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Session 11 - Radioactive dispersion devices (RDD): What are the odds?

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Radioactive Dispersion Devices (RDD): What are the Odds?

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Abstract
Since the tragic events of September 11th, 2001 there has been apprehension that the United States may be ill-prepared to prevent future terrorist events. One source of concern is that a Radioactive Dispersion Device (RDD) could be detonated at a vulnerable target anywhere in the nation. A RDD, also known as a “dirty bomb, is a conventional explosive packed with radioactive material. The explosion could disperse radioactive material over a wide area. The target could be an icon associated with American democracy and government, critical systems and infrastructure, a water supply, a nuclear power plant and others. Such an event could result in impact to citizens and communities on a number of levels: physical, economic, psychological and fiscal. The paper provides an overview of salient issues associated with RDD and offers perspectives on the vulnerability of the U.S., to attacks using such devices.

1. Weapons of Mass Destruction

The events of September 11, 2001 raised concerns about America’s vulnerability to a number of potential terrorist threats. Of particular concern has been the use of “weapons of mass destruction” (WMD). WMD is a generic term that could include nuclear weapons, toxic chemicals and/or biological agents. A nuclear WMD could result in death, destruction and long term contamination of extensive areas of a community (equivalent, for example, to the damage experienced from the Chernobyl event). Significant economic impacts and “stigma” effects could result. Had the 9/11 terrorists utilized a nuclear WMD the consequences would have been even more catastrophic.

The fear of WMD has been compounded by reports of vulnerable security arrangements at critical infrastructure: ports, nuclear power plants, chemical manufacturing facilities, refineries and others.

Exacerbating the concerns has been an apparent breakdown in security arrangements in nations producing nuclear weapons. There is evidence to suggest, for example, that nuclear weapons/resources are vulnerable to loss in a number of nations. In particular, there has been concern about loss of nuclear weapons from stock piles in the nations that comprised the former Soviet Union (e.g., Russia, Belarus, Ukraine, and Kazakhstan). Evidence suggests that this laxness in security has facilitated the ability of rogue groups to obtain nuclear weapons and materials.

Similarly, individuals such as Pakistan’s A.Q. Khan and the policies of states such as North Korea and Iran have also probably provided opportunity for WMD or related technology to get in the hands of terrorists. Preventing terrorist groups from obtaining WMD will continue to be a major challenge for national security agencies.

While the U.S. has been fortunate, thus far, in avoiding incidents involving WMD (although the anthrax event in late 2001 discussed later may have been a wake up call) it is difficult to know whether this has been due to improved national security procedures or because of fortuitous circumstances.

2. Radiological Dispersion Devices (RDD)

There are other concerns, however. The potential use of Radiological Dispersion Devices (RDD) should also heighten our apprehension. RDD are also termed “dirty bombs,” or “weapons of mass disruption.”

Many Americans first heard the term dirty bomb on June 10, 2002, when Attorney General John Ashcroft announced the arrest of Jose Padilla on the charge of plotting to detonate a device containing both high explosive and very radioactive material.1

What are RDD? Graham Allison, a leading authority on nuclear weapons and national security issues, defines a RDD as “conventional explosives packed into radioactive material.”2 “(RDD) can take many forms—from sticks of dynamite packed … with cesium to a fertilizer-based truck bomb wrapped in cobalt.”3 A RDD could be

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3 Ibid. 57.
manufatured by surrounding TNT, C-4, or other chemical explosive with a radioisotope.

Many terrorist groups have the skill and materials needed to make the explosive part of the device. Terrorists could also disperse radioactive material without an explosive by spraying, scattering, or simply dumping it.  

The threat posed by terrorist RDD use and the magnitude of potential impact are matters of contention. Some experts believe that terrorists could, without great difficulty, obtain radioactive material and construct a RDD. Others assert that the inherent difficulties of handling radioactive material (coupled with (causing relatively) few direct casualties make RDD less likely terrorist weapons. Despite the possible complexities, the potential use of RDD by terrorists makes it imperative that this source be considered in national security planning efforts.

RDD can be produced employing biological, chemical and radioactive materials. The radioactive segment, however, is the most significant for reasons ranging from the actual risk itself to the perception by the public of its danger. The focus of the paper, therefore, will be placed on the radioactive component of the RDD.

The radioactive materials most likely to cause harm, based only on their physical properties, are also those most widely available and having significant commercial application. A partial list of purposes to which radioactive elements are applied include medical, academic, agricultural, industrial, food irradiation, smoke detection, communication, navigation, and in oil well logging.  

The prevalence of these sources in the public domain, coupled with inadequate control and monitoring mechanisms, poses a significant threat to health and security, not only from the possible terrorist use of radioactive materials, but also from accidents.

Additional impacts from RDD would include negative economic influences (e.g., cost of cleanup, business disruption, and long term contamination) and stigma effects to citizens and communities. These will be discussed in more detail later in the report.

3. Terrorist Objectives

The objectives of terrorists or rogue states are manifold. Besides causing death and destruction, other important goals are creating impact to economic interests, spreading fear among the civilian population, fostering distrust in government, and attempting to change governmental policies, particularly in the Middle East. Osama bin Laden and his cohorts have acknowledged the possible use of radioactivity in terrorist operations.

The Congressional Research Service (CRS) examined RDD issues extensively. The CRS surmised that terrorists with small amounts of radioactive material might create as much panic RDD could attempt to influence policies by causing the following actions:

3.1 Deaths and injuries.

Any immediate casualties would most likely come from the explosion of a dirty bomb.

3.2 Panic.

Small amounts of radioactive material might create as much panic as larger amounts. This could result in the voluntary or involuntary mass evacuation of citizens.

3.3 Recruitment.

The worldwide media coverage of a RDD attack would be a powerful advertisement for a terrorist group claiming responsibility. This could assist in recruitment efforts.

3.4 Asset (or geographic area) denial.

Public concern over the presence of radioactive material might lead people to abandon a subway system, building, university, or areas of a city for months to years due to contamination concerns.

3.5 Economic disruption.

If a port, central area of a city, or other area of viable economic activity were contaminated with radioactive material, commerce might be suspended or curtailed. This could create economic impact.

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9 Ibid.

7 “One can use them (radioactive elements) to contaminate an area or to halt the advance of an enemy.” Statement from Abu Khabab, al Qaeda’s WMD chief, in a letter recovered in Afghanistan after the fall of the Taliban cited in Bergen, Peter L. (2006), The Osama bin Laden I Know. (Free Press: New York), 345.

8 Medalia, CRS-4.

9 U.S.Senate Foreign Relations Committee, Dirty Bombs and Basement Nukes, March 6, 2002, 8.
3.6 Long-term casualties.

Inhalation of radioactive material or exposure to gamma sources could lead to (an unknown number of long-term) casualties.

4. What are the Odds?

How feasible would it be for terrorists to obtain materials to develop a RDD and to carry out an attack? The U.S. Nuclear Regulatory Commission has estimated that approximately one licensed U.S. (radioactive) source is lost every day of the year. An August 2003 United States General Accounting Office report states that from 1998 to 2002 there were over 1300 incidents in which sealed sources were lost, stolen, or abandoned in the United States. These “orphan” sources generally remain undiscovered.

By far the most likely route for terrorist acquisition of intermediate amounts of radioactive material (defined as between 100 and 10,000 curies) is open and legal purchase from a legitimate supplier. Until the 9/11 terrorist attacks, regulation of radioactive sources was focused on ensuring the safe use of the material by people and organizations presumed to be acting without malice.

In addition to purchase, the prevalence of equipment employing radioactive elements for medical and other purposes provides ample opportunities for theft.

5. How Destructive are RDD?

The destructiveness of a RDD is contingent on a number of factors:

(a) The characteristics of the radioactive element employed is important (e.g., energy, type of radiation, half-life). Radioactive elements (including their isotopes), using cesium, bond strongly to concrete and asphalt. This could also complicate decontamination efforts and increase cleanup costs.

(b) Smaller particles would be dispersed more easily (than larger ones) and, potentially, (be transported) to greater distances. Smaller particles are also more readily inhalable.

(c) The greater the quantity of radioactive material, the greater the extent of physical impact.

(d) The greater the quantity of conventional explosives employed, the greater the potential for radioactive material to be dispersed more widely.

(e) Meteorological conditions would play a role in the dispersion of radioactive materials. Wind speed and direction, for example, would determine the dispersion location and the extent of contamination. Precipitation would concentrate radioactivity on certain land surfaces and water sources.

(f) The availability of the radioactive elements, the portability of the weapon, and the characteristics of the environment will also determine the effect of the RDD.

6. Potential RDD Impacts

In examining the potential impacts from the detonation of a RDD, it is first important to consider the costs incurred from the events of September 11. These included thousands of deaths, the destruction of buildings and infrastructure, billions of dollars in loss of economic activity, costs of cleanup, reconstruction and health care. It could also be argued that 9/11 caused the weakening of American liberties, and the loss of life and treasure from the wars in Afghanistan and Iraq.

A RDD strategically placed in a large American city, at an event or in an area where large numbers of people congregate could create extensive and similar negative effects. Previous experience suggests that RDD could cause impacts disproportionate to the significance of the incident.

Adding to the uncertainty is that a number of methods can be employed to disseminate radiological material. For example, some forms of isotopes can be dissolved in solvents and sprayed widely; still others can be burned or vaporized.

Any (comprehensive) plan to respond to an RDD must take into account all of the reasonable ways such a device might function, including those so stealthy that the population might ingest or inhale significant doses before an attack becomes apparent.

Figure 1 is illustrative of the potential geographical impact of a RDD placed in the Capitol Hill area of Washington, D.C. As discussed in the prior section the
extent of contamination is contingent on a number of variables. Similar effects could be experienced in communities throughout the country.

Damages from a RDD (or WMD) can be categorized as deterministic, stochastic, economic, psychosocial and physical.

6.1 Deterministic Injuries.

Radiation is said to cause deterministic harm if an individual can be identified who received a known exposure to radiation and became ill as a result. Such illness or injury can include classic radiation sickness (hematological effects, loss of appetite, vomiting and other gastrointestinal damage, hair loss, and death) or radiation burns on the skin. In general, the threshold dose for deterministic injury is quite high.\(^{15}\)

6.2 Stochastic Injuries.

A common assumption is that any radiation dose, no matter how small, can cause harm and that the biological response increases with the size of the dose. It is conceivable that some individuals exposed to quite small doses of radiation might develop cancers. The risk of developing a health problem, including cancer, can increase with added radiation exposure.\(^{16}\)

6.3 Economic Impact.

It is likely that any RDD involving more than a few curies of radioactive material will contaminate some areas so heavily that any economic viability would be permanently destroyed. The contaminated area would either be abandoned and fenced, any buildings razed, the soil (at the site) excavated to a depth of a meter or so, and removing both building waste and soil to a low-level radioactive waste depository (as happened at Goiânia discussed in the next section). Even after cleanup has been accomplished, there would likely be residual public fear of the site. Any tourist related activities would be impacted and other commerce handicapped. If an agricultural area is involved, the farmers may find it difficult to market their produce.\(^{17}\)

The economic impact on a major metropolitan area from a successful RDD attack could exceed that of the September 2001 attacks. The estimated cost to return the lower Manhattan area to conditions prior to the September terrorist attacks was in excess of $30 Billion. The immediate response costs exceeded $11 Billion.\(^{18}\)

Much of the private cost of recovery from the September 2001 attacks was paid by insurance. That may not be the case following an RDD attack. Radiation is a specifically excluded risk in virtually all policies written in the United States. The government, therefore, would have to step in to subsidize economic recovery after an attack, or some form of insurance reform would be required to facilitate economic recovery.\(^{19}\)

6.4 Psychosocial Damage.\(^{20}\)

Psychosocial effects are likely to be one of the most serious impacts from use of a RDD. The fear of ionizing radiation is a deep-seated and frequently irrational carryover from the Cold War.\(^{21}\)

Graham Allison describes probable impacts in the aftermath of a RDD incident. “After a radiation bomb attack, the panic will likely be even more widespread. Fear of radiation exposure … will prompt many people to flee their homes.”\(^{22}\)

The anthrax attacks of October 2001 in Washington, D.C. may provide an analogue. In that event letters containing anthrax spores were sent to Congressional representatives and media personnel. Anthrax spores were spread through the ventilation system in the Hart Senate Office Building and several Washington, D.C. area post offices. Three months later, after extensive disinfection with chlorine dioxide gas, at a cost of $20 million, the buildings were finally reopened.\(^{23}\)

Associated with this event was the considerable panic to the public from the uncertain risk.

6.5 Infrastructure Damages.

In the long term (if a RDD is detonated in an urban area), entire city blocks will have to be decontaminated. Radioactive dust particles will require vacuuming or pressure washing to remove. Sandblasting and acid will be needed where radioactive material has penetrated deeply. Concrete, asphalt, vegetation, and topsoil might have to be excavated and disposed of safely. Thousands

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\(^{16}\) Zimmerman and Loeb, 2.

\(^{17}\) Ibid, 9.

\(^{18}\) Ibid.

\(^{19}\) Ibid.

\(^{20}\) These could also be termed as “stigma” and “socioeconomic” impacts, respectively.

\(^{21}\) Ibid.

\(^{22}\) Allison, Ibid.

\(^{23}\) Allison, 59.
of people would have to relocate, and some might never be allowed to return.\textsuperscript{24}

\textbf{Figure 1.}
\textit{Hypothetical Cesium Bomb Impact}  
\textit{Washington, D.C.}

\begin{center}
\includegraphics[width=\textwidth]{hypothetical_cesium_bomb_impact}
\end{center}

Source: Federation of American Scientists

\textbf{6.6 Other Effects.}

Finally, because of the great trauma that the nation experienced due to 9/11, RDD could greatly exacerbate national insecurities on terrorism and create other unknown effects to our government and way of life.

\textbf{7. The Lessons from Goiânia and TMI}

Examining an analogous incident, although unrelated to terrorism, can illustrate potential economic impacts. What is interesting is that these effects can be attributed more to fear than actual risk.

Although not attributed to terrorists, scavengers in 1987 dismantled a metal canister from a radiotherapy machine at an abandoned cancer clinic in Goiânia, Goias State, Brazil. Goiânia is a city with a mixed industrial and tourist economy located west of Brazil’s capital, Brasília. Five days after the theft a junkyard worker pried open the lead canister to reveal what was described as “a pretty blue, glowing dust,” which turned out to be radioactive cesium\textsuperscript{137}. In the following days, scores of Goiânian citizens were exposed to the radioactive element.\textsuperscript{25} Several deaths and many injuries were attributed to exposure to the radioactive element.

Costs to all levels of Brazilian government and the economy were dramatic. The physical decontamination effort, for example, covered about one square kilometer (roughly 40 city blocks), demolished seven homes and other buildings, and produced about 3,500 cubic meters of radioactive waste. The clean-up costs amounted to $20 million. Hundreds of millions of dollars were estimated to have been lost due to the collapse of the tourism industry and impacts to businesses. Many people left the area due to fears of the remaining contamination, and although not contaminated, prices of manufactured products fell by 40 percent and stayed at that level for 30 to 40 days.\textsuperscript{26}

The Government Accounting Office (GAO) itemized negative economic effects from the incident:\textsuperscript{27}

“Economically, there was discrimination against products from Goiânia, resulting in a 20 percent decrease in the sales of cattle, grains, and other agricultural products from the region. Tourism decreased virtually to zero and the gross domestic product for the region declined from pre-accident levels. In total, the direct and indirect costs for emergency response and remedial action are estimated to be $36 million.\textsuperscript{28}

News reports about the accidents and events associated with modern science of technology (which could include the radioactive elements in the Goiânia incident) have, in certain cases, stigmatized places, products and technologies.\textsuperscript{29}

Assessing the impacts from incidents such as Goiânia, a minor event involving a relatively unimportant radioactive source, provides some perspective on potential impacts that could take place from the detonation of a dirty bomb.

\textsuperscript{24}Ibid.

\textsuperscript{25}Dwyer, Augusta. \textit{Playing with Radiation}. Macleans. 100:44; 44.

\textsuperscript{26}http://www.nti.org/h_learnmore/radtutorial/2_brazil.html

\textsuperscript{27}Ibid.

\textsuperscript{28}Ibid.

While in the case of Goiânia cultural differences were examined (although Goiânia was a somewhat sophisticated industrial area located relatively near to the nation’s capital of Brasilia) there is evidence to suggest that Americans would react similarly.

The accident at the Three Mile Island (TMI) nuclear power facility near Harrisburg, Pennsylvania on March 28, 1979, demonstrated that the United States is not immune to situations of unpredictable behavior. For example, what began as an evacuation advisory from Pennsylvania’s Governor Thornburgh many was looked upon by the public more seriously.

“Thousands of people made hasty preparations to leave their homes, phone lines jammed, lines formed at gas stations, and traffic backed up. There was palpable concern, confusion, and anger. Approximately 144,000 people within a fifteen-mile radius of the plant evacuated at some point during the crisis.”

Goiânia and TMI provide important examples of how the public might react to an attack involving RDD.

8. Summary

RDD pose a unique threat to American citizens. While an RDD attack is unlikely to cause mass fatalities, such weapons offer the potential to create mass panic and extensive economic impact. RDD could be constructed with small quantities of fissionable or non-fissionable material laced with chemicals and biological agents. In addition to utilizing potentially common radioactive materials from, for example, x-ray machines (Cs$^{137}$), smoke detectors and similar, etc., the devices are easily made portable.

Part of the danger is attributable to the fact that extensive amounts of materials, radioactive and chemical are widely available in the nation. Since equipment utilizing radioactive elements have become integral to day-to-day American life it will be extremely difficult to prevent the loss of these materials.

Despite the sense of vulnerability to terrorism created by the September 11, 2001 terror attacks, an adequate system of licensing and control of radioactive sources designed need to be given priority in national security efforts.

To learn more about RDD there are numerous excellent references available. The Reference section at the end of the text notes several excellent documents.


The following are selected recommendations by authorities that would assist in preventing or remediating effects from a RDD:

- RDD must be recognized by the Department of Homeland Security and related state emergency response agencies as a potentially significant terrorist threat. While WMD are being evaluated by some agencies, the use of RDD by terrorists may be more likely. Greater planning efforts are required both for prevention purposes and to ameliorate potential effects should an attack occur.

- The Department of Energy weapons laboratories, in cooperation with other agencies and institutions, should identify, test, and deploy technologies that would enable the rapid cleanup and decontamination of buildings, vehicles, and similar.

- Citizens are not currently able to obtain insurance to pay for the results of radiological terrorist events. Even the smallest of attacks could result in financial catastrophe for victims. It goes without saying that the cost of cleanup, even if feasible, would be too great to be borne by individual owners and businesses. (Indeed, cleanup to the degree that buildings could be reoccupied might not be possible)

There is precedent for government to provide insurance assistance. The Federal government, for example, currently subsidizes flood insurance. Providing some form of national insurance against radiological terrorism could be explored. The Price-Anderson Act (PAA) already offers insurance coverage for nuclear accidents caused by a licensed company or nuclear power facility acting within the terms of its license. PAA compensated the victims of the Three Mile Island event. Expanding coverage under PAA to include victims of radiological terror would be one way to compensate uninsured victims. Another option would be that the government could mandate the inclusion of radiation as an insurable risk in standard-form insurance policies.

- Evidence suggests that residual radiation will reduce property values in or near a contaminated area. This could be offset by a direct payment by the federal government to affected property owners. Legislative or regulatory remedies could also provide relief to Americans in the


31 Zimmerman, Ibid.
wake of an RDD attack on issues such as property value impacts.

• Where feasible, non-radioactive technologies such as X-rays and accelerators should be substituted for radioactive sources. This will reduce the opportunities for loss, theft and misuse of radioactive materials.

• A program of public education about the dangers of RDDs, how to behave after an attack, should be instituted as soon as possible.

• Citizens can contribute to preventing RDD attacks or reducing their effects. Since 9/11 most Americans are aware, for example, of the importance of identifying unattended packages or of reporting individuals acting strangely. Developing “situational awareness” in citizens is important. Some of our biggest successes have been made by an observant public.32

10. References.


32 One example was the Y2K arrest at the Washington/British Columbia border by an observant border agent that occurred well before 9/11.


