Sandia National Laboratories

Americium Use and Security Risks

PRESENTED BY

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ACKNOWLEDGEMENTS:

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U.S. DEPARTMENT OF ENERGY NNSA

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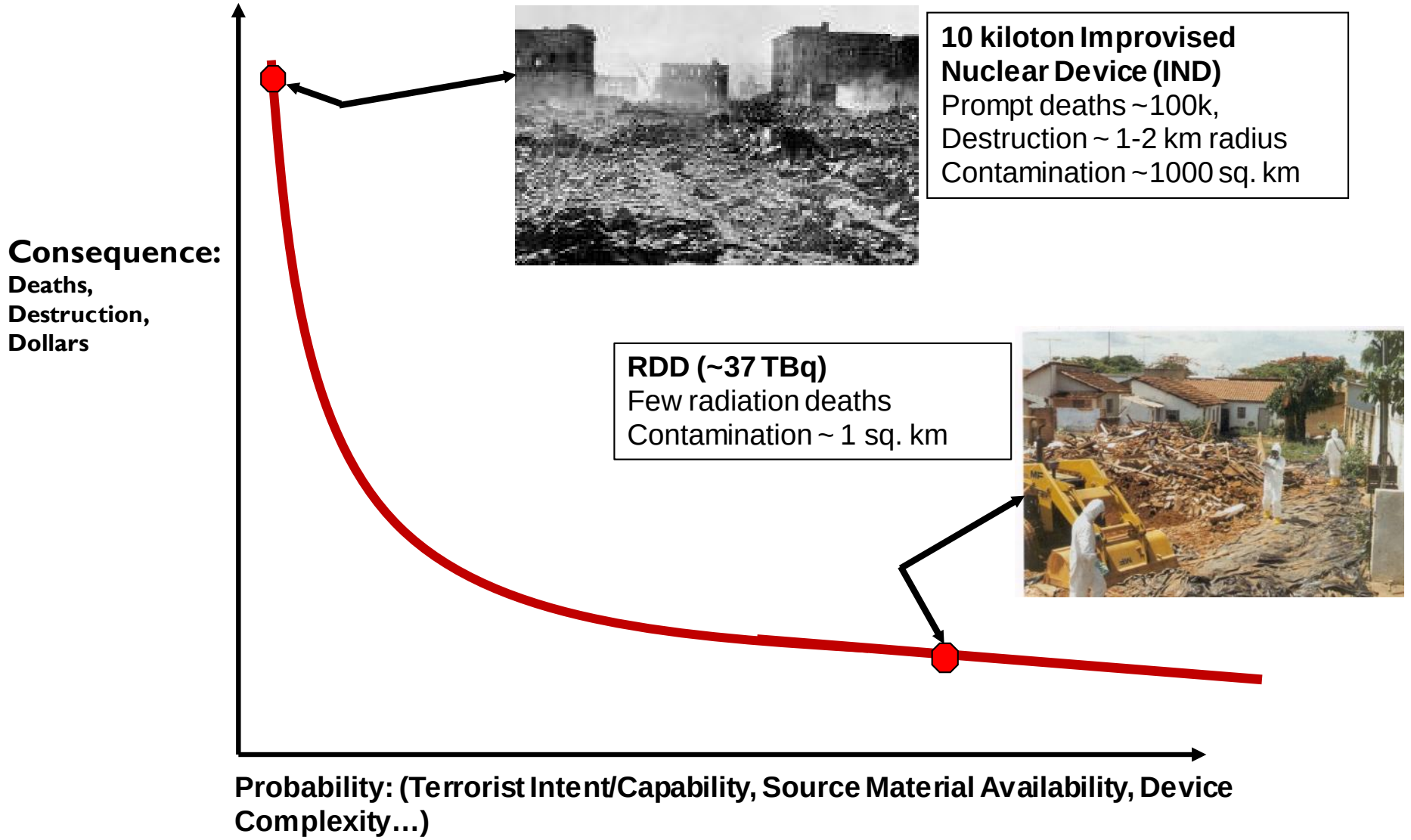
SAND2020-12998 PE

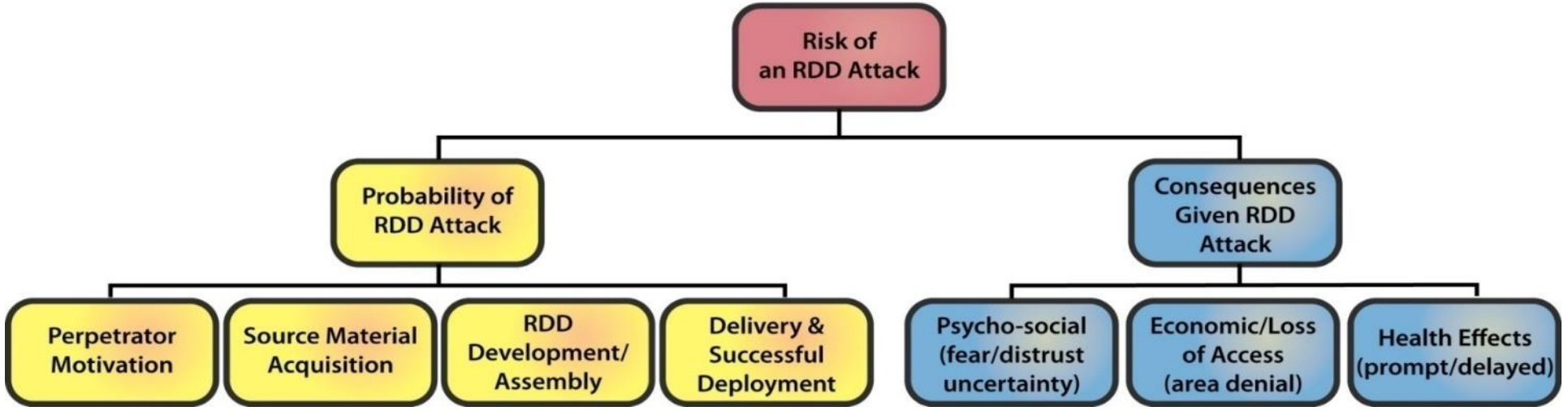
RADIOLOGICAL CONSEQUENCES

are by nature much reduced from nuclear, but likelihood is greater.



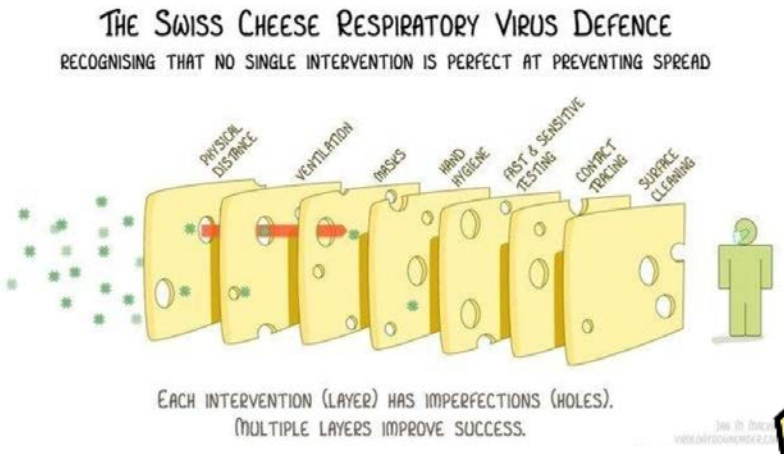
RDD ACQUISITION

allows view of the breadth of the problem.



RDD ACQUISITION

Complexity increases difficulty - each step poses a potential barrier



01 Motivation
- Deterrence

02 Material Acquisition
- Source security

03 RDD Development and Assembly
- Secure information and components

04 Delivery and Successful Deployment
- Secure targets, mobile detection

JIHADISTS AND ANARCHISTS

have included the radiological threat in their rhetoric.

Shamil Basaev, 1995	Abu Ayyub al-Masri, 2006	Anders Breivik, 2011	Al-Taqwa Media Foundation, 2018 (notionalized)

There have been some unsuccessful attempts to obtain material and construct an RDD.

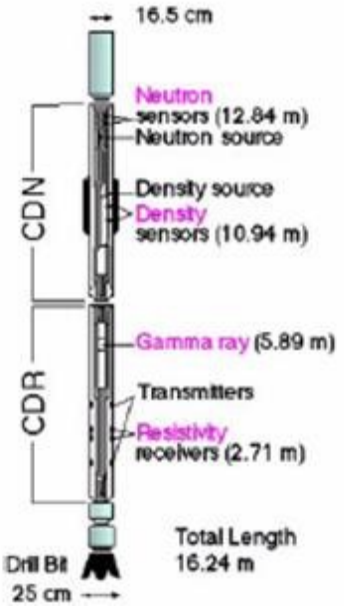
There is some experience with widespread accidental dispersion of radioactive material.

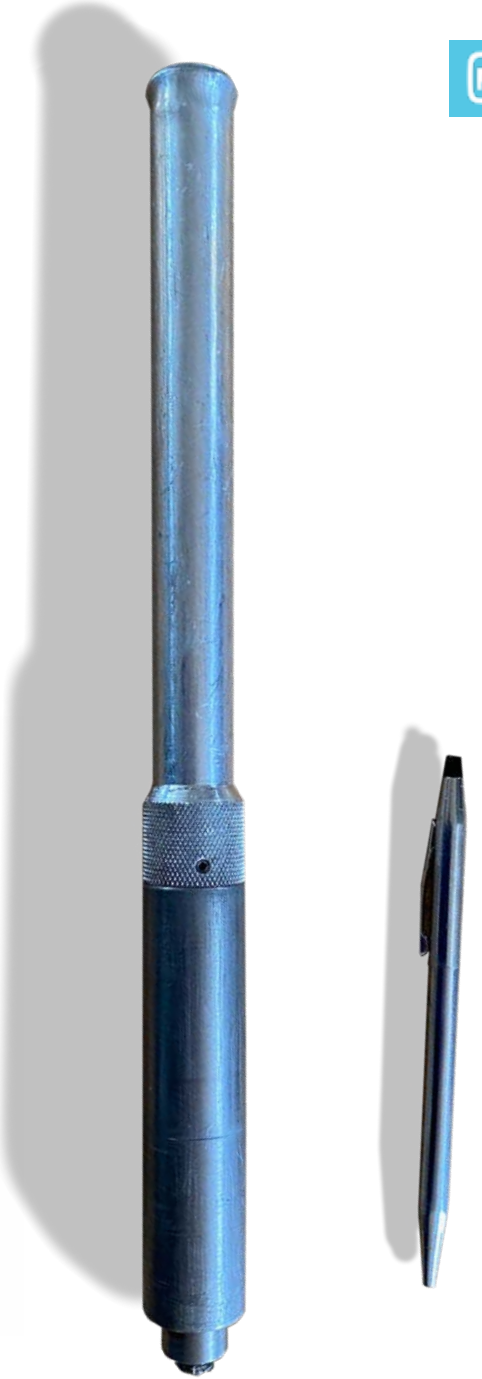
^{137}Cs, Goiânia, Brazil, September 1987

^{60}Co, Cuidad Juárez, Mexico, December 1983

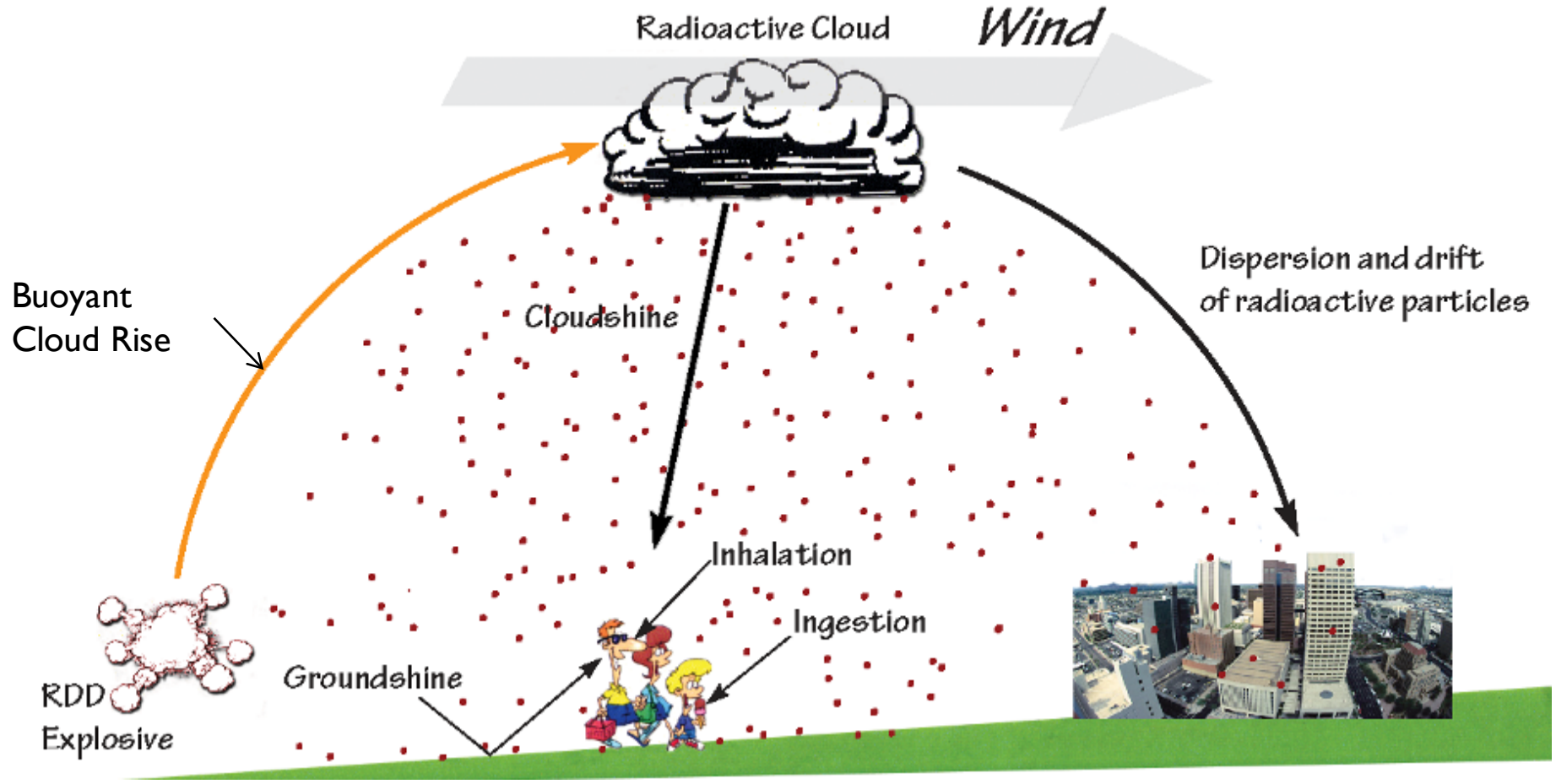
Well-logging sources are portable, constantly in transport, and vulnerable to theft

Up to 25 Ci of 241Am used in neutron well-logging source	("Troxler" moisture gauges: small amounts (max 44 mCi))
Pressed powder in stainless steel capsule	Tested up to 60,000 psi
Am/Be well logging sources used worldwide (~170 in US)	Oilfield services: Halliburton, Schlumberger, Baker Hughes, etc.
Number of domestic thefts 2000-2016: 2	16 losses



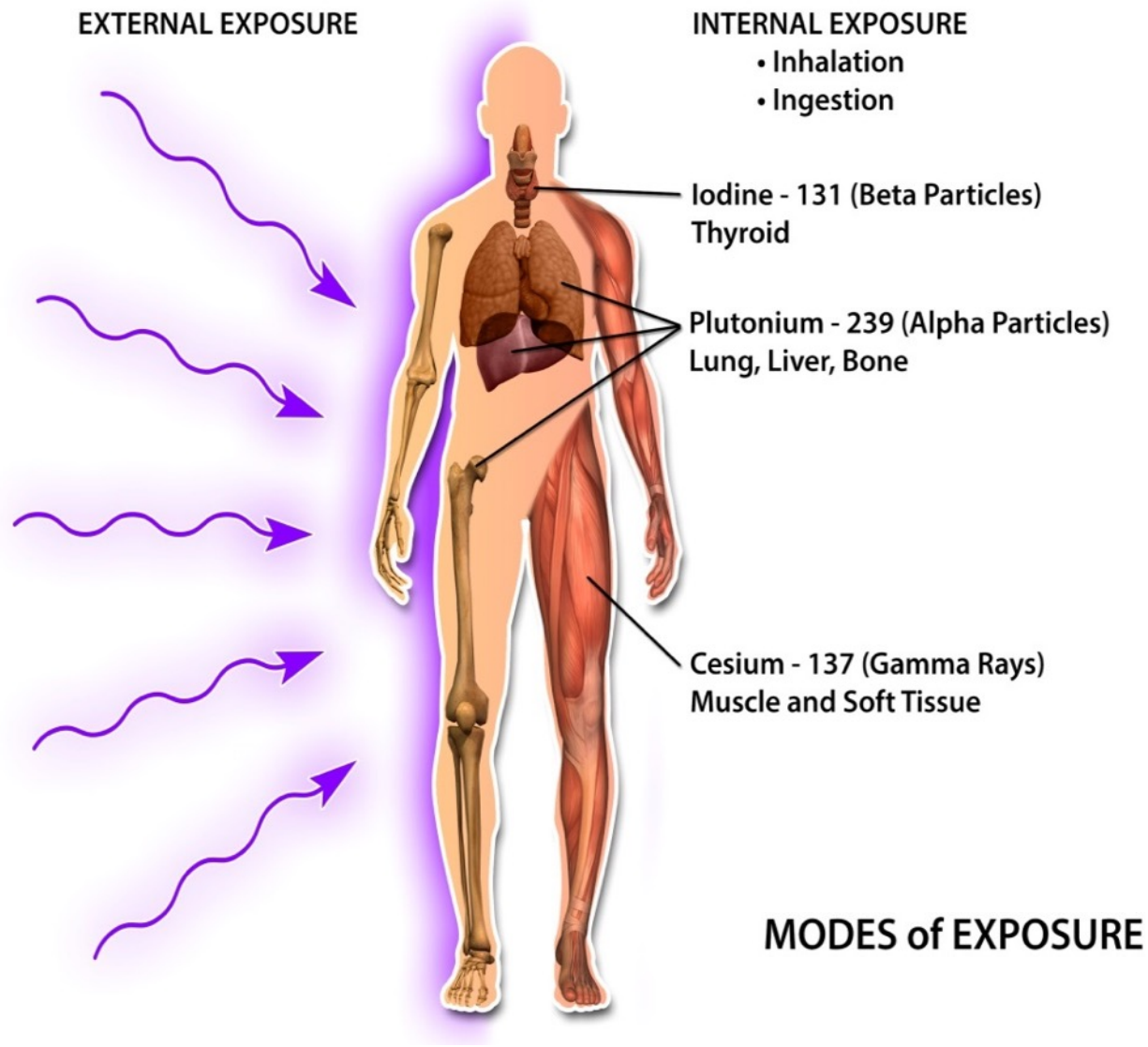


Inhalation of alpha-emitting ^{241}Am poses the greatest health risk following dispersion.



Complications in calculating thresholds increase when the hazard is internal.

Resuspension:	internal-dose determination depended on lung deposition, systemic models describing chemical transport
Groundshine:	external-dose determination dependent on radiation emitted from ground surface
Internal dose limiting for alpha-particle emitting radionuclides	



IAEA "D-values"
are based on radiation safety scenarios.

Adopted in US as category thresholds

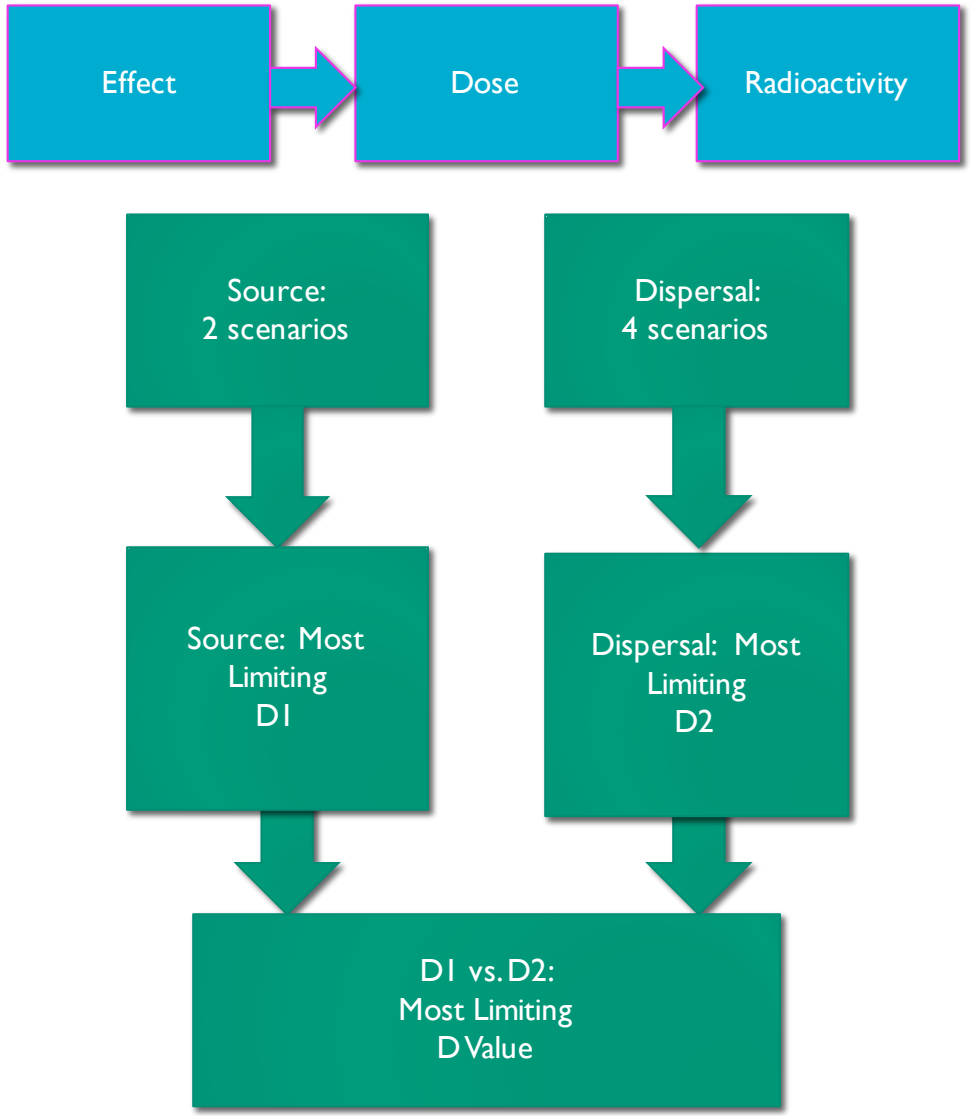
Deterministic effects considered:

- "Fatal effects are those that, if developed, lead to death"
- "Non-fatal effects are those that reduce the quality of life and are organ or tissue specific"

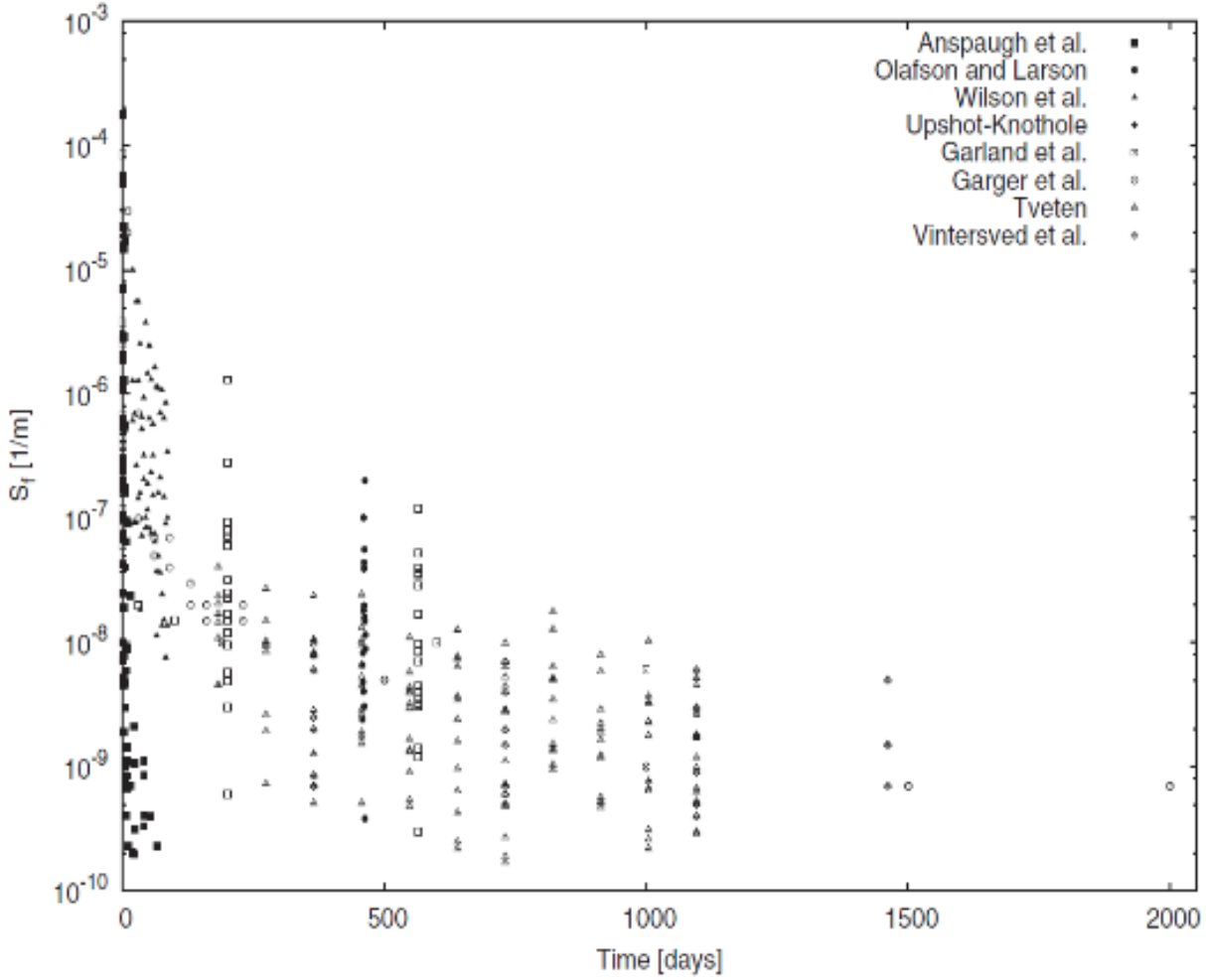
D1 – 2 non-dispersal scenarios

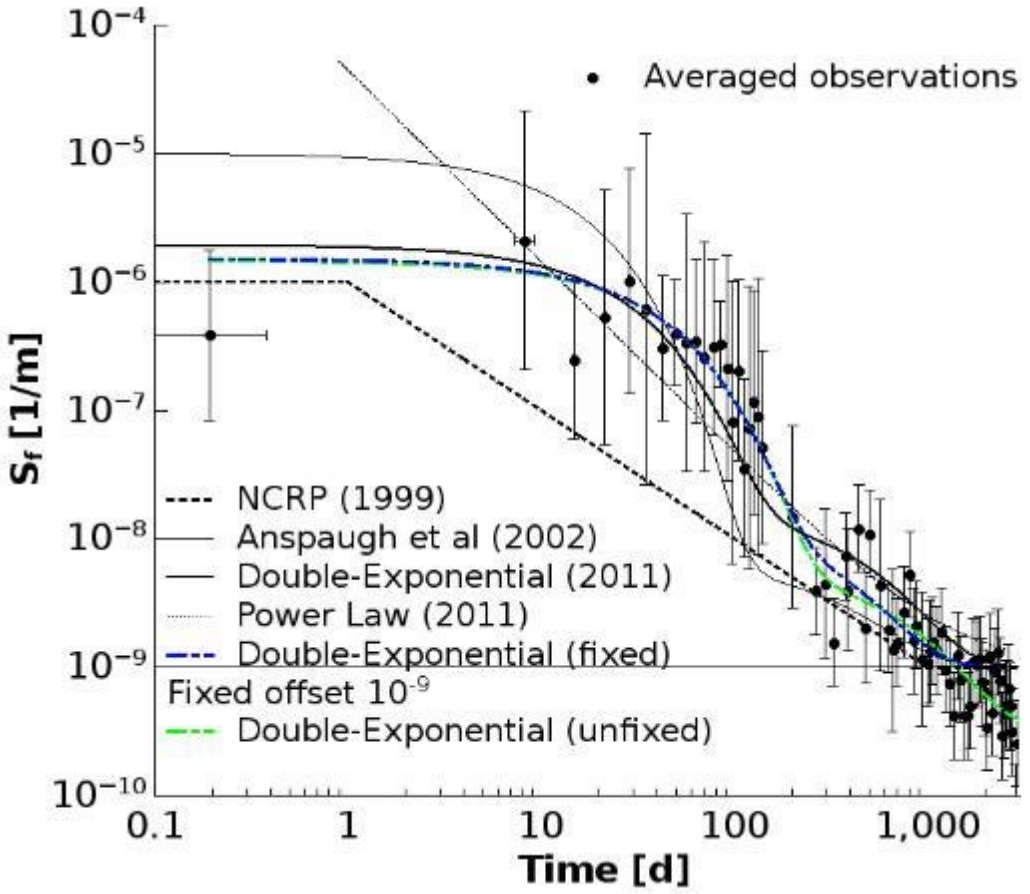
D2 – 4 dispersal scenarios

- ^{241}Am limit



Prospective dose calculations from alpha emitters are difficult due to the lack of proper science behind resuspension models.





National and international analyses may not have included neutron interactions in analysis.

^{241}Am listed in COC but not ^{241}AmBe

Degree of separation of Am and Be unknown

$$^{241}_{95}\mathrm{Am} \longrightarrow {}^{237}_{93}\mathrm{Np} + \alpha + \mathrm{Q}\,(5980.9\ \mathrm{keV})$$

Majority of energy to alpha particle

Neutron interaction leaves nucleus in excited state

$$^{9}_{4}\mathrm{Be} + \alpha \longrightarrow \mathrm{n} + {}^{12}_{6}\mathrm{C}^{*} + \mathrm{Q}\,(5704\ \mathrm{keV})$$

Majority of energy emitted in 4.4 MeV γ-ray

GAO studies have shown gaps in licensing process that could be exploited by adversary.

NRC category thresholds:

- Cat 1: 1620 Ci
- Cat 2: 16.2 Ci
- Cat 3: 1.6 Ci

Security requirements generally applicable to Cat 1 or 2 amounts

2016: GAO obtained Cat 3 license forAmBe sources, commitments to purchase aggregate CAT 2 amount

2019: GAO recognized improvements, still saw aggregation as risk

Source: National Nuclear Security Administration. | GAO-19-468

Sources are more typically lost as in this example from 2012

https://www.theguardian.com/business/2012/sep/17/hunt-halliburton-radioactive-rod-texas-desert

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Halliburton

Hunt launched after Halliburton loses radioactive rod in Texas desert

Fears rod containing americium-241/beryllium could fall into hands of terrorists after employees of US oilfield services company lost it in transit between oil wells

Rupert Neate

@RupertNeate

Mon 17 Sep 2012 11.38 EDT

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This article is over 6 years old

A radioactive rod similar to the one lost by Halliburton

Halliburton has lost a seven-inch radioactive rod somewhere in the Texas desert. The National Guard has been called in to help to find the device, which employees of the controversial US oilfield services company lost a week ago.

The rod, which contains americium-241/beryllium and is stamped with a radiation warning symbol with the words "Danger Radioactive: Do not handle. Notify civil authorities if found", was lost during a 130-mile journey between oil well sites in Pecos and Odessa last Tuesday.

The US Nuclear Regulatory Commission (NRC) warned that the radioactive materials "could cause permanent injury to a person who handled them".

Pecos, Texas, September 2012. Loss of 555 GBq (15 curie) Am-241/Be device between Pecos and Odessa, Texas. Presumably fell off truck. Despite intensive ground and air searches, device remained unrecovered for several weeks until found by member of public lying in middle of dirt road.

Midland FBI Speaks Up About Missing Radioactive Rod

Published: Wednesday, September 19th 2012, 10:39 pm CDT
Updated: Wednesday, September 19th 2012, 10:50 pm CDT

By Jen Kastner
NewsWest 9

MIDLAND- The Midland Federal Bureau of Investigation is working alongside local and state officials in the hunt for the seven inch radioactive rod that's been missing in the Basin for more than a week.

Local law enforcement and even a realm of the Texas National Guard have been searching for it. So far, no luck. The Texas Department of State Health Services says the Texas National Guard decided to end its search on Sunday. Local officials, however, are still looking for it.

The Midland FBI office says they got involved because the rod could be used for harmful purposes, if it gets into the wrong hands.

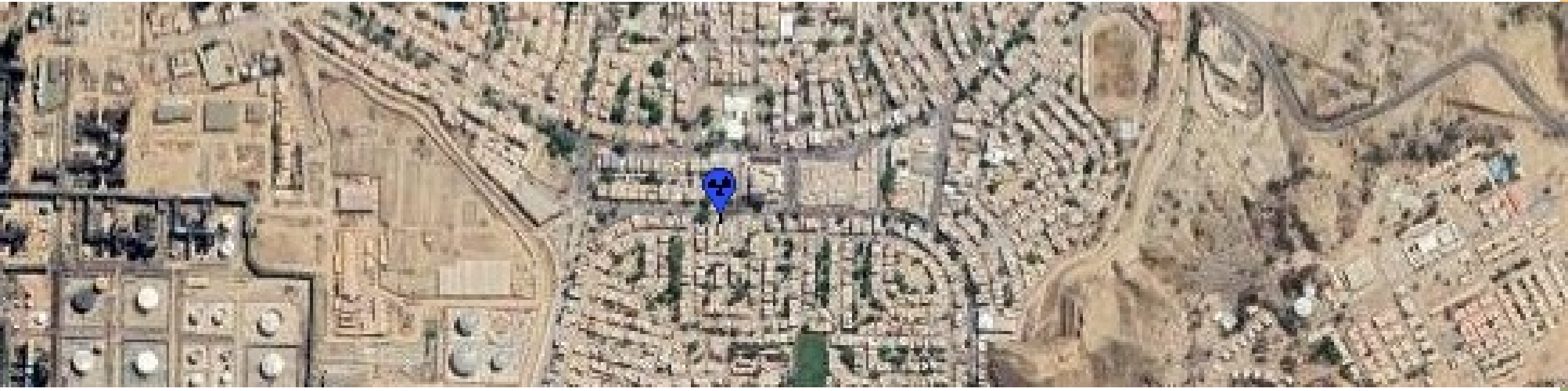
Midland FBI Special Agent Lamar Pruit says, "That was one of the biggest concerns that we had-

Thefts such as in Talara, Peru in 2014 probably mistook the source for something easily trafficked.

October 8: armed thieves entered the storage facility at the company and equipment and various electronic ítems were stolen, as well as two sources of Am-Be 185 GBq each (Category 3), within a yellow container.

The company notified the National Police and the IPEN (regulatory body), who sent a team for performing a quick search of the sources in the area. Local advisory warnings to the public were issued.

October 9th, the National Police located the sources at 80 km from Talara, and called the IPEN Team which identified the two Am-Be sources and put them into safe an secure condition. The sources were not removed from the container so irradiation of thieves did not happen.



Summary: Protection of AmBe sources reduces the overall RDD risk.

Smaller in numbers, more vulnerable to theft

- Thefts typically in stolen vehicles or with other valuable items

Can be acquired through legal means and aggregated to Cat 2 quantities

Resuspension risk more difficult to infer due to science

External dose risk may be more important than considered by IAEA