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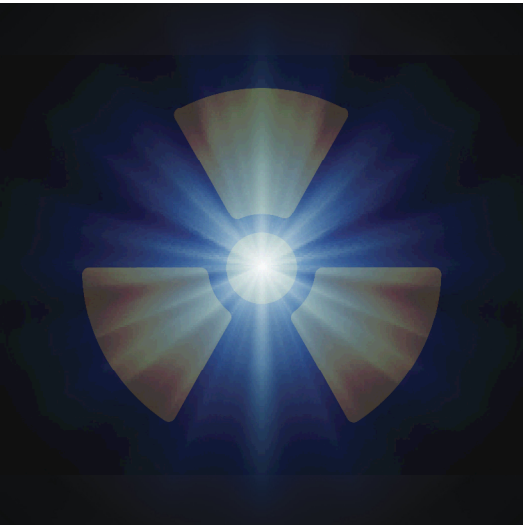

Radiological Terrorism Risk and the NAS Study

Briefing to Conference

On Moving Towards Zero Risk

June 19, 2015

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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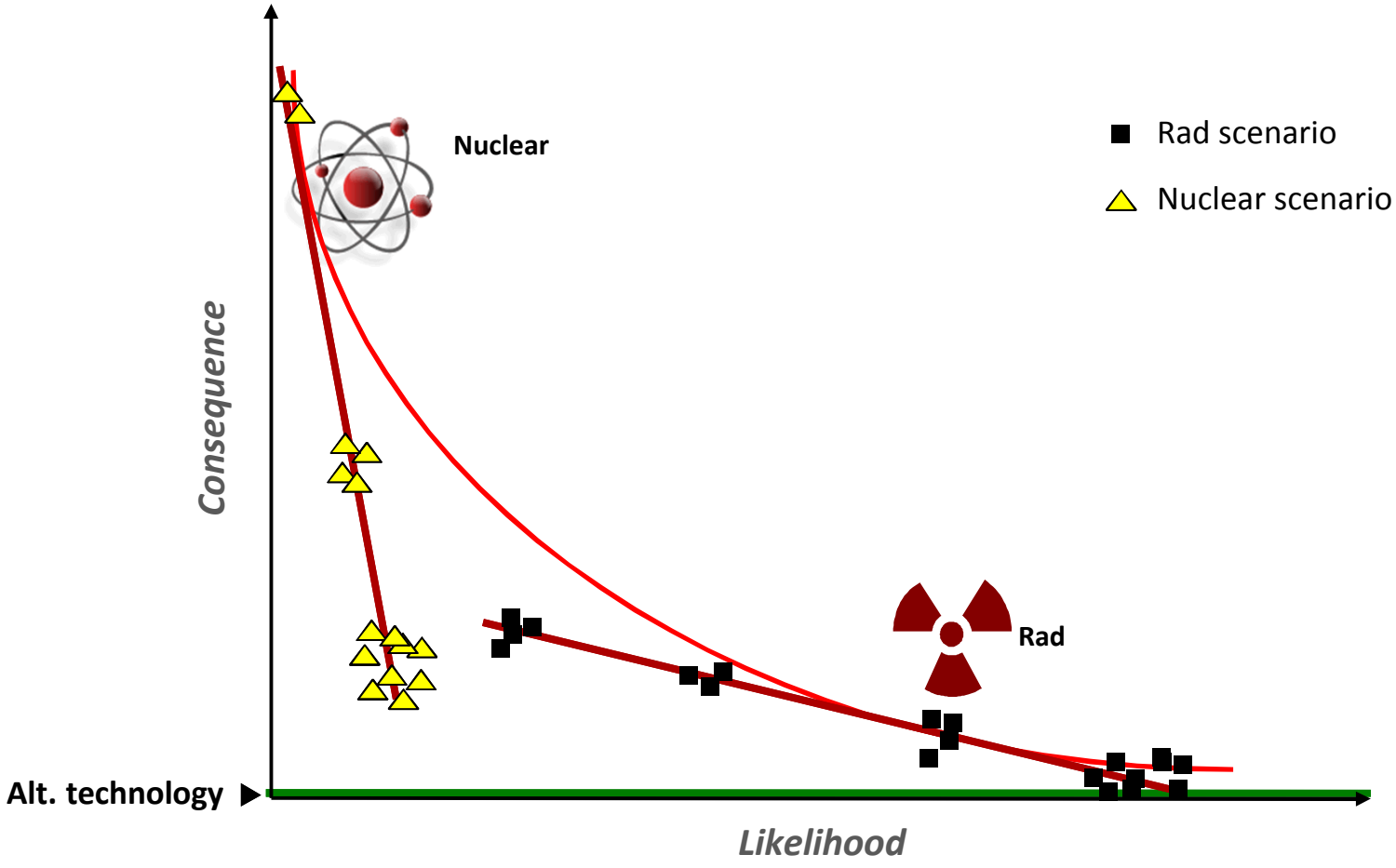
Outline

- RDD Risk in Context
- Adversary Intent
- Source Material: Availability and Vulnerability
- Consequences: Depend on Adversary Capability
- US NAS Study Summary
- Since the NAS Study
- Summary & Conclusions

Rad Terrorism Risk In Context

Alternative technology reduces RDD risk to zero.



Public Perception of Risk

- Public's perception of risk often differs from mathematical risk
  - Understanding of risk
  - Trust in government information
  - Short-term vs. long-term risk
  - Personal control of risk
  - Benefit/cost of risk
  - Seen vs. hidden risk
  - Equitable sharing of risk

- What does this tell us about the public's perception of RDD risk?

The Explosive RDD

Lofted material can create a large-area contamination

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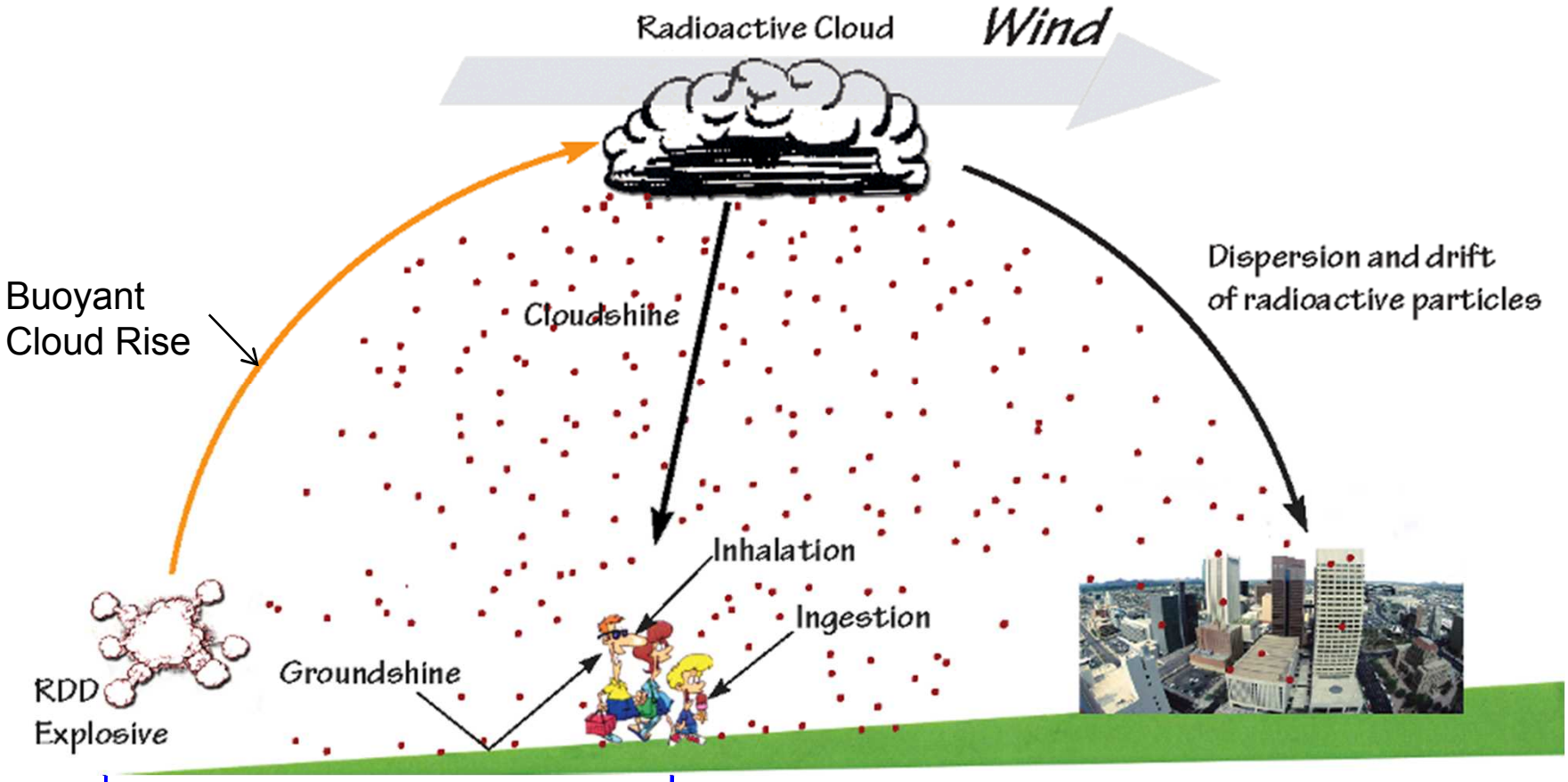

RDD Risk Elements

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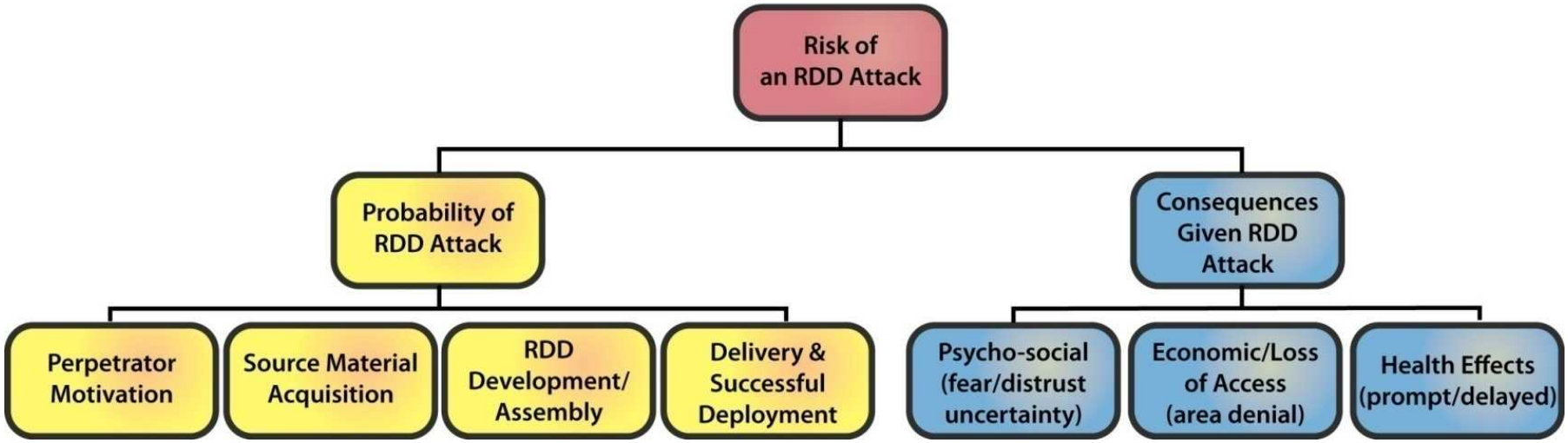
Each Box Needs to be Studied for a Complete Understanding of RDD Risk



Systems Analysis: Looking for the "easy" paths through the layered defense

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ADVERSARY INTENT

Terrorist RDD Intent, Post 9-11

Some intent has been shown, but not a lot of capability

- 2002 US terrorist Jose Padilla was encouraged by Abu Zubaydah to attempt a dirty bomb attack in the US.

- In 2003, the first detailed posting of an RDD appeared on the jihadist Web site *Sada al-Jihad*.
  - provided a case study of the 1987 CsCl release in Goiania, Brazil, and
  - addressed the financial impact and disruption caused by an RDD

The Echo of Jihad

- 2004 British terrorist Dhiren Barot became seized with the idea of using radioactive materials in attacks.

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RADIOLOGICAL SOURCE MATERIAL

Availability, Dispersiblity, and Vulnerability

Radioactive Materials of Concern

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Here are the most commonly used radionuclides and their IAEA Categorization threshold activities.

Radionuclide	IAEA Category 1 (Ci)	IAEA Category 2 (Ci)	IAEA Category 3 (Ci)
^{60}Co	810	8.1	0.81
^{137}Cs	2,700	27	2.7
^{192}Ir	2,200	22	2.2
^{241}Am	1,600	16	1.6

The Top 4 Radionuclides and Devices

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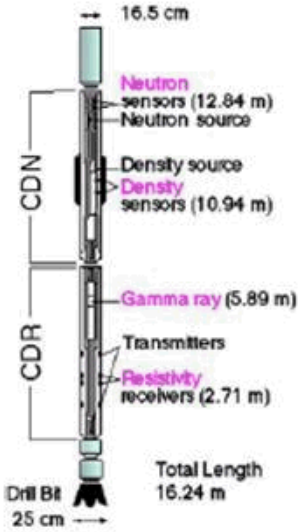
Category 1, Co-60 Teletherapy

Category 1, Cs-137 Self-Contained Irradiator

Category 2, Am-241/Be, Well Logging



Category 2, Ir-192, Radiography

IAEA Cat 1 Co-60 and Cs-137 Devices Worldwide

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World Map Showing # of Co-60 and Cs-137 Sources is OUO and is removed for this UUR version.

Radionuclide Properties

CsCl poses unique concerns as a salt powder.

Radionuclide and emission	Half-life	Specific Activity Typical Value (Ci/g)	Dose Rate at 1 meter (rad/hr per Ci)	Chemical Form (typical)	Power to Contaminate* (Ci/km^2)	Typical Use and Activity
Co-60 (β,γ)	5.3 yr	100	1.4	Metal	10	Irradiators (≥1000 Ci)
Cs-137 (β,γ)	30 yr	20	0.38	Salt Powder	40	Irradiators (≥1000 Ci)
Ir-192 (β,γ)	74 d	450	0.6	Metal	100	Radiography (~100 Ci)
Am-241/Be (α,γ, n)	430 yr	3.5	(0.005)**	Oxide Powder	2	Well Logging (~ 10 Ci)

*Radionuclide ground contamination level in Curies, uniformly spread over 1 sq. km, that would trigger EPA Relocation Protective Action Guide (PAG) of 2 rem/yr in the first year after the incident.

** This is the dose rate from an AmBe sealed source, typically double encapsulated in ~ 1 mm of stainless steel.

Experience with Cs-137 Contamination

Accidents depict significant consequences from dispersion of Cs-137.

Goiania, Brazil Sept. 1987

5 rem/first yr Threshold

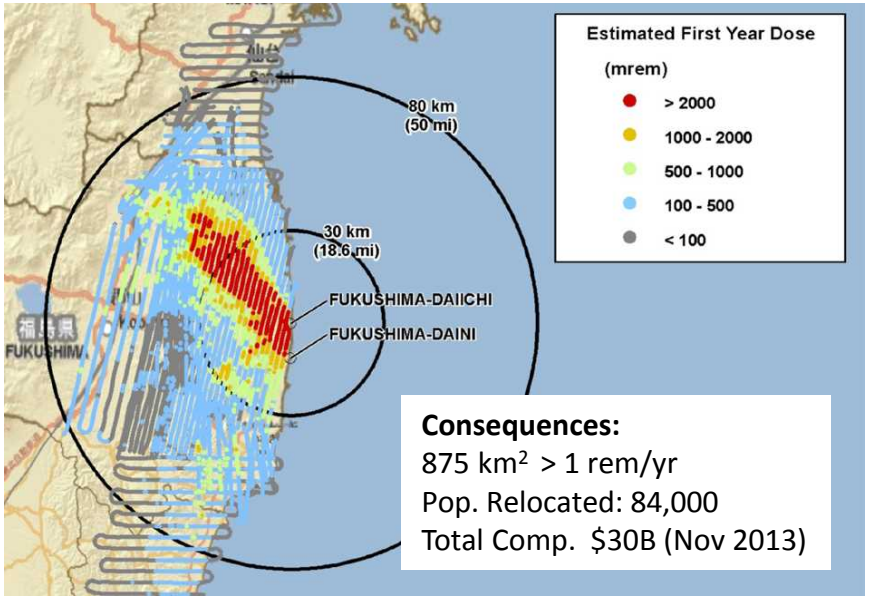
Cs-137 teletherapy machine source

Consequences:
4 Deaths
200 People Relocated
112,000 People Monitored
3500 m^3 rad-waste.
Decon Costs: $10's Million (1988)

Source: The Radiological Accident in Goiania, IAEA 1988

Fukushima, Japan March 2011

1 rem/yr Threshold



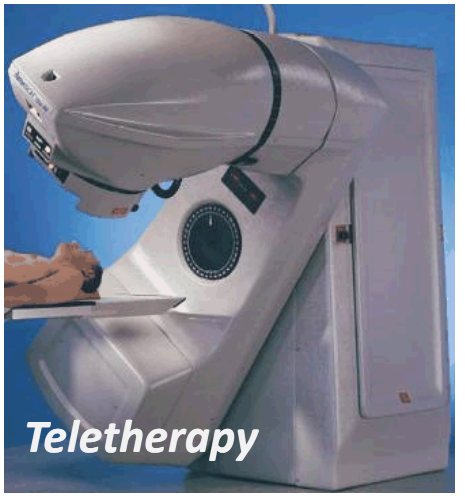
Consequences:
875 km^2 > 1 rem/yr
Pop. Relocated: 84,000
Total Comp. $30B (Nov 2013)

Source: DOE/NNSA Nuclear Incident Team

Material Vulnerability

Is it too hard to remove the source?

- Difficulty of attack--a key part of risk assessment.
- Vulnerability assessments were performed in 2003-4.
  - Adversary capability levels were developed.
  - small team with technician level knowledge and basic tools.
- US interagency consensus to move forward with security enhancements.



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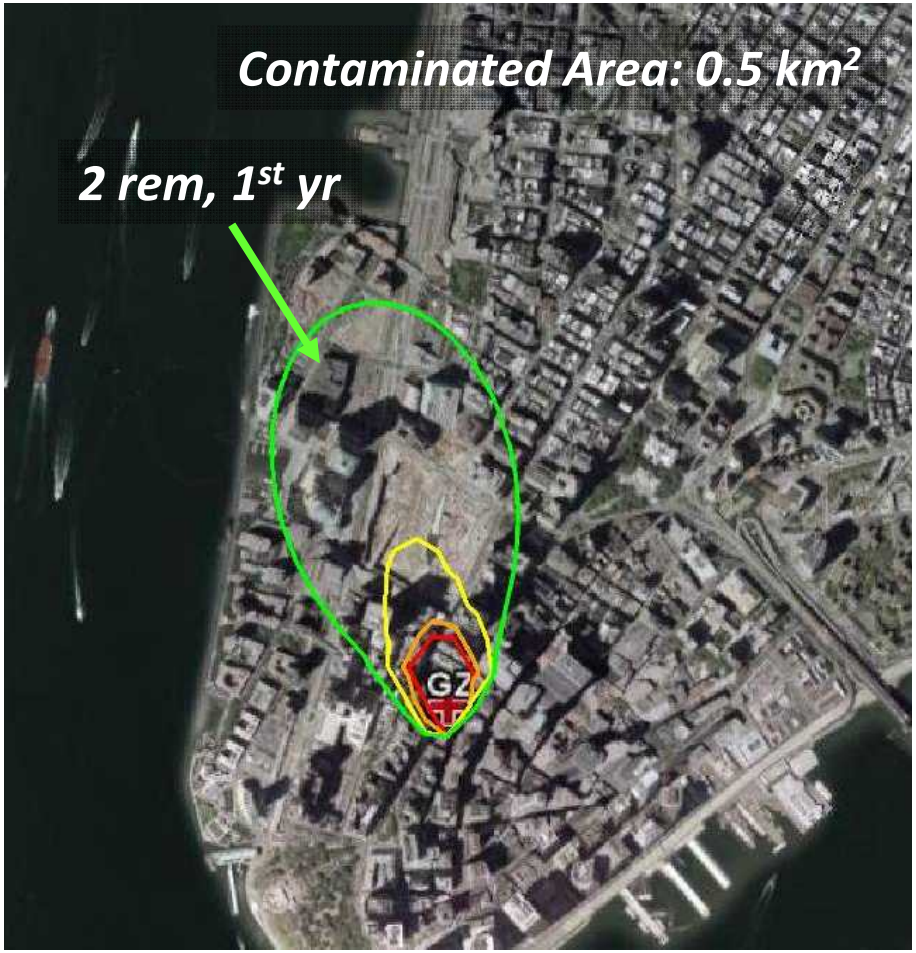
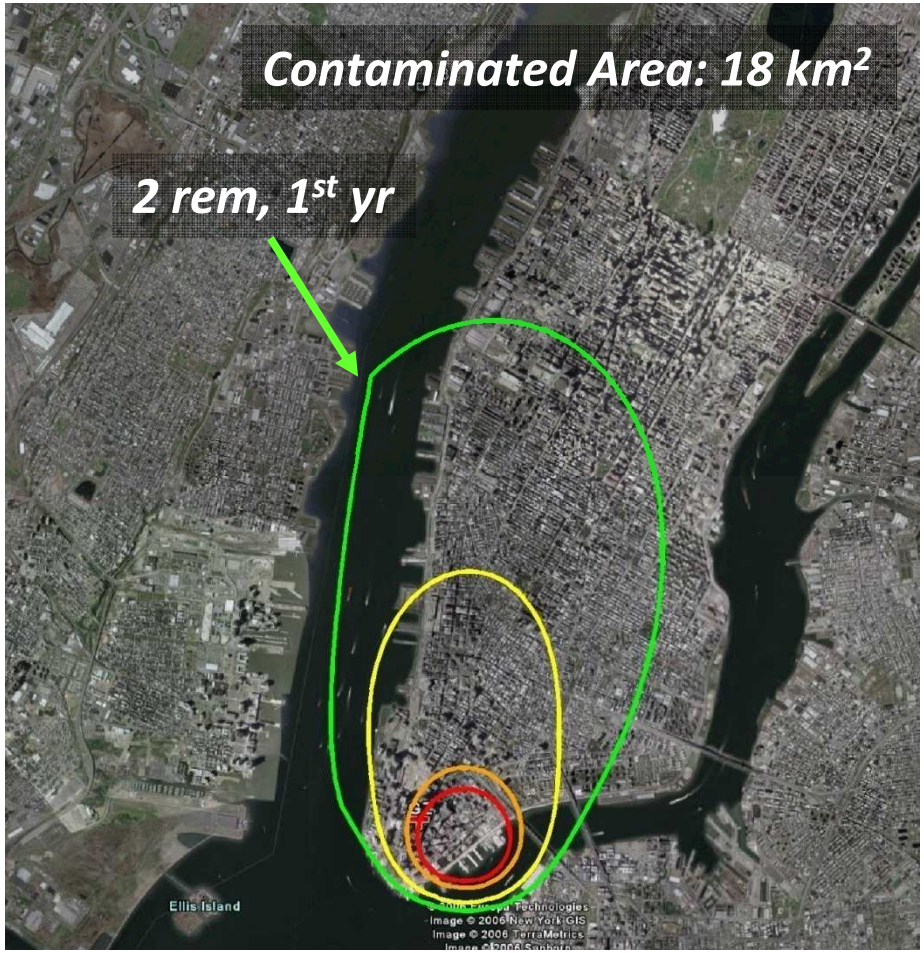
RDD CONSEQUENCES

Depend on Adversary Capability

RDD Plume Modeling and the 2 rem PAG

RDD consequences will depend on many factors such as adversary capability





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NAS Study 2008

NAS Committee Members

Assessment requires diverse set of stakeholders.

THEODORE L. PHILLIPS (*chairman*), University of California, San Francisco

EVERETT BLOOM, University of Tennessee—Knoxville

DAVID R. CLARKE, University of California, Santa Barbara

LEONARD W. CONNELL, Sandia National Laboratories

ROBIN GARDNER, North Carolina State University, Raleigh

C. RICHARD LIU, University of Houston

RUTH MCBURNEY, Conference of Radiation Control Program Directors

ERVIN B. PODGORSAK, McGill University

TOR RAUBENHEIMER, Stanford Linear Accelerator Center

STEPHEN WAGNER, American Red Cross

DAVID L. WEIMER, University of Wisconsin at Madison

STAFF

Micah Lowenthal, Study Director
Federico San Martini, Staff Officer
Mandi Boykin, Sr. Program Asst
Tracey Bonner, Program Asst
Marili Ulloa, Sr. Program Asst

NAS Committee Recommendation

Phase Out IAEA Category 1 and 2 Cesium-Chloride Source Use

- **RECOMMENDATION: In view of the overall liabilities of radioactive cesium chloride, the U.S. Government should implement options for eliminating Category 1 and 2 cesium chloride sources from use in the United States and, to the extent possible, elsewhere.**

- The committee suggests these steps
  - i. Discontinue licensing of new cesium chloride irradiator sources
  - ii. Put in place incentives for decommissioning existing sources
  - iii. Prohibit the export of cesium chloride sources to other countries, except for purposes of disposal in an appropriately licensed facility.

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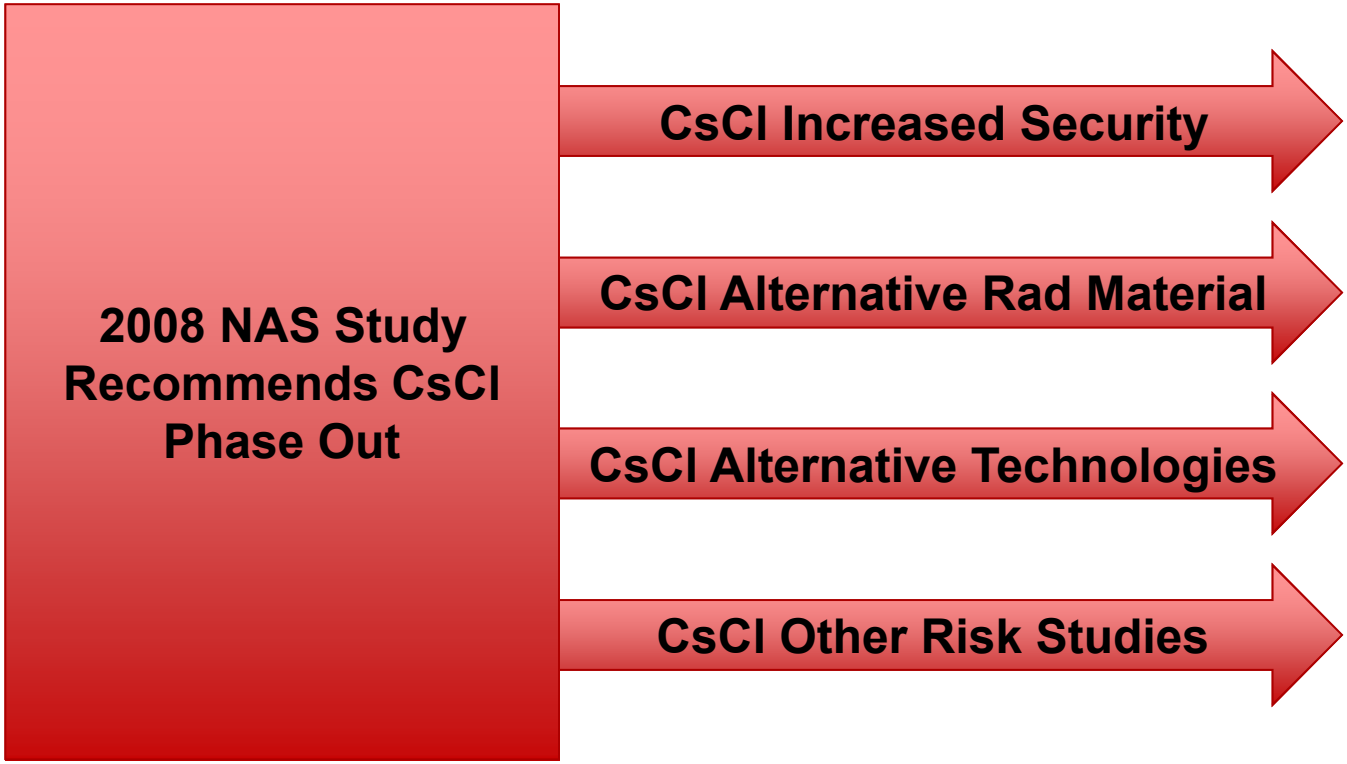
SINCE THE NAS STUDY
New Studies on RDD Risk

CsCl Study Paths Since the 2008 NAS Study



2008 CsCl Irradiator Hardening Program

Make it more difficult to extract the CsCl sealed source

- Design, and prototype hardening kits to delay source removal
- Validate the delay kits against a Design Basis Threat
- Satisfy constraints and requirements set by DHS, DOE, NRC, and manufacturers.
- Pilot for the GTRI IDD program

The Mark I

Gammacell 40

The IBL 437C

Gammacell 1000

2009 GTRI CsCl Alternate Material Risk Study

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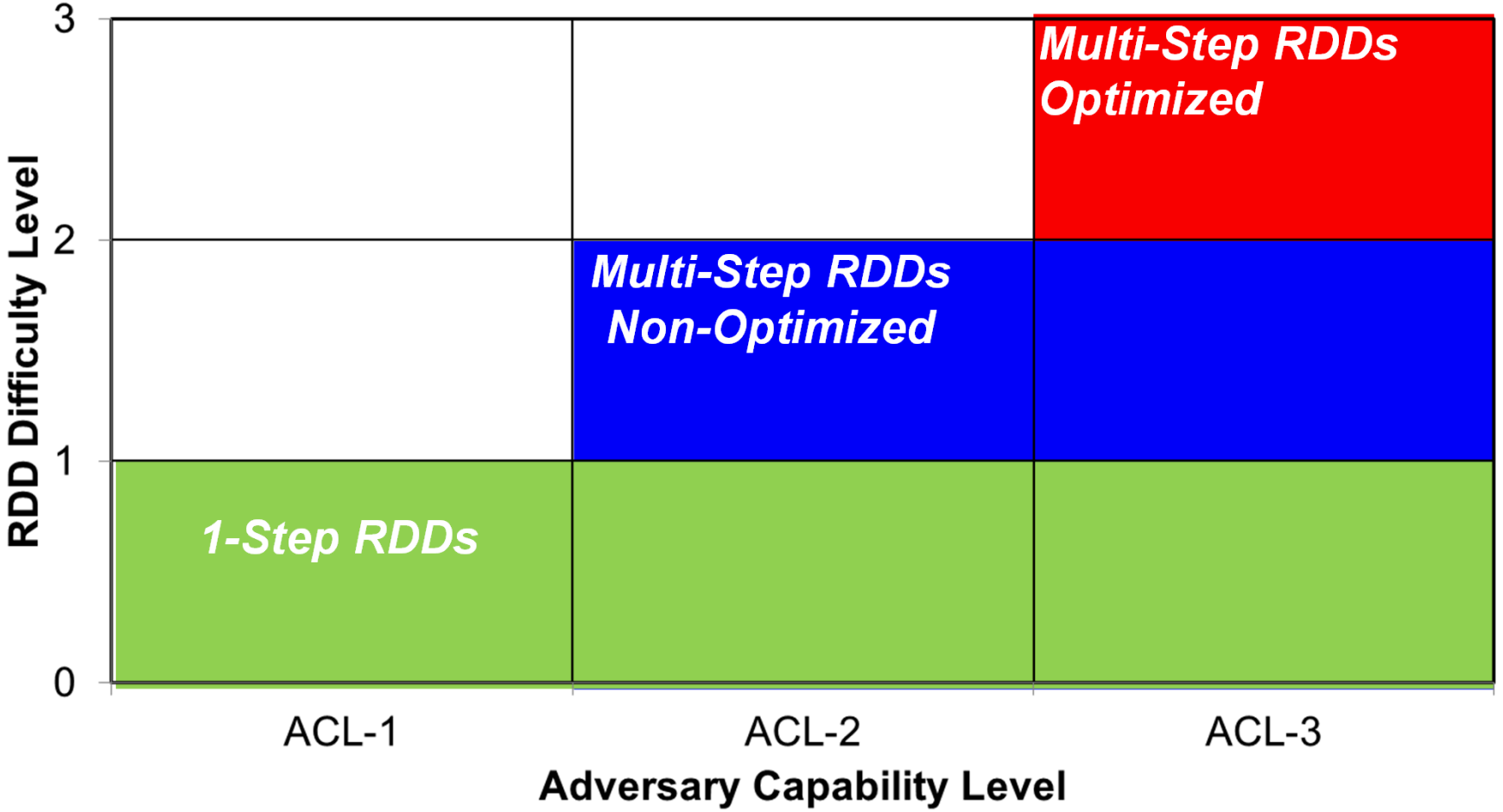
Mapping RDD Types to Adversary Capability Levels (ACL)



Amount of Risk Reduction Depends on Adversary Capability Level

2010 DHS Rad-Food Study

Investigated Food Supply Chain vulnerabilities

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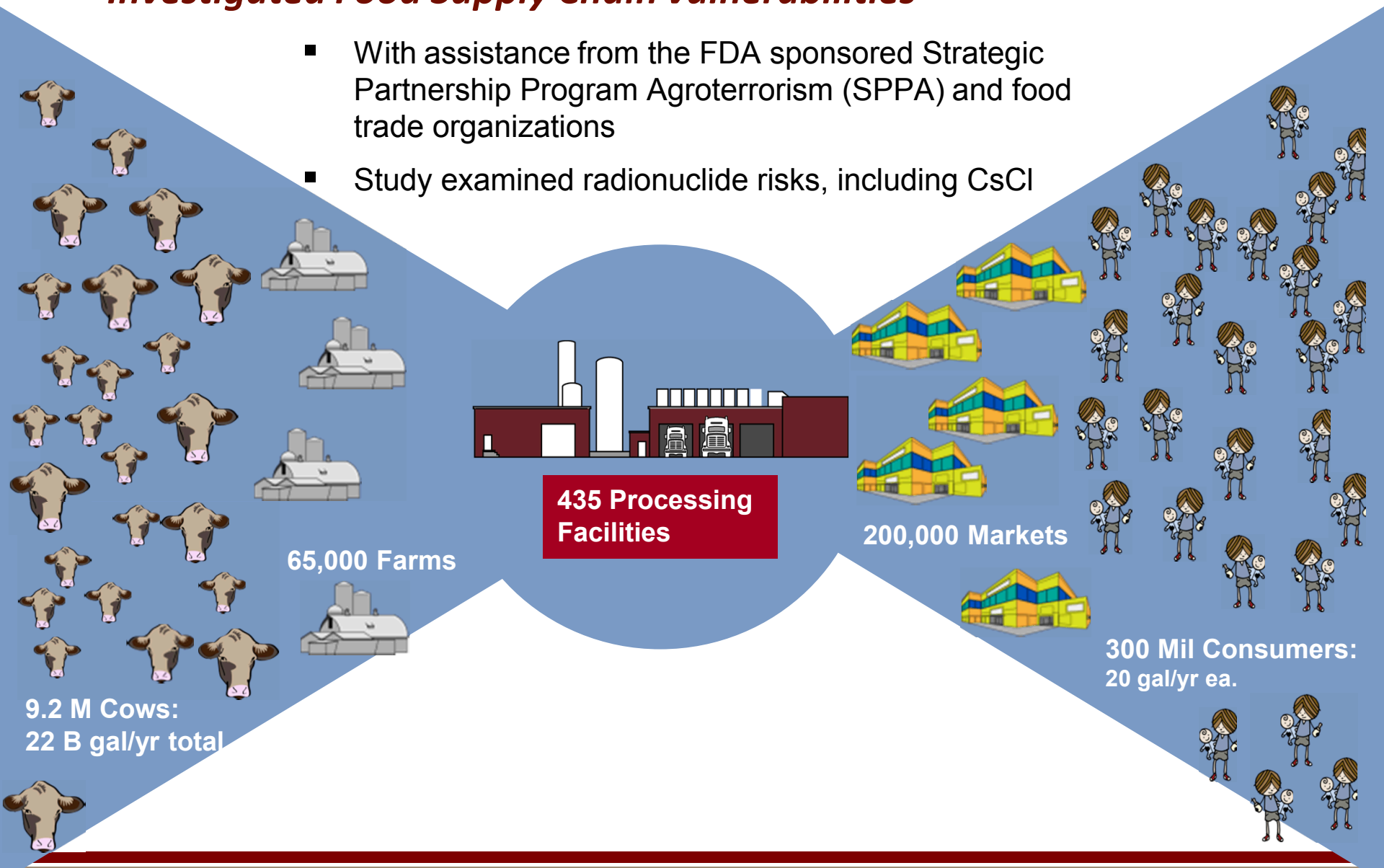
- With assistance from the FDA sponsored Strategic Partnership Program Agroterrorism (SPPA) and food trade organizations
- Study examined radionuclide risks, including CsCl



2011-2015 DHS/NA21 Sponsored Irradiator Sabotage Studies

- Experiments and modeling to assess risk.

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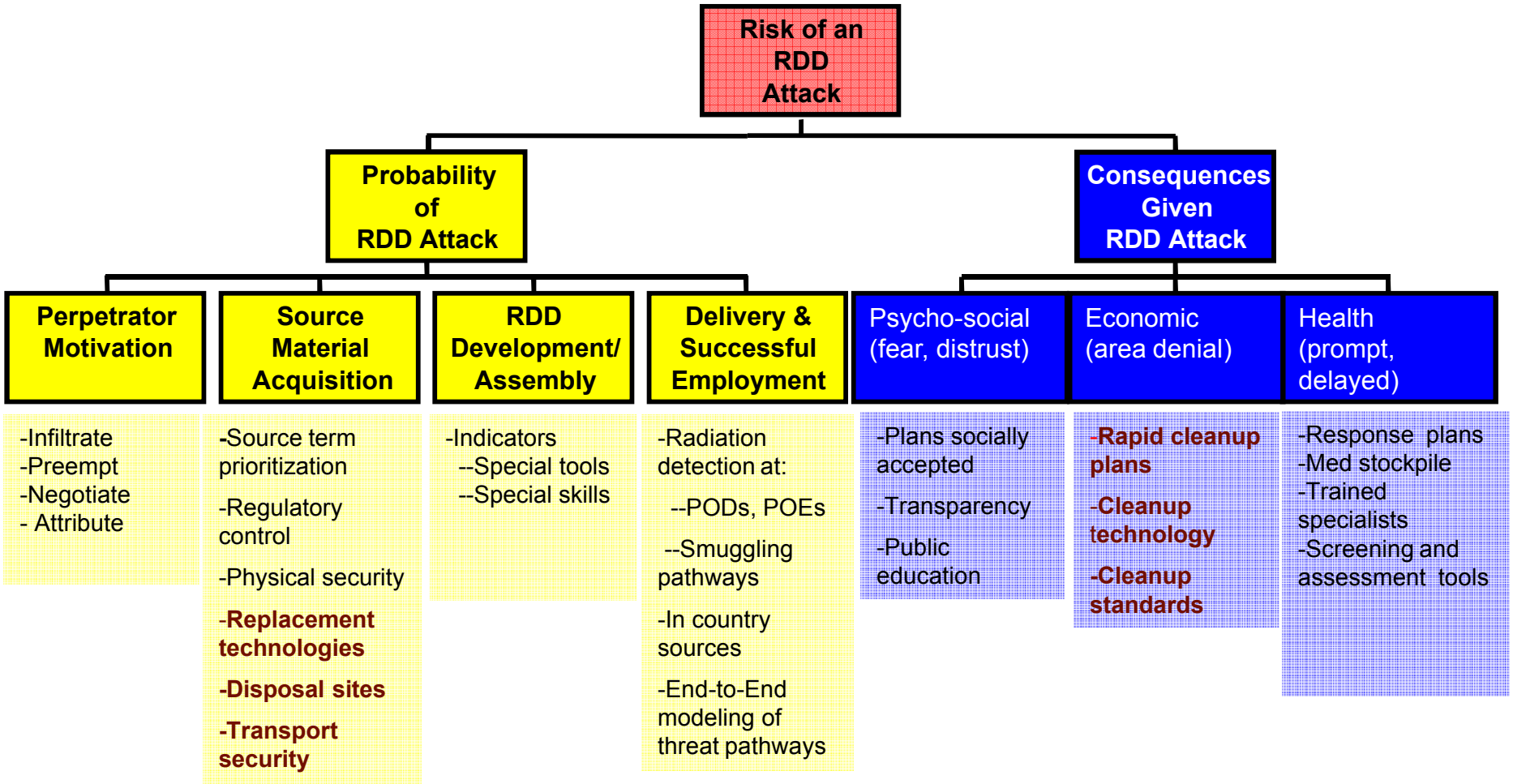
SUMMARY & CONCLUSIONS

RDD Risk Reduction Countermeasures



The RDD risks are manageable