nuclear Detection Architecture: Issues for Congress," Congressional Research Service, July 16, 2008.

246 The layered defense concept was advocated by the Defense Science Board in its 2004 report on the threat of a smuggled nuclear weapon. Defense Science Board Task Force, *Preventing and Defending Against Clandestine Nuclear Attack* (Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, June 2004), p. 33.

247 Spencer S. Hsu, "U.S. Weighs How Best to Defend Against Nuclear Threats," *Washington Post*, April 15, 2006; and Ralph Vartabedian, "Detecting Radiation an Arduous Job at Ports," *Los Angeles Times*, November 25, 2007.

monitors, by contrast, have the ability to analyze the energy signature of gamma rays in order to identify their source, which should lead to fewer false alarms. Despite this additional capability, ASPs have experienced delays and significant cost increases.[248] According to the Government Accountability Office, these units could cost between $2 and $4 billion over the next decade, depending on the number and type of ASP units that are ultimately procured.[249] Moreover, these radiation monitors do not provide increased effectiveness over earlier units in detecting shielded HEU.[250]

Ultimately, detection can play an important role in preventing a nuclear terrorist attack, not only by stopping a group from successfully transporting a nuclear weapon or material to its target, but also by dissuading terrorists from pursuing the nuclear option. In concert with the other measures discussed above, the deployment of radiation monitors and other detection systems can increase the likelihood that would-be nuclear terrorists will judge the possibility of success as too low to merit the effort required.[251] Vayl Oxford, the previous director of DNDO, is therefore correct to argue that terrorists can be discouraged from attempting an attack by complicating their ability to undertake certain operations, and that detection systems can have this effect.[252]

Even the best possible detection architecture will only provide a partial solution.

Nevertheless, skeptics are also correct to note that even the best possible detection architecture will only provide a partial solution. Even if detection technologies improve considerably and are deployed widely, no defense will be perfect; terrorists capable of acquiring nuclear materials can — and almost certainly will — devote a corresponding level of effort to evading discovery, in particular by avoiding well defended routes and entry points. There are also questions as to whether R&D efforts are likely to produce major breakthroughs anytime in the near future, as opposed to evolutionary improvements in effectiveness or ease of use.[253] Calls for a Manhattan or Apollo Project-like effort to develop new detection systems should therefore be received with

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248 Robert O'Harrow, "Radiation Detectors for Border are Delayed Again," *Washington Post*, November 2007; O'Harrow, "DHS Tests of Radiation Detectors Were Inconclusive, Report Says," *Washington Post*, March 5, 2008; and O'Harrow, "Radiation Monitors to Cost More Than DHS Estimated in '06," *Washington Post*, June 28, 2006.

249 US Government Accountability Office, "Combating Nuclear Smuggling: DHS's Program to Procure and Deploy Advanced Radiation Detection Port Monitors Is Likely to Exceed the Department's Previous Cost Estimate," September 22, 2008, pp. 4-5.

250 Thomas B. Cochran and Matthew G. McKinzie, "Detecting Nuclear Smuggling," *Scientific American*, April 2008. DNDO is also funding the development of a new imaging system that could eventually be deployed in tandem with ASP monitors, which would increase the prospects of discovering shielded fissile material. Opening Statement of Mr. Vayl S. Oxford, Director, Domestic Nuclear Detection Office, Department of Homeland Security, Before the Senate Judiciary Committee, Subcommittee on Terrorism, Technology, and Homeland Security, July 27, 2006, accessed at http://kyl.senate.gov/legis_center/subdocs/072706Oxford.pdf on October 27, 2008.

251 Defense Science Board, *Preventing and Defending Against Clandestine Nuclear Attack*, p. 33.

252 Eric Lipton, "New York to Test Ways to Prevent Nuclear Terror," *New York Times*, February 9, 2007.

253 See, for example, Statement of William Happer, Ph.D., Hearing before the Subcommittee on Prevention of Nuclear and Biological Attack of the Committee on Homeland Security, House of Representatives, "The Science of Prevention," September 14, 2006, pp. 34, 38.

caution, especially in terms of the resources devoted to this effort.[254] As the continuing debates over the value of ASP monitors have demonstrated, it is essential that any new systems represent more than a marginal improvement over existing systems before they are procured in quantity.

Finally, if the role of detection is partially—and perhaps even predominantly—to discourage prospective nuclear terrorists, then new technologies may only be one part of the answer. It is equally important to ensure that the presence of these systems influences terrorists' calculations in the expected way—i.e., that they discourage terrorists from pursuing nuclear weapons and material as opposed to providing a roadmap for which routes, ports, or border crossings should be avoided. In addition to "red teaming" how terrorist might attempt to sneak a weapon or fissile material into the United States, analyses should also be undertaken to determine how terrorists might be convinced that they will be unable to circumvent existing defenses, something which may depend as much on publicizing (and possibly exaggerating) existing capabilities as developing new ones.

If the role of detection is partially to discourage prospective nuclear terrorists, then new technologies may only be one part of the answer.

STOPPING TERRORISTS FROM DELIVERING A WEAPON

Although preventing terrorists from acquiring nuclear weapons and material is the best, safest, and most feasible way to avoid a catastrophic attack, prudence dictates that the US government be as well prepared as possible to locate and intercept terrorists groups that obtain these items before they can deliver a weapon to their intended target. This section focuses on two areas in particular that are likely to play a crucial role in these efforts—human intelligence (HUMINT) and Special Operations Forces.[255]

Human Intelligence

One of the keys to preventing future terrorist attacks is to learn as much as possible about where terrorists are hiding and what they may be planning. Because terrorists are the weaker party in a conflict, they rely heavily on secrecy and anonymity—if they can be found, they can be captured or killed. Obtaining accurate intelligence is therefore crucial. As one prominent analyst notes, "intelligence is the spearhead of counter-terrorism . . . With high-grade, high-quality intelligence—especially human

254 The Manhattan Project cost an estimated $21 billion, while the Apollo Project cost $95.7 billion (both figures are in 2007 dollars). Deborah D. Stine, "The Manhattan Project, the Apollo Program, and Federal Energy Technology R&D Programs: A Comparative Analysis," Congressional Research Service, updated September 24, 2008, pp. 2–3.

255 In theory, high quality HUMINT and robust SOF could contribute to dissuasion by decreasing the likelihood that terrorists could construct or deliver a weapon without being discovered, but because these capabilities cannot easily be advertised this is unlikely to be the case.

intelligence—the threat of terrorism and extremism can be managed."[256] The US intelligence community must therefore continue (and if possible accelerate) the process of rebuilding and expanding its HUMINT capability, which was exposed after 9/11 as extremely limited.[257]

HUMINT has a particularly important role to play in averting any potential nuclear attack, for at least two reasons. First, given the inherent difficulty of detecting nuclear material, especially from any significant distance, locating and stopping terrorists who are in possession of these items may depend first and foremost on knowing where to look. Second, the terrorists most likely to be involved in a serious plot to conduct this type of attack—the members of al Qaeda's senior leadership and their key operatives—are extremely difficult to penetrate through technical means, due in part to their reluctance to use electronic forms of communication.[258] Yet HUMINT also has limitations in this regard: modern terrorists groups are notoriously difficult to penetrate through the cultivation of human sources because of their networked structure, closely knit cells, and high levels of operational security.[259] This is particularly the case for prominent al Qaeda operatives. According to one former CIA intelligence officer, "They [members of al Qaeda hiding in Pakistan] have had a Darwinian education in what can give them away, and their tradecraft has improved as we have eliminated some of the less careful members of their organization…They're hiding in a sea of people who are very xenophobic of outsiders, so it's a very, very tough nut to crack."[260]

HUMINT has a particularly important role to play in averting any potential nuclear attack.

While attempts to penetrate al Qaeda's leadership through all available means should of course continue, these constraints do suggest that, at least in terms of preventing a nuclear terrorist attack, some of the resources that support these efforts might be better spent on developing assets within the military and/or scientific establishments of nations that are the most likely sources of loose nuclear weapons and material, especially workers at high-risk facilities. Admittedly, this is an indirect way of uncovering a potential nuclear terror plot, and there is no guarantee that stolen or diverted items will be discovered in time to prevent an attack. Nevertheless, if a weapon or material is lost or stolen, it may be the only warning the United States receives, especially if a foreign government chooses not to communicate what has occurred.

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[256] Rohan Gunaranta, "Terrorism Threat in 2008," Research Briefing, Jebsen Center for Counter-Terrorism Studies, February 2008, p. 3.

[257] John Diamond, "CIA's Spy Network Thin," *USA Today*, September 21, 2004. Human intelligence is defined as intelligence "derived from information collected and provided human sources." Joint Publication 1-02, *DOD Dictionary of Military and Associated Terms* (as amended through 26 August 2008), accessed at http://www.dtic.mil/doctrine/jel/doddict/data/h/02523.html on September 22, 2008.

[258] Whitlock, "The New Al-Qaeda Central."

[259] Russell D. Howard, "The New Terrorism and Weapons of Mass Destruction," in Howard and James J.F. Forest, eds., *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2007), p. 15.

[260] Quoted in Bergen, "Al-Qaeda at 20." See also Whitlock, "In Hunt for Bin Laden, A New Approach." Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, Laurence H. Silberman and Charles S. Robb, Co-Chairmen, Report to the President of the United States, March 31, 2005, p. 274.

The sooner the US Government learns that a nuclear weapon or a significant quantity of fissile material has gone missing, the better the chances that these items will be located and recovered. If they are stolen from a facility in a foreign country, however, it is possible that the United States may not be informed right away, or perhaps even at all. A foreign government might be unwilling to admit to such a major lapse in security, or it may believe that it can successfully recover the missing items on its own. Alternatively, it may fear that if it does reveal what has occurred, but the weapon or material is later used in an attack, it could be a target for reprisal; despite being forthcoming, if the source nation of a weapon or material used in a nuclear terrorist attack became publicly known, the demands for retaliation might be overwhelming (or so the government responsible for the missing weapon or material might assume). While having intelligence sources that can indicate where and when sensitive items have gone missing may not be as desirable as learning of a plot before it gets underway, it may be one of the best and most realistic ways of stopping an attack before it is carried out. Moreover, there is the possibility that increased HUMINT in this area could in fact provide advance warning of a plot, if elements of a state's military or members of its nuclear program intend to provide nuclear weapons, material, or expertise to a terrorist group, or to assist a group in the theft of a nuclear weapon or fissile material.

For a number of reasons, Special Operations Forces will likely be tasked to conduct a WMD elimination mission if it is discovered that a terrorist group overseas has acquired or is constructing a nuclear device.

Special Operations Forces

For a number of reasons (including the need to confirm that any nuclear weapons are effectively disabled and any plutonium or HEU is secured, to avoid the dispersal of radioactive material and contamination of surrounding areas that could result from the use of stand-off weapons, and to ensure that operations in politically sensitive areas remain clandestine), Special Operations Forces will likely be tasked to conduct a WMD elimination mission if it is discovered that a terrorist group overseas has acquired or is constructing a nuclear device. Every effort should therefore be made to implement the 2006 QDR's vision of SOF that have a "greater capacity to detect, locate, and render safe WMD," and that can perform these tasks as rapidly as possible, given that potential targets may be extremely time-sensitive.[261] How might these goals be achieved? Because details regarding the current and projected SOF capabilities and capacity for detecting, locating, and "rendering safe" WMD are classified, it is impossible to know what measures are already in place or are scheduled to be implemented in the near future. With these caveats in mind, this section briefly outlines several recommendations that could help increase capacity, decrease response time, and create redundancy for this critical mission both domestically and globally.

According to open sources, the only SOF units qualified to seize, disable and secure (render safe) a nuclear device belong to Joint Special Operations Command (JSOC), the subordinate command to Special Operations Command (SOCOM) that controls

[261] *Quadrennial Defense Review Report* (2006), p. 44.

the US military's premier counterterrorism forces, including the Special Military Units (SMUs) Delta Force and Seal Team Six.[262] Ideally, dedicated SMU personnel trained in the tactics, techniques, and procedures (TTPs) for the render-safe mission would be available to respond quickly to a nuclear terrorist threat overseas, and, if necessary, would also be positioned to rapidly assist the Federal Bureau of Investigation (FBI) in the event of a domestic nuclear terrorist incident within the United States.[263] In reality, however, the small number of personnel assigned to SMUs and the even smaller number specifically trained to render safe a nuclear device, the extremely high demand for SMUs in support of the global war on terrorism and the wars in Afghanistan and Iraq, the inherent uncertainty over where a nuclear terrorist threat might materialize, and the constraints imposed by geography all make the ideal response capability difficult and perhaps impossible to realize. Despite these problems, a number of measures should be considered to increase the probability that qualified personnel will be able to respond to a nuclear terrorist threat as quickly as possible.

When it comes to responding to a possible nuclear terrorist threat in the homeland, speed will be critical, whether terrorists are constructing a weapon or transporting one. Perhaps the most vital step is simply ensuring that when SMU personnel are in the United States for rest, recovery, and training, some (including personnel trained in render safe TTPs) are prepared to assist the FBI anywhere in the United States, and have the necessary equipment and transportation readily available. It may also be worthwhile to consider basing some SMU personnel in the western part of the country, which would allow them to respond to an emergency in that region more rapidly than if they were called on to deploy from their home bases on the east coast. A model might be the NNSA's Search Response Teams, which are a part of its Nuclear Emergency Support Team (NEST) program and are based in both Nevada and Maryland.[264]

The ability to respond to potential nuclear terrorist threats globally is challenging because a threat could in principle materialize anywhere.

The ability to respond to potential nuclear terrorist threats globally is obviously far more challenging, simply because a threat could in principle materialize anywhere. In some cases — for example, if the target is located in a denied area — a rapid reaction using SOF may not be possible, because SMU personnel will have to be accompanied

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[262] See Robert Martinage, *Special Operations Forces* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008), chap. 1.

[263] The FBI is responsible for the render safe mission in the national capital region, and is supported by the Department of Defense in this mission throughout the rest of the United States. Robert S. Mueller III, Director, Federal Bureau of Investigation, "Statement before the Senate Appropriations Committee, Subcommittee on Commerce, Justice, Science, and Related Agencies," April 26, 2007, accessed at http://www.fbi.gov/congress/congress07/mueller042607.htm on September 14, 2008. In certain circumstances, this support could include the use of SOF units. For example, in 2002, it was reported that elements of Delta Force had been placed on standby alert to engage possible terrorist groups in the United States armed with nuclear or radiological weapons. Gellman, "Fears Prompt U.S. to Beef Up Nuclear Terror Detection."

[264] "Nuclear Incident Response Teams," Hearing Before the Subcommittee on Prevention of Nuclear and Biological Attack of the Committee on Homeland Security, House of Representatives, October 27, 2005, p. 20

by a significant number of additional forces, most likely Army Rangers, who would be charged with securing a contested site and providing perimeter security.[265] In other scenarios, however, a rapid response will remain crucial. The problems this poses could be made somewhat more tractable through several measures, including but not limited to the following:

> Training select allies and partners in render safe procedures if they do not already possess this capability. Should terrorists armed with a nuclear device be located in one of these nations, local forces would be able to respond far more rapidly; time permitting, they could also augment US forces once the latter arrived. In addition, US forces might also be able to preposition necessary equipment in these countries for use in the event of a crisis, whether in the countries themselves or somewhere else in that region.

> Ensuring that forward deployed SMU personnel engaged in counterterrorism operations can be redirected as quickly as possible to address a nuclear terrorist contingency. One measure that might increase their response time would be the additional prepositioning of necessary equipment at a number of bases or operating sites that are centrally located to various known smuggling routes and/or terrorist sanctuaries.

> If SMU personnel qualified to render safe a nuclear device do not operate together as a distinct unit but instead are dispersed among different sub-units operating globally, it is important to make certain that JSOC can quickly determine where all such personnel are located at all times, and has a record of which personnel have the best or most recent training in this area. This, along with their geographic location, should determine who is called upon to respond to an emergency.

> Having a small number of dedicated SMU personnel trained in render safe procedures forward deployed, possibly somewhere in Europe or Central Asia, on a rotational basis. These personnel could link up with other SMU personnel in a crisis, and would provide redundancy in the event that re-tasking other forces proved difficult. Because SMU personnel are such a valuable and scarce commodity, one way to justify this time spent on-call and not in the field would be to have these personnel help train ally and partner forces in order to increase their capability and capacity for the render safe mission.

> Should intelligence indicate that a terrorist cell is in the process of moving an improvised nuclear device, it is possible that other forward-deployed SOF — for example, Army Special Forces "A-Teams" or Navy SEAL Teams — may be much closer than available SMU personnel. If so, these units might be called up to interdict the

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[265] In these cases, if a ground operation is still deemed necessary or preferable, it will be critical to have sufficient UAV assets to maintain persistent surveillance over the target until sufficient military forces can be mobilized and deployed.

movement of the device and create a secure perimeter around it until SMU personnel arrive on the scene. Therefore, ensuring that these forward-deployed SOF units have the logistical capability to undertake this mission on short notice would also be a valuable development.

Additionally, SMUs performing render-safe missions may require the assistance of NEST personnel, which provide technical support to both the FBI and Department of Defense.[266] According to the NNSA, NEST draws on personnel from the national weapons laboratories and engages in "search and identification of nuclear materials, diagnostics and assessment of suspected nuclear devices, technical operations in support of render safe procedures, and packaging for transport to final disposition."[267] NEST personnel are prepared to deploy outside of the United States, and members of its Joint Technical Operations Teams (JTOTs) are trained to work with military explosive ordinance disposal units in the case of a nuclear terrorist incident.[268] If this support is indeed required, it may also be worthwhile to consider embedding at least a small JTOT with any dedicated, forward deployed SMU units on a short-term rotational basis, reducing their response time as well.

A nuclear terrorist attack would place an enormous burden on government at all levels, and an ineffective or poorly executed response could make a dire situation even worse.

Responding to an Attack

If terrorists cannot be dissuaded from seeking nuclear weapons and material, if they somehow manage to steal, build, or otherwise obtain a nuclear device, and if efforts to stop them from delivering a weapon to their target fall short, the United States Government could face the worst-case scenario of a successful nuclear terrorist attack on an American city. Preparing for this outcome may provide little comfort, but it can mitigate the effects of a nuclear explosion, prevent additional attacks, and even help to identify potential targets for retaliation.

In general, the aftermath of any terrorist attack involves response efforts both at home and abroad. The principal goal of the former is consequence management—limiting the damage caused by an attack. As discussed in Chapter 2, a nuclear terrorist attack would place an enormous burden on government at all levels, and an ineffective or poorly executed response could make a dire situation even worse. Improving consequence management efforts will require continued investment in a number of areas, for example training first responders, in particular those located in or near major cities that are the most likely targets for an attack; prepositioning stockpiles of

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266 "Nuclear Incident Response Teams," p. 6.

267 NNSA NEST factsheet, accessed at http://www.nv.doe.gov/nationalsecurity/homelandsecurity/nest.htm on September 14, 2008. See also Jeffrey Richelson, "Defusing Nuclear Terror," *Bulletin of the Atomic Scientists*, March/April 2002; and Ralph Vartabedian, "How the U.S. Seeks to Avert Nuclear Terrorism," *Los Angeles Times*, January 6, 2008.

268 See NEST factsheet; and Eileen Patterson, "Render Safe: Defusing a Nuclear Emergency," *Los Alamos Research Quarterly*, Fall 2002.

medication to treat radiation sickness; ensuring that various federal as well as state agencies have clearly defined and well understood areas of responsibility in the event of an attack; developing public communication strategies that can quickly and effectively instruct citizens near the site of the attack whether they should shelter in place or evacuate, which directions they should travel in to avoid radioactive fallout, and which routes they should use; and improving capabilities for decontaminating large areas that have been exposed to radiation but can still be salvaged.

Although the government's immediate focus will be on mitigating the consequences of an attack, it will not be long before its attention shifts toward identifying those responsible and retaliating against the perpetrators. For obvious reasons, identification and retaliation may be difficult. Even if a terrorist group were to claim credit for an attack, locating them after the fact may not be possible, at least not right away. Moreover, even if those directly responsible can be found, a nuclear terrorist attack would raise a number of additional questions: Where did terrorists acquire a nuclear weapon or the fuel needed to build one? Did a foreign government deliberately provide the means to carry out such an attack? Was a government negligent in securing its nuclear arsenal or fissile material stockpiles?

Scientists would be tasked with analyzing the radioactive debris from a nuclear explosion in order to gain as much information as possible about the weapon and material used.

As a first step toward answering these questions, scientists would be tasked with analyzing the radioactive debris from a nuclear explosion in order to gain as much information as possible about the weapon and material used — an area that has received increased attention and funding in recent years.[269] This type of forensic analysis could help to determine the efficiency of the device, which could in turn provide clues about its design, whether the bomb used HEU or plutonium, and the isotopic composition of the fissile material, which might indicate where the uranium had been mined and its level of enrichment (in the case of HEU), or how long it had been in a reactor and the length of time since it had been reprocessed (in the case of plutonium).[270] This type of analysis is likely to prove better at ruling out potential suspects than definitively confirming the source of a weapon or material, but combined with other information — for example, the operating histories of reactors that would indicate when their fuel was removed — it could prove extremely useful. Where possible, debris from an explosion could also be compared to fissile material samples previously collected by individual countries or international organizations like the IAEA, which would allow for a more accurate and precise determination of a material's origins. According to one expert, without this basis for comparison, a scientist conducting a forensic analysis

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[269] William J. Broad, "Addressing the Unthinkable, U.S. Revives Study of Fallout," *New York Times*, March 19, 2004; and Calvin Biesecker, "DHS Establishes Center for Nuclear Forensics," *Defense Daily*, October 23, 2006.

[270] Vartabedian, "A U.S. Plan to Avert Nuclear Terror"; Matthew B. Stannard, "New Tools for a New World Order," San Francisco Chronicle, October 29, 2006; William Dunlop and Harold Smith, "Who Did It? Using International Forensics to Detect and Deter Nuclear Terrorism," Arms Control Today, October 2006; Jay C Davis, "The Attribution of WMD Events," Journal of Homeland Security, April 2003; and Michael Miller, "Nuclear Attribution as Deterrence," Nonproliferation Review, March 2007, pp. 36–42.

would be "like someone with a DNA sample and no DNA bank."[271] Because of this constraint, there have been several proposals for the development of an international data bank comprised of fissile material samples from as many nations as possible.[272]

One of the underlying goals of an effective nuclear attribution capability is not only to facilitate an appropriate reprisal in the aftermath of an attack, but also to prevent an attack in the first place. Virtually every discussion of nuclear forensics suggests that as the United States improves its capabilities in this area, other states will be less likely to provide support to terrorists seeking nuclear weapons due to increased fear of identification and retaliation. A number of analysts have also recommended that the United States publicly declare its right to retaliate against any state that is determined to be the source of a nuclear weapon or fissile material used in a terrorist attack,[273] while others have gone even further and advocated an explicit commitment to military reprisal if a state deliberately provides nuclear weapons or material to terrorists or simply fails to properly secure these items, allowing them to fall into terrorists' hands.[274] The logic behind this argument is that such a threat will not only deter the overt transfer of weapons or material from a state to a terrorist group, but will also compel states to improve the security of their most vulnerable nuclear facilities.

These suggestions have recently found their way into US policy. In the period preceding North Korea's nuclear test in October 2005, there were debates within the Bush administration over the merits of a declaratory policy holding states accountable for the transfer of nuclear weapons or material. Skeptics argued that such a policy would not necessarily be credible, particularly because the United States did not possess samples of nuclear material from a number of nations (although it apparently did have access to samples from North Korea).[275] Nevertheless, in response to the North Korean test, President Bush announced that "the transfer of a nuclear weapon or material by North Korea to states or non-state entities would be considered a grave threat to the United States, and we would hold North Korea fully accountable of the consequences of such action."[276] Since then, both National Security Advisor Stephen Hadley and Secretary of Defense Robert Gates have generalized this sentiment, declaring that "the United States will hold any state, terrorist group or other nonstate

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[271] Michael May, as quoted in Stannard, "New Tools for a New World Order."

[272] Michael A. Levi, "Deterring Nuclear Terrorism," *Issues in Science and Technology*, Spring 2004; and Michael May, Jay Davis, and Raymond Jeanloz, "Preparing for the Worst," *Nature,* October 2006.

[273] See, for example, Miller, "Nuclear Attribution as Deterrence"; Robert Galucci, "Averting Nuclear Catastrophe: Contemplating Extreme Responses to U.S. Vulnerability," *Annals of the American Academy of Political and Social Science*, September 2006; and Matthew Phillips, "Uncertain Justice for Nuclear Terror: Deterrence of Anonymous Attacks through Attribution," *Orbis*, Summer 2007.

[274] Anders Corr, "Deterrence of Nuclear Terror: A Negligence Doctrine," *Nonproliferation Review,* March 2005; and Paul K. Davis and Brian Michael Jenkins, *Deterrence & Influence in Counterterrorism: A Component in the War on al Qaeda* (Santa Monica, CA: RAND, 2002), pp. 40–41.

[275] David E. Sanger and Thom Shanker, "U.S. Debates Deterrence for Nuclear Terrorism," *New York Times*, May 8, 2007.

[276] "President Bush's Statement on North Korea Nuclear Test," October 9, 2006, accessed at http://www.whitehouse.gov/news/releases/2006/10/20061009.html on October 29, 2008.

actor or individual fully accountable for supporting or enabling terrorist efforts to obtain or use weapons of mass destruction—whether by facilitating, financing or providing expertise or safe haven for such efforts."[277]

There is little doubt that nuclear forensics could play a valuable role in the aftermath of a nuclear terrorist attack. A well developed and well publicized attribution capability might also induce caution in states that would otherwise contemplate providing assistance to aspiring nuclear terrorists. The US Government should therefore continue to invest in this area, and may even want to exaggerate its capabilities if necessary to foster the impression that state sponsors will not be able to remain anonymous.

Declarations that overtly threaten a military reprisal are unlikely to prove credible or particularly effective in the most important cases, and could even risk doing more harm than good.

At the same time, policymakers should also exercise caution when contemplating public declarations regarding who will be held responsible for an attack and what type of response will follow. Ambiguous warnings that do not explicitly call for a military reprisal could be somewhat useful by reinforcing the notion that governments may be culpable for the actions of a terrorist group if they assist that group or turn a blind eye as it prepares to attack. Yet these messages should not be expected to contribute very much to deterrence or compellance; in all likelihood, statements such as those President Bush and other administration officials have already made do little more than tell potential sponsors or facilitators what they can undoubtedly figure out for themselves—if it is discovered or strongly suspected that they assisted terrorists in acquiring WMD, and especially nuclear weapons, they will suffer some type of response, whether diplomatic, economic, or possibly military. Alternatively, while declarations that overtly threaten a military reprisal will certainly capture a state's attention, these threats are unlikely to prove credible or particularly effective in the most important cases, and could even risk doing more harm than good.

To be successful, a nation issuing a retaliatory threat—especially a threat to use force—must articulate that threat clearly, have sufficient capabilities to carry out its reprisal, and demonstrate a clear willingness to do so if the target fails to comply with its warnings. Unfortunately, all three conditions pose problems for the United States in this instance. First, any threat will have loopholes that the accused state might attempt to exploit. For example, what if that state did increase the security of its nuclear facilities after the United States issued its threat, but claimed that the weapon or fissile material used in a terrorist attack was actually stolen before these improvements were undertaken or completed? Would it still be possible to carry out an attack under these circumstances? Second, it is not clear that the United States does in fact have the technical capability to determine the origin of a detonated nuclear weapon, or that it can convincingly demonstrate such a capability.[278] If this is the case, it may not be

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[277] Thom Shanker, "Gates Gives Rationale for Expanded Deterrence," *New York Times,* October 29, 2008; and Wade Boese, "U.S. Issues Broad Threat to WMD Accomplices," *Arms Control Today*, July/August 2008.

[278] Eileen Sullivan, "US Ill-Equipped to ID Nuclear Material," *USA Today* [Associated Press], October 10, 2007.

possible to convince states that their guilt can be established. Third and perhaps most importantly, while US threats might be effective in some cases, the credibility of those threats will likely be weakest against two of the most likely sources of loose nuclear weapons and material — Pakistan and Russia. In either case, it is highly questionable whether the United States would in fact be willing to undertake a significant military reprisal; while a military attack against Pakistan's government or its nuclear sites could further destabilize the country, pushing it toward state failure and/or civil war, an attack on Russia could precipitate a direct nuclear exchange. Knowing this, both countries may simply dismiss the threat of an attack.

Even if the threat to use military force is issued and does appear credible, it still may not motivate states to improve the security of their nuclear facilities. Nations like Russia and Pakistan have already been targeted by terrorists, and any missing weapons or material originating in these states could very well be used against them. Once bought or stolen, terrorists would have to choose between transporting these items to the United States or perhaps Western Europe, depending on their preferred target, while trying to avoid not only regular detection measures but also the large-scale recovery efforts that would likely be mounted when the stolen items were found missing. Under these circumstances, the culprits might very well opt to attack the state of origin, even if that was not their first choice. Both the Russian and Pakistani governments are certainly aware of the danger they face given the recent history of terrorist attacks in both countries, although they may not yet take it seriously enough.[279] If the prospect of suffering a nuclear terrorist attack does not motivate them to improve security at vulnerable facilities, it seems unlikely that a threat from the US will.[280] The United States should, therefore, make a sustained effort to convince these countries not only that the threat of nuclear terrorism is real, but also that they themselves are as likely and perhaps even more likely than the United State to be the target of a nuclear terrorist attack.[281] Moreover, as discussed in earlier in this chapter, fear of a military reprisal could have the unintended and unfortunate effect of discouraging a state from seeking international assistance to help secure missing nuclear weapons or material; rather than admit its negligence, a state might attempt to recover these items on its own, which could decrease the likelihood that they will be found.[282]

Fear of a military reprisal could have the unintended and unfortunate effect of discouraging a state from seeking international assistance to help secure missing nuclear weapons or material.

[279] Bunn, "Cooperation to Secure Nuclear Stockpiles," pp. 130–131.

[280] Michael A. Levi, *Deterring States Sponsorship of Nuclear Terrorism*, Council on Foreign Relations, Council Special Report No. 39, September 2008, pp. 12–13.

[281] For a number of specific suggestions along these lines, see Bunn, *Securing the Bomb 2007*, pp. 103–107.

[282] A similar observation is made in a recent report by Michael Levi, although based on this point he advocates the much more extreme suggestion that the United States should publicly rule out retaliation against a state that has lost a nuclear weapon or nuclear material so long as that state informs others about its lapse in security. Levi, *Deterring States Sponsorship of Nuclear Terrorism*, p. 14.

CONCLUSION

Nuclear weapons are unique in their ability to kill and injure massive numbers of people, damage and destroy infrastructure, create widespread panic, and perhaps influence the policies and even the international position of a nation that has been attacked. Moreover, terrorist groups like al Qaeda and its various affiliates have demonstrated a serious and longstanding interest in acquiring these weapons, along with a willingness to use them against their enemies. For these underlying reasons, there is little doubt that the possibility of a nuclear terrorist attack, while thankfully small, represents one of the most significant threats to the security of the United States. Addressing this threat must therefore be a priority for the new administration.

Although this threat is real and must be taken seriously, it is extremely difficult to judge accurately. For example, nuclear proliferation over the past decade has arguably increased the likelihood that a terrorist group could obtain a nuclear weapon or the fissile material needed to build one, especially from a chronically unstable nation such as Pakistan, and further proliferation will almost certainly make this situation considerably worse. Yet the number of states that are currently developing nuclear fuel cycle capabilities and nuclear weapons programs has remained quite small, and the nightmarish future in which an increasingly large number of states possess these capabilities is by no means certain. At the same time, al Qaeda—in particular the group's senior leaders and their core lieutenants, who pose the greatest threat of conducting a nuclear attack in the near-to-medium term—is clearly weaker than it was before losing its sanctuary in Afghanistan, and is therefore less capable of planning, financing, and executing a catastrophic attack on the US homeland. Yet the group has also established a new sanctuary in Pakistan and appears to be regaining its strength, meaning the prospect of such an attack is probably increasing, even if it remains smaller than it was in 2001. Finally, any terrorist group seeking nuclear weapons would face enormous hurdles: manufacturing fissile material is nearly impossible for a nonstate actor; finding a state sponsor that would be willing to part with a nuclear weapon or material is highly unlikely; stealing an intact nuclear weapon would also be extremely difficult, as would bypassing the safety measure that most weapons possess; and constructing and IND would require a group to obtain the large amount of HEU needed to build a gun-type device or, if it acquired either plutonium or a small quantity of HEU, to have the skills and components needed to build a complicated implosion device. Nevertheless, the existence of inadequately secured nuclear weapons and material, and the relative ease of building a gun-type device, represent a significant threat. In short, there are both major causes for concern as well as reasons for cautious optimism.

As described in the preceding chapters, decreasing the likelihood that terrorist will obtain nuclear weapons can be achieved by pursuing several goals: halting further nuclear proliferation, in particular by developing a comprehensive plan to discourage Iran's neighbors from pursuing nuclear capabilities if and when Tehran acquires nuclear weapons; eliminating or at the very least restricting al Qaeda's sanctuary in Pakistan's FATA region; and taking steps to decrease the prospects that terrorists will succeed at each major stage in their plot, which may also dissuade them from seriously pursuing the nuclear option at all. In addition, by improving its HUMINT, SOF, and nuclear attribution capabilities, the United States can increase its ability to intercept stolen nuclear material before it is smuggled into the country and to its target, and can, if the worst occurs, improve the odds of determining who is responsible for an attack.

GLOSSARY

AQI	al Qaeda in Iraq
ASP	Advanced Spectroscopic Portal Monitor
CIA	Central Intelligence Agency
CTR	Cooperative Threat Reduction
DHS	Department of Homeland Security
DNDO	Domestic Nuclear Detection Office
DoD	Department of Defense
DoE	Department of Energy
ESD	Environmental Sensing Device
FATA	Federally Administered Tribal Areas
FBI	Federal Bureau of Investigation
GTRI	Global Threat Reduction Initiative
HEU	Highly Enriched Uranium
HUMINT	Human Intelligence
IAEA	International Atomic Energy Agency
ICBM	Intercontinental Ballistic Missile
IND	Improvised Nuclear Device
JSOC	Joint Special Operations Command
JTOT	Joint Technical Operations Team
LEU	Low Enriched Uranium
MOX	Mixed Oxide Fuel
MPC&A	Material Protection, Control, and Accounting
NEST	Nuclear Emergency Support Team
NNSA	National Nuclear Security Administration
NPT	Nuclear Non-Proliferation Treaty
OTA	Office of Technology Assessment
PAL	Permissive Action Link
psi	Pounds per Square Inch
Pu	Plutonium
QDR	Quadrennial Defense Review

R&D	Research and Development
RDD	Radiological Dispersal Device
SLBM	Submarine Launched Ballistic Missile
SOF	Special Operations Forces
SOCOM	Special Operations Command
SMU	Special Military Unit
TTP	Tactics, Techniques, and Procedures
U	Uranium
UAV	Unmanned Aerial Vehicle
WMD	Weapon of Mass Destruction

Acknowledgments

The author would like to thank Christopher Dougherty, Steven Kosiak, Andrew Krepinevich, and Robert Martinage for their comments and suggestions on this report. Special thanks go to Charlotte Brock and Eric Lindsey for their editorial and production support and Cutting Edge for their design.

The analysis and findings presented here are solely the responsibility of the Center for Strategic and Budgetary Assessments and the author.

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