NEWS & TERRORISM
COMMUNICATING IN A CRISIS

A fact sheet from the National Academies and the U.S. Department of Homeland Security

"The ease of recovery from [a radiological] attack would depend to a great extent on how the attack was handled by first responders, political leaders, and the news media, all of which would help to shape public opinion and reactions."

Making the Nation Safer
National Research Council (2002)

RADIOLOGICAL ATTACK
DIRTY BOMBS AND OTHER DEVICES

WHAT IS IT?

A **radiological attack** is the spreading of radioactive material with the intent to do harm. Radioactive materials are used every day in laboratories, medical centers, food irradiation plants, and for industrial uses. If stolen or otherwise acquired, many of these materials could be used in a "radiological dispersal device" (RDD).

Radiological Dispersal Devices, a.k.a. Dirty Bombs

A **"dirty bomb"** is one type of RDD that uses a conventional explosion to disperse radioactive material over a targeted area. The term dirty bomb and RDD are often used interchangeably in technical literature. However, RDDs could also include other means of dispersal such as placing a container of radioactive material in a public place, or using an airplane to disperse powdered or aerosolized forms of radioactive material.

A Dirty Bomb Is Not a Nuclear Bomb

A nuclear bomb creates an explosion that is thousands to millions of times more powerful than any conventional explosive that might be used in a dirty bomb. The resulting mushroom cloud from a nuclear detonation contains fine particles of radioactive dust and other debris that can blanket large areas (tens to hundreds of square miles) with "fallout." By contrast, most of the radioactive particles dispersed by a dirty bomb would likely fall to the ground within a few city blocks or miles of the explosion.

How an RDD Might be Used

It is very difficult to design an RDD that would deliver radiation doses high enough to cause immediate health effects or fatalities in a large number of people. Therefore, experts generally agree that an RDD would most likely be used to:

- Contaminate facilities or places where people live and work, disrupting lives and livelihoods.
- Cause anxiety in those who think they are being, or have been, exposed.

Detection and Measurement

Radiation can be readily detected with equipment carried by many emergency responders, such as Geiger counters, which provide a measure of radiation dose rate. Other types of instruments are used to identify the radioactive element(s) present.

What is ionizing radiation?

When radioactive elements decay, they produce energetic emissions (alpha particles, beta particles, or gamma rays) that can cause chemical changes in tissues. The average person in the United States receives a "background" dose of about one-third of a rem* per year—about 80% from natural sources including earth materials and cosmic radiation, and the remaining 20% from man-made radiation sources, such as medical x-rays. There are different types of radioactive materials that emit different kinds of radiation:

Gamma and X-rays can travel long distances in air and can pass through the body exposing internal organs; it is also a concern if gamma emitting material is ingested or inhaled.

Beta radiation can travel a few yards in the air and in sufficient quantities might cause skin damage; beta-emitting material is an internal hazard if ingested or inhaled.

Alpha radiation travels only an inch or two in the air and cannot even penetrate skin; alpha-emitting material is a hazard if it is ingested or inhaled.

** A rem is a measure of radiation dose, based on the amount of energy absorbed in a mass of tissue. Dose can also be measured in Sieverts (1 Sievert=100 rem).*

What are some common radioactive materials used in our society?

GAMMA EMITTERS

Cobalt-60 (Co-60)—cancer therapy, industrial radiography, industrial gauges, food irradiation.

Cesium-137 (Cs-137)—same uses as Cobalt-60 plus well logging.

Iridium-192 (Ir-192)—industrial radiography and medical implants for cancer therapy.

BETA EMITTER

Strontium-90 (Sr-90)—radioisotope thermo-electric generators (RTGs), which are used to make electricity in remote areas.

ALPHA EMITTERS

Plutonium-238 (Pu-238)—research and well logging and in RTGs for space missions.

Americium-241 (Am-241)—industrial gauges and well logging.

Comparison of common radiation exposures with doses known to produce near-term health effects.

	Approx. dose (in rems)
Chest X-ray	0.03
Average annual dose from exposure to natural sources	0.2-0.3
CAT scan (whole body)	1
Recommended annual limit in occupational exposure (exclusive of medical exposures)	1 to 5 max per year
No symptoms of illness	15
No symptoms of illness; minor, temporary decreases in white cells and platelets	50
Possible acute radiation syndrome; 10% will have nausea and vomiting within 48 hours and mildly depressed blood counts;	100
Half of those exposed will die within 30 days without medical care	300-400[1]

[1]Hall, EJ. 2000. *Radiobiology for the Radiologist.* Lippincott Williams & Wilkins.

WHAT DO RDDs DO?

The Area Affected

Most dirty bombs and other RDDs would have very localized effects, ranging from less than a city block to several square miles. The area over which radioactive materials would be dispersed depends on factors such as:

- Amount and type of radioactive material dispersed.
- Means of dispersal (e.g. explosion, spraying, fire).
- Physical and chemical form of the radioactive material. For example, if the material is dispersed as fine particles, it might be carried by the wind over a relatively large area.
- Local topography, location of buildings, and other landscape characteristics.
- Local weather conditions.

Spread of a Radioactive Plume

If the radioactive material is release as fine particles, the plume would spread roughly with the speed and direction of the wind. As a radioactive plume spreads over a larger area, the radioactivity becomes less concentrated. Atmospheric models might be used to estimate the location and movement of a radioactive plume.

WHAT IS THE DANGER?

Immediate Impact to Human Health

Most injuries from a dirty bomb would probably occur from the heat, debris, radiological dust, and force of the conventional explosion used to disperse the radioactive material, affecting only individuals close to the site of the explosion. At the low radiation levels expected from an RDD, the immediate health effects from radiation exposure would likely be minimal.

Health Effects of Radiation Exposure

Health effects of radiation exposure are determined by the:

- Amount of radiation absorbed by the body.
- Radiation type (see "What is ionizing radiation?," p.1).
- Means of exposure—external or internal (absorbed by the skin, inhaled, or ingested).
- Length of time exposed.

The health effects of radiation tend to be directly proportional to radiation dose. If a reasonable estimate can be made of a person's dose, a lot is known about the health effects at that dose.

Acute Radiation Syndrome (ARS)

ARS is not likely to result from a dirty bomb. It is a short-term health effect that begins to appear when individuals are exposed to a highly radioactive material over a relatively small amount of time. The chart shows that an estimated 10% of the population may exhibit signs of ARS if they are exposed to large radiation doses of 100 rems or more. Principal signs and symptoms of ARS are nausea, vomiting, diarrhea, and reduced blood cell counts.

Psychological Impacts

Psychological effects from fear of being exposed may be one of the major consequences of a dirty bomb. Unless information about potential exposure is made available from a credible source, people unsure about their exposure might seek advice from medical centers, complicating the centers' ability to deal with acute injuries.

WHAT SHOULD PEOPLE DO TO PROTECT THEMSELVES?

Time, Distance, and Shielding

Following any radiological explosion, people should:

- Minimize the time they are exposed to the radiation materials from the dirty bomb.
- Maximize their distance from the source; walking even a short distance from the scene could provide significant protection since dose rate drops dramatically with distance from the source.
- Shield themselves from external exposure and inhalation of radioactive material.

Practical Steps

If people are near the site of a dirty bomb or release of radioactive material, they should:

1. Stay away from any obvious plume or dust cloud.
2. Cover their mouth and nose with a tissue, filter, or damp cloth to avoid inhaling or ingesting the radioactive material.
3. Walk inside a building with closed doors and windows as quickly as can be done in an orderly manner and listen for information from emergency responders and authorities.
4. Remove contaminated clothes as soon as possible; place them in a sealed container such as a plastic bag. The clothing could be used later to estimate a person's exposure.
5. Gently wash skin to remove possible contamination; people should make sure that no radioactive material enters the mouth or is transferred to areas of the face where it could be easily moved to the mouth and ingested. For example don't eat, drink, or smoke.

Questions such as when it's safe to leave a building or return home, what is safe to eat and drink and when, and how children will be cared for if they are separated from their parents would be answered by authorities who would have to make decisions on a case-by-case basis depending on the many variables of the situation.

Decisions Regarding Evacuation

Evacuation as a plume is passing could result in greater exposures than sheltering in place. The best course of action will be provided by emergency officials who may use computations from models of plume travel and potential radiation health effects.

Reducing Contamination

Contaminated individuals can expose or contaminate other people with whom they come in close contact and should avoid contact with others until they are decontaminated. People who have inhaled or ingested radioactive material require assistance by medical personnel.

Antidotes

There are no reliable antidotes once radioactive material is inhaled or ingested; however, symptoms can be treated. There are some chemicals that help cleanse the body of specific radioactive materials. Prussian blue has been proven effective for cesium-137 ingestion. Potassium iodide (KI) tablets are recommended only for exposure to iodine-131 (I-131), a short-lived radioactive element produced in nuclear power plants. Trained medical professionals will determine how to treat symptoms.

WHAT ARE THE LONG-TERM CONSEQUENCES?

Monitoring and Clean-up of Affected Areas

In the days and weeks following the use of an RDD, officials might be expected to:

- Establish a plan for careful monitoring and assessment of affected areas.
- Impose quarantines as necessary to prevent further exposures.
- Remove contamination from areas where persons might continue to be exposed.

Delayed Health Effects of Radiation

One concern of radiation exposure is an elevated risk of developing cancer later in life, although studies have shown that radiation is a relatively weak carcinogen. Exposure at the low radiation doses expected from an RDD would increase the risk of cancer only slightly over naturally occurring rates. Long-term health studies on the survivors of the 1945 nuclear bombings of Hiroshima and Nagasaki indicate that for those who received radiation doses from 0 up to 10 rems, less than 1% of cancers in that population were attributable to radiation. A long-term medical surveillance program might be established for victims of a significant radiological attack to monitor potential health effects.

Economic Impact

Such impacts might involve disruption to lives and livelihoods as the contaminated area is being cleaned up. This impact could continue even after the site has been cleaned up if people are reluctant to return to the affected area.

ADDITIONAL INFORMATION

General information on radiation and radiological emergencies:

- Centers for Disease Control and Prevention — **http://www.bt.cdc.gov/radiation/index.asp**
- Department of Homeland Security — **http://www.ready.gov**
- Nuclear Regulatory Commission — **http://www.nrc.gov/what-we-do/radiation/what-is.html**

Radiation protection and measurement:

- International Commission on Radiological Protection — **http://www.icrp.org**
- National Council on Radiation Protection and Measurements — **http://www.ncrp.com**

Health effects of radiation:

- Health Physics Society — **http://hps.org/publicinformation/radfactsheets/**
- Radiation Effects Research Foundation — **http://www.rerf.or.jp**

This report brief was prepared by the National Academy of Engineering and National Research Council of the National Academies in cooperation with the Department of Homeland Security. For more information or referrals to subject-matter experts, contact Randy Atkins at 202-334 1508, atkins@nae.edu, or visit www.nae.edu/factsheets. *Making the Nation Safer, Tracking the Atmospheric Dispersion of Hazardous Materials Releases* and other National Research Council reports related to this topic are available from the National Academies Press, 500 Fifth Street, NW, Washington, DC 20001; 800-624-6242; www.nap.edu.

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