NTI Efforts to Encourage Replacement of Cesium-137 Blood and Research Irradiators with Effective Alternative Technologies

The National Academies of Sciences

Radioactive Sources: Applications and Alternative Technologies Meeting

January 30-31, 2020

Ioanna Iliopulos

NTI

BUILDING A SAFER WORLD

PRESENTATION OUTLINE

- Background
- Models for Action
  - International
  - US
- NTI Report - Recommendations

BUILDING A SAFER WORLD

THE NUCLEAR THREAT INITIATIVE PROTECTS LIVES, THE ENVIRONMENT AND OUR QUALITY OF LIFE NOW AND FOR FUTURE GENERATIONS. Every day, we work to prevent catastrophic attacks with weapons of mass destruction and disruption—nuclear, biological, radiological, chemical and cyber.

NTI
BUILDING A SAFER WORLD

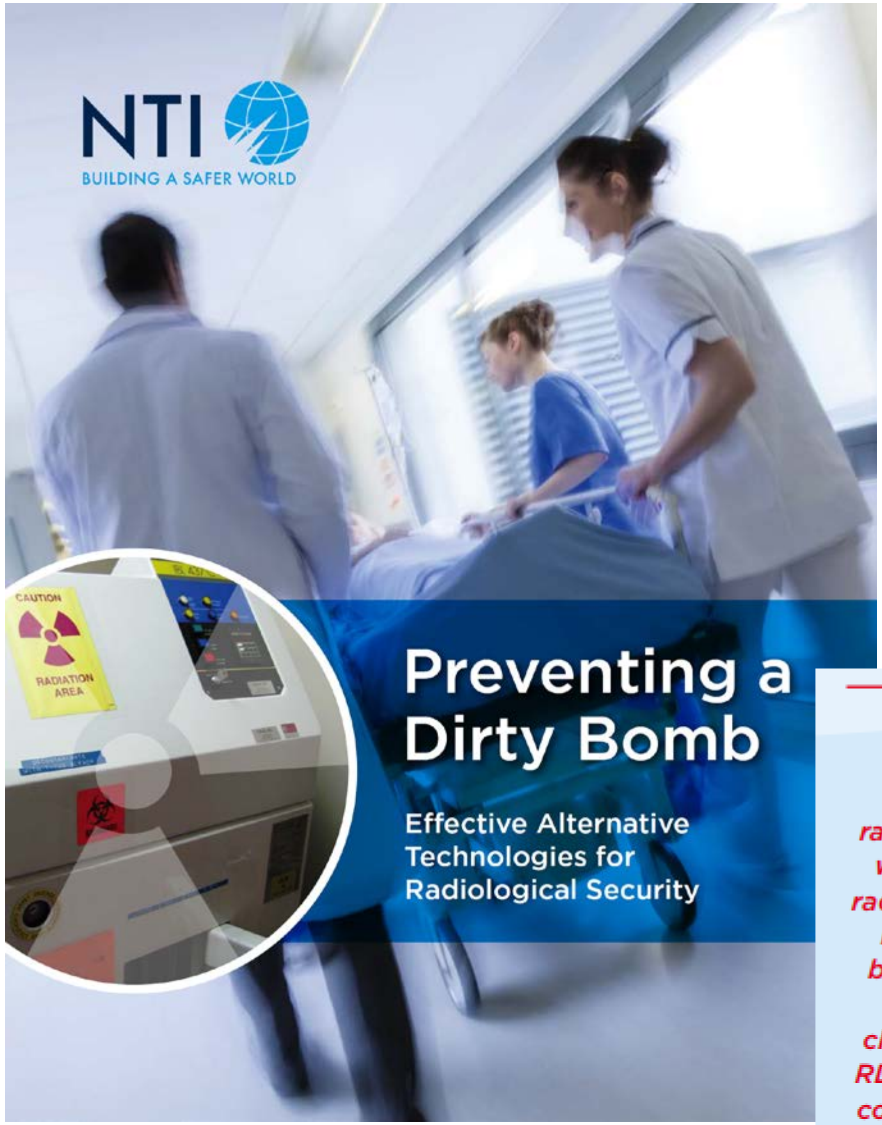
NTI Program Focus – Advocacy for Cesium-137 Substitution

Commercially available: Application	Typical Isotope	Commercially Available Alternatives?
Blood Irradiation	Cs-137	Yes: X-ray—2 FDA approved devices Partial: UV Pathogen Reduction—FDA approval for platelet & plasma systems, ongoing R&D for red blood cell systems
Research Irradiation	Cs-137 Co-60	Partial: X-ray Irradiators for most research applications
External Beam Radiotherapy	Co-60	Yes: Linear Accelerators (LINACs)
Industrial Sterilization	Co-60	Yes: X-Ray, E-beam, LINACs
Well Logging	Am-241 & Cs-137	Incomplete: Am-241 - alternatives available, Cs-137 – ongoing R&D
Radiography	Ir-192	Yes: X-ray

"The Committee recommends that the U.S. government take steps in the near term to replace radioactive cesium chloride radiation sources, a potential "dirty bomb" ingredient used in some medical and research equipment, with lower risk alternatives."

International Models for Action: A Range of Approaches

- Norway
- Japan
- France

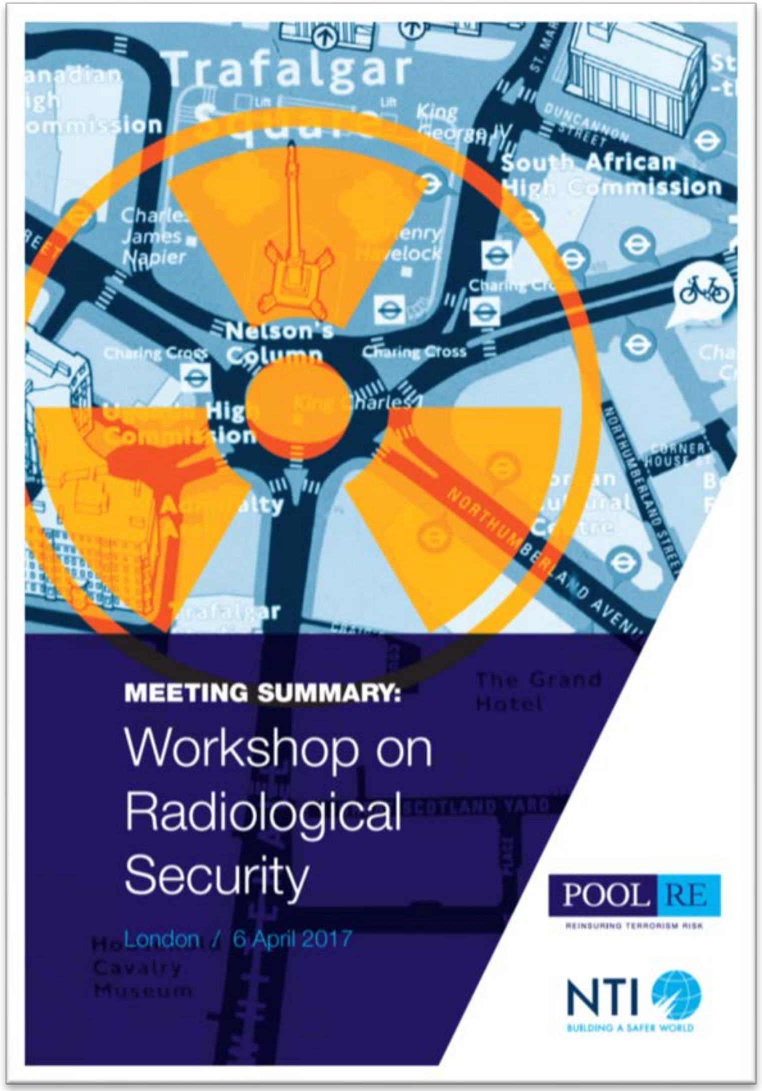


"In order for us to construct and detonate a radiological bomb, we must acquire radioactive material by stealing it or buying it through legal or illegal channels. Possible RDD material could come from millions of radioactive sources used worldwide…"

- from the terrorist manifesto

NTI
BUILDING A SAFER WORLD

International Models for Action: Liability Driven Replacements



- Pool Re and NTI hosted a joint conference in London (April 2017)
- Pool Re currently underwrites more than £2 trillion of exposure in commercial property to terrorism risk across the UK mainland – including chemical, biological, **radiological** and nuclear (CBRN).
- Awareness raising led to U.K.'s internal discussions (via Home Office) to evaluate replacing all cesium-137 irradiators.

NTI
BUILDING A SAFER WORLD

International Models for Action:
2020 NTI Radiological Security Index Assessment

NTI
BUILDING A SAFER WORLD

METHODOLOGY

National Measures: National measures in place to manage and secure radioactive sources.

Global Norms: A country's international commitments and support for global norms around radioactive source sources.

Alternative Technologies: The country's capacity for introducing alternative technologies.

Risk Environment: The risk environment and its potential effect on the security of radioactive sources

Goals of the NTI Radiological Security Index

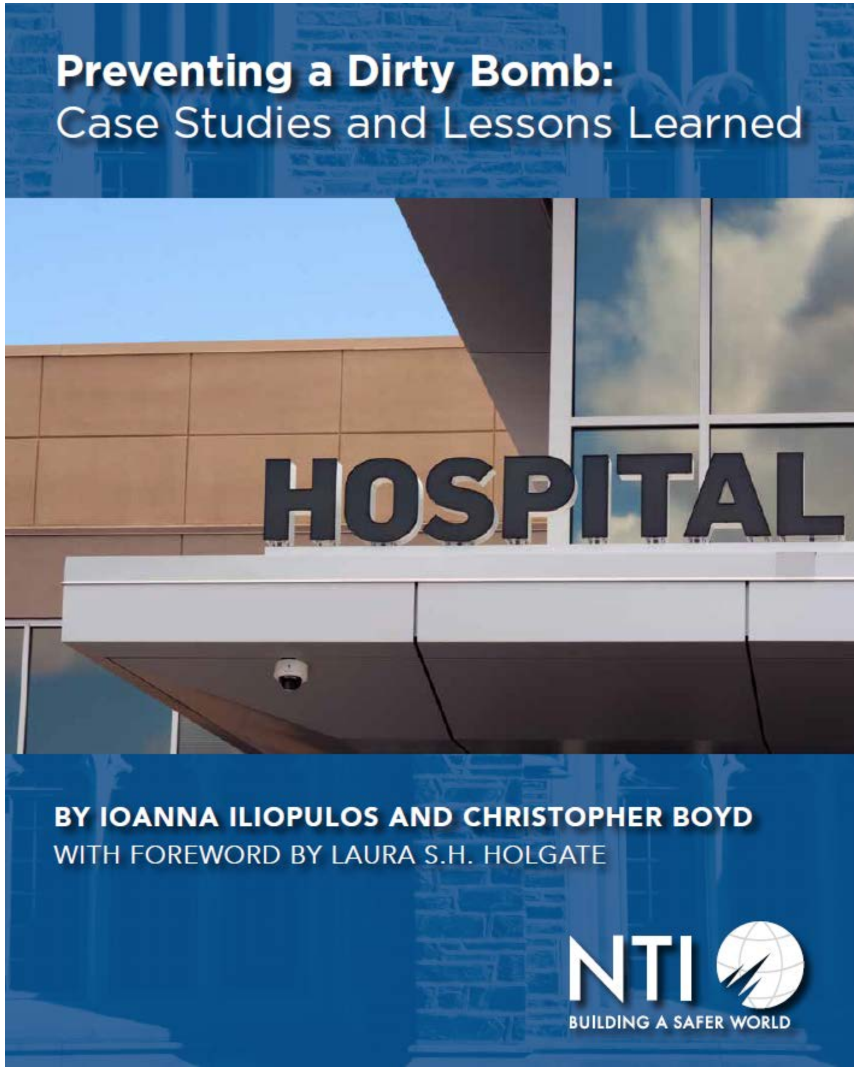
Assessment of national policies, commitments, and actions governing radioactive sources to:

- Build awareness of importance of radiological security
- Catalyze a dialogue about priorities
- Promote progress in securing radioactive sources and promoting alternative technologies
- Highlight leading practices in radiological security
- Set baseline understanding of global radiological architecture
- Promote reporting, information sharing, and benchmarking

NTI
BUILDING A SAFER WORLD

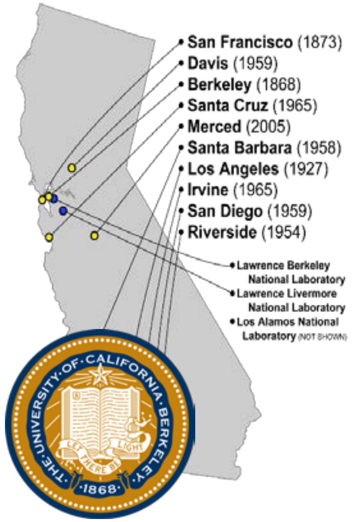
US Models for Action

Report: Preventing a Dirty Bomb: Case Studies and Lessons Learned



Major Urban City - NYC

State-Wide University -UC

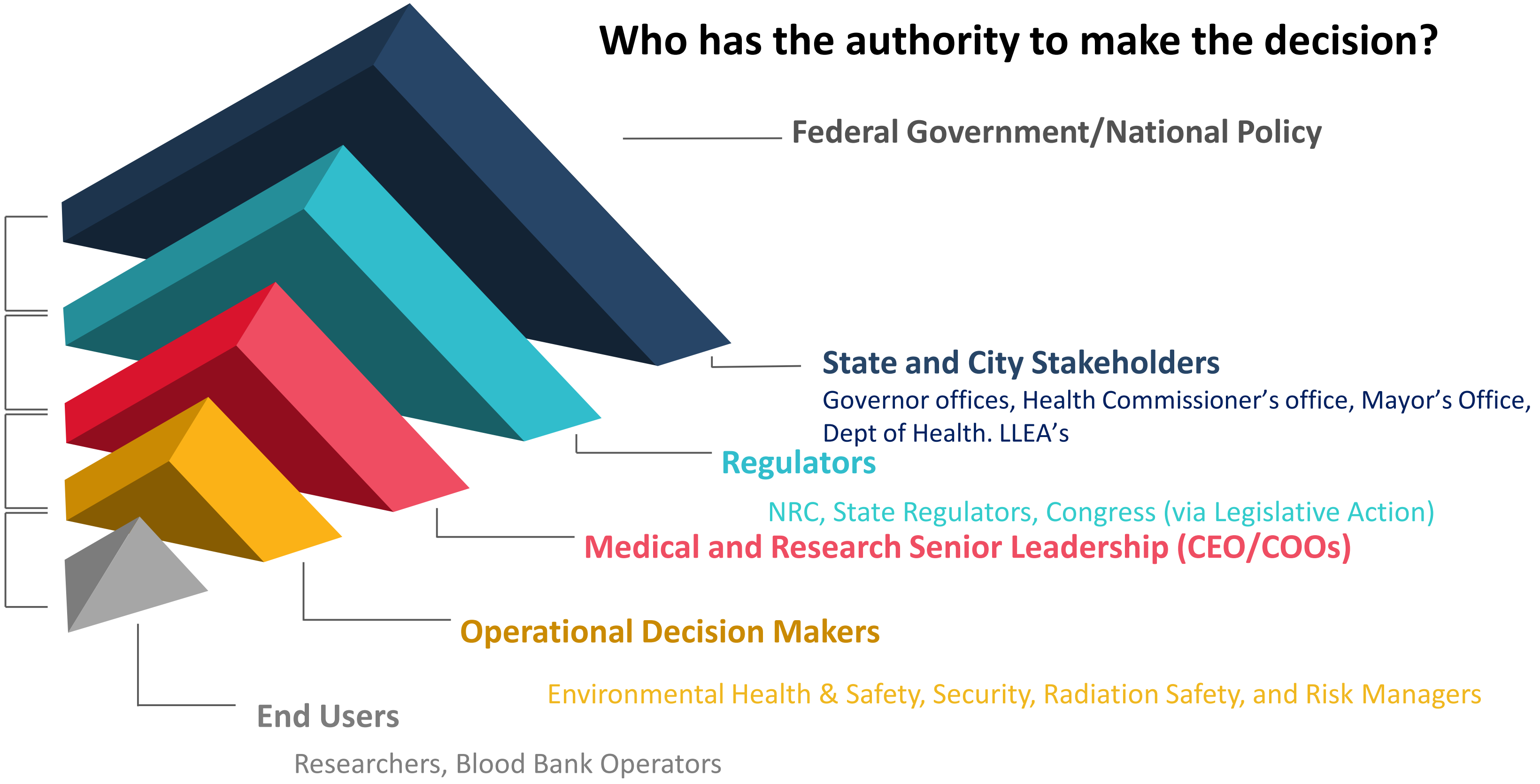


Medical Institution – Emory University

EMORY UNIVERSITY

NTI BUILDING A SAFER WORLD

1. Identify Local Advocates and Build Support Networks



NTI
BUILDING A SAFER WORLD

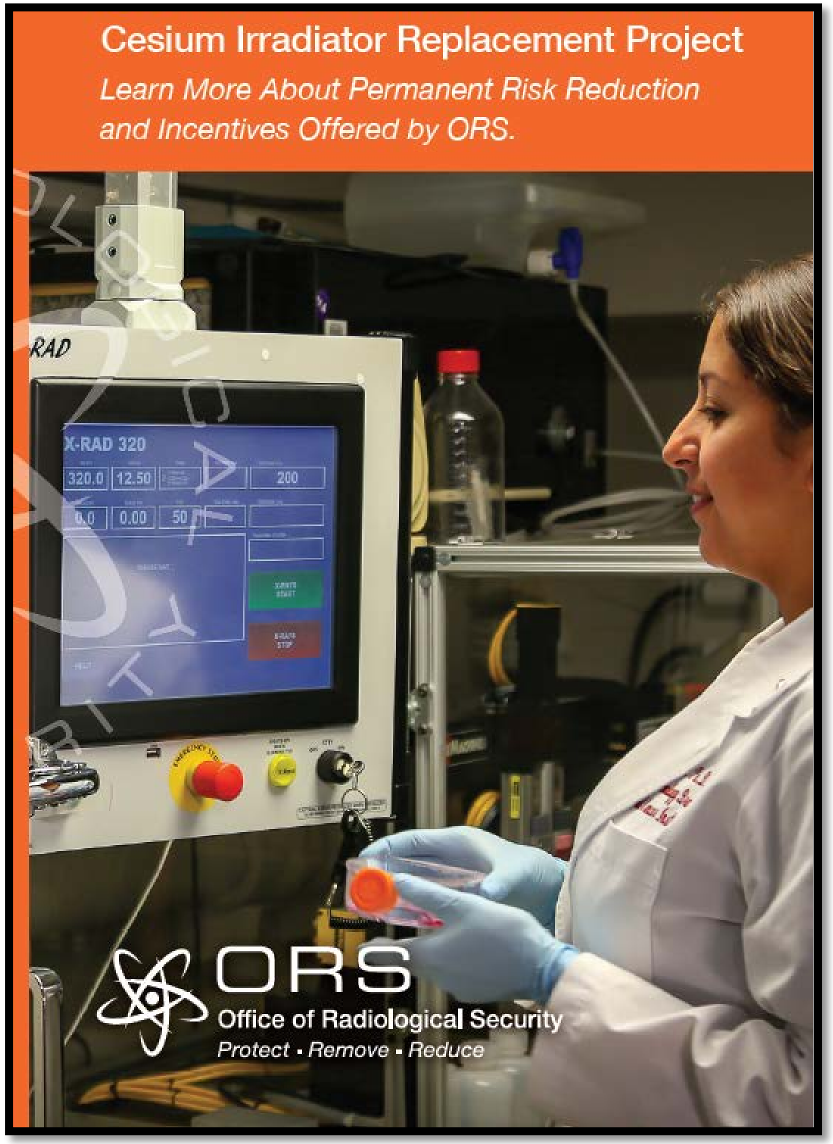
2. Seek Consensus Among Stakeholders

- Management
- Administrators
- Researchers
- Faculty
- Medical professionals

NTI
BUILDING A SAFER WORLD

3. Identify Funding and Support at the Institutional and Federal Level

- Commitments to implement a successful transition required securing funding at the institutional and federal levels.
- KEY INCENTIVE for facilities to participate.



BUILDING A SAFER WORLD

4. Compare Cradle to Grave Costs

COST AND LIABILITY ESTIMATES

Learn about irradiator lifecycle costs and liability, and estimate the lifecycle costs of your irradiator using our worksheet

LEARN MORE

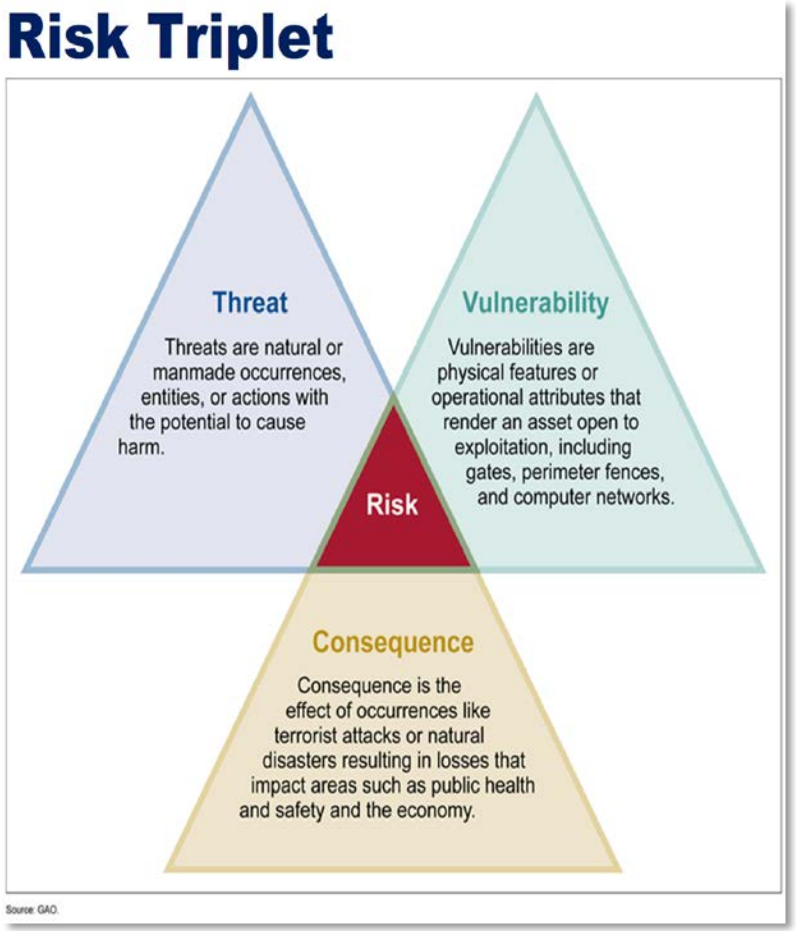
Irradiator Replacement Costs Estimate Worksheet Template

	Cesium-137 Irradiator	X-Ray Irradiator
Fixed Costs		
Cost of Purchase		
Cost of Licensing and Registration		
Cost of Facility Modifications		
Cost of Regulatory Compliance		
Cost of Termination		
Other Costs?		
Annual Costs		
Cost of Regulatory Compliance (Security Program)		
Annual Operating Cost (Utilities)		
Annual Maintenance Cost (Service Contracts)		
Annual Training Cost for Operators		
Annual Physical Security Cost		
Annual Insurance Cost		
Other Costs?		
Sum of Annual Costs		
Sum of Annual Cost Multiplied by Lifespan		
FULL LIFECYCLE COSTS OF OWNING AND OPERATING THE DEVICE		

NTI
BUILDING A SAFER WORLD

5. Communicate Benefits of Cesium-137 Irradiator Replacements

NTI BUILDING A SAFER WORLD



1. Protection of Public Health, Safety and Security
2. Elimination of Terrorism Risk and Potential Liability
3. Elimination of Costly Physical Protection and Procedural Requirements (10 CFR, Part 37) and Vulnerabilities
4. Elimination of Costly Disposition (GTCC) at End-of-Life
5. Elimination of Source Decay and Performance
6. Enhanced Capabilities from X-ray Alternatives (Automated Dosimetry and Imaging)

6. Improve the Dissemination of Information

- Educate stakeholders
- Peer-to-peer outreach
- Comparative Studies
- NTI website: www.nti.org/cesium137

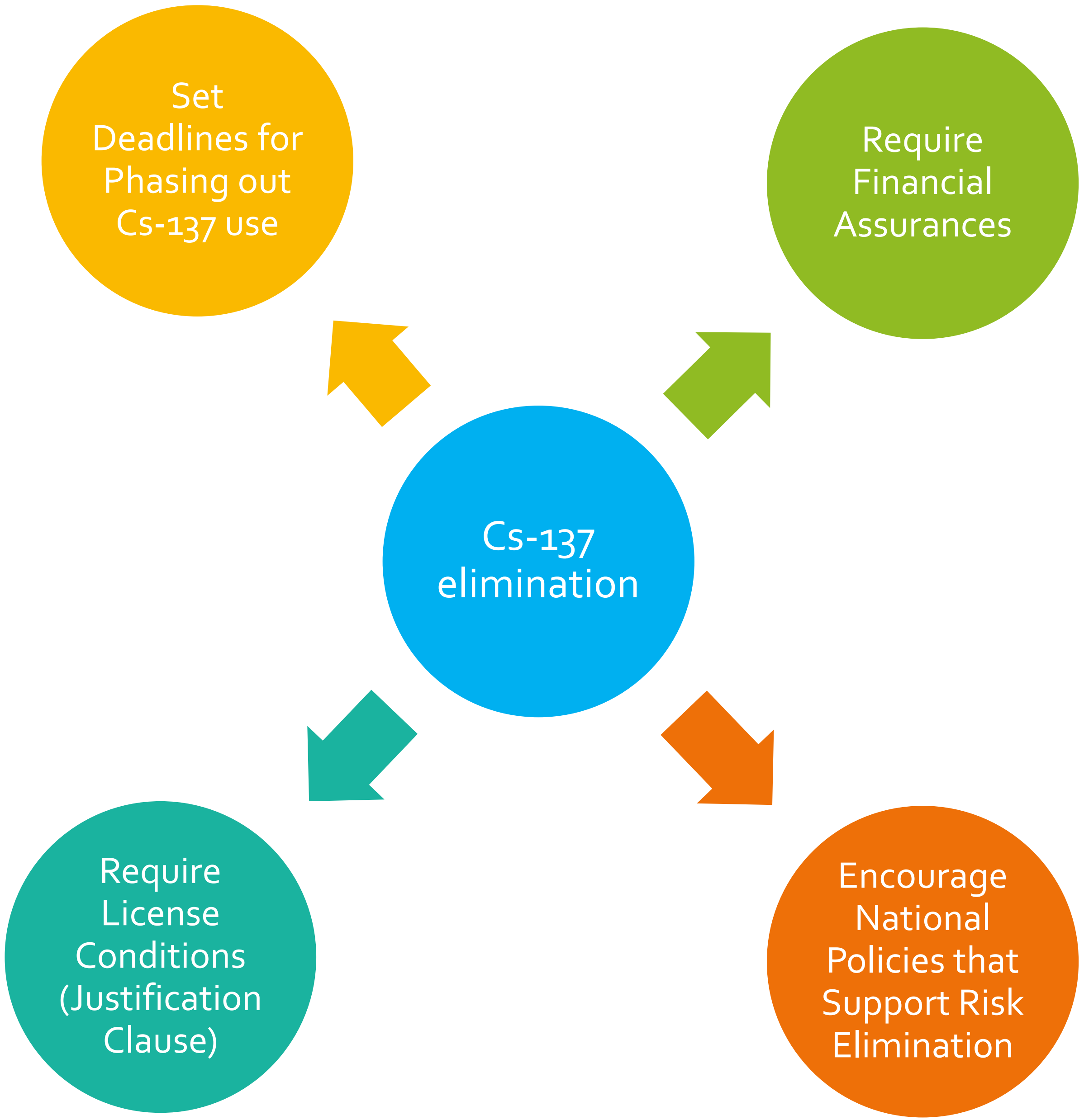
NTI
BUILDING A SAFER WORLD

Overcoming Technical Challenges

	X-ray	Cesium-137
Relative Biological Effectiveness (RBE)	There is a wide variation in RBE values in the literature for x-rays as compared with cesium-137. X-rays are more effective than cesium-137 gamma rays, suggesting that lower doses will be required to achieve the same biological endpoint.	There are fewer variations in the RBE values in literature for cesium-137.
Machine-to-Machine Variation	X-ray irradiators produce different energies and spectra due to variations in x-ray tubes, energy settings, and filtration. While this allows for greater precision in calibration, it also requires more detailed reporting when comparing results from different x-ray machines.	With the single gamma-ray energy, cesium-137 devices yield less variation than x-ray machines.
Effectiveness	X-ray is generally better than cesium-137 for collimation, e.g., for partial body exposures, since it is easy to precisely collimate the x-ray point source with thin sheets of lead. X-ray offers advanced features and imaging that may be needed for some experiments.	Cesium-137 requires thicker collimation and casts a broad penumbra from the extended line source.
Conversion Factors	Each experiment needs to be individually calibrated when converting from cesium-137 irradiators to x-ray irradiators. Conversion factors depend on multiple inputs, including x-ray peak energy, x-ray energy spectrum (filtration), distance of the specimen from the source, field size, and biological system, among others.	Cesium-137 irradiator outputs (energy, dose distributions) are less variable than those of x-rays.

NTI
BUILDING A SAFER WORLD

7. Encourage Regulatory Changes for Cesium-137 Users to Accelerate and Standardize Permanent Risk Reduction



We Don’t Do This Alone

- Federal (e.g., DOE Office of Radiological Security, NAS, GAO, DOS, DHS, NRC)
- State and local champions
- Public-private partnerships (universities and hospitals)
- Insurance industry (Pool Re)
- Other governments
- IAEA

NTI
BUILDING A SAFER WORLD

Thank you!

Contact Information

Laura Holgate, Vice President

Jessica Bufford, Program Officer

Ioanna Iliopulos, Senior Consultant

Materials Risk Management

Nuclear Threat Initiative

1776 Eye Street NW, Suite 600
Washington, DC 20006
Tel: + 1 (202) 454-7741

www.nti.org/about/radiological/

https://www.nti.org/analysis/reports/preventing-dirty-bomb-case-studies-and-lessons-learned/

Follow: @NTI_WMD

NTI BUILDING A SAFER WORLD