Preventing Nuclear and Radiological Terrorism[1]

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There is no single solution to the terrifying possibility of nuclear and radiological terrorism. Still, that has not stopped many from trying to pinpoint one. Some have proposed a strong focus on controlling nuclear and radiological materials in cooperative countries, particularly in the states of the former Soviet Union. Others have emphasized the need to challenge so-called rogue states, like Iraq, which might actively supply dangerous weapons to terrorists. Still others have argued that homeland security, understood narrowly as a mix of border controls, domestic surveillance, and emergency response capacity, should be the primary means of addressing the threat. To be successful, though, a strategy must combine these three approaches.

An effective strategy will also need to carefully distinguish the nuclear and radiological problems, which are too often lumped together. One recent study estimated that a small nuclear weapon detonated at midday in New York City could quickly kill over five hundred thousand people[3]; in contrast, it is difficult to imagine a credible radiological weapon that would cause any near-term deaths[4]. This alone suggests that the nuclear threat be maintained as a clear priority. Moreover, nuclear weapons are significantly more difficult to obtain or construct than are radiological weapons, while radiological weapons are much easier to defend against than their nuclear cousins. These differences should play a major role in tailoring solutions to the two problems.

Designing strategies for preventing nuclear and radiological terrorism thus requires finding different admixtures of the three broad approaches, each appropriate to different weapons problems. Rogue states should be a major concern with regards to nuclear terrorism, but are largely irrelevant to the radiological weapons problem. Cooperative materials security is extremely valuable in confronting both problems, though particularly useful in addressing the nuclear dimension. And homeland security – in particular, border control and emergency response – is far more valuable in dealing with the potential for radiological terrorism than it is for preventing nuclear terror.

Radiological Terrorism

The most commonly cited mode of radiological terrorism is the "dirty bomb", which uses conventional explosives to spread radioactive materials over a wide area. Radiological attacks might also use covert means of dispersal, but the effects would be similar. A third possibility, planting a single radiological source and allowing people to be exposed to it, is unlikely to cause distributed effects, and thus is not considered here.

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[3] M. Bunn, A. Wier, J.P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Washington, D.C.: Nuclear Threat Initiative and the Project on Managing the Atom, Harvard University, March 2003).

[4] M. Levi, H. Kelly, "Weapons of Mass Disruption", *Scientific American*, November 2002.

The primary challenge in building a dirty bomb is obtaining sufficient radioactive material in a relatively compact form. In some cases, converting the material to a dispersible state may add to the difficulty. In addition, extremely strong radioactive sources are unlikely to be employed, as they would kill their handlers before an attack could be executed, or before the material could be transferred to another handler.

Given those restrictions, efforts to prevent radiological terrorism should focus on seven primary radioisotopes: Cobalt-60, Cesium-137, Iridium-192, Strontium-90, Plutonium-238, Americium-242, and Californium-252. The first three emit "gamma" rays, and thus are dangerous if people are exposed to them externally. As a result, if they are used in a dirty bomb, people can greatly limit their exposure by leaving the affected area quickly. In addition, the danger from external exposure imposes practical limits on the amounts of material an individual terrorist can handle – an upper limit equivalent to 10,000 curies of Cobalt-60, which would kill its holder in four minutes if held unshielded at a one meter distance, seems appropriate. The fourth, Strontium-90, emits "beta" particles, and the final three emit "alpha" particles; in each case, the material must be inhaled for significant exposure to occur. As a result, if the materials are breathed in during an attack, leaving the affected area quickly will not be as effective as in the gamma-ray case. Moreover, since there is little radiological danger from external exposure to a terrorist handling the material, there is no theoretical upper limit on the amount of radioactive material that might be employed.

The effects of a dirty bomb attack can vary widely, but several general conclusions are possible[5]. First, spreading small amounts of radiological materials will have no real effect other than to instill public fear. Larger amounts of material – upwards of approximately the equivalent of one curie of Cobalt-60 – will cause enough contamination to force cleanup or abandonment of substantial areas, if strict, peacetime safety standards are imposed. Even greater amounts – upwards of approximately the equivalent of one-hundred curies of Cobalt-60 – will cause enough contamination to force cleanup or abandonment of substantial areas even if weaker, post-Chernobyl-type safety standards are imposed. The largest practical dirty bomb attacks would likely contaminate several square miles to levels exceeding the safety standards imposed after Chernobyl – abandonment of areas where the risk of death from cancer was increased by more than one part in thirty.

Few if any deaths will result promptly from radiation exposure in a dirty bomb attack. Instead, the major challenge will be long-term consequence mitigation. This will involve cleanup, relocation, and public education to ensure that areas are not abandoned due to inflated fears of radiation. Emergency response, however, should not be overly stressed, since there will be few immediate effects to deal with beyond public panic.

Given these facts, what does a proper strategy for confronting radiological terrorism look like? First, the wide availability of radiological materials in commerce, medicine, and academe suggests that terrorists would not require a state sponsor to obtain the ingredients for a radiological attack. Thus, confronting states simply because they possess radiological materials or weapons of mass destruction (WMD) programs would be an ineffective strategy. However,

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[5] M. Levi, H. Kelly, "Weapons of Mass Disruption", *Scientific American*, November 2002.

some attention should still be paid to the role of rogue states, as they can provide shelter and support to terrorists during the planning phase of an attack.

Cooperative control over radiological sources is a crucial element of any strategy. There is a finite, though large, set of radiological sources than need to be protected – given enough money and a cooperative effort, achieving a high level of security should be possible. Security efforts should be prioritized, focusing first on the largest sources, and ignoring sources weaker than approximately one curie. In addition, greater focus should be placed on securing alpha and beta sources than on securing gamma sources since, as we will discuss later, using border controls to prevent alpha and beta source smuggling is much more difficult than using such controls to block transfer of gamma emitters[6].

Much effort to date has been aimed at securing radiological sources in states of the former Soviet Union. Part of this focus is wise, as the Soviet Union lost control over a large number of strong sources, but part of it is misdirected, as poorly-secured radiological sources extend far beyond the former Soviet Union. Most likely, the current emphasis is an extrapolation of the focus placed on the former Soviet Union in securing nuclear weapons materials. However, there is little natural correlation between possession of radiological materials and possession of nuclear weapons materials, making a simple extensions of existing programs inadequate. To be successful, programs to secure loose radiological materials must be extended worldwide, including into advanced industrial states.

Border control also has an important role to play in preventing radiological terrorism. If a country has already taken effective steps to secure radiological materials within its own borders, detecting imports of highly-radioactive materials can provide an important complement. This approach will only be effective, however, against attempts to import gamma-emitting materials, which emit penetrating radiation. In contrast, it would be extremely easy for terrorists to shield alpha and beta emitters from radiation detectors.

Because so many radiological sources are in circulation, both domestically and internationally, relying merely on prevention is insufficient – authorities must invest in consequence mitigation measures too. To date, though, consequence mitigation efforts have focused excessively on emergency response, despite scientific consensus that the effects of a radiological attack are long-term rather than immediate. To remedy that discrepancy, efforts need to focus on the long-term problem of decontamination, aiming both to develop technologies and to design plans for efficient decontamination[7]. In addition, preparations should be made for effective communication and education on the dangers of radioactive contamination, in order to minimize disruptions that will result from exaggerated fears.

Nuclear Terrorism

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[6] For an excellent review of source security measures, see C.D. Ferguson, T. Kazi, J. Perera, "Commercial Radioactive Sources: Surveying the Security Risks," Occasional Paper No. 11, Center for Nonproliferation Studies, January 2003.

[7] J. Yassif, "U.S. Unprepared for Dirty Bomb Aftermath," *Defense News*, April 28, 2003.

Preventing nuclear attack should be a much greater priority than stopping radiological terrorism. Unlike a radiological attack, whose toll in lives can be effectively controlled, a nuclear attack could kill hundreds of thousands within seconds, allowing no possibility for meaningful mitigation. Our efforts to thwart nuclear terrorism should thus be aimed almost entirely at prevention.

There are two principal routes by which terrorists might obtain nuclear weapons, and both should be taken seriously. Terrorists might steal a complete warhead or fissile material – Highly Enriched Uranium (HEU) or Plutonium (Pu) – from an inadequately secured state arsenal. Alternatively, a rogue state might actively provide a terrorist group with either a complete a nuclear weapon or with the fissile material necessary to build one themselves. A third possibility, terrorists producing their own fissile material, is technically and logistically implausible, and should thus be disregarded.

The first possibility, theft, is currently addressed primarily through the Nunn-Lugar Cooperative Threat Reduction programs, extended last year to the G-8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction[8]. The programs work primarily with Russia and other states of the former Soviet Union to secure and destroy nuclear warheads and fissile materials, and to reemploy former Soviet weapons scientists. By most measures, they need more funding to be successful: The blue-ribbon Baker-Cutler report recommended two years ago that $30 billion be spent over the next ten years to secure weapons and materials in the former Soviet Union[9]; the G-8 Partnership has committed to spend up to $20 billion, and must be supplemented by additional sources. In addition, high-level political efforts are necessary to break the bureaucratic and political deadlocks that threaten the program's success[10]. On the Russian side, President Putin needs to push facility operators to provide greater access to American contractors and inspectors to verify implementation of security upgrades. On the American side, President Bush should pressure conservative lawmakers to remove legal obstacles to efficient and flexible implementation of the programs.

For cooperative threat reduction to be broadly successful, it must be agressively expanded beyond the former Soviet Union; to do that, financial contributions from outside the G-8 will be needed. At a political level, expanding the program to provide security at civilian nuclear facilities worldwide that use plutonium or HEU should be straightforward. Every effort should also be made for eliminate the use of HEU in civilian research reactors worldwide.

Assisting India and Pakistan with security for their nuclear arsenals will be much more challenging. Cooperation with such *de-facto* nuclear states outside the Non-Proliferation Treaty might confronts legal barriers – Article I of the Non-Proliferation Treaty (NPT) obligates the five *de jure* nuclear weapons states not to "assist, encourage, or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or

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[8] M. Bunn, A. Wier, J.P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Washington, DC: Nuclear Threat Initiative and the Project on Managing the Atom, Harvard University, March 2003).
[9] H. Baker and L. Cutler, co-chairs, *A Report Card on the Department of Energy's Nonproliferation Programs with Russia* (Washington, D.C.: U.S. Department of Energy, Secretary of Energy Advisory Board, January 10, 2001).
[10] *Reshaping U.S.-Russian Threat Reduction: New Approaches for the Second Decade* (Washington, DC: Russian American Nuclear Security Advisory Council and Nuclear Threat Initiative, November 2002).

control over such weapons or explosive devices." This legally prohibits states from offering certain types of assistance – in particular, Permissive Action Links (PALs), sophisticated locking devices for nuclear weapons – to India or Pakistan. There are also political objections to offering any assistance, as many contend that aiding India or Pakistan in any way would weaken nonproliferation norms[11]. In a third vein, some analysts worry that assisting India or Pakistan with PALs could push those countries to more readily deploy their nuclear weapons, destabilizing the subcontinent[12]. In light of these concerns, it appears wise for now to stop short of aiding India or Pakistan with PALs. However, to the extent that hose countries are willing to accept other forms of assistance, outside states should aid them in securing their nuclear materials, and in screening personnel with access to sensitive equipment and information. Moreover, if Pakistan and India move independently to regularly deploy their weapons, states should reconsider their reluctance to provide PALs.

By itself, cooperative security will be insufficient – as long as states potentially friendly with terrorists pursue nuclear weapons programs, coercive measures will also be required. Currently, our primary worries in this regard are North Korea and Iran, though Pakistan could be added to the list if the government there fell to Islamist radicals. (Iran has demonstrated links with Hezbollah and other terrorist groups, and while North Korea has no active links to terrorism, it has shown a disturbing willingness to sell weapons to rogues, which requires us to not exclude its possibly selling nuclear weapons to terrorists.) A strategy to deal with the non-cooperative side requires us to both prevent proliferation, and to mitigate the potential nuclear-terrorism consequences when does occur.

Preventing proliferation requires a broad toolkit. We should not abandon global regimes, like the Non-Proliferation Treaty, that while not panaceas do reduce incentives to proliferate. Still, the NPT alone is insufficient. At a cooperative level, it must be supplemented by regional security arrangements that further reduce incentives to proliferate. It might also be supplemented by additional global regimes, like the Comprehensive Test Ban Treaty and a potential Fissile Material Cutoff Treaty, along with the continued application of export controls.

States should also consider a global agreement that would ban production of highly-enriched uranium and separated plutonium, whether civilian or military, worldwide[13]. Such an agreement would require, at the least, significant reinterpretation of Article IV of the NPT, which currently guarantees non-nuclear state parties to the treaty assistance with peaceful nuclear technologies. To secure such a reinterpretation, nuclear state-parties to the NPT might offer other forms of energy assistance, including assistance with advanced fossil fuel technologies, in lieu of assistance with nuclear energy. Such a change would likely be opposed not only by some non-nuclear states, but also by the nuclear industry; it would, however, give great benefits to nonproliferation.

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[11] For example, *The US and Pakistan: Allies, but no PALs*, (Washington, DC: Council for a Livable World, October 2001).

[12] For example, Z. Mian, R. Rajaraman, F. von Hippel, "Nuclear Role Models", *Washington Post*, August 6, 2002.

[13] H. Sokolski, "Nukes on the Loose: Time for a new Nonproliferation Regime", *The Weekly Standard*, June 23, 2003.

The various treaties that now form the nuclear nonproliferation regime urgently need to be supplemented with broad agreements about how to enforce them. Most of the tools we need for coercive enforcement – political and economic sanctions, in addition to military force – already exist at a technical level, but lack an international political framework. For example, during the lead-up to the Second Gulf War, most interested states argued that military force could be used if all other options had been exhausted, but few agreed on when that point of exhaustion had been reached. It would be extremely valuable to begin a broad dialogue at the United Nations Security Council over when, indeed, various coercive measures can be used to pursue nonproliferation goals, with the goal of developing more explicit guidelines than currently exist. In addition to promoting international cooperation during crises, this would provide a more effective deterrent to states considering acquiring nuclear weapons, as they would clearly know the consequences for their actions.

There is also room for novel enforcement approaches, but they will almost always require international cooperation. To highlight one recent example, the new Proliferation Security Initiative (PSI), a limited international coalition aimed at interdicting trade in weapons of mass destruction and related technologies, has potential[14]. It is not alone a solution to proliferation, in considerable part because radiation detection technology is too limited to allow the coalition to reliably interdict shipments of fissile materials, and in large part too because the technology required to build nuclear weapons is widespread, not limited to a small group of states. The PSI, though, is still potentially valuable – it can be used to starve shoestring weapons programs of funds by stopping the weapons sales that fund them, and can stop the transfer of heavy equipment destined for nuclear programs, slowing down those programs down. It might also serve as a deterrent, if the consequences of exporting nuclear materials are clearly communicated to proliferant states. To be effective, though, it will need new international legal authority. Right now, the PSI is limited by laws preventing it from conducting interdictions on the high seas, where dangerous shipments could spend most of their voyages. By appealing to the UN Security Council, states might obtain new rights to interdict shipments from a small group of states designated as urgent proliferation threats.

As a final layer, measures must be developed to cope with hostile states that manage, despite our best efforts, to acquire nuclear weapons. In those cases, we must make clear to rogue states the high penalty for transferring nuclear weapons or materials to terrorists, and we must develop technologies to more effectively attribute proliferated materials to their sources. This last challenge – attribution – is neglected, yet crucial. We can only restore the effectiveness of deterrence in confronting terrorist-delivered weapons by effectively linking terrorist-borne nuclear bombs to their state-providers.

The technology to do this is better developed than most assume[15]. Attribution requires two key steps: determining the composition of an intercepted weapon (even, if necessary, after it has been detonated), and matching that composition to a known source. The first step is relatively straightforward. During the Cold War, for example, the United States and Russia analyzed the residues from each others' bomb tests to determine the initial compositions and designs of their

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[14] M. Levi, M. O'Hanlon, "A Global Solution is Needed for Illicit Weapons", *Financial Times (London)*, July 11, 2003.

[15] J. Davis, "The Attribution of WMD Events", *Journal of Homeland Security*, April 2003.

adversaries' weapons. To extend that technology to the terrorism problem, US designers would have only to develop templates of possible terrorist weapon designs. The second problem – essentially, creating fingerprints for various sources of nuclear weapon materials – is more challenging. The IAEA could potentially take a large role, cataloguing the composition of all nuclear materials subjected to its safeguards. This could be effective even if the IAEA were ultimately ejected by the proliferant state, as a known nuclear facility will produce nuclear material with a predictable signature. Other less cooperative means for fingerprinting programs should also be investigated.

Forging Consensus

Common throughout the above analysis is a conviction that preventing radiological and nuclear terrorism is not something to be done alone by one state, or even by a small coalition. It requires cooperation on a near-global scale, and consistency of resolve. Preventing nuclear terrorism, in particular, is one of the great challenges facing the world in the coming decade. We must move beyond platitudes to discuss cooperation on substance if we are to succeed.