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Sealed Source Management and Disposal

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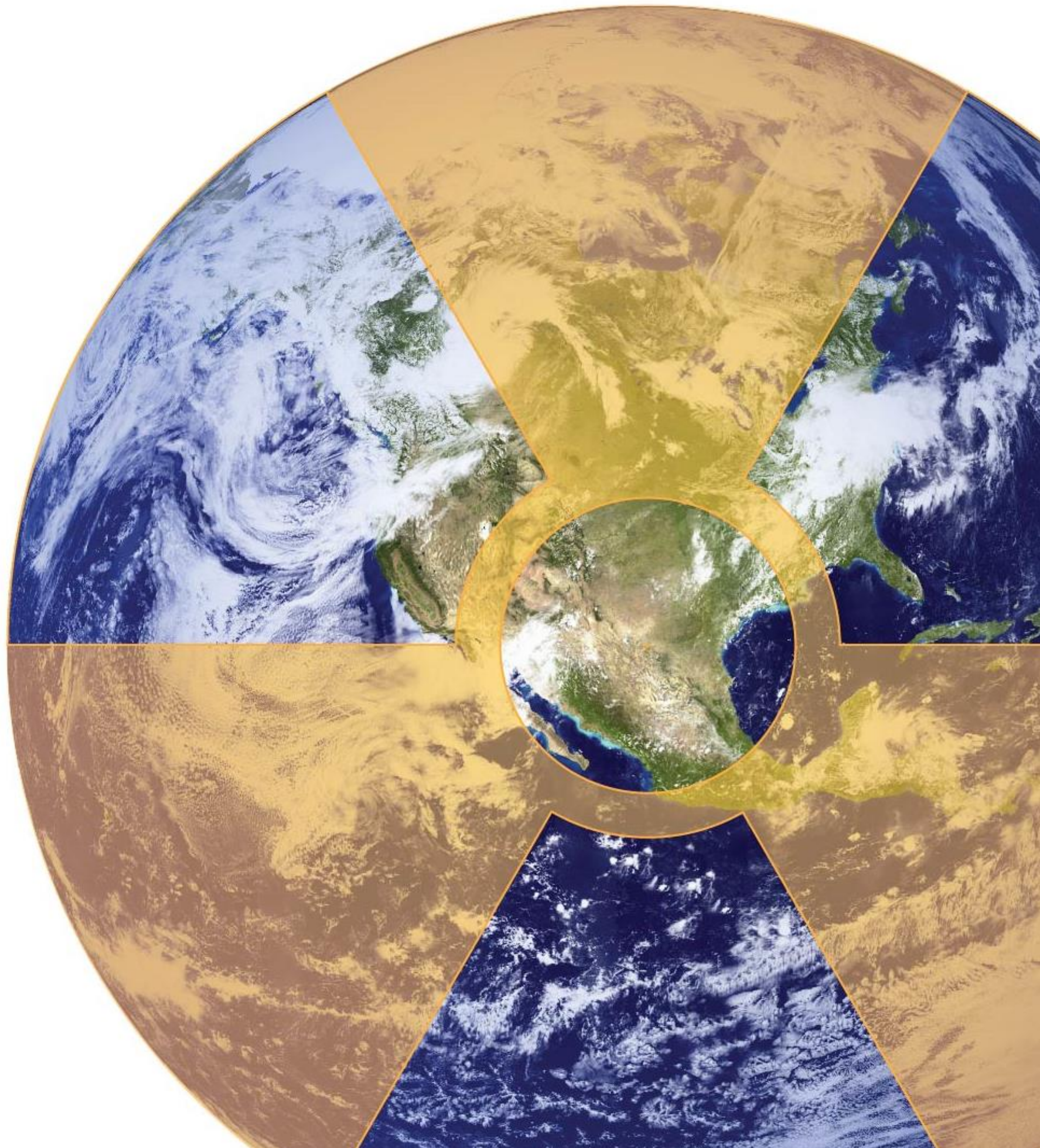

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Radioactive Materials and RDDs

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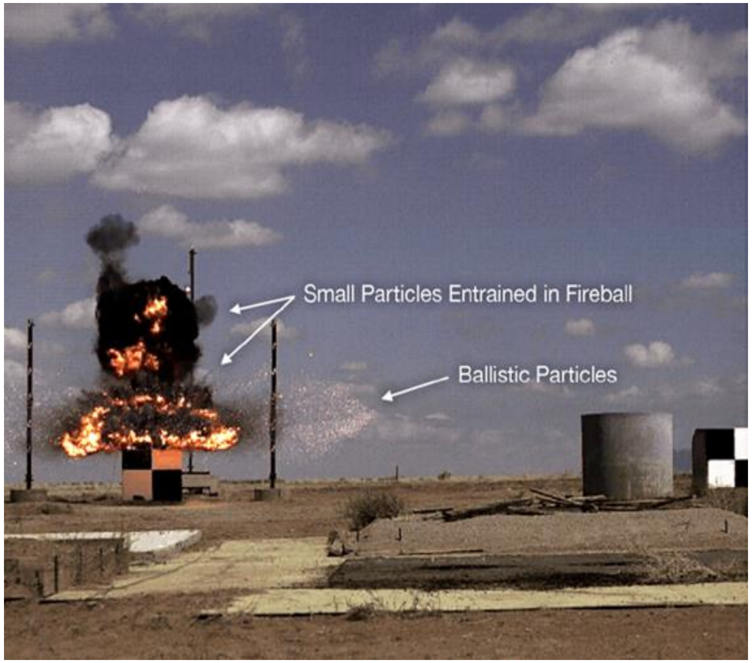
Radioactive Materials and RDDs



- Sept 11 attacks ⟶ increased concern regarding misuse of common sealed sources
- RDD threat in changed security environment
- Result: more sophisticated modeling of the potential consequences of an attack
    - Health and safety impacts
    - Economic consequences
    - Different radionuclides under different environmental conditions
- Terrorist groups continue actively to seek nuclear and radiological materials and the expertise needed to weaponize them
- Increasing concern regarding homegrown extremists – “lone-wolf” attacks and insider threats

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Regional Radiological Incidents

Stolen Cs-137 (North Carolina, 1998) - 19 vials of Cesium-137 were stolen from a locked safe at a Greensboro, NC hospital during the NCAA basketball tournament hosted in Greensboro. The vials were never recovered and insider involvement was likely.

Truck with Co-60 Hijacked (Mexico, 2013) - A vehicle carrying a disused 3,000 Co-60 teletherapy source was hijacked during transit to a disposal site

Dhiren Barot (UK, 2006) - Arrested in the U.K. and admitted to performing reconnaissance of American targets for Al-Qaeda. Plotted to blow up the NY Stock Exchange with a “dirty bomb”.

Unauthorized Access to GammaKnife Room (Pittsburgh, 2006) - Egyptian national, on a student visa and possessing a large industrial screwdriver, was found after hours in a hospital room housing a large gamma knife machine containing hundreds of Co-60 sources. Scratch marks were left on the back of the machine.

Cs-137 Source Stolen for Extortion Purposes (Argentina, 2009) - Two armed men entered the Baker Atlas drilling equipment storage facility and took a container containing Cs-137 sources used for oil well logging for extortion

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RDD Cost Assessments in Context

- Open-source RDD cost assessments suggest a variety of post-event costs and challenges
- Economic impact of a ‘significant RDD’ – potentially in billions of dollars
  - ‘Significant RDD’ definition from DHS/EPA Protective Action Guide (PAG)
  - 1 km^2 contamination resulting in 2 rem/yr first year and 500 mrem/yr in subsequent years
- Event recovery challenges will vary substantially depending on the location:
  - Population center vs. economic infrastructure = different cost types and policy challenges

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RDD Cost Considerations

Two independent studies of RDD attacks on the ports of Los Angeles and Long Beach:

“economic consequences . . . losses in the tens of billions of dollars, including the decontamination costs, and the indirect economic impacts due to the port shutdown.”

(A Risk and Economic Analysis of Dirty Bomb Attacks on the Ports of Los Angeles and Long Beach. H. Rosoff and D. von Winterfeldt. Society of Risk Analysis (2007)).

“$36.4B in losses for one month on export-import losses and $3.3B in indirect impacts.”

(JiYoung Park, The Economic Impact of Dirty Bomb Attacks on the Los Angeles and Long Beach Ports: Applying the Supply-Driven NIEMO (National Interstate Economic Model), Journal of Homeland Security Emergency Management (2008).

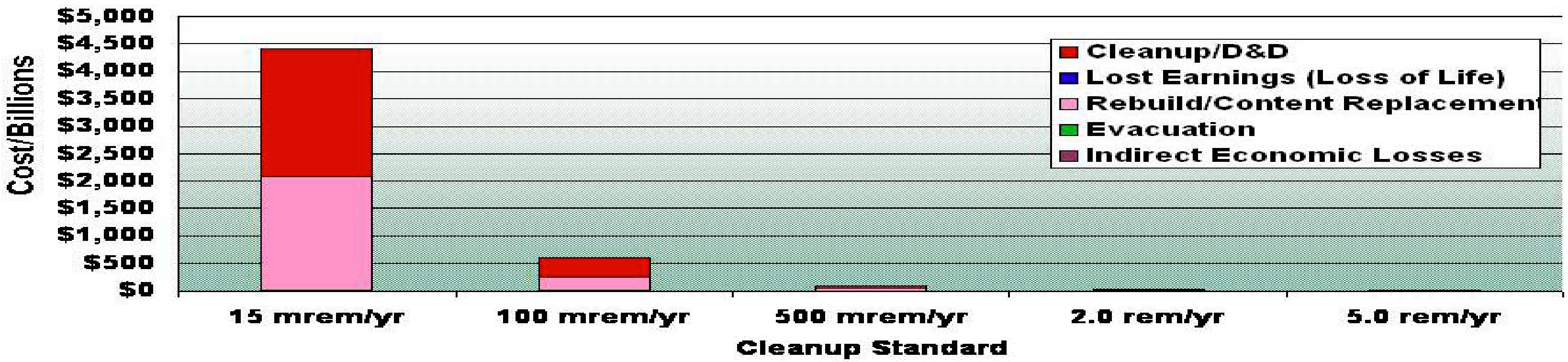
- Costs typically considered in RDD economic impact analyses include:
  - Emergency response
  - Evacuation and/or relocation
  - Infrastructure decontamination or demolition/replacement
  - Agriculture impacts
  - Lost business revenues during remediation (i.e., near-term)

- Costs less often considered in impact analyses include:
  - Commercial waste disposal costs and challenges
  - Medical services for the “worried well”
  - Psychological impacts
  - Trade restrictions
  - Long-term business impacts

Post-Event Policy Considerations

Policy/legal uncertainties could contribute to a challenging/costly post-event environment:

- Public communications – effectively sharing radiation and radiation protection information to mitigate costly "panic responses"
- Decontamination standards – what levels would an affected community require?
- Waste management challenges – waste transportation and disposal capacity and costs for large scale remediation
- Cost-recovery and liability determination – how will the costs be allocated? Who pays?



10-kCi Cs-137 Detonation in New York City

Source: Reichmuth, Barbara, et al. *Economic Consequences of a Rad/Nuc Attack: Cleanup Standards Significantly Affect Cost*, Richland, WA: Pacific Northwest National Laboratories, PNNL-SA-45256, 2005, Figure 9.

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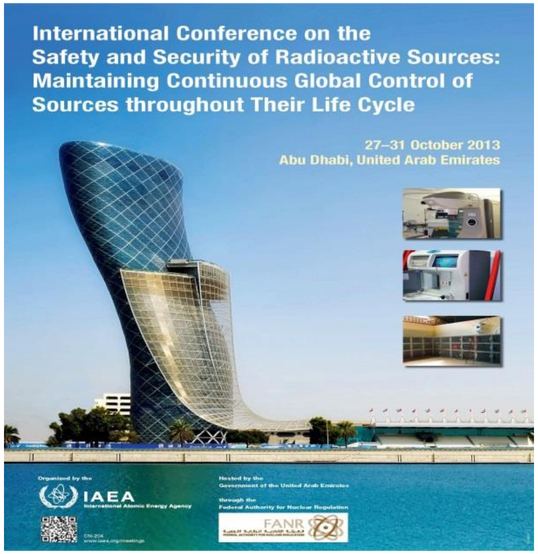
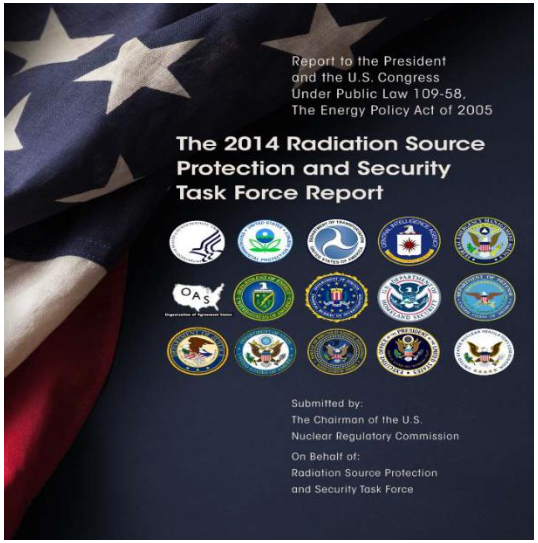
Sealed Sources and Liability – 'Who Pays?'

- 2013 – IAEA Code of Conduct meeting in Abu Dhabi
  - Concerns raised regarding liabilities related to misuse of sources
  - International nuclear liability conventions do not cover sealed sources



- 2014 – Report of the U.S. Federal interagency Radiation Source Protection and Security Task Force (Task Force) addressed the challenge:

"For licensees to make informed decisions on the management and use of sealed sources, information on the potential liabilities must be as clear as possible."



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Radiological Source Security and the ORS Lifecycle Approach

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The risk of malicious use of radiological material requires action

ORS works with partners to enhance security by preventing high-activity radioactive materials from being used in acts of terrorism.

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Radioactive Materials of Greatest Concern

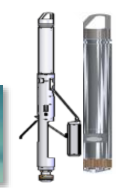
- IAEA and USG independent assessments ⟶ 15 radionuclides used commercially in quantities large enough to create a significant RDD
- Approximately 99% of the risk significant sources used commercially in the U.S. are Am-241, Cs-137, Co-60, or Ir-192

Radionuclide	Category 2 Threshold (Ci)
Am-241	16
Am-241/Be	16
Cf-252	5
Cm-244	14
Co-60	8
Cs-137	27
Gd-153	270
Ir-192	22
Pm-147	11,000
Pu-238	16
Pu-239/Be	16
Ra-226	11
Se-75	54
Sr-90	270
Tm-170	5,400
Yb-169	81

Radionuclide	Threshold to Contaminate 1 km^2 (Ci)	Normal Device Activity (Ci)
Co-60	11	1,000 – 1,000,000+
Am-241	78	8 – 20
Ir-192	100	10 - 100
Cs-137	42	1,000 – 50,000

Ir-192:
Radiography (industrial imaging)

Am-241:
Oil well logging (industrial imaging)



Co-60:
Teletherapy and Gamma Knife units (cancer treatment), self-shielded and panoramic irradiators (research and sterilization)

Cs-137:
Self-shielded irradiators (research and sterilization), brachytherapy (cancer treatment), and calibrators (dosimeter and detector calibration)

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ORS Lifecycle Approach

- In January 2015, the Global Threat Reduction Initiative (GTRI) became the Office of Radiological Security (ORS) within the new DOE/NNSA Office of Global Material Security

Mission: The Office of Radiological Security enhances global security by preventing high activity radioactive materials from use in acts of terrorism.

- ORS strategic approach:
  - PROTECT radioactive sources used for vital medical, research, and commercial purposes
  - REMOVE and dispose of disused radioactive sources
  - REDUCE the global reliance on radioactive sources through replacement with viable non-isotopic alternative technologies

ORS Holistic Approach to Sealed Source Security

Source manufacture

- **PROTECT:** Collaborate with manufacturer to install security by device design

Transportation, use, and storage

- **PROTECT:** Facility , mobile source, and transportation security enhancements , as well as alarm response training, help to ensure the protection of material before, during, and after use

End of life management and replacement

- **REMOVE:** Permanent disposal each year of thousands of disused and unwanted sealed sources through ORS/OSRP and CRCPD/SCATR
- **REDUCE:** Support for the development and use of alternative, non-isotopic technologies leads to permanent threat reduction

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Protect: Containment Strategy

DETECT
Prompt Detection and Reliable Notification

Next Generation Integrated Remote Monitoring System (Sentry RMS): *Fully networked, hardened, and encrypted security monitor*

Multi-Factor Access Control: *Requires combination of card, pin, or biometric scan for entry*

DELAY
Extended Adversary Task Time

Hardened Doors

Facility Hardening

RESPOND
Timely, Aware, Equipped and Trained Response

Centralized Monitoring Stations

Personal Radiation Detectors (PRDs) (Domestic only)

TRAIN
Security and Response Training

Alarm Response Training . Response Planning PRD Training, Tabletop Exercises

Security Planning, Performance Testing, Regulatory Development

ORS Containment Strategy

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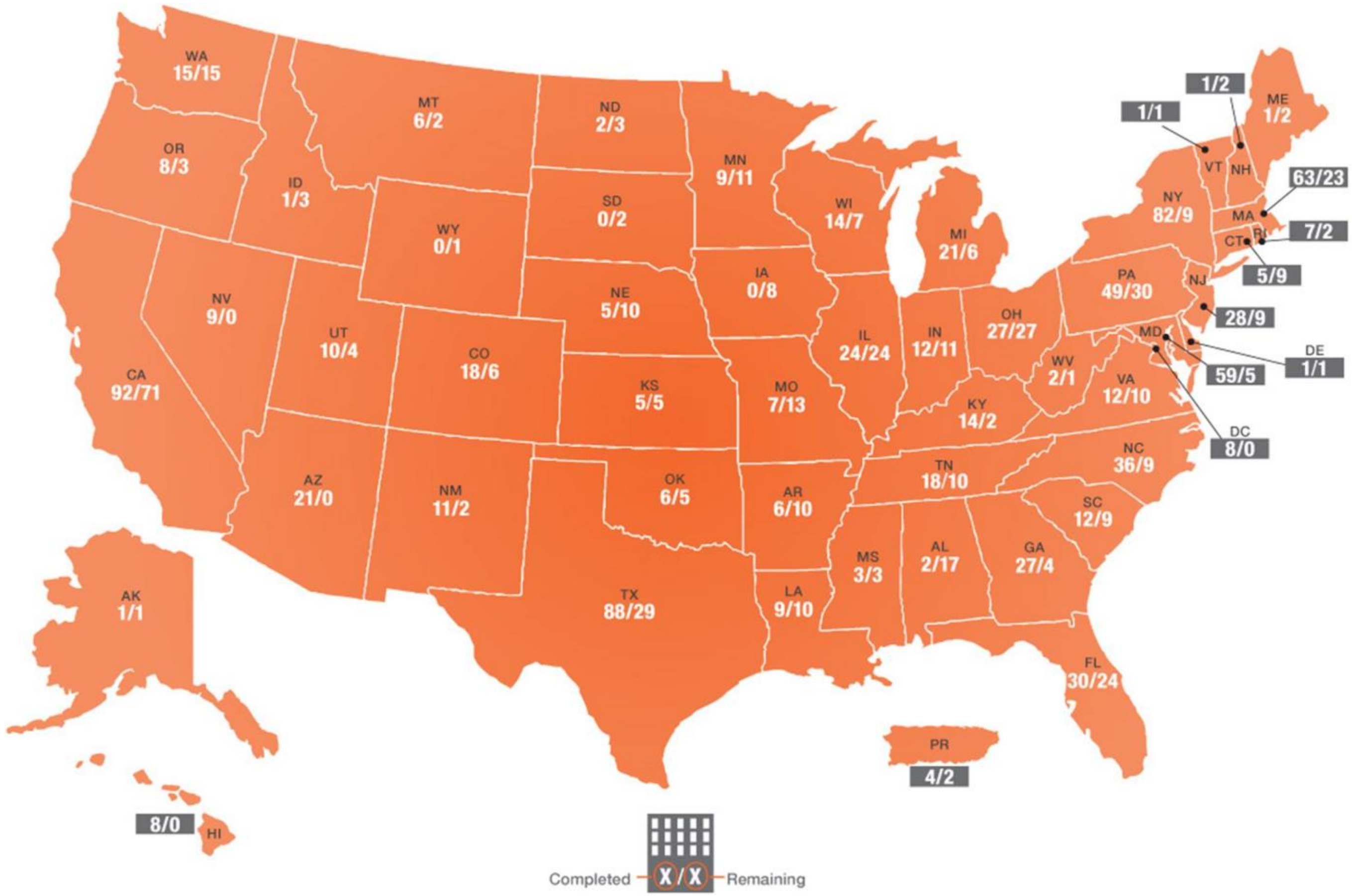

Protecting Radiological Material in the United States

ORS Plans to complete security upgrades for all high-activity radioactive sources in the U.S. These sources are in all 50 states.

Accomplishments to Date

- Secured 900 buildings out of 1,372 buildings (65%) that have the highest priority materials (cesium-137 and cobalt-60) in universities, hospitals, and businesses across the U.S. (as shown on map).
- Secured 75% of all cesium-137 buildings (667 out of 896), which make up the highest priority buildings.
- Launched a pilot project for well-logging and radiography device security as part of the Mobile Source Transit Security Initiative. There are over 1,000 well-logging and radiography buildings in the U.S.

Future Plans

- Complete all cesium buildings by 2020.
- Rollout security enhancements for well-logging and radiography devices nationwide.
- Complete all security enhancements in the U.S. by 2029.

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Reduce: Alternative Technologies

Initiative seeks to convert and replace radiological devices with non-isotopic devices and achieve **permanent threat reduction** by reducing or eliminating risk-significant radioactive materials

Cesium Irradiator Replacement Project

A pilot project to offer incentives to replace cesium irradiators with alternative technologies

Non-radioactive x-ray devices pose no RDD risk; no federally funded security enhancements are required. Do not need to be disposed of as low level or greater- than-class C (GTCC) waste.

Cobalt Teletherapy Replacements

NNSA, in coordination with the State Department, funded the shipment of a used medical LINAC to Ukraine. We are working with global partners to develop options for expansion of Cobalt teletherapy replacements

Linear Accelerator is an alternative to Cobalt Teletherapy

Research and Development

RSP Collaboration with the Office of Nonproliferation Research and Development (NA-22) to analyze and prioritize R&D requirements for improvement or development of non-isotopic replacements to make alternative technologies more attractive to industry.

NNSA is funding R&D *grants to U.S. small businesses and national laboratories to explore using x-rays for industrial sterilization, flat panel x-rays for blood, and low-cost, micro-linacs for radiography, and various options for well-logging.*

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Consultations available to sites interested in replacing their existing high-activity source with non-isotopic alternatives

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Reduce: Alternative Technologies

Reduce initiative seeks to convert and replace radiological devices with non-radioactive source-based devices, where feasible, and achieve permanent risk reduction by reducing the footprint of risk-significant radiological materials

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

Commercially available, non-isotopic alternatives exist for most major applications of high activity radioactive materials.

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Remove: Recovery and Disposal of Disused and Unwanted Sealed Sources

- ORS facilitates the recovery and disposition of disused and unwanted sources in the interest of National security, public health, and safety
- ORS/Off-Site Source Recovery Project (OSRP)
  - Recovery and disposition of high-activity sources and devices
  - Administered by the Los Alamos National Laboratory (LANL) and Idaho National Laboratory (INL)
  - Recoveries prioritized according to a threat reduction methodology developed in coordination with the NRC
- Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) Program
  - Recovery and commercial disposition of disused sealed sources
  - Funded by DOE/NNSA
  - Technical assistance and cost-share support to small generators

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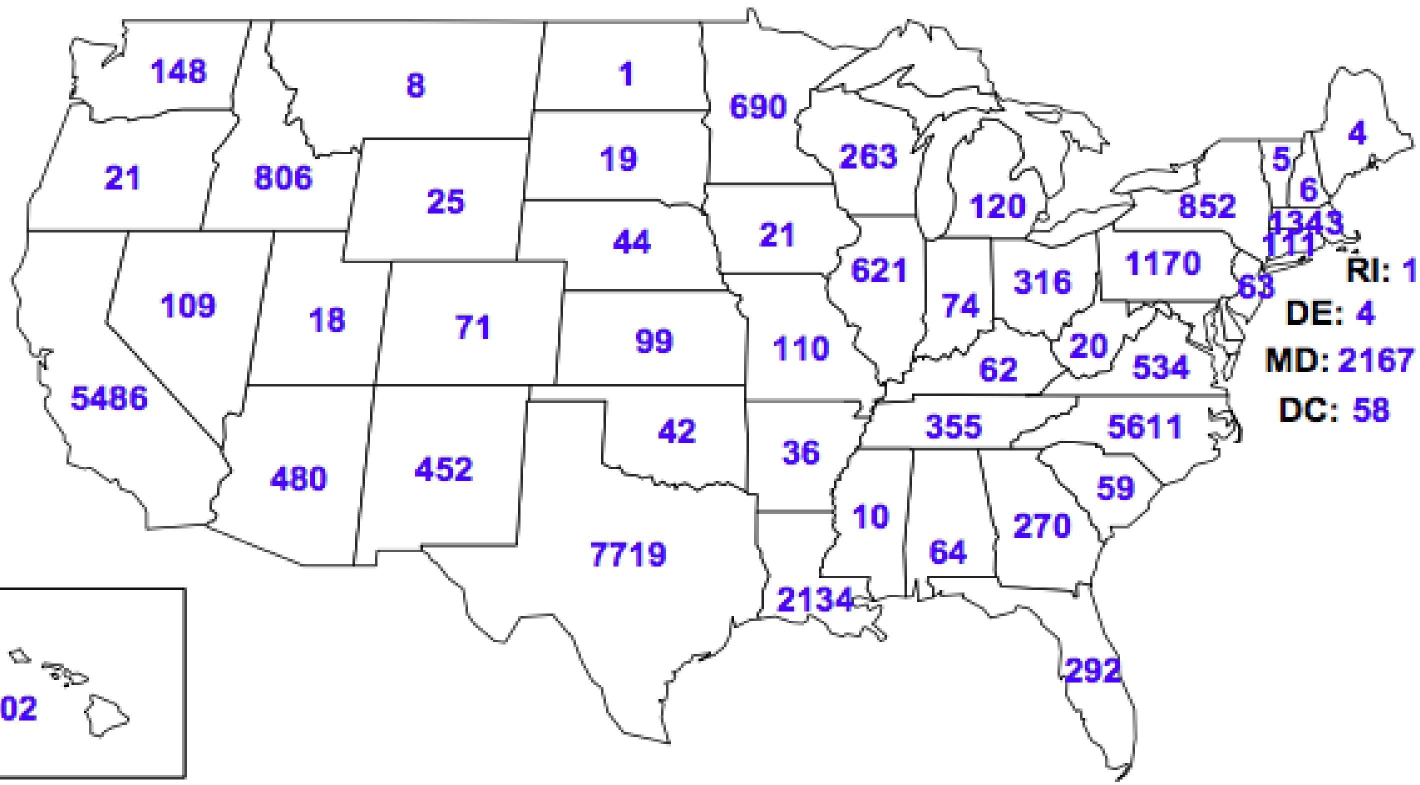
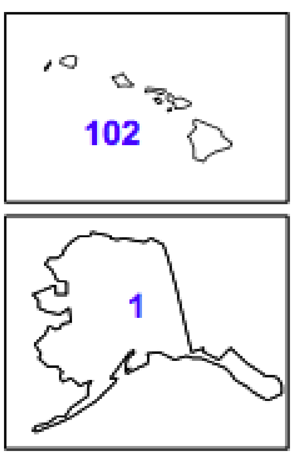
Registration of sources for both SCATR & OSRP located at:
http://osrp.lanl.gov/PickUpSources.aspx

Off-Site Source Recovery Project

OSRP Recoveries to Date





Total U.S. Sources: 33,099 (1,076,257 Ci)

Total International Sources: 2,909 (63,802 Ci)

As of March 9, 2016

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Questions?

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