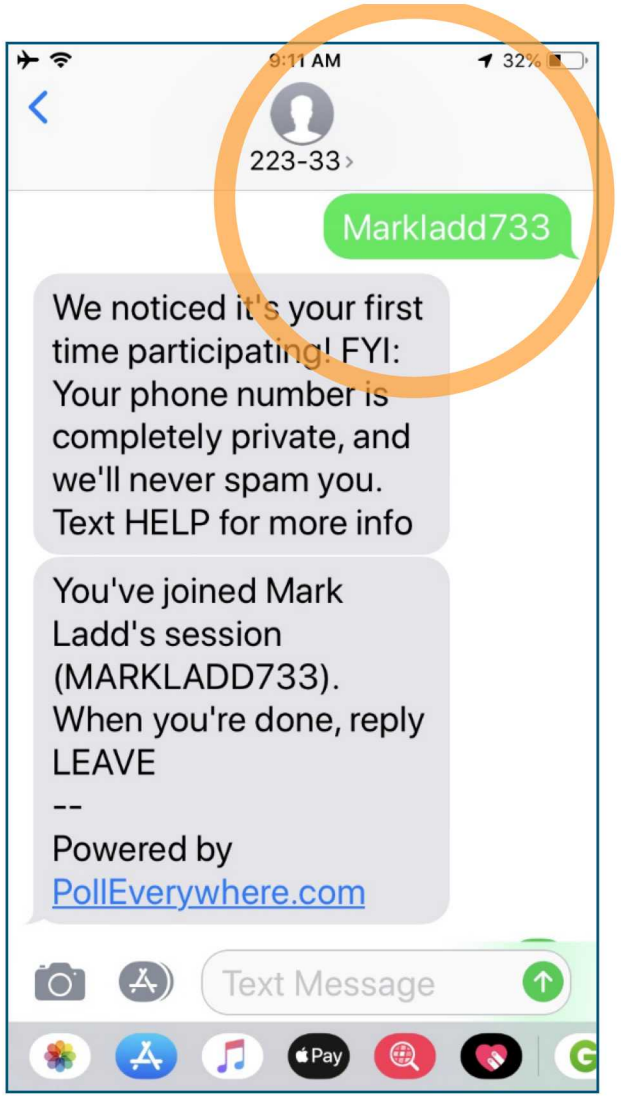
SETUP FOR DIRTY BOMB POLICY DISCUSSION

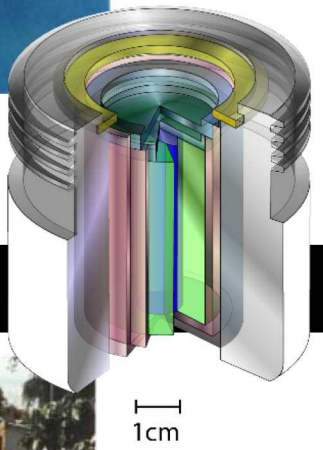
Polling will be used to answer select regulatory actions.



Send to 22333…

…the text **MARKLADD733** to initiate polling.

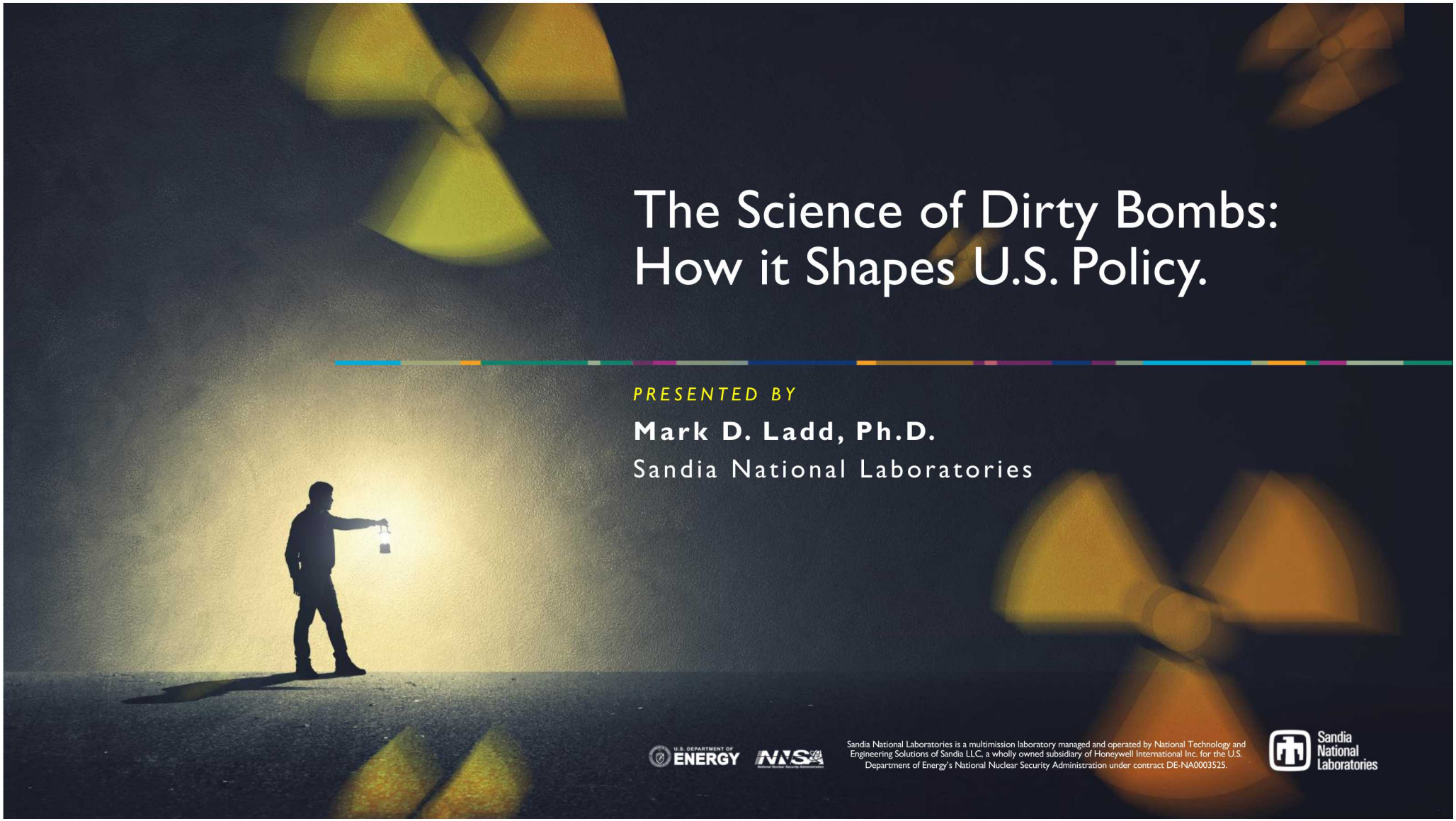
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



Simple incident, significant consequences.

GOIÂNIA, BRAZIL | SEPTEMBER 13, 1987

Photos: International Atomic Energy Agency | Radiation Capsule Graphic – User KDS444 under CC 3.0



The Science of Dirty Bombs: How it Shapes U.S. Policy.

PRESENTED BY

Mark D. Ladd, Ph.D.

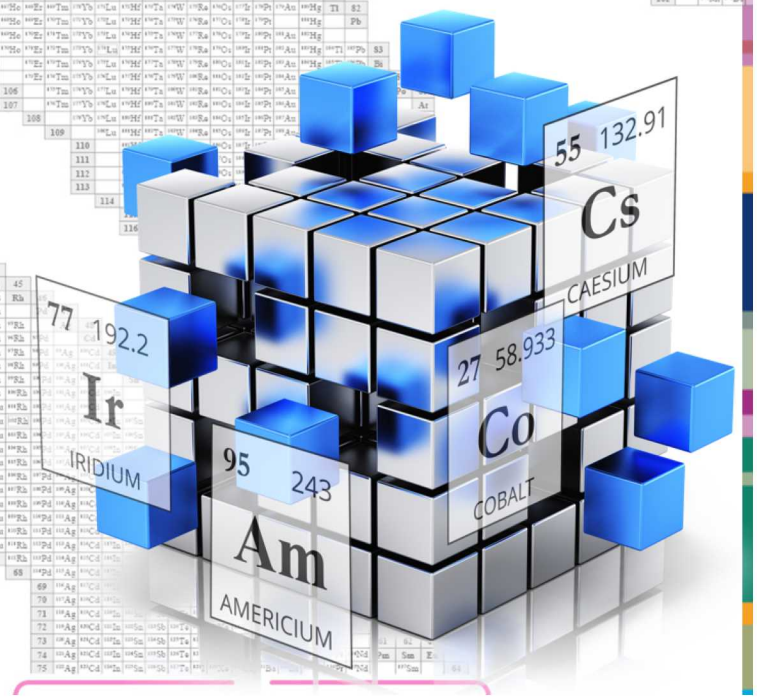
Sandia National Laboratories

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SYSTEMS ANALYSIS USED TO ASSESS DIRTY BOMB RISK

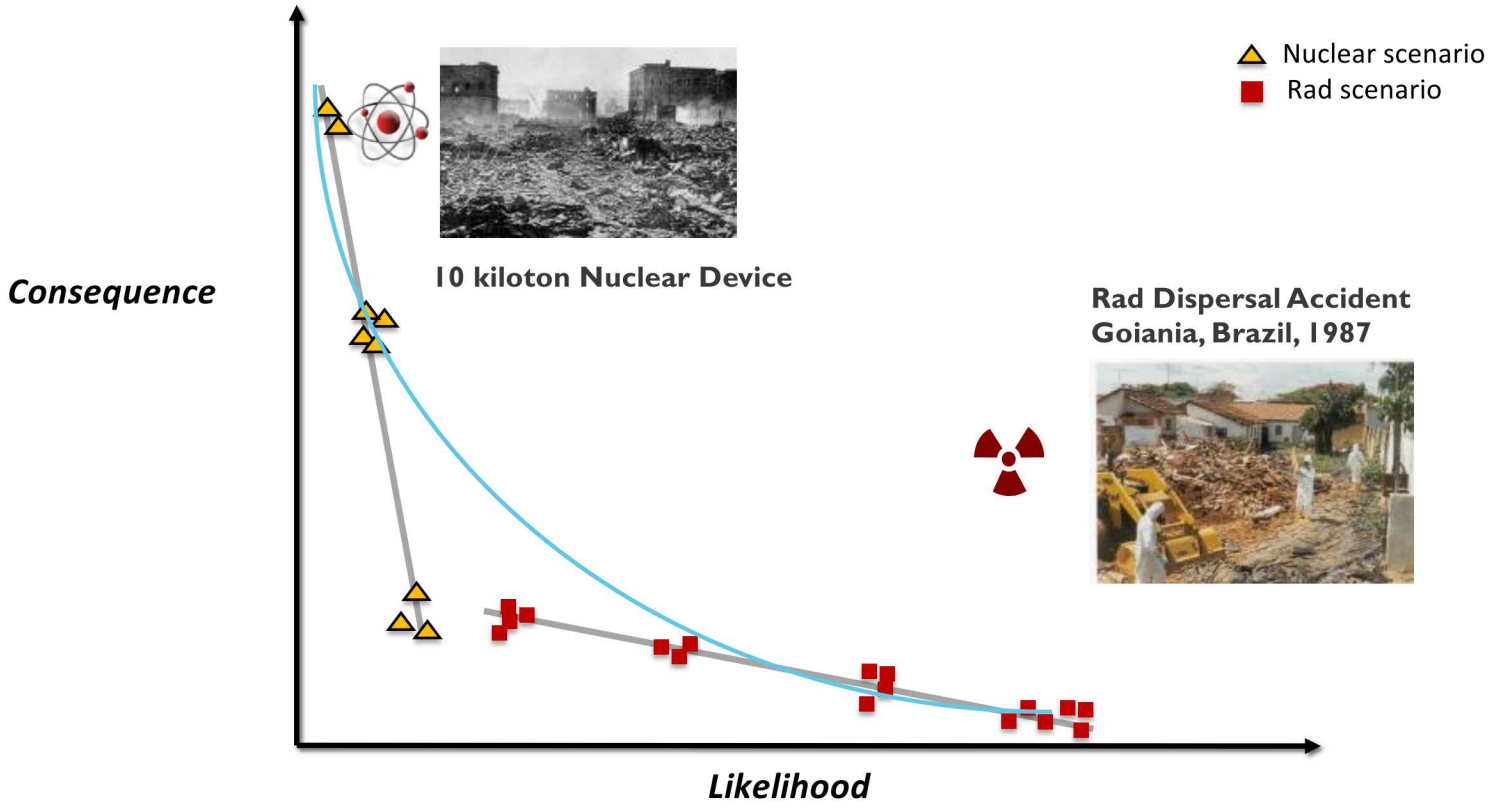
Provides salient, scientific information for the decision maker

> Risk comes from not knowing what you're doing.
>
> -Warren Buffet



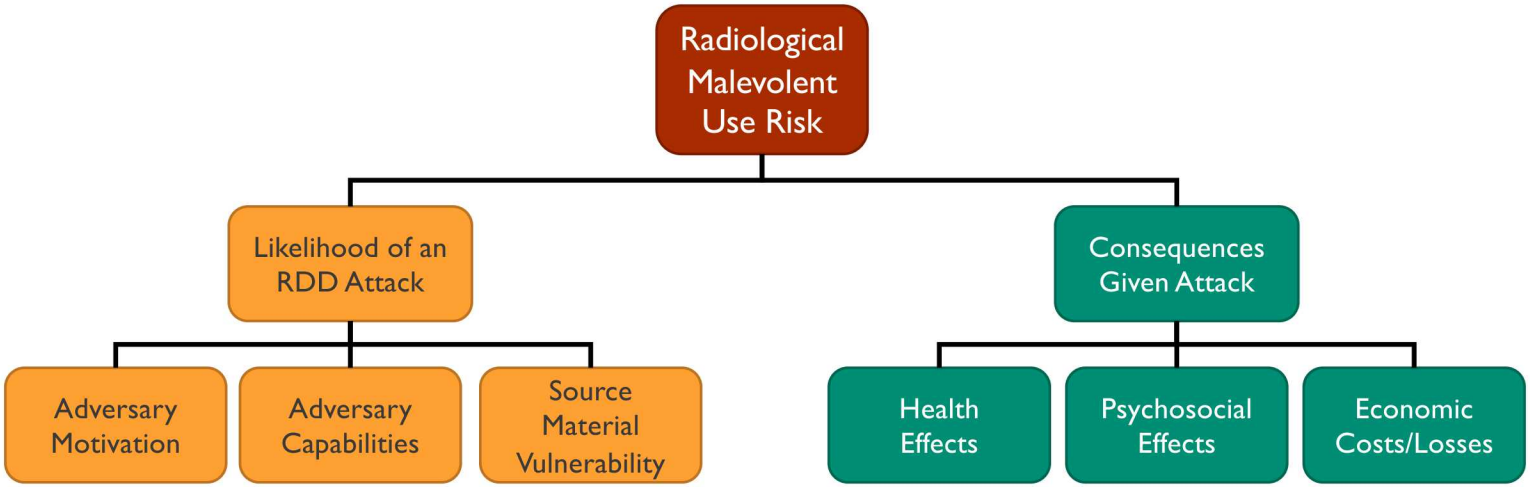
RISK IS MORE THAN POTENTIAL CONSEQUENCES

Opened U.S. view of nuclear risk to include radiological attacks



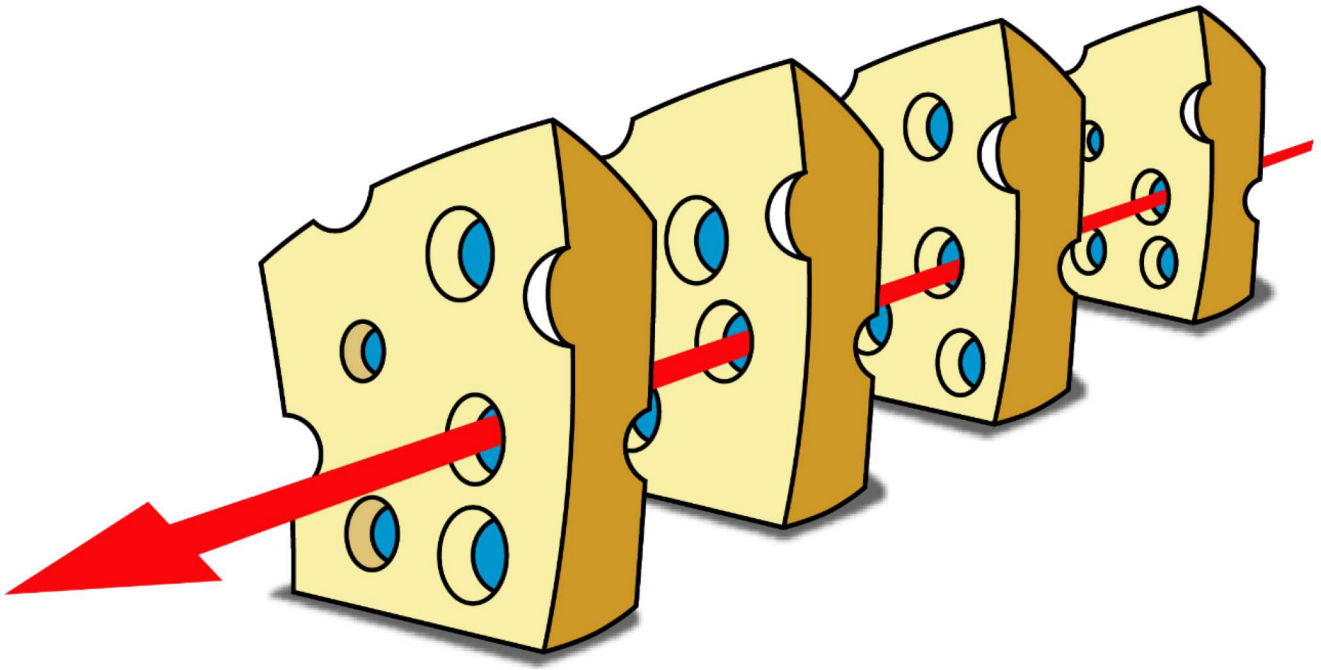
RISK ASSESSMENT FRAMEWORK

Drives comprehension



RISK ASSESSMENT FRAMEWORK

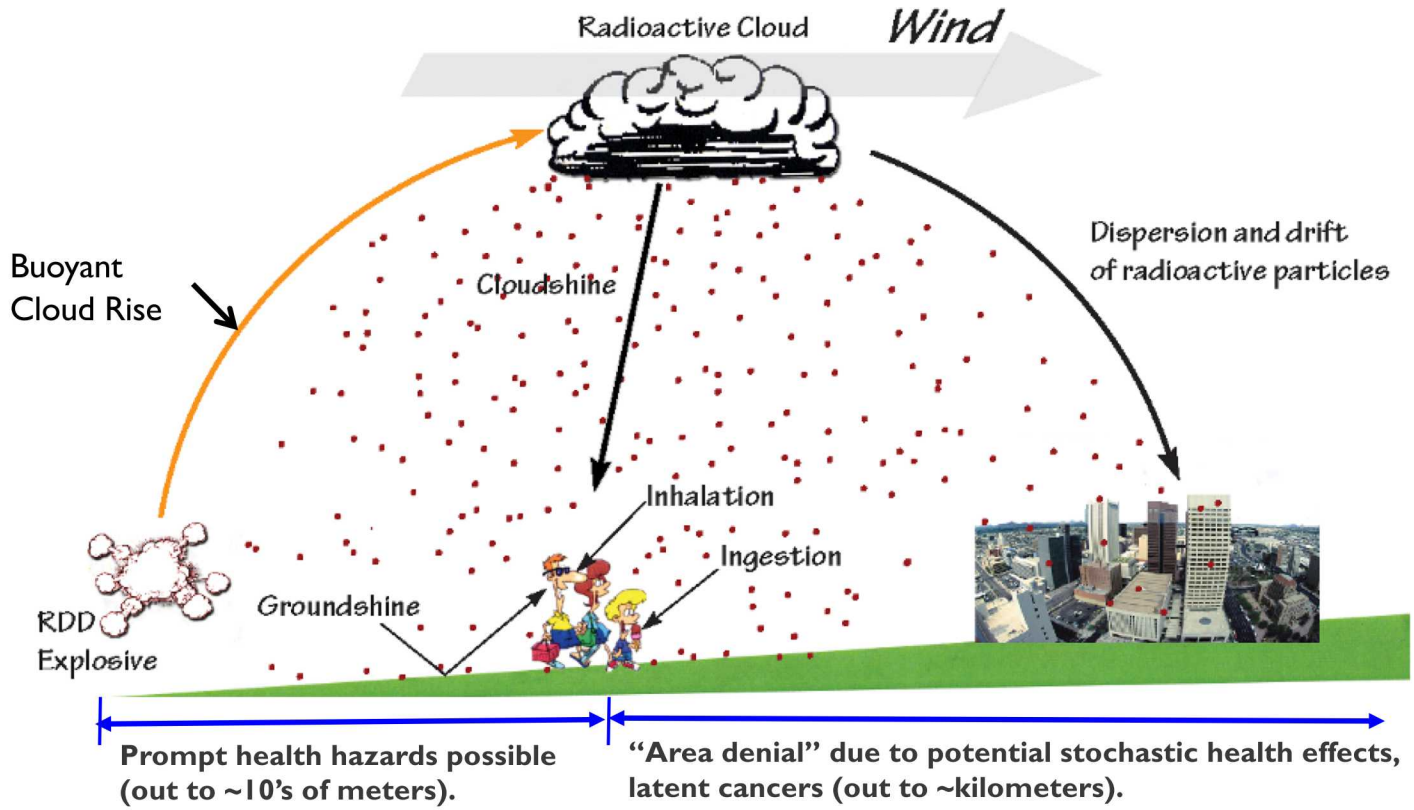
Identify paths that lead to an "easy" attack with significant consequences



Radiological Dispersal Device (RDD) scenario identified as the path with high likelihood and high consequence.

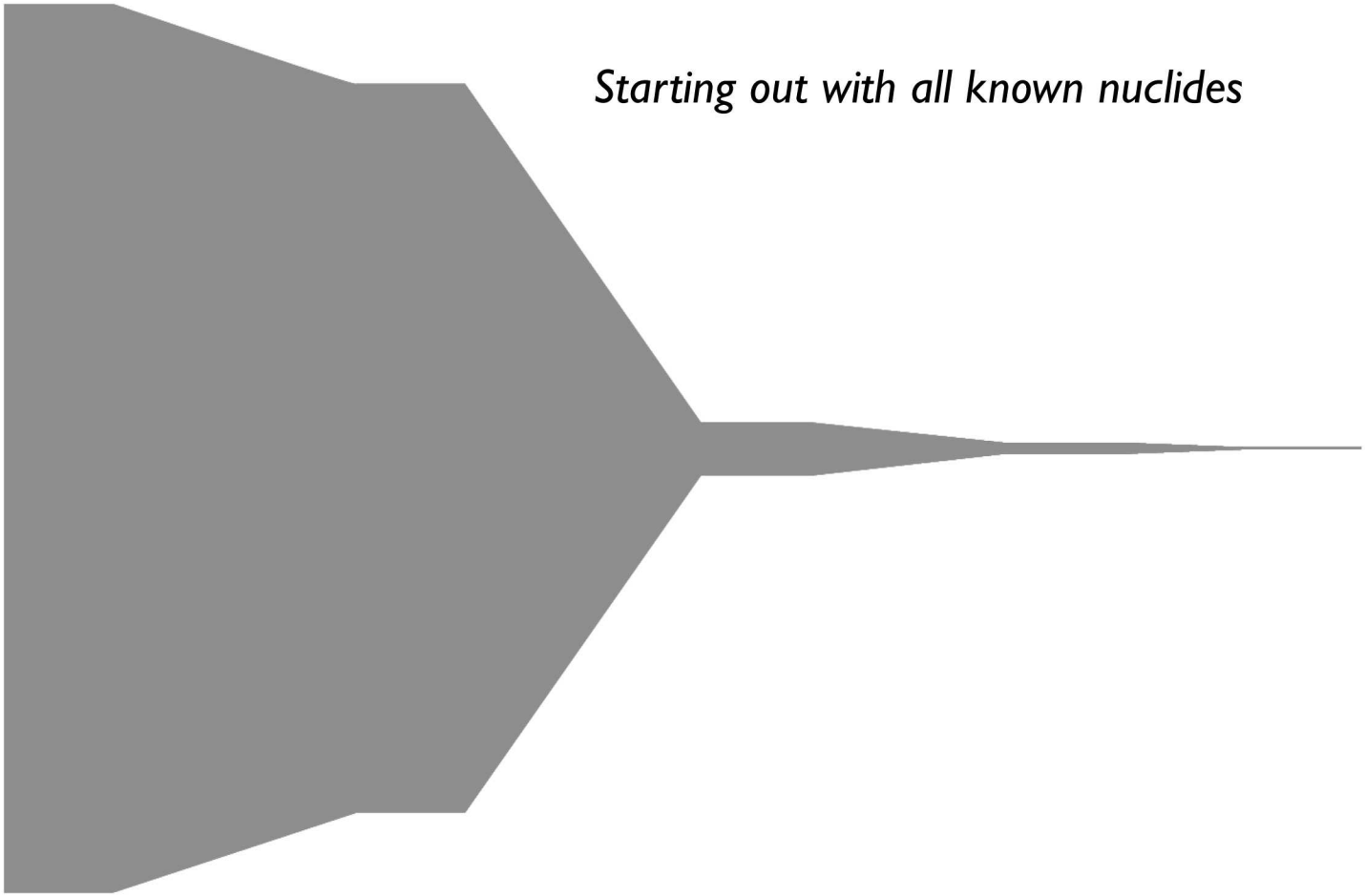
CONSEQUENCES FOR THE EXPLOSIVE RDD

Radioactive ground contamination can have a lasting, mass effect by creating an "area denial"



RDD MATERIAL ATTRACTIVENESS:
What radionuclides are of most concern?

Down selection process criteria



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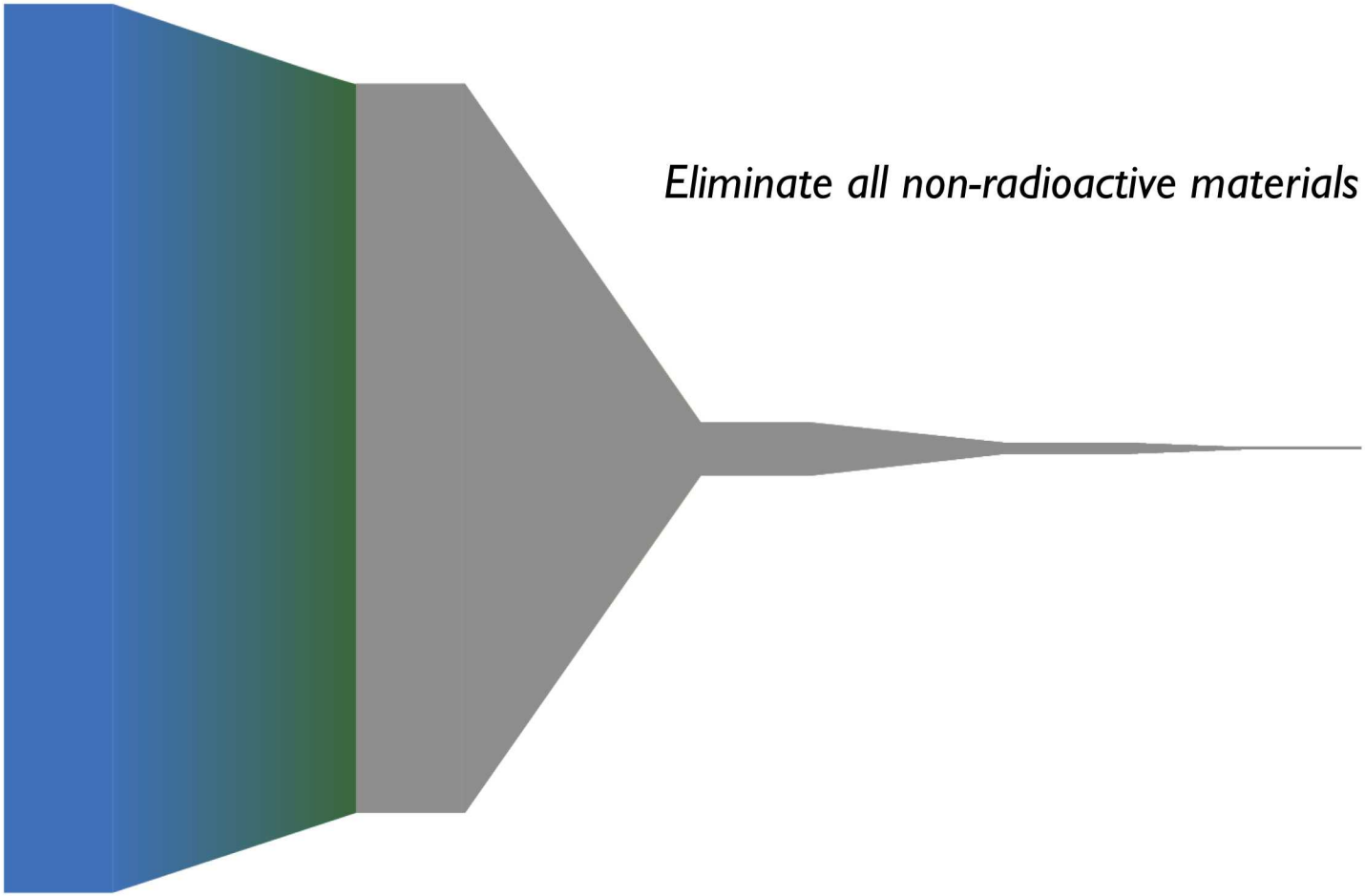
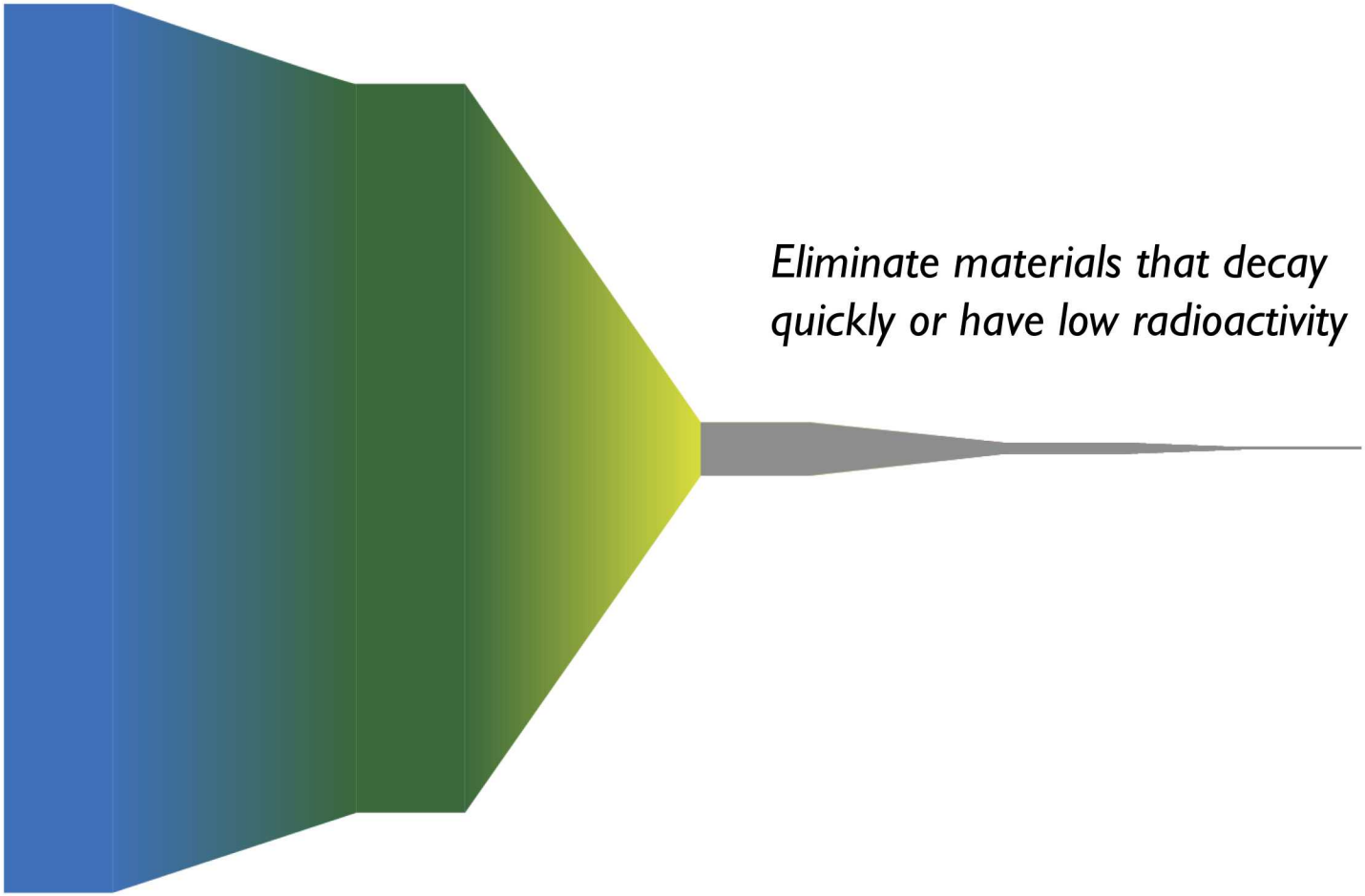


Eliminate all non-radioactive materials

Down selection process criteria
Radioactivity

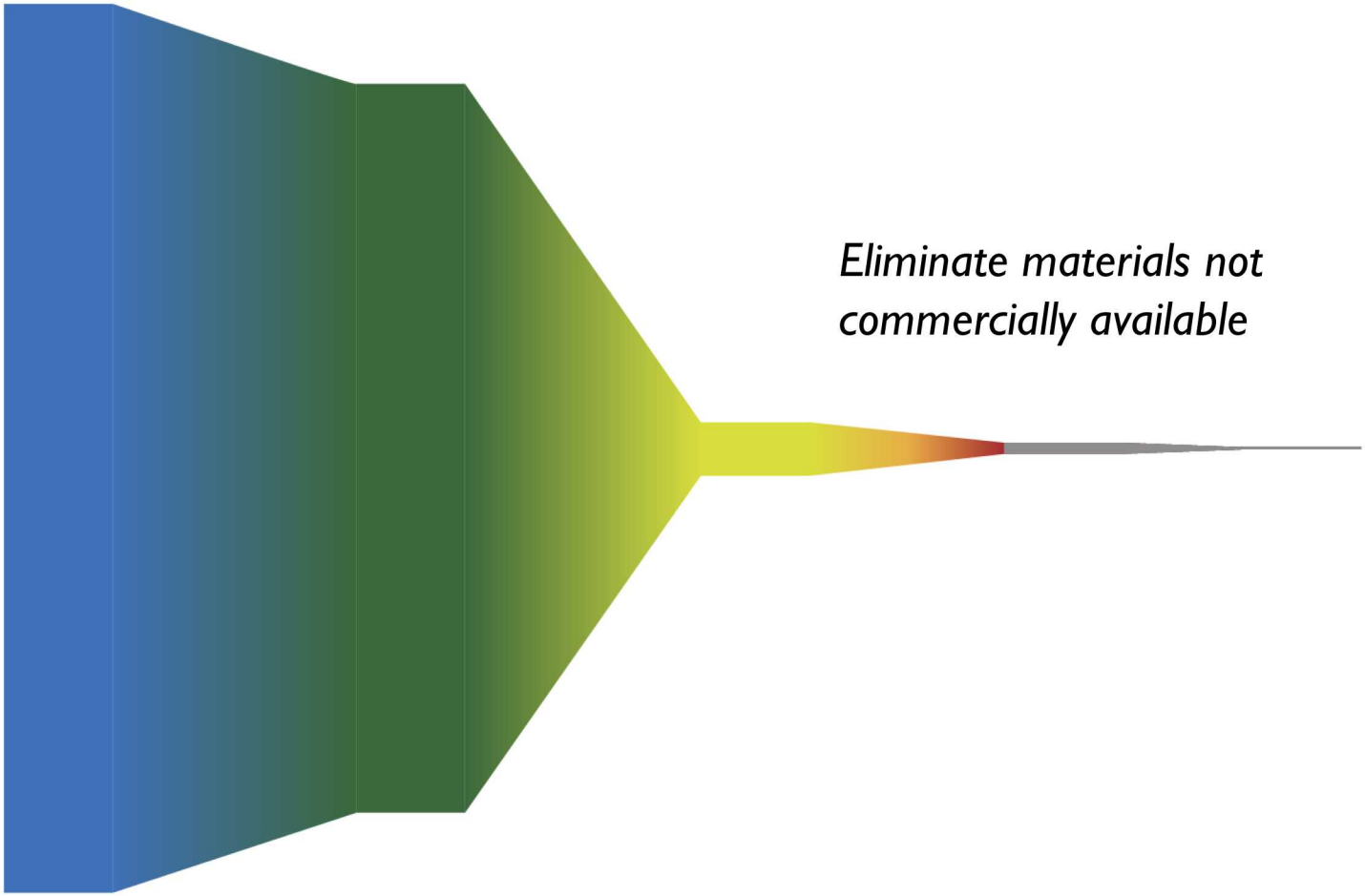
RDD MATERIAL ATTRACTIVENESS:
What radionuclides are of most concern?



Eliminate materials that decay quickly or have low radioactivity

Down selection process criteria
Radioactivity
Moderate half-life with high activity

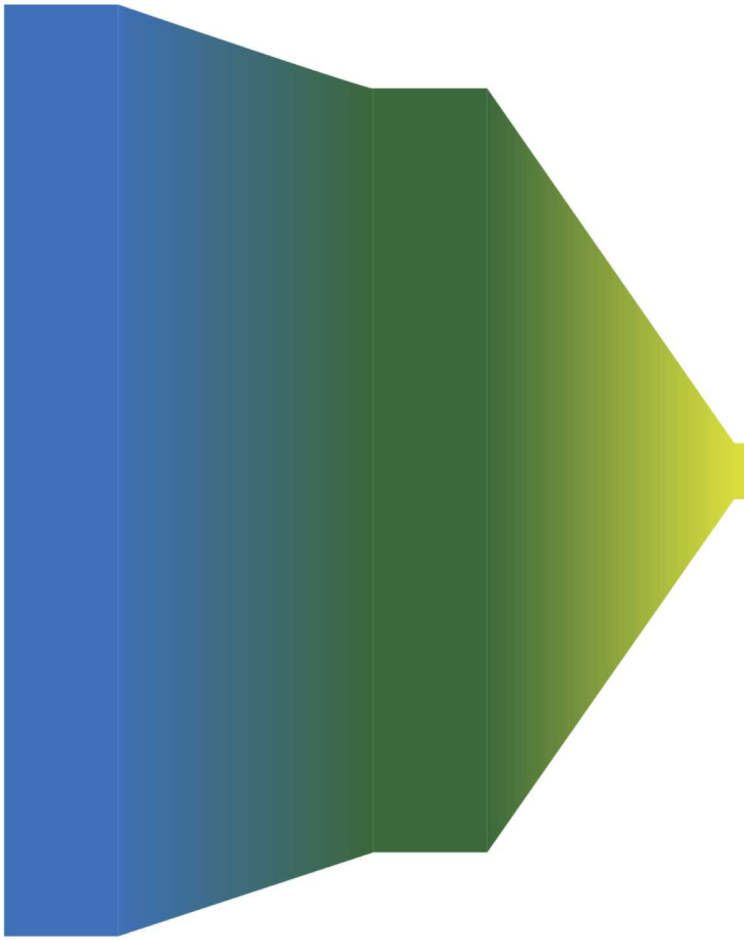
RDD MATERIAL ATTRACTIVENESS:
What radionuclides are of most concern?



Eliminate materials not commercially available

Down selection process criteria
Radioactivity
Moderate half-life with high activity
Commercially available

RDD MATERIAL ATTRACTIVENESS:
Final four are …



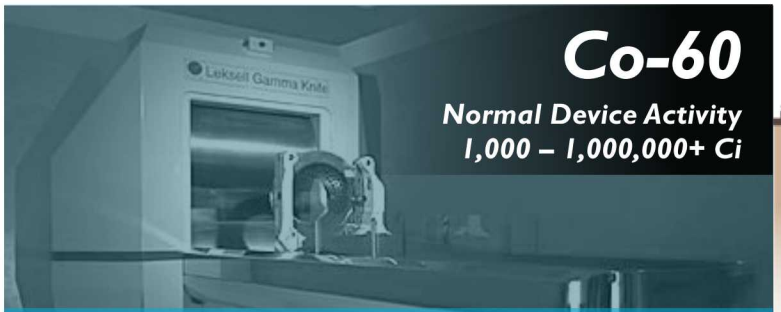
Identify the top four materials available in quantities suitable for a significant RDD

Down selection process criteria
Radioactivity
Moderate half-life with high activity
Commercially available

Radionuclide	Material Form Type
Co-60	Hard Metal
Cs-137	**Salt Powder**
Ir-192	Hard Metal
Am-241/ Be	Oxide Powder

CsCl poses unique concerns as a salt powder.

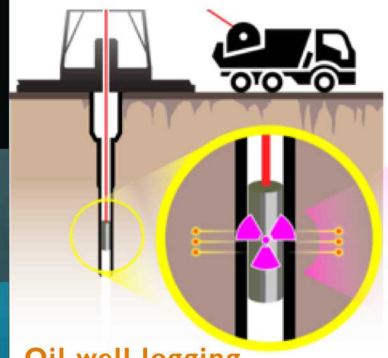
TOP FOUR ARE FOUND IN CRUCIAL MEDICAL AND INDUSTRIAL APPLICATIONS



Co-60

Normal Device Activity
1,000 – 1,000,000+ Ci

- Teletherapy and Gamma Knife units (cancer treatment)
- Self-shielded and panoramic irradiators (research and sterilization)



Am-241

Normal Device Activity
5-20 Ci

Oil well logging
(industrial imaging)

Ir-192

Normal Device Activity
10-100 Ci

Radiography
(industrial imaging)

Cs-137

Normal Device Activity
1,000 – 50,000 Ci

- Self-shielded irradiators (i.e. blood and research irradiators)
- calibrators (dosimeter and detector calibration)

IS IT DIFFICULT TO STEAL A SOURCE?

Source removal analysis shows it is not

Attack Exposure Analysis for Fixed Devices

- Typical Cs-137 blood irradiators: less than 24 rems
- Teletherapy: less than 2.3 rems
- Gamma Knife: up to 330 rems

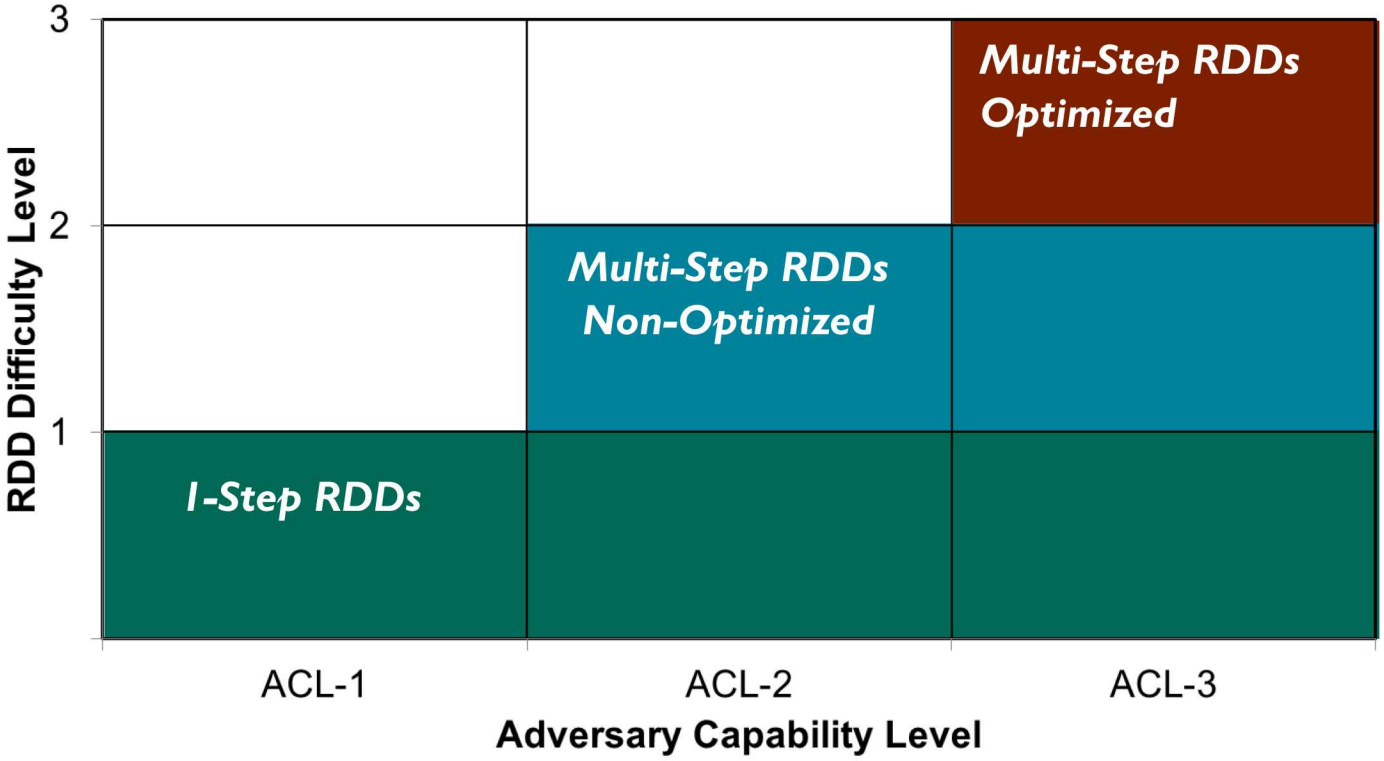
Interagency program to develop security enhancements.

- **Collaborate with manufacture's engineers and regulators**
- **In-field retro-fit plates to delay attacks**

Avoid assuming that sources and devices are "self-protecting"

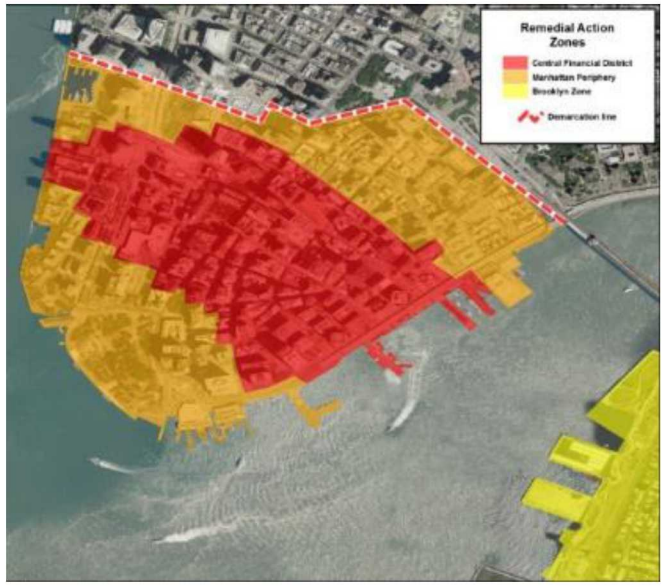
IS IT DIFFICULT TO MAKE AN RDD?

Adversary capability analysis shows it is not



Cs-137 RDD in NEW YORK CITY

Representative, not worse case, scenario shows the contamination area leads to significant consequence



Plume large but missed air and seaports.

The study used the US relocation threshold of 500 mrem second year, which is guidance, not the law.

RESPONSE ACTIONS DEFINE MANY OF THE CONSEQUENCES

Relocating/evacuating 195,000 people could lead to a significant number of deaths.

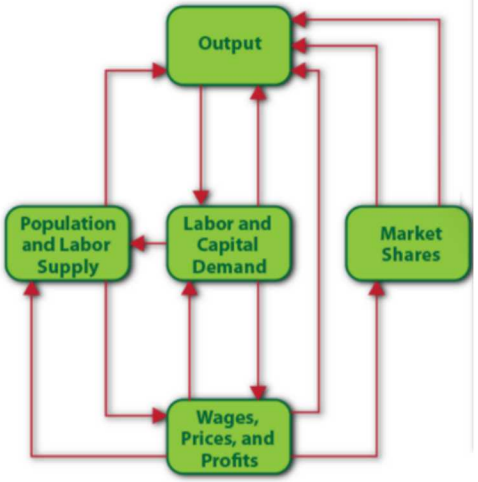
Event (40 min.)	Emergency Phase (4 days)	Stabilization (10 days)	Recovery (10 years)

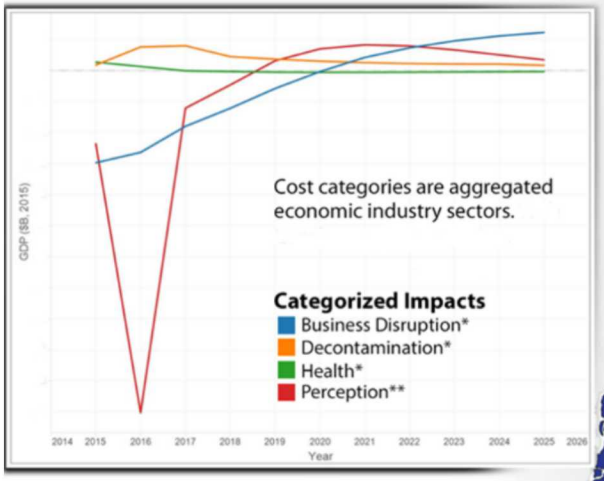
Event lasts for 40 minutes. However, remediation can last 10 years.
New York City is very, very well prepared and that was accounted for in the study.

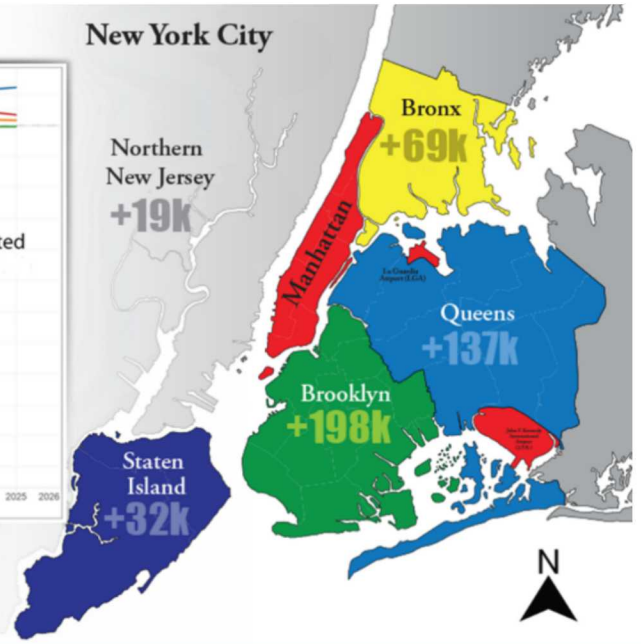
U.S. ECONOMIC CONSEQUENCES

Net $30 billion GDP loss over 10 years.

The economy: circular and dynamic	Output (GDP) contributed by activity	Relocation of economic activity within the NYC MSA.





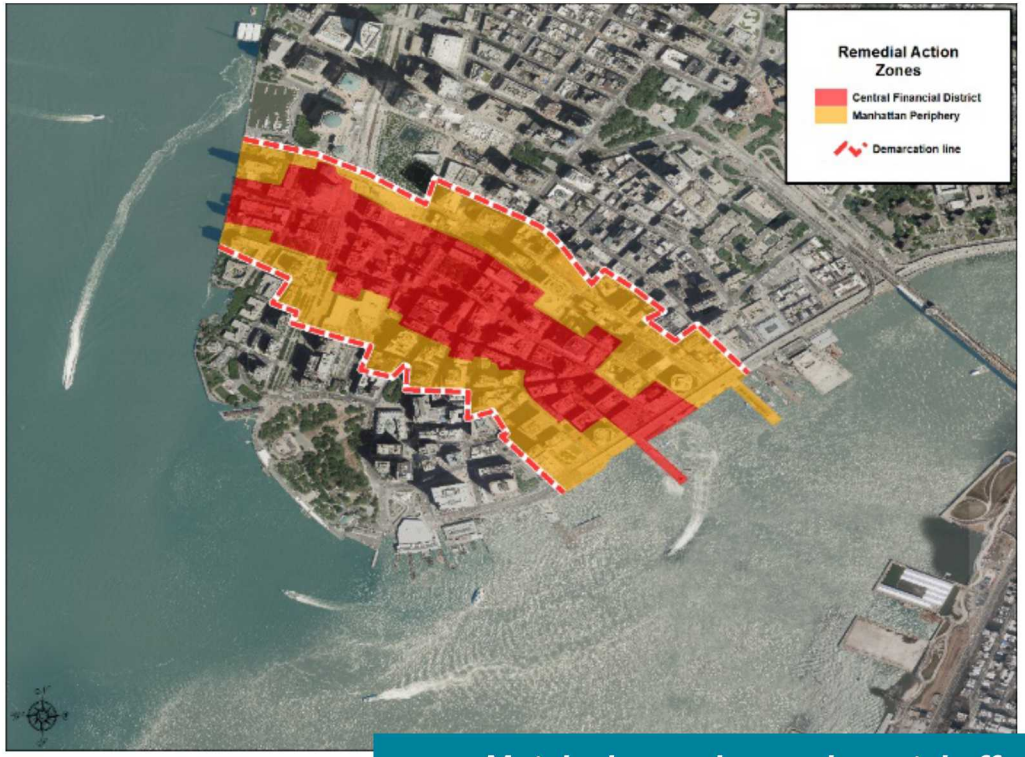


GDP impacts are not intuitive. They can be negative or positive, but all represent economic disruption.

PSYCHOSOCIAL IMPACTS OF AN RDD ATTACK ARE THE LARGEST CONTRIBUTOR TOWARDS THE ECONOMIC IMPACTS

WHAT IF…

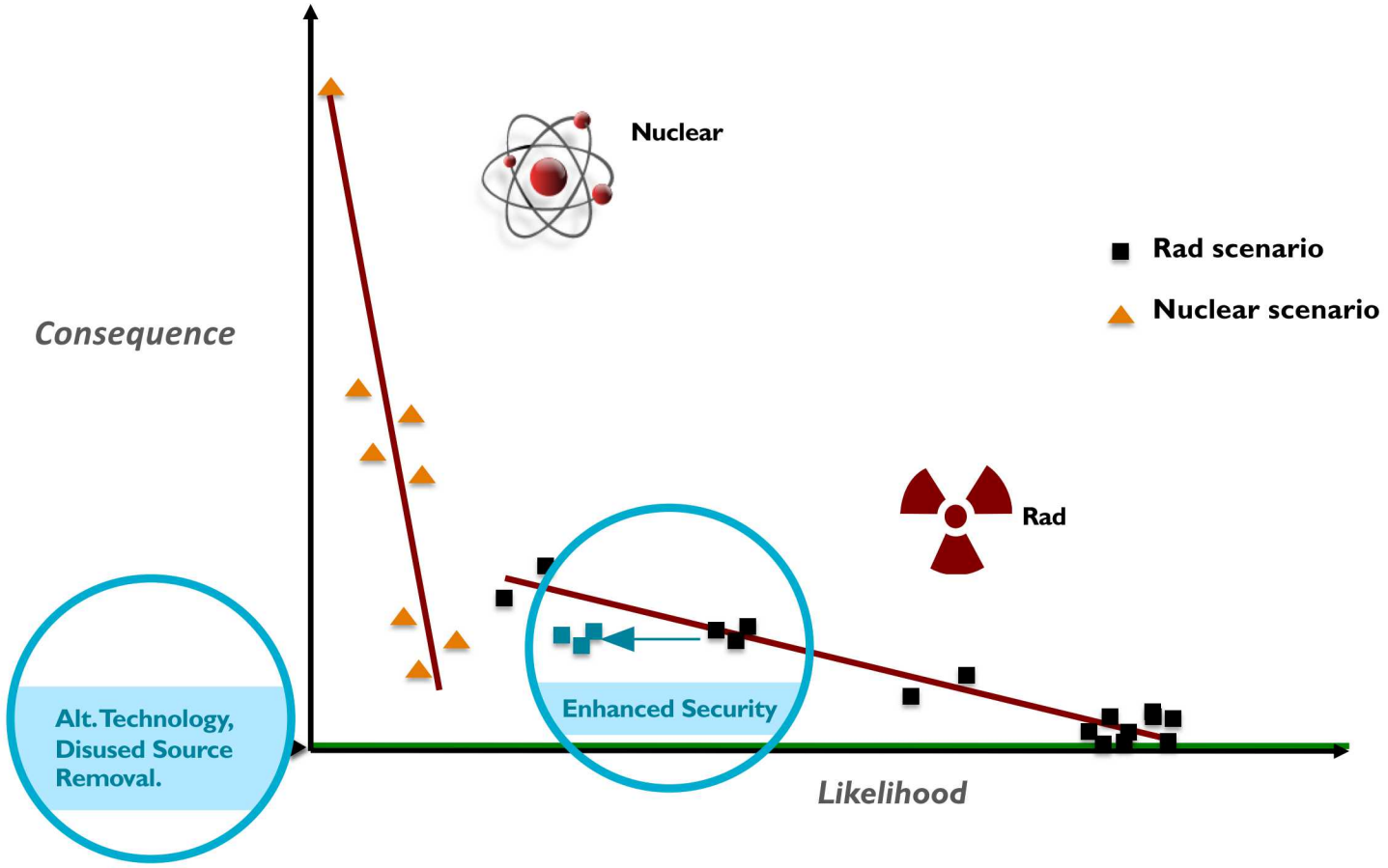
…a much smaller source is used?



Mainly due to the psychosocial effects, the impacts are still very significant with a net impact $24B USD on the US GDP over 10 years.

RISK MITIGATION

RDD risk can be high but can be mitigated through security, alternative technology, and removing disused sources.



US POLICY
A two-pronged approach

REGULATE

INCENTIVIZE

ORS
Office of Radiological Security
Protect · Remove · Reduce

THREE EXAMPLES OF REGULATORY POLICY DECISIONS

REDUCE

CsCl special licensing requirements

- Should there be additional special licensing requirements to use CsCl?

REMOVE

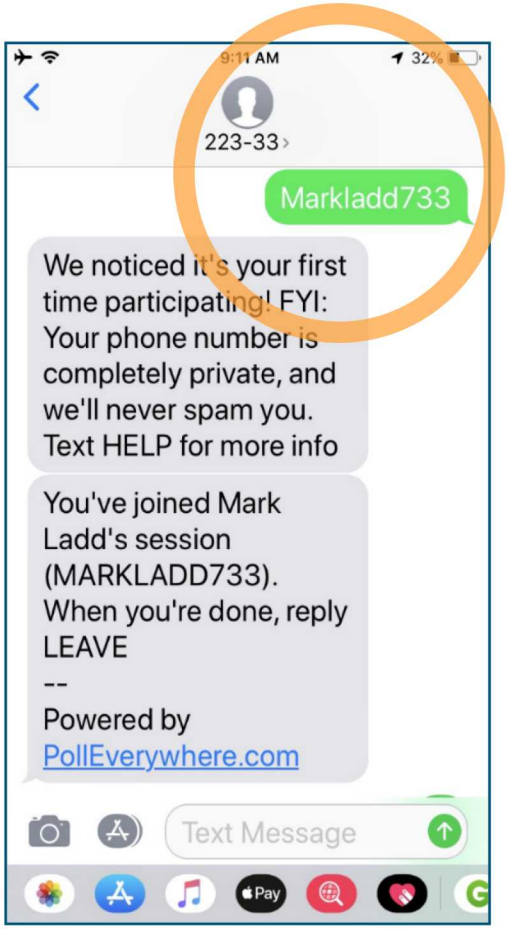
Disposition assurances

- Should facilities establish a financial guarantee to address decommissioning?

PROTECT

Security requirements

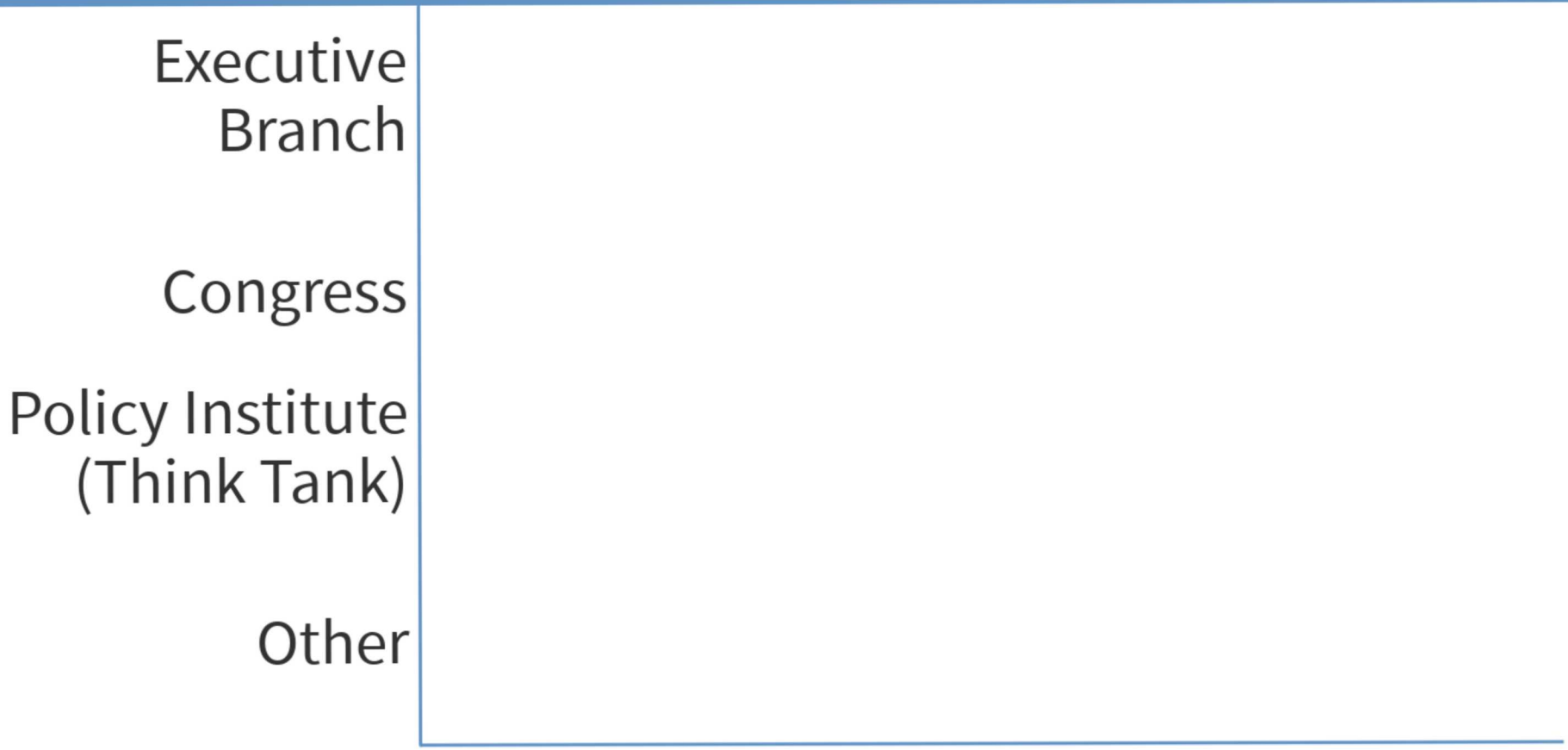
- What security should be required for high-activity source sites?



Send to 22333

…the text **MARKLADD733** to initiate polling.

WHO'S IN THE AUDIENCE



SHOULD THERE BE SPECIAL LICENSING REQUIREMENTS FOR CsCl?

No special requirements.

Supplemental requirements.

Not allow the use of CsCl.

Other or not sure.

WHAT REGULATIONS WOULD MITIGATE RISK?

CsCl special licensing requirements

Should there be special licensing requirements for CsCl?

A) No special requirements.

B) Justify the need.

C) Not allow the use of CsCl.

E) Other or not sure.

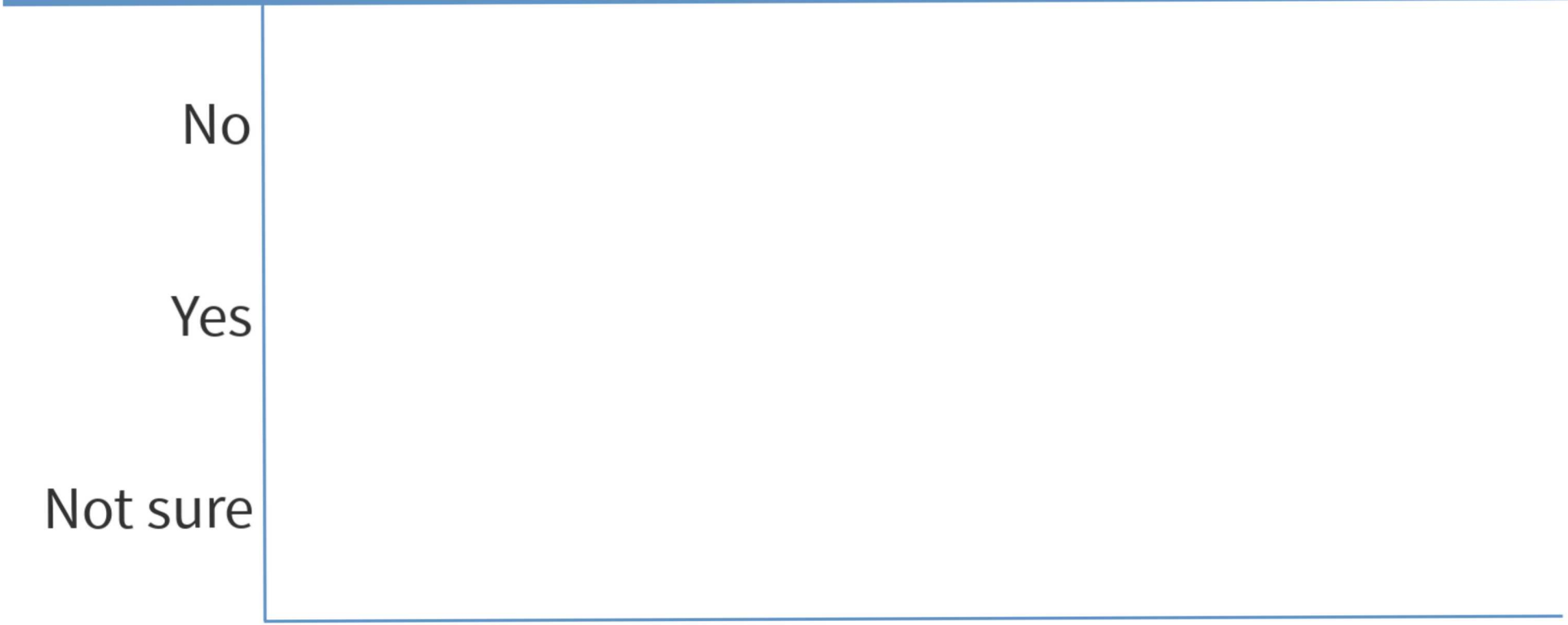
Examples:

C) Countries that ban: France, Denmark, Norway

B) Countries that require justification: Belgium

A) Countries that don't have special requirements: U.S.

SHOULD FACILITIES ESTABLISH A FINANCIAL GUARANTEE TO ADDRESS DECOMMISSIONING?



WHAT REGULATIONS WOULD MITIGATE RISK?

Disposition assurances

Should facilities establish a financial guarantee to address decommissioning?

A) No.

B) Yes.

C) Not sure.

Examples:

B) Countries that require: Canada, France, Germany, Switzerland, United Kingdom

A) Countries that do not require: U.S.

WHAT SECURITY LEVEL SHOULD BE REQUIRED FOR HIGH-ACTIVITY SOURCE SITES?

None

Low (home burglar: surveillance or detection sensor(s), monitoring with LLEA notification)

Medium (layered intrusion detection system, delay (e.g. safe), LLEA notification & response training)

High (layered intrusion detection system, delay, on-site armed response)

Very high (layered intrusion detection system, delay, on-site “military" response)

WHAT REGULATIONS WOULD MITIGATE RISK?

Security requirements

What security level should be required by high-activity sources?

A) None

B) Low (home burglar: surveillance or detection sensor(s), monitoring with LLEA notification)

C) Medium (layered intrusion detection system, delay (e.g. safe), LLEA notification & response training)

D) High (layered intrusion detection system, delay, on-site armed response)

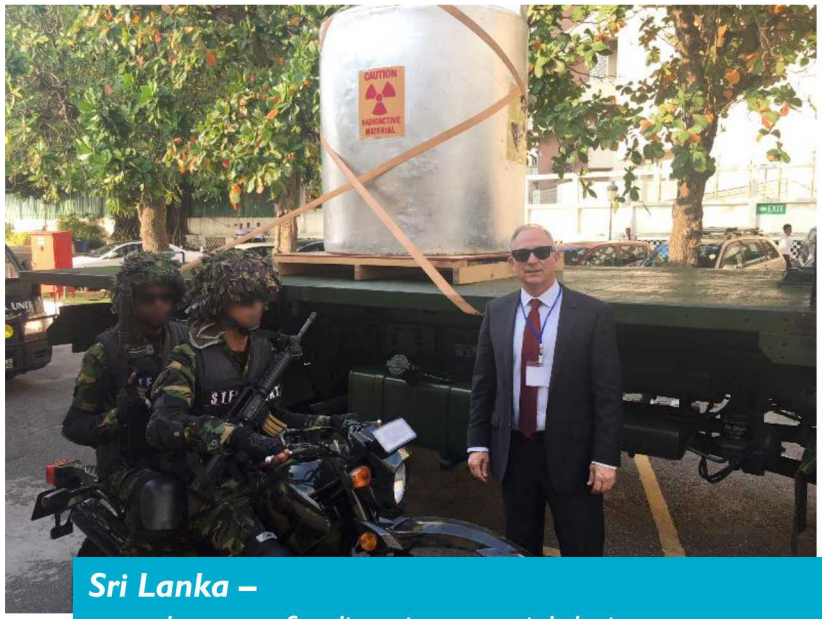
E) Very High (layered intrusion detection system, delay, on-site "military" response)

Examples:

B) Low: US-NRC

C) & D) Medium/high: U.S.-ORS upgrades

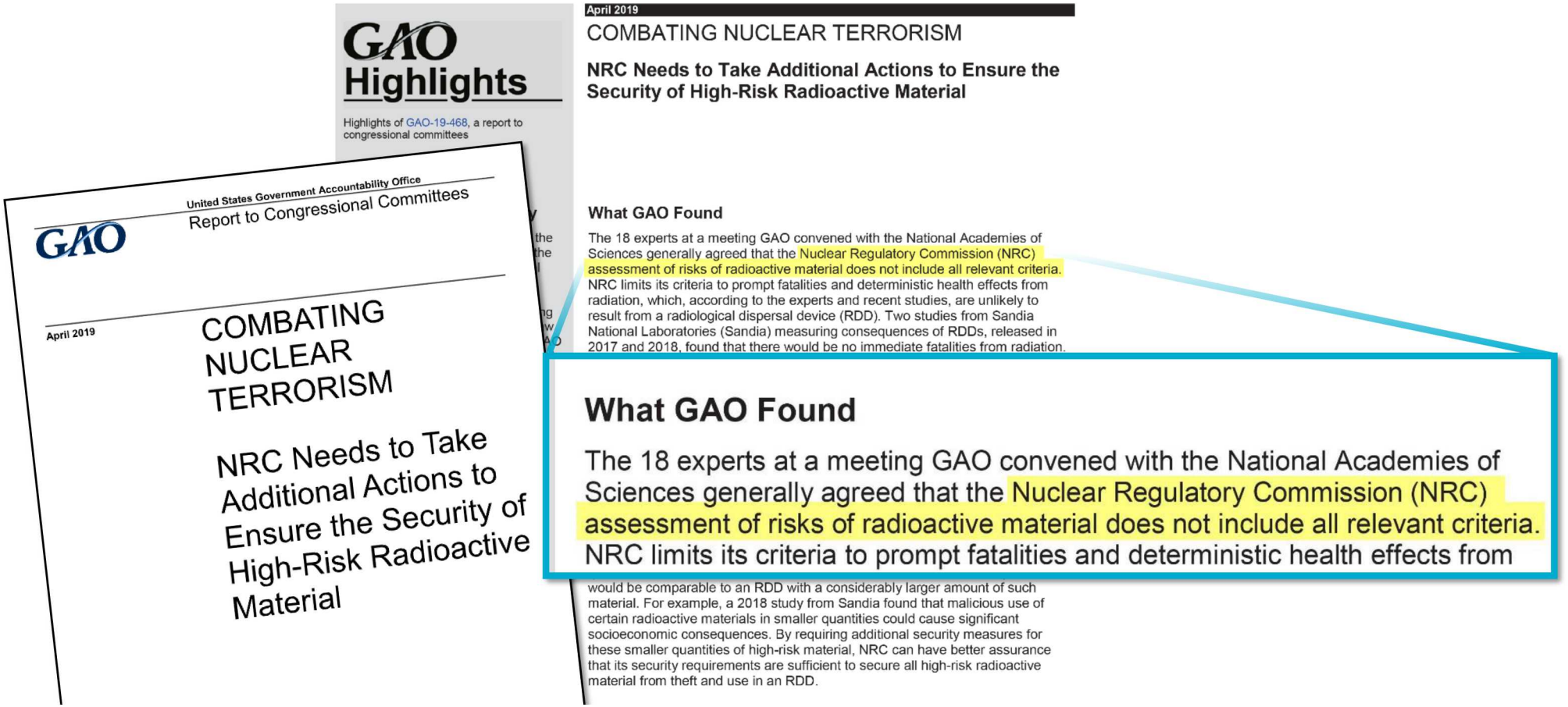
E) Very High: Sri Lanka transportation



Sri Lanka –
armed escort of radioactive material during transport.

US POLICY DEBATE

GAO asks how should the NRC define risk for combating nuclear terrorism?



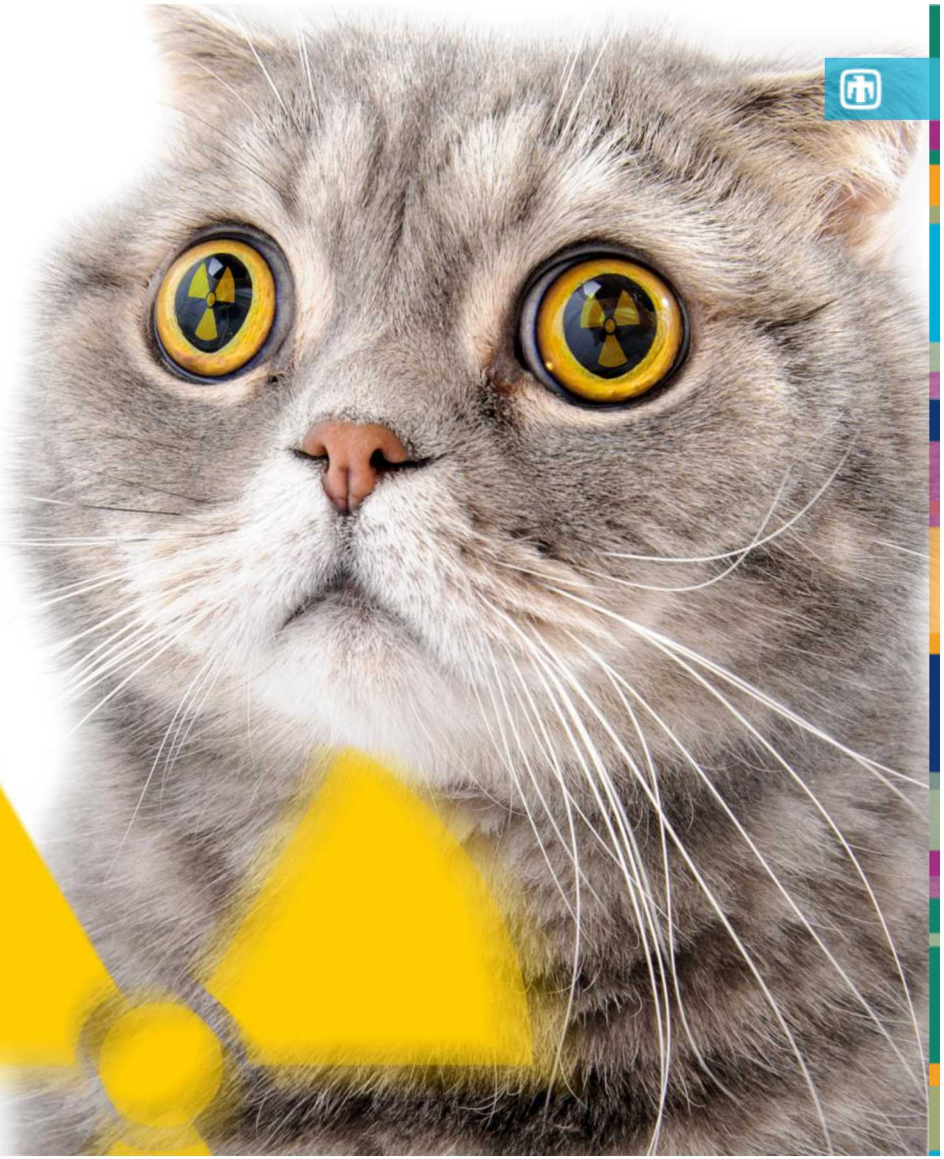
The DOE NATIONAL LABORATORIES

A useful resource for you.

> Risk comes from not knowing what you're doing.
>
> -Warren Buffet

Science provided the knowledge needed to develop radioactive material use policy.

QUESTIONS?



QUESTIONS?

DECONTAMINATION ACTIVITIES DIFFER BY ZONE, LEVEL OF EFFORT

Manhattan: Major Remediation

- **Streets, sidewalks, and open spaces**: removed and resurfaced
- **Building interiors**: decontaminated using scabbling and strippable coatings
- **Rooftops**: scabbled or stripped of their membranes
- **Building facades**: removed and replaced if possible. Scabbling and/or demolition are last resort.

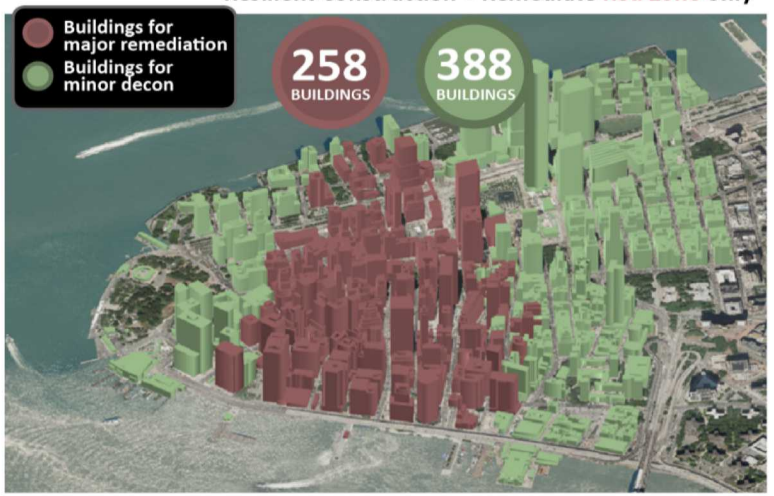
Manhattan: Minor Remediation

- **Interior floors, walls, and ceilings**: decontaminated using strippable coatings

Brooklyn

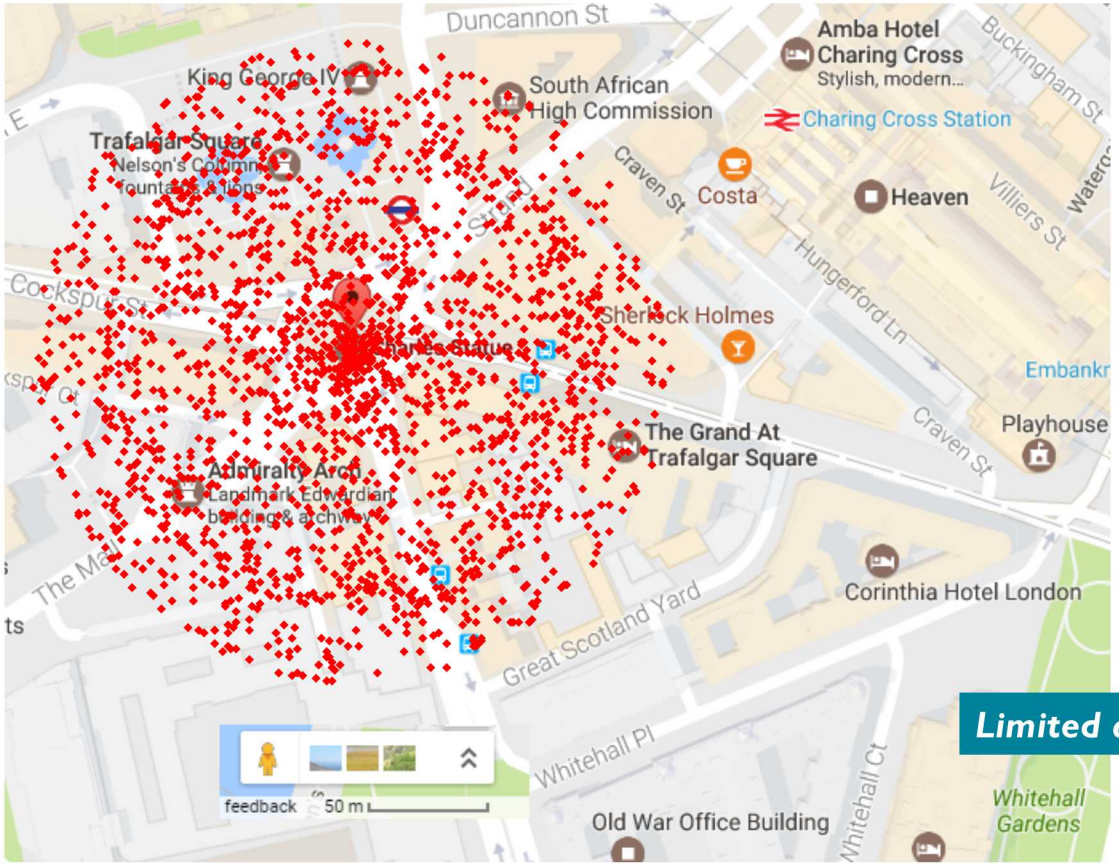
- **Private property**: owners will assume responsibility for cleanup (if any)
- **Public buildings:** interior floors will be decontaminated using strippable coatings

Resilient Construction = Remediate Red Zone only



- **Building-by-building analysis reduces cost and time from one size fits all approach: Façade replacement.**
- **Costs highly dependent on actual decontamination effectiveness.**

SCENARIO:
Co-60 Teletherapy Source



- Pellets Scatter as ballistic projectiles
- ~ 100 m radius
- Embedded pellets, a concern
- Entire ~100 m radius zone is rad-hot
  - > 10 mSv/hr (1 rem/hr)

Limited area denial; injuries from embedded Co-60 pellets.

RETROFIT PLATES
Used to increase delay

SNL with DNDO, GTRI, NRC, SwRI, and manufactures.

Requirements:

- Add delay time to meet increased controls response requirements
- Less than 10% cost of irradiator to install
- Installable and removable by manufacturers
- Regulator approval

Challenges

- Spot welding technology & certification
- Manufacture training and quality control

Coupled with detection & assessment, increases time for local law enforcement to respond.

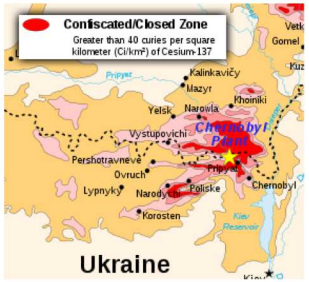
EXPERIENCE WITH Cs-137 CONTAMINATION

Goiania, Brazil Sept. 1987

CsCl teletherapy machine source

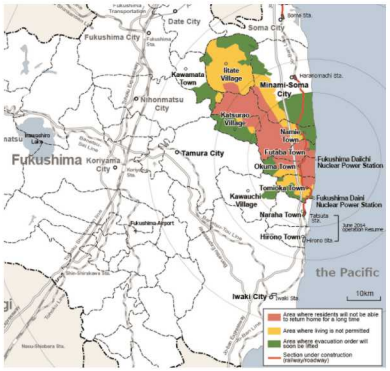
~ 1400 Ci of CsCl, partial release.
Economic Impact
Relocation criterion: 5 mSv/yr
Impact area: uneven over 1 km² Decon.
Goal: ~ 1 mSv/yr (residual)
Pop. Relocated: 200
112,000 People Monitored

Chernobyl, USSR April 1986



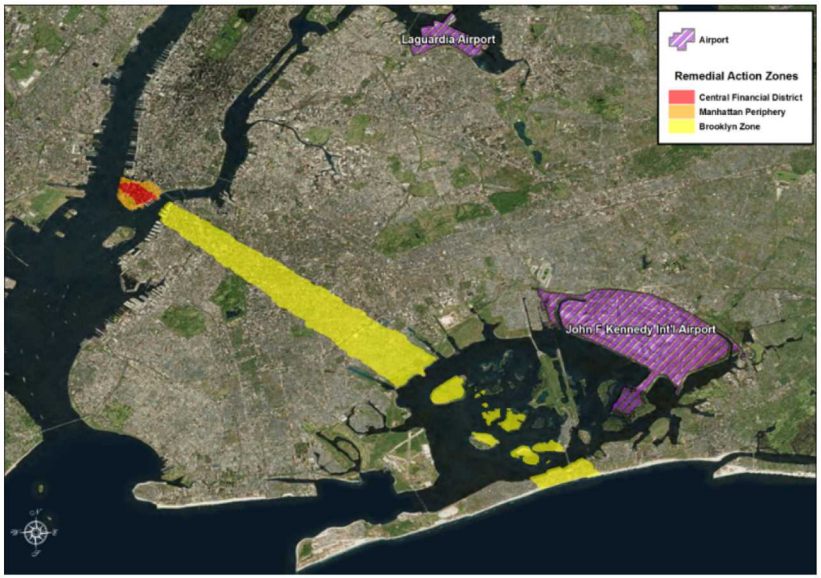
~ 2,000,000 Ci Cs-137 Released
Economic Impact:
Relocation criterion: 40 Ci/km² Cs-137
~ 20 mSv/yr
Impact area: Confiscated zone~3000 km²
Pop. Relocated:~300,000
Decontamination efforts stopped.

Fukushima, Japan March 2011



~ 500,000 Ci, Cs-137 Released
Economic Impact:
Relocation Criterion: 20 mSv/yr
Impact area ~ 1000 km²
Pop. Relocated: ~180,000
Decon. Goal:
20 mSv/yr→10 mSv/yr→1 mSv/yr

THE INSIGHTS ARE AS IMPORTANT AS THE CONSEQUENCE NUMBERS



Cost and human impact:

- Evacuation deaths could be significant.
- Perception and avoidance largest economic impact.
- Modeled low interior contamination levels reduced demolition significantly.

Regional/national effects:

- Regional impacts vary tremendously.
- Multi-year analysis showed recovery possible.
- Limited national effects found in the analysis.

Scenario/analysis factors:

- Wind direction and speed.
- Different city with less redundancy and resilience.
- Other business types that are difficult to relocate.
- Delays in remediation actions.
- Lower contamination action level.

Would the U.S. maintain its world financial standing after an RDD attack in lower Manhattan?