Commercial radioactive sources: surveying the security risks

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In June 2002, the Center for Nonproliferation Studies (CNS) of the Monterey Institute of International Studies launched a project, co-directed by Dr. William C. Potter and Dr. Charles D. Ferguson, to conduct a systematic assessment of all four major threats of nuclear and radiological terrorism. These threats are construction and use of radiological dispersal devices or 'dirty bombs', theft or purchase of fissile material in order to build improvised nuclear devices, acquisition of intact nuclear weapons, and attacks or sabotage of nuclear power installations or other nuclear facilities. Although many governments have renewed efforts to combat nuclear and radiological terrorism soon after 11 September 2001, they are still in need of a careful and systematic assessment of these threats in order to determine how to effectively direct limited resources. The CNS nuclear and radiological terrorism assessment project endeavours to provide this guidance to government officials and other policy makers. As the first part of this project, CNS examined the radiological dispersal device threat.

This study examines the security risks posed by commercial radioactive sources. While these sources provide benefits to humanity through numerous applications in medicine, industry and research, some of these same materials, if not secured, may end up in radiological dispersal devices (RDDs)—one type of which is popularly known as a 'dirty bomb'. Though RDD use has not occurred, the 11 September 2001 terrorist attacks, al-Qaeda's expressed interest in acquiring the means to unleash radiological terror, and widespread news reporting on this topic have sparked renewed concern about the security of commercial radioactive sources.

Although radioactive materials other than commercial radioactive sources—such as radioactive waste from nuclear power plant operations—might contribute to the components of an RDD, an examination of these materials is beyond the scope of this study.[1] This study focuses on the security of commercial radioactive sources because they represent a significant category of radioactive materials that are used widely throughout the world and, until recently, have not been considered high security risks.

A major finding of this study is that only a small fraction of the millions of commercial radioactive sources used globally, perhaps several tens of thousands, pose inherently high security risks because of their portability, dispersibility and higher levels of radioactivity. As a rule, these more dangerous

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commercial sources are those containing relatively large amounts of radioactivity (typically more than a few curies—greater than a hundred gigabecquerel—worth of radioactivity) of seven reactor-produced radioisotopes: americium-241, californium-252, cesium-137, cobalt-60, iridium-192, plutonium-238 and strontium-90. Some of these isotopes (americium-241, californium-252 and plutonium-238) would only pose internal health hazards by means of ingestion or inhalation, while the others would present both internal and external health hazards because the emitted ionizing radiation could penetrate the dead outer layer of human skin.[2]

To maximize harm to the targeted population, radiological terrorists would tend to seek very highly radioactive sources (containing tens of thousands or more curies) that pose external and internal health hazards. However, even suicidal terrorists might not live long enough to deliver an RDD because they might receive lethal acute doses of ionizing radiation from these sources in the absence of adequate shielding surrounding the radioactive material. But adding heavy protective shielding could substantially increase the difficulty in transporting an RDD and could dissuade terrorists from employing these types of sources. In contrast, sources that only present an internal health hazard and that contain very high amounts of radioactivity could be handled safely without heavy shielding as long as precautions are taken to minimize internal exposure.

While terrorist misuse of radioactive sources with low levels of radioactivity might cause a degree of panic for a brief period, the high-security risk sources are those that present genuine dangers to the public, in terms of long-term health effects and major financial loss. For this reason, this study concludes that properly regulating and securing this smaller subset of sources could contribute significantly to reducing the overall dangers posed by commercial radioactive sources. Public education, however, is also needed to familiarize the public with the RDD threat and, in particular, to provide, insofar as is possible, reassurance that some RDDs will have so little radioactivity as to pose little, if any, actual danger to the public.

This study finds that, unlike nuclear weapons, RDDs (including those using the seven radioactive isotopes noted above) are typically not weapons of mass destruction. Few, if any, people would die immediately or shortly after use of an RDD from exposure to the ionizing radiation from such a device, although, depending on its placement and size, many individuals might die from the conventional bomb blast if this method were used to disperse radiological materials. Most people not directly affected by the conventional blast would receive relatively low doses of ionizing radiation, even from weapons using the seven high-security threat radioactive isotopes, and possible cancer deaths would usually require years to decades to develop.[3] Nonetheless, an RDD can be a weapon of mass disruption or dislocation. Preying on the public's fears of radioactivity, terrorists who used RDDs would try to cause panic. The possible resulting chaos during evacuation of the immediate and surrounding areas of RDD use could not only cause injury and anguish, but could hinder emergency response efforts to assist the victims of the conventional blast. Moreover, the time needed for first responders to prepare to operate safely in a radioactive environment could add to delays in tending to these casualties. Further, the decontamination costs and the rebuilding costs, if necessary, from an RDD could be immense—perhaps upwards of billions of dollars. Therefore, while not causing the immediate, large-scale loss of life and physical destruction associated with nuclear detonations, RDD effects could be substantial.

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In addition, this study points out that only a few corporations, headquartered in a handful of nations produce most of the commercial radioactive sources that pose high security concerns. This small group then distributes sources to tens of thousands of radioactive source users throughout the world. The leading radioactive source producing nations are Canada, South Africa, the Russian Federation, Belgium, Argentina and France. In addition, the United States and the European Union

(EU) also play leading roles. Although the United States is not presently a major commercial radioactive source producing nation, it has the potential to re-emerge as one, and it contributes to a large market share of source use. The member states of the EU also use a significant portion of the commercial radioactive sources. This source production finding is significant because it indicates that by tightening export control standards and by conditioning exports on certification that effective security measures will cover the sources in recipient countries, some half-dozen exporting nations, together with the EU, could rapidly ensure that the considerable majority of high-risk radioactive sources in use around the world are properly protected against misuse. (As explained below, in discussing a major gap in current export control rules, implementing this change regarding importer-country regulations could be made in conjunction with a restructuring of the export licensing system that is needed for other reasons.)

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This finding is part of the study's broader analysis of the 'cradle to grave' stages of a radioactive source's lifecycle. All of the high-risk radioisotopes that are the active components of the sources of greatest security concern are created in nuclear reactors. These sources are then distributed to tens of thousands of global users. Ideally at the end of life, a source is safely and securely disposed of in a corporate or government-operated depository. Advanced industrialized countries use most of the high-risk radioactive sources, which are subject to regulation throughout their lifecycles. Traditionally, these regulations were concerned principally with protecting worker and public safety, rather than with securing high-risk sources against malevolent misuse, but these states are taking steps to address this gap. Indeed, this study finds that private industry and regulatory agencies in these industrialized countries have already taken steps to secure those commercial radioactive sources that pose the highest security risks, in particular, at reactors that produce commercial radioisotopes, in transit, and at the facilities employing the highest-risk sources. In other settings in these countries, industrial practices intended to protect sources as dangerous and valuable items provide an important measure of security against theft.

Domestic regulatory controls in the states of the former Soviet Union and in a number of developing countries are weaker or, in some cases, non-existent, and reforms (supported, as appropriate, by external assistance) are urgently needed in these places. In many of these states, however, the number of high-risk radioactive sources is more limited than in the advanced industrialized states. Therefore, intensive efforts to improve security over high-risk sources are needed for only a relatively small fraction of these sources worldwide, permitting efforts to be concentrated on this aspect of the radioactive source threat and offering the prospect of rapid improvement. By focusing its regulatory assistance programmes on many of the nations in this group, the International Atomic Energy Agency (IAEA) has helped develop new regulatory agencies or improved weak regulatory infrastructures. However, further improvement requires additional funding from IAEA member states that can provide it. Moreover, time and diligence are needed to instil a safety and security culture in nations that lack it.

Irrespective of the regulatory environment, this study points out that many end-users retain disused sources because of high disposal costs or lack of adequate depositories. These barriers to proper disposal create pressures on end-users to dispose of their high-risk sources outside of regulated channels, that is, to abandon, or 'orphan', them. Although major source manufacturers and many industrialized countries have programmes to sweep up disused sources before they are abandoned, these programmes should be expanded to mitigate this aspect of the risk posed by radioactive sources. Moreover, these efforts should concentrate on the high-risk radioisotopes. In addition, this study examines the dangers posed by previously lost or abandoned orphan sources. Although official reports and press accounts suggest that there are conceivably tens of thousands of such orphan sources worldwide, the study finds that of these, only a small fraction are in the high-risk category, with the

preponderance probably to be found in the states of the former Soviet Union, as a legacy of the Cold War. By focusing resources on the high-risk sources (especially in the latter setting) significant progress can be made to reduce the worldwide dangers posed by orphan sources.

This study identifies a significant gap in US export licensing rules covering high-risk radioactive sources that could facilitate illicit commerce in these materials, a gap also seen in the licensing rules of a number of other developed Western states. Specifically, current US regulations permit the unlimited export of most high-risk sources under 'general' licenses, to all destinations, except Cuba, Iran, Iraq, Libya, North Korea and Sudan. Consequently, exports of these materials can be made without any governmental review of the bona fides of end-users, and exporters are not required to report on transfers of these materials. In other words, unlimited exports of cobalt-60, cesium-137 and other potentially dangerous radioisotopes incorporated in sources are permitted without any official review of end-users to many states where extensive terrorist activities are taking place—including all the states of the former Soviet Union, Afghanistan, Algeria, Columbia, India, Indonesia, Israel, the Philippines, Pakistan, Saudi Arabia and—to at least one state deemed by the US Department of State to be a state supporter of terrorism—Syria. Although the licensing authority, the US Nuclear Regulatory Commission, has taken interim steps (until permanent regulations are adopted) to intensify security at domestic sites where high-risk radioactive sources are used, it has not taken parallel interim steps to tighten export controls over these materials. (Separately, the Commission needs to intensify efforts to ensure the legitimacy of US end-users, when it grants domestic licenses for the possession of high-risk radioactive sources.)

Finally, this study examines a number of technical approaches, some of which are now being implemented, for reducing the dangers from radioactive sources. These measures include creating sources that are difficult to disperse, lowering the radioactivity level of radioactive sources, and developing non-radioactive alternatives for uses of radioactive sources.

Based on the above findings, this study urges high priority work in the following areas.

Protect against illicit commerce of radioactive sources by:

- Requiring specific licenses for exports of the high-risk radioactive sources to permit end-user reviews, beginning with the United States implementing and leading this effort.
- Maintaining strong domestic regulatory oversight of users of highly radioactive sources through verifying the legitimacy of the user before issuing a license to possess these sources and conducting more frequent inspections once a license is granted.
- Conditioning exports of high-risk sources on confirmation that the importing country has in place adequate controls and security measures; allow exceptions on humanitarian grounds, with case-specific safeguards.
- Continuing to enhance border and port security to prevent smuggling of illicitly obtained highly radioactive sources.

Dispose of the large pool of disused sources by:

- Developing, or ensuring adequate funding for, national programmes aimed at recovering disused sources from the public domain and placing them in secure interim storage. For example, the Off-Site Source Recovery Project operated by the United States Department of Energy has secured more than 3,000 disused sources, but the project faces a substantial funding shortage that, if not remedied, would cripple its ability to secure more than 10,000 additional disused sources that potentially pose a high security concern.

- Creating incentives for the prompt and proper disposal of disused sources, for example, by imposing a disposal fee to be paid when sources are acquired that would be partially refunded upon evidence of their proper disposition.
- Expediting creation of a permanent, secure disposal site in the United States for Greater Than Class C disused sources (which are long-lived and relatively highly radioactive sources that currently exceed regulatory standards for near surface disposal).
- Developing secure disused source depositories in countries that lack such facilities or in regional settings open to many contributing countries.

Address the outstanding problem of the thousands of radioactive sources that have been lost, abandoned or stolen—the so-called 'orphan' sources—by:

- Concentrating recovery efforts on the small fraction of orphan sources that pose a high security concern.
- Providing adequate funding for the United States Orphan Source Initiative, operated by the Environmental Protection Agency in conjunction with the Department of Energy and the Nuclear Regulatory Commission.
- Assessing whether adequate resources are being devoted to address the worldwide orphan source problem.
- Prioritizing finding and securing high security risk orphan sources in the Newly Independent States. In particular, the United States, the Russian Federation and the IAEA should ensure that their recently launched tripartite initiative to secure orphan sources in the Newly Independent States remains a top priority.

Assist the approximately 100 nations—about half the world's total number—with weak regulatory controls, starting with those having the greatest number of high-risk radioactive sources, by:

- Expanding the IAEA's regulatory assistance efforts, which have been successful in building up the regulatory infrastructure in several IAEA member states. Moreover, all member states should adhere to the Code of Conduct on the Safety and Security of Radioactive Sources, which is currently being revised to focus more on security concerns.
- Offering regulatory and security assistance to the approximately fifty non-member states of the IAEA that possess radioactive sources, but lack adequate regulatory infrastructures. The leading radioactive source producing nations should consider providing this assistance.

Reduce security risks from future radioactive sources by:

- Encouraging producers to make sources that are relatively difficult to disperse. For example, reduce the production of powdered cesium-chloride.
- Continuing to reduce the radioactivity levels of sources to the minimum required to perform the necessary, beneficial task.
- Promoting the use of non-radioactive alternatives to radioactive sources (such as accelerators),[4] where those non-radioactive methods can provide the same or greater benefit as radioactive sources.

Mitigate the potential effects of RDD use by:

- Educating the public and the press about the hazards and appropriate responses to the use of an RDD.
- Preparing first responders by providing radiological training and equipment.
- Conducting regular emergency planning exercises involving coordinated efforts of local and federal officials, and applying lessons learned from these exercises to develop more effective response capabilities.
- Investing in research and development of effective decontamination technologies.
- Investing in research and development to enhance the protection, detection and tracking of radioactive sources.

In addition to reducing the risks from RDDs, these recommended measures will improve radiation safety and, thereby, enhance public health. Through continued attentive effort, clear vision of priorities, and focused initiatives, governments, international organizations and industry can meet the challenge of the potential misuse of highly radioactive sources by terrorists.

Notes

1 The Center for Nonproliferation Studies intends to publish in the near term a systematic, comparative analysis of the major aspects of nuclear and radiological terrorism. The forthcoming report will examine the security risks posed by all relevant radioactive materials.
2 Strontium-90 would primarily present an internal health hazard.
3 Under certain highly specialized scenarios, it is possible to imagine many thousands of individuals receiving small ionizing radiation doses that could ultimately prove lethal over a long time period. For this reason, under some circumstances, RDDs could result in mass long-term casualties, making them weapons of mass destruction of a unique variety, but ones unlikely to be attractive to terrorists.
4 Non-radioactive alternatives, such as accelerators, which generate radiation by accelerating charged particles, only produce radiation when an electrical power supply is turned on and do not pose a radiological dispersal device threat.