Dirty Bombs
Dirty Bombs

1. Radiological attacks constitute a credible threat. Radioactive materials that could be used for such attacks are stored in thousands of facilities around the US, many of which may not be adequately protected against theft by determined terrorists. Some of this material could be easily dispersed in urban areas by using conventional explosives or by other methods.

2. While radiological attacks would result in some deaths, they would not result in the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon. Attacks could contaminate large urban areas with radiation levels that exceed EPA health and toxic material guidelines.

3. Materials that could easily be lost or stolen from US research institutions and commercial sites could contaminate tens of city blocks at a level that would require prompt evacuation and create terror in large communities even if radiation casualties were low. Areas as large as tens of square miles could be contaminated at levels that exceed recommended civilian exposure limits. Since there are often no effective ways to decontaminate buildings that have been exposed at these levels, demolition may be the only practical solution. If such an event were to take place in a city like New York, it would result in losses of potentially trillions of dollars.
What is a “Dirty Bomb”?

- A dirty bomb or radiological dispersion device (RDD), is a bomb that combines conventional explosives, such as dynamite, with radioactive materials in the form of powder or pellets.
Dirty Bomb: Overview

- A radiation dispersion device, or RDD

- Conventional explosive device with radioactive material added

- Radioactive material spreads to surrounding area by physical dispersion and airborne diffusion
Dirty Bomb: The Threat

- Threat of fear and disruption
- Panic over radiation exposure
  - Produce additional casualties
  - Disrupt rescue and evacuation efforts
- Disruption arises from area remaining off-limits and unusable during clean-up work
Purpose and Function

• The main purpose is to frighten people and make buildings or land unusable for a long period of time.

• The function of a dirty bomb is to blast radioactive material into the area around the explosion.
Dirty Bomb vs Atomic Bomb

• The atomic explosions that occurred in Hiroshima and Nagasaki were conventional nuclear weapons involving a fission reaction.

• A dirty bomb is designed to spread radioactive material and contaminate a small area.
Control of Material

- There are over 21,000 organizations in the United States licensed to use radioactive material.

- The Nuclear Regulatory Commission together with 32 states regulate radioactive materials.

- Other than nuclear facilities most are of small amounts.
Sources of Radioactive Materials

• Most potentially harmful type of radioactive materials can be found in:
  – Nuclear Power Plants
  – Nuclear Weapon Sites

• Most nuclear facilities are under extreme security making it a less vulnerable option.
Locations of U.S. Nuclear Power Plants
Dirty Bomb: Materials

- Most likely to be used: cobalt-60, strontium-90, cesium-137, and americium-241
- Less likely: phosphorus-32 and radium-226
- Obtained from military, medical, industrial, academic or research sources
  - Examples:
    - Cobalt-60: food and mail irradiation
    - Americium-241: smoke detectors and oil
Other Source Locations

- More reasonably accessible sources of radioactive material are:
  - Hospitals
  - Construction Sites
  - Food Irradiation Plants
  - College and High School Laboratories
  - Research Facilities
  - Smoke Detector Manufacturers

 Extreme risk due to minimal to complete lack of security present
Impact of a Dirty Bomb

- The extent would depend on a number of factors:
  - Size of the explosive
  - Weather conditions
  - Density of population
  - Type of radioactive material
Case Studies

Three specific cases to illustrate the range of impacts that could be created by malicious use of comparatively small radioactive sources:

2 ounces of cesium that was discovered recently abandoned in North Carolina (2002)

The amount of cobalt commonly found in a single rod in a food irradiation facility

The amount of americium typically found in oil well logging systems.
Case Studies

The impact of radioactive material release in a populated area would vary depending on a number of factors:

• The amount of material released
• The nature of the material
• The details of the device that distributes the material
• The direction and speed of the wind
• Other weather conditions
• The size of the particles released (which affects their ability to be carried by the wind and to be inhaled)
• The location and size of buildings near the release site.
In all three cases it is assumed that the material is released on a calm day (wind speed of one mile per hour) and that the material is distributed by an explosion that causes a mist of fine particles to spread downwind in a cloud.

People will be exposed to radiation in several ways:

- They will be exposed to material in the dust inhaled during the initial passage of the radiation cloud, if they have not been able to escape the area before the dust cloud arrives. It is assumed that about twenty percent of the material is in particles small enough to be inhaled. If this material is an alpha emitter, it will stay in the body and lead to long term exposure.

- Anyone living in the affected area will be exposed to material deposited from the dust that settles from the cloud. If the material contains gamma emitters, residents will be continuously exposed to radiation from this dust. If the material contains alpha emitters, dust that is pulled off the ground and into the air by wind, automobile movement, or other actions will continue to be inhaled, adding to exposure.

- In a rural area, people would also be exposed to radiation from contaminated food and water sources.
Case Study
Cesium (Gamma Emitter)

2 ounces of cesium in this device was exploded in Washington, DC in a bomb using ten pounds of TNT.

The initial passing of the radioactive cloud would be relatively harmless, and no one would have to evacuate immediately.

However, residents of an area of about five city blocks, if they remained, would have a one-in-a-thousand chance of getting cancer.

A swath about one mile long covering an area of forty city blocks would exceed EPA contamination limits, with remaining residents having a one-in-ten thousand chance of getting cancer.

If decontamination were not possible, these areas would have to be abandoned for decades.
Inner Ring: One cancer death per 100 people due to remaining radiation
Middle Ring: One cancer death per 1,000 people due to remaining radiation
Outer Ring: One cancer death per 10,000 people due to remaining radiation
EPA recommends decontamination or destruction
Case Study
Cobalt (Gamma Emitter)

Single piece of radioactive cobalt from a food irradiation plant were dispersed by an explosion at the lower tip of Manhattan.

Typically, each of these cobalt "pencils" is about one inch in diameter and one foot long, with hundreds of such pieces often being found in the same facility.

No immediate evacuation would be necessary, but in this case, an area of approximately one-thousand square kilometers, extending over three states, would be contaminated.

Over an area of about three hundred typical city blocks, there would be a one-in-ten risk of death from cancer for residents living in the contaminated area for forty years.

The entire borough of Manhattan would be so contaminated that anyone living there would have a one-in-a-hundred chance of dying from cancer caused by the residual radiation.

It would be decades before the city was inhabitable again, and demolition might be necessary.
Inner Ring: One cancer death per 100 people due to remaining radiation
Middle Ring: One cancer death per 1,000 people due to remaining radiation
Outer Ring: One cancer death per 10,000 people due to remaining radiation
EPA recommends decontamination or destruction
Case Study
Americium (Alpha Emitter)

If a typical americium source used in oil well surveying were blown up with one pound of TNT, people in a region roughly ten times the area of the initial bomb blast would require medical supervision and monitoring, as depicted in Figure 4.

An area thirty times the size of the first area (a swath one kilometer long and covering twenty city blocks) would have to be evacuated within half an hour.

After the initial passage of the cloud, most of the radioactive materials would settle to the ground.

Of these materials, some would be forced back up into the air and inhaled, thus posing a long-term health hazard, as illustrated by Figure 5.

A ten-block area contaminated in this way would have a cancer death probability of one-in-a-thousand.

A region two kilometers long and covering sixty city blocks would be contaminated in excess of EPA safety guidelines.

If the buildings in this area had to be demolished and rebuilt, the cost would exceed fifty billion dollars.
Immediate Effects Due to Americium Bomb in New York City

**Inner Ring:** All people must receive medical supervision

**Middle Ring:** Maximum annual dose for radiation workers exceeded

**Outer Ring:** Area should be evacuated before radiation cloud passes
Contamination Due to Americium Bomb in New York City

**Inner Ring:** One cancer death per 100 people due to remaining radiation

**Middle Ring:** One cancer death per 1,000 people due to remaining radiation

**Outer Ring:** One cancer death per 10,000 people due to remaining radiation

EPA recommends decontamination or destruction
Response

The EPA has a series of recommendations for addressing radioactive contamination that would likely guide official response to a radiological attack.

Immediately after the attack, authorities would evacuate people from areas contaminated to levels exceeding those guidelines.

People who received more than twenty-five times the threshold dose for evacuation would have to be taken in for medical supervision.
Recovery

In the long term, the cancer hazard from the remaining radioactive contamination would have to be addressed.

Typically, if decontamination could not reduce the danger of cancer death to about one-in-ten-thousand, the EPA would recommend the contaminated area be eventually abandoned.

Several materials that might be used in a radiological attack can chemically bind to concrete and asphalt, while other materials would become physically lodged in crevices on the surface of buildings, sidewalks and streets.

Options for decontamination would range from sandblasting to demolition, with the latter likely being the only feasible option.

Some radiological materials would also chemically bind to soil in city parks, with the only disposal method being large scale removal of contaminated dirt.

In short, there is a high risk that the area contaminated by a radiological attack would have to be deserted.
Potential Locations

• Potential Dirty Bomb targets are usually highly populated public areas such as:
  – Malls
  – Subways and Trains
  – Trash Cans or Dumpsters
  – Amusement Parks
  – Restaurants
  – Airports

Anywhere that people passing by might get a significant dose of radiation is a potential target hazard.
First Responders

**Firefighters / Paramedics**  (Responding to fires, explosions, hazmat spills, and medical calls)

**Law Enforcement**  (Investigating suspicious activity, serving warrants, etc...)

**US Coast Guard**  (Inspecting vessels, responding to waterborne emergencies)

**Hospital Emergency Department Staff**  
(Large event and walk in emergencies)
Recognition of a Radiological Event

- The radiological nature of a nuclear facility and placarded transportation accidents may be self evident, however

- Less obvious is the radiological components of;
  - Fire involving radiological materials,
  - Radiological “dirty bomb,“
  - Dispersed material (fire, sprayed, etc…), and
  - Exposed high intensity sources.

Tools are needed to help first Responders recognize the radiological nature of an event.
Early Detection

• Is your key to limiting potential exposure.

• Time is a huge factor in how much exposure one could receive.
Desirable Properties for Detection Tools

- Alerts user of radiation above background
- Detect alpha & beta radiation
- Records dose
- Alarms in hazardous situations
- Work continuously without user intervention
- Simple and intuitive, requiring little training
- Small size, something easily worn
- Inexpensive to purchase and maintain
Detection Equipment

- **Personal Dosimeters**
  Radiation meters that look like pagers, watches, key chains, rings and even pens.
Electronic Dosimeters

The Pros

– Alarms in hazardous situations.
– Can identify a significant radiological event.
– Records dose.
– Long battery life.
– Small size.
– Simple operation and often very rugged.

The Cons

– Not necessarily sensitive enough to detect low levels of radiation.
– Won’t detect alpha or low energy beta radiation.
Dirty Bomb: Decontamination

- Primary contaminants: alpha and gamma emitters
- Shoe and clothing removal will reduce contamination by 90%
- Other external contaminants are particulates that can be washed off the skin and hair
- Internal contaminants pose no secondary threat to healthcare workers

Photo: Law enforcement, medical staff and local residents play roles in FEMA Region 3’s first Civil-Cat exercise inBethlehem, Pennsylvania. Photo by Melissa Poul
Dirty Bomb: Signs and Symptoms

- The primary injuries, and their associated signs and symptoms, will be related to blast trauma

- Signs and symptoms of Acute or Chronic Radiation Syndromes will not be seen
Dirty Bomb: Summary

- Major health risks include
  - Acute blast trauma
  - Cancer
  - Specific target organ damage
  - Heavy metal poisoning

- A non-linear, threshold model of exposure is favored by health physicists