

44.348: ADVANCED SEMINAR ON WEAPONS OF MASS DESTRUCTION AND TERRORISM



Week 4: Radiological Weapons

Dr. James Forest

DIRTY WAR



- Part 4: Suspicions (3:20)
<http://www.youtube.com/watch?v=IUUpNYmkZPo&feature=related>
- Part 5: Making a Bomb (1:05)
<http://www.youtube.com/watch?v=eVhzKrKIDL A&feature=related>
- Part 6: Detonation, downtown London (2:10)
<http://www.youtube.com/watch?v=1FiXOJASXh4&feature=related>

QUIZ



RADIOLOGICAL WEAPONS: 2 TYPES

- RDD: any means used to disperse radioactive material.
- can use conventional explosives, an aerial sprayer, or other means
- Could be a backpack, truck, boat, etc.
- A conventional high explosive bomb placed near a radioactive source
- So-called “dirty bomb”
- RED: using materials to emit radiation
- a highly radioactive source is placed somewhere while unshielded
- Likely target: locations where many people would be exposed (subways, airports, office buildings, indoor stadiums, etc.)
- Not really a “bomb” at all



RADIOLOGICAL MATERIALS



- Alpha, Beta, Gamma and Neutron
- Isotope
- Radioactivity
 - When certain atoms decay, they release excess energy in the form of radiation.
 - Substances that do this are called radioisotopes
 - When these substances are processed into a usable form, such as pellets or powder, they are called radioactive sources
 - Shorter “half-life” (faster decay) means higher radioactivity (longer “half-life” means lower radioactivity)
 - The best radioactive sources for a radiological weapon have an “intermediate half-life” – these are the same kinds of materials used everyday for peaceful purposes in the fields of medicine, industry, agriculture, and research

HIGH RISK ISOTOPES



All of the high-risk isotopes that pose the greatest security risk for a RDD are produced in the nuclear fuel cycle

- Americium-241
- Californium-252
- Cesium-137
- Cobalt-60
- Iridium-192
- Plutonium-238 and -239
- Radium-226
- Strontium-90

Determining whether a radioisotope is most hazardous:

- How much energy does it produce?
- What type of radiation does it produce?
- What is its half-life (high vs. low radioactivity)?
- How much of the radioactive material is available?
- How prevalent is the radioactive material (and *where* is it found)?
- What is the radioactive material's shape, size and portability? and
- How easy is it to disperse the material over a wide area?

HIGH RISK ISOTOPES



Element

Half-life

Found/used in

Strong Gamma and Beta emitters:

Cobalt 60	5.3 years	Radiotherapy; irradiating bacteria in spices and other food products
Cesium 137	30 years	Radiation devices to treat cancers; equipment to monitor wells for oil
Iridium-192	74 days	Treating prostate cancer; detecting faults below the surface of certain materials

Strong Beta emitter:

Strontium 90	29 years	Medical and agricultural research; provides a long-lived source of electricity, and has often been used to power remote locations such as lighthouses and weather stations
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HIGH RISK ISOTOPES



Element

Half-life

Found/used in

Strong Alpha emitters:

Americium-241	433 years	Household and industrial smoke detectors; research and medical diagnostic devices
Californium-252	2.7 years	Cancer therapy; used to detect explosive devices in airline luggage
Plutonium-238 and -239	88 years/ 24,000 years	Plutonium 238 helps power satellites and heart pacemakers; Plutonium 239 is used in nuclear weapons

Strong Alpha and Gamma emitter:

Radium-226	1,600 years	Glow-in-the-dark clocks, paint for aircraft dials and gauges; cancer treatment
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EXPOSURE AND SYMPTOMS



Types of Exposure

- Acute – exposure to any dose in a short amount of time.
- Chronic – exposure to lower doses over extended period of time
- Internal – exposure through skin (cuts, abrasions), inhalation, ingestion
- External – exposure to outer surfaces of the body

Symptoms can include:

- Nausea, fatigue, increased temperature, blood changes, hair loss, diarrhea, bleeding gums, convulsions
- Radiation interacts with DNA, potentially causing cell malfunction or death
- A speck of Plutonium-239 in your lungs can cause cancer
- Strontium-90 concentrates in bones; can cause bone cancer, breast cancer, and leukemia

MOTIVATIONS



Who has expressed interest in radiological weapons?

- Limited evidence of states interested in radiological weapons
 - Saddam Hussein tested one in 1987, but Iraq abandoned the effort soon after
- More evidence (though also limited) of terrorist or insurgents interested in radiological weapons
 - Chechen rebels
 - Aum Shinrikyo, other apocalyptic cults
 - Al Qaida
- There is always the possibility of a state developing and deploying radiological weapons either on their own or in secret collaboration with a terrorist network.
- Particular concerns include isolated, rogue regimes like North Korea or Iran with nuclear energy or research facilities, and thus relatively easy access to the radioactive materials used to make a dirty bomb.

INTENDED IMPACTS



What is the intended impact of using a radiological weapon?

- Immediate casualties, from the explosive blast
- Fear and Panic, chaos that could overwhelm medical facilities
- Recruitment, possibility for media coverage, demonstration of strength
- Economic disruption, costs of clean up, impact of fear on markets, etc.
- Asset denial, contaminated areas would be uninhabitable for many years
- Long-term casualties, from radiation exposure

Overall, a radiological terrorist attack would cause disruption, confusion, and mass panic, and could help gain notoriety for the terrorists and their objectives

However, chemical weapons produce similar kinds of effects (some deaths by explosives, more deaths from exposure) and are much cheaper and more easily available than radioactive materials

RADIOLOGICAL EVENTS OF CONCERN

Goioia, Brazil (1987)

- Individuals found an old discarded X-ray machine from a dentist's office
- Broke it open and found canister of **cesium-137**
- Fascinating “glowing material”, was shown around the community
- Exposure killed 4 people, made hundreds very sick, including higher cancer rates in the long term

HISTORY OF SELECT INCIDENTS



- 1987: Iraq tests a radiological weapon; later abandons program
- 1990s: Chechen rebels make several threats against nuclear power plant
- 1993: Russian mafia use RED to kill a Moscow businessman
- 1995: Chechens bury dirty bomb with **cesium-137** in Moscow's Ismailovsky Park
- 1996: John J. Ford, Joseph Mazzuchelli, & Edward Zabo plot to kill 3 New York politicians by putting **radium** in their food, cars, and toothpaste
- 1998: 19 small tubes of **cesium** are stolen from a Greensboro, NC hospital, and have never been recovered
- 1998: Chechen rebels attempt to detonate dirty bomb on railway line
- 1999: Thieves try to steal 200g of radioactive material from a chemical factory in Grozny, Chechnya.

HISTORY OF SELECT INCIDENTS



- 2001: **strontium-90** stolen from aging Russian lighthouse
- 2002: Jose Padilla charged with Al Qaida dirty bomb plot in US
- 2003: Attempt to smuggle (highly radioactive) **cesium-137** and **strontium-90** from Georgia to Turkey
- 2003: Chinese doctor Gu Tianming attacks colleague with **iridium-192**
- 2003: Schoolteacher in Bangkok arrested attempting to sell **cesium-137**
- 2006: Alexander Litvinenko, former Russian spy, is poisoned with radioactive **polonium-210**
- 2007: Australian home-grown terrorist group allegedly plans to attack the Lucas Heights nuclear reactor with rocket launchers
- 2008: FARC attempts to sell **uranium**, but not “weapons-grade”
- 2008: Right-wing extremist in Maine orders radioactive materials through the Internet, along with precursors for high-grade chemical explosives

A HOMEGROWN “DIRTY BOMBER”?

9 December 9, 2008: James Cummings, resident of Belfast, Maine, shot dead by his wife; had \$2 million inheritance, and believed to have ties with white supremacist groups

Radioactive materials found in the home:

- Four bottles of depleted **uranium 238**, purchased online from [United Nuclear Scientific Equipment & Supplies](#)
- Two jars of **thorium 232**, produced at home from electrodes
- Beryllium, purchased from a vendor in Colorado

Explosives materials found in the home:

- Four 1-gallon containers of 35% hydrogen peroxide (necessary precursor for the manufacture of peroxide-based explosives – *used in London 2005 suicide attack, et al.*)
- Lithium metal, thermite, and aluminum powder (materials used to sensitize and amplify the effects of explosives)
- boron, black iron oxide and magnesium ribbon

Instructions for making “dirty bombs” are also found, including information about **cesium-137**, **strontium-90** and **cobalt-60**



James Cummings



346 High Street
Belfast, Maine

FILM CLIP



- PBS Newshour Feb 8, 2011, “How Tough is it to Build a Dirty Bomb?”

http://www.pbs.org/newshour/bb/science/jan-june11/dirtybombs_02-08.html (11 minutes)

PRE-POSITIONED WMD?



- About 440 commercial N-power reactors in 31 countries
- An attack on a nuclear installation could include commando raids by land or water; truck bombs; an aerial (9/11-type) mission or cyber attacks.
 - 1982 attack against Koerberg nuclear power plant, South Africa
 - October 2001 reported threat against U.S. nuclear power plants
 - Diagrams of American power plants found in Afghanistan.
- Khalid Sheikh Mohammed and Ramzi Binalshibh, two organizers of the 9/11 attacks, acknowledged in 2002:
 - “We first thought of striking a couple of nuclear facilities but it was eventually decided to leave out the nuclear targets – for now.”
- Arrests made in Canada (2003), Britain (2004), Australia (2005), India (2006) to foil planned attacks on nuclear plants

CONCLUSION



- Millions of radioactive materials can be found in industry, at medical/educational facilities, atomic waste storage reservations, etc.
 - Some may lack strong physical security, especially medical facilities, educational institutions
 - You can also acquire radioactive materials via mail order or the Internet
- Radioisotopes vary in lethality and potential usefulness for weapons.
 - Key attributes include the amount and type of radiation, the half-life of the isotope, and its availability

CONCLUSION



- Challenges faced by terrorists in developing, acquiring, and/or deploying these kinds of weapons
 - Acquiring a sufficient amount of material
 - Constructing the RDD without overexposure to radiation in the process
 - Effectively delivering the RDD on target, and
 - Achieving the necessary lethality
- Securing the radiological materials is a critical first step to preventing RED or RDD attacks.
- Detecting radiation, particularly at ports, borders, airports, train stations, bridges, tunnels, sports arenas, major buildings, etc. also important
- Need to appreciate all aspects of the threat, including motivations

DISCUSSION



- What do you think about online resources, like this University of Idaho website, which publishes an outline of its handling procedures on its website (<http://www.uidaho.edu/ehs/topics/radiationsafetymanual/radman310>),

The creation of a basic pipe bomb attached to a source of radiological material would result in high amounts of dispersal. (http://www.army-guide.com/eng/article/article_895.html)

Is there enough radioactive material in a dentist office's XRay machines to use in an effective radiological weapon?

How about the makers of X-Ray machines?