PREVENTING A DIRTY BOMB.
Case Studies and Lessons Learned

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Abstract

Today, tens of thousands of high activity radioactive sources are used in over 100 countries. They are used in medicine, industry, agriculture, academic, and government facilities for a variety of beneficial purposes. Many of these sources are poorly secured, vulnerable to mishandling or even theft by terrorist organizations seeking the materials needed for a radiological dispersal device (RDD), often referred to as a "dirty bomb." Cesium-137 is of particular concern, as it the most dangerous radioactive material that can be used in a (RDD). The economic impact of a Cesium-137 bomb explosion could be in the order of tens of billions of dollars.

The purpose of this paper is threefold. First, we propose a shift in paradigm, from a security perspective geared towards risk reduction to a public health approach invested in risk elimination. We are currently at a moment where new technologies can safely and effectively replace many Cesium-137 devices with equal or even improved outcomes. This is certainly the case with blood irradiation devices, where the consensus on the benefits of x-ray irradiators have led several countries to eliminate their use and others to prioritize their replacement. The marketplace in many countries has already seen the uncoordinated and voluntary replacement of Cesium-137 for blood irradiation. Similarly, there is growing consensus that x-ray devices can meet and exceed medical and research goals of Cesium-137 devices for a wide range of uses. The paper will provide a brief overview of the current state of efforts that aim at eliminating the use of Cesium-137 irradiators for blood sterilization and research, including interviews with blood bank operators and research scientists who have adopted the new technologies successfully in their programs.

Second, in the absence of regulatory requirements, this paper will propose a model for achieving voluntary permanent threat reduction at institutions within major urban areas. The paper will highlight factors that encourage voluntary replacement of Cesium-137 devices, identify key roles played by regulators and decision makers at different levels of government in implementing Cesium-137 substitution strategies. The paper will highlight the incentives, challenges, and information gaps that shape decisions to adopt a public health paradigm for managing the inherent risks of Cesium-137 irradiators. To this end, the authors will argue for the creation of an "advocacy network" of organizations and individuals committed to cesium replacement. This network would facilitate collaboration and share experiences amongst users and create informal channels for distributing information on latest technological advances, practical experiences with converting to alternative technologies, comparative research studies, and fiscal implications of converting to devices that pose no terror risks. The network would also provide assistance to those navigating the process of technological substitution by tracking and documenting regulatory changes and voluntary substitution efforts across the globe; supply the necessary infrastructure to coordinate voluntary threat elimination efforts across institutions, regions and national governments; and serve as the public facing clearing house of efforts aiming to eliminate risks through the use of alternative technologies.

Thirdly, the paper will recommend that IAEA Member States encourage the IAEA to promote alternative technologies to radioactive sources and provide guidelines that support States in their implementation of INFCIRC/910 on the Joint Statement on Strengthening the Security of High Activity Sealed Radioactive Sources. While there are clear viable alternatives for Cesium-137 irradiators, more research is needed to develop equivalent alternatives for other radiation sources. The authors believe that IAEA Member States should encourage the IAEA to promote and support research efforts on the development of technically and economically realistic and acceptable non-HASS technologies, incorporating in these efforts the manufacturers, end-users, standards-setting bodies, and technical experts. IAEA engagement on alternative technologies could include formally incorporating alternative technologies into key planning documents such as the next Nuclear Security Plan, coordinating the development of standards and guidance for alternative technologies, and facilitating sharing of information related to alternative technology to support the decision-making of operators, regulatory bodies, and other competent authorities. In a world where there are heightened concerns about radiological terrorism as well as increased requests by Member States for access to effective cancer care, alternative technologies can simultaneously support public health needs and risk elimination to build a healthier, more secure world.

1. WHAT IS THE RISK?

The ingredients for a radiological “dirty bomb”—the very same isotopes that can make life-saving blood transfusions and cancer treatments possible—are located at hundreds of facilities across the United States, many of them only meeting basic security requirements and all too vulnerable to theft. As a result, experts believe that the probability of a terrorist detonating a dirty bomb is much higher than that of an improvised nuclear weapon. The vulnerability of these radiological sources, particularly the cesium-137 used in blood and research irradiators in hospitals and other open environments, has caused concern for years, and the risk is growing.

Radical terrorist organizations have said they are looking to acquire and use radioactive material in a dirty bomb. In 2016, Belgian investigators discovered terrorists monitoring an employee at a highly enriched uranium reactor that also produces medical isotopes for a large part of Europe. Although radioactive isotopes also are used for various purposes at universities and research centers, in agriculture and industry, and by governments, they are considered most vulnerable in busy -- often unguarded --medical settings where staff turnover can be high, and where many people have access to the machines housing the isotopes.

2. WHAT IS AT STAKE?

Unlike a nuclear weapon, a radioactive dirty bomb would not cause catastrophic levels of death and injury, but depending on its chemistry, form, and location, it could cause tens of billions of dollars of damage due to the costs of evacuation, relocation, and cleanup.

There are several radiological isotopes of concern, but a bomb that intentionally spreads cesium-137 would have the most devastating consequences. Some of the other potentially dangerous isotopes are hard metals that likely would be dispersed as fragments and could be picked up from the ground or extracted from buildings after a detonation. Cesium-137, however, is a highly dispersible powder, so exposed buildings might need to be demolished and the debris removed. Following that, access to the contaminated area likely would be denied for years while the site was cleaned up well enough to meet minimal environmental guidelines for protecting the public.

3. WHAT CAN BE DONE?

Cesium-137 blood irradiators once were regarded as the most effective technology for sterilizing blood. In recent years, however, there have been significant technological advances in developing effective and safe alternative technologies that do not use radiological isotopes but have equivalent medical outcomes. In the United States, for example, the U.S. Food and Drug Administration (FDA) in 2012 approved the use of non-radioactive x-ray devices as a replacement for cesium-137 based blood irradiators. As of 2015, two types of these devices are available with a typical cost between $200,000 and $270,000 per unit. In addition to being a relatively inexpensive replacement for cesium-137 blood irradiators, the x-ray units require far less security and shielding, eliminate liability, and require no expensive disposal at the end of the machine’s life-cycle. That makes replacement much more cost-effective than increasing security around radiological sources— and it completely eliminates the risk. Replacement also protects hospitals that don’t have insurance to cover terrorism losses; otherwise, there is a possibility of financial devastation from having to pay huge damages in the wake of a dirty bomb attack using hospital materials.

4. MODELS FOR ACTION

NTI has worked with Emory University, the University of California, and New York City to encourage permanent risk reduction related to radiological materials. These case studies can guide other hospitals, research centers, municipalities, and regulators on key steps, such as selecting alternative technologies, following regulations, and identifying funding sources.

4.1. New York City

As security tightened around the United States following the 9/11 terrorist attacks in 2001, New York City officials, with federal assistance, took significant steps to strengthen security at sites that used high-risk radiological sources. They understood that if high-activity radiological materials were stolen and detonated in a bomb in a city as densely populated as Manhattan, the public health consequences and environmental contamination would be severe, possibly requiring massive relocation of residents and indefinite quarantine of large areas pending lengthy cleanup efforts.

By 2014, the US Department of Energy's (DOE) National Nuclear Security Administration (NNSA) was expanding the focus of their federal efforts from voluntary—and often costly—physical protection measures to include alternatives for cesium-137 irradiators that would result in permanent risk reduction. As a result, New York City's Department of Health and Mental Hygiene decided to apply a public health approach to radiation safety: Eliminate the risk first and only take steps to minimize consequences if risk elimination is not possible.

At the time, the New York City healthcare community, with its 32 cesium-137 irradiators, was undergoing significant change with multiple mergers that brought new management teams into decision-making roles. In some ways, the mergers, which brought multiple independent research and health organizations together, made decision-making more complex. In others, the mergers offered opportunities for change in institutional cultures.

Amid this changing business landscape, the city health department, with support from NTI, organized a symposium: "Moving Towards Zero Risk: Can We Eliminate the Risks from High-Activity Radioactive Materials through Adoption of Alternative Technologies?" The event brought together more than 130 security experts, federal officials, radiation safety regulators, medical physicists, and health and safety personnel. Participants agreed that the high cost of disposal and decommissioning of cesium-137 irradiators could drive the facilities toward permanent risk reduction, and there was a shared sense that health and safety departments at healthcare facilities should work toward that end. The group recommended studies comparing the use of x-ray technology alternatives with medical equipment using radioactive materials and more programs and funding to facilitate replacement of irradiators with alternative technologies.

Building on the success of that first symposium, the health department in 2016 took steps to promote cesium-137 replacement in New York City. Officials collaborated with NTI once again to sponsor a discussion about cesium-137 replacement at an annual meeting of state regulators of radioactive materials and to plan a second symposium focusing on the science of alternative technologies. In addition, health department officials conducted two workshops on cesium-137 replacement specifically geared towards radiation security officers (RSOs). Lastly, the department surveyed RSOs on their views about permanent risk reduction and created tools to evaluate the viability of alternative technologies. The tools were designed to:

- understand the major concerns of RSOs in considering alternative technologies
- allow licensees to make more informed decisions when purchasing radioactive sources versus non-isotopic alternatives
- provide comprehensive analysis of the cost and performance data of both technologies, including the costly burden of regulatory requirements.
- inform RSOs and their health care facilities about the potential liability costs they could face if the radioactive source is stolen
- assess which devices could be immediately replaced and which would take longer to be replaced
- collect data to enable the health department to support public and private sector stakeholders in applying for federal incentives to replace high-activity radiation sources.

All operators surveyed provided feedback using the audit tools.

Based on the discussions and data collected, the health department concluded that the leading factor for the decision not to switch to alternative technologies was the cost of purchasing and maintaining new equipment, combined with the cost of disposing of the cesium-137 devices no longer needed. Another key finding was that many hospital administrators did not fully understand or appreciate their liability if one of their cesium-137 devices was stolen or maliciously used. It was clear that creating financial incentives was the most important effective strategy to encourage the switch.

Lack of information also played a role among those reluctant to consider alternatives. RSOs expressed unease about operational issues such as equipment down-time and malfunction, infrastructure considerations, and complications related to changing standard operating procedures. Most RSOs were not familiar with the recent

FDA approvals for alternative x-ray technologies and their updated performance standards. Many referred to experiences with early devices that had not performed efficiently. While most RSOs viewed x-ray technologies as viable replacement for blood irradiators, additional data was needed to drive action on research irradiators.

Once it became clear that most institutions with cesium-137 irradiators were willing to commit to replacing them, health department officials met with NNSA to review the logistics of a multi-device removal schedule for a defined geographic area. A second coordination meeting with all committed institutions allowed for a review of the application process for the NNSA Cesium Irradiation Replacement Project (CIRP), as well as scheduling vendor presentations for institutions to collectively review device pricing, specifications, warranties, customer service support, and add-on equipment, and scheduling tours of facilities to see alternative technology devices already in use. A workshop in June 2017 focused on the comparability of x-ray and cesium-137 devices for a range of research purposes. This provided an opportunity for researchers who had compared the devices to discuss their experiences with researchers from across the United States. The workshop also included background on regulatory experiences in Norway, where all cesium-137 devices have been replaced with alternative technologies.

The New York City Department of Health and Mental Hygiene's efforts resulted in important risk reductions. Today, fifteen of the 32 irradiators in use in 2014 have been replaced, and 7 more are either under contract for replacement or have contracts pending. Of the remaining 10 devices, institutional commitments exist for the removal of 8, and NNSA and the health department are continuing to discuss the status of the two others.

4.2. Emory University and Atlanta

Emory University decided to address its three devices and encourage other Atlanta facilities to do the same. In 2016, Emory University Hospital received the "Medical Innovation Award" at the Nuclear Industry Summit for its efforts to convert their blood irradiator and highlight the achievement. In February 2018, Emory invited NTI to co-sponsor a workshop on radiological security to discuss the city's planning and preparedness programs for radiological emergencies and steps that had already been taken to secure radiological sources. The workshop developed an action plan on additional steps to further reduce the risk posed by radiological sources, and Emory played a central advocacy role in encouraging facilities to remove and replace 13 blood and research irradiators across six institutions in the Atlanta region.

Emory's decision to become cesium-137-free was informed by:

(a) Advances in x-ray technologies that are safe and produced effective and equivalent medical and research outcomes.
(b) Elimination of regulatory requirements and associated costs of cesium-137-based devices—extensive security alarm fingerprinting and background checks, drills and training with police, recordkeeping and other administrative measures mandated by regulations. These cost savings could be applied to future maintenance costs of x-ray devices.
(c) Federal funding subsidies, through NNSA's Cesium Irradiator Replacement Program, for a portion of the purchase price of the replacement x-ray irradiators and the full cost of disposing of their cesium-137 irradiators, which costs the federal government $100,000 - $200,000 for each device.
(d) Elimination of liability – alternative technologies result in permanent risk reduction and the elimination of the possibility that their irradiators could be stolen or sabotaged and used in an act of radiological terrorism.

Emory's successful transition also was made possible with the advocacy of NTI Co-Chair Sam Nunn and support from senior management at Emory, including Dr. David Wynes, former Vice President for Research Administration, whose department provided the funding required to match the NNSA federal subsidy under CIRP for the replacement and the removal of their cesium-137 devices. Emory mandated a deadline for research departments to reach a decision on converting their cesium-137 devices and choosing an appropriate x-ray alternative. Emory health and safety staff encouraged x-ray manufacturers to meet individually with each department and provide information about their product line, specifications, and device capabilities.

4.3. University of California and the State of California

Building on the success of the New York and Atlanta models, NTI in 2017 launched a new radiological effort with the State of California, which has the largest number of high-activity cesium-137 devices in the United States, estimated at more than 120. NTI built broad political stakeholder support for a radiological device

replacement initiative by partnering with the Office of Governor Jerry Brown, the Office of Senator Dianne Feinstein, the California Department of Public Health, and the Office of the President of the University of California (UC) — which operates more than 30 percent of the state's cesium-137 devices across 10 institutions and five medical centers.

To encourage hospitals and research facilities within the UC system to consider converting to x-ray technologies, UC sponsored a series of workshops, facilitating technical dialogues and information exchanges for researchers to share experiences and lessons learned in making the technology switch. Representatives from state and city executive offices, regulators, operational decision-makers, law enforcement and emergency response officials, and research and blood bank operators, along with senior leadership from NTI and NNSA's Office of Radiological Security attended and contributed to these discussions. These meetings informed senior management at UC about the potential risk and liability of owning cesium-137 irradiators and prompted them to take action.

Scientific reference materials—including x-ray energies, distributions, and applications; radiological biological effectiveness variations among research modalities of the new x-ray technologies; and manufacturer information--also were shared to help alleviate information gaps and perceived scientific uncertainty surrounding the effectiveness and comparability of the new x-ray technologies. The workshop also provided information about federal assistance programs and subsidies, associated costs of switching to new technologies, manufacturer data, as well as the overall risk reduction benefits of making the technology switch (i.e., liability, relief from burdensome regulations and associated costs, as well as the opportunity to upgrade equipment capabilities for automated dosimetry and imaging systems).

Following the workshops, University of California President Janet Napolitano, who served as U.S. Secretary of Homeland Security from 2009 to 2013, provided top-level support for this institution-wide campaign. She requested a commitment from University chancellors, who were required to complete a Decision Form regarding removal and replacement of the 42 cesium-137 irradiators within the UC system. The Decision Form (included in the Appendix of this report) required detailed information about each irradiator and whether the device would be removed, removed and replaced, or retained. To complete this task, the UC Office of the President created a faculty-led, system-wide Radioactive Source Replacement Working Group and appointed a full-time coordinator to lead the three-year, phased effort.

Key faculty as well as research and medical departments using cesium-137 irradiators reached a science-informed consensus on source equivalency for most applications and a determination was made that replacing the irradiators would not adversely impact ongoing research. The approach was collaborative and inclusive, allowing the medical and research communities to discuss pros and cons and be involved in the decision-making process. The resulting Working Group report concluded that x-ray irradiators could effectively replace their cesium-137 instruments in many applications on their campuses, with some notable exceptions, and laid out scientific recommendations for users looking to make the switch.

UC medical center blood banks, in particular, were very receptive to switching to x-ray technology, based on a clear demonstration of equivalent results for blood irradiation, and chief executives at the six medical centers supported the blood bank operators' decision to convert for blood sterilization. The singular application, FDA approvals on equivalency, and increased throughput (blood volume may be up to six times higher for x-ray irradiators than cesium-137 blood irradiators) were the most persuasive rationales for the switch.

To ensure a smooth transition following a decision, the University deployed several tools to support researchers and blood bank operators. The first was a system-wide contract to obtain funding under CIRP and identify additional funding resources through the UC Chancellor's office. It was important to convey that funding would not be taken out of individual research grants.

To streamline the purchasing process, the UC Coordinator also provided information on device options as well as maintenance and warranty costs and negotiated best pricing with equipment vendors for multiple device purchases. A project manager and purchasing agent were designated for each research department involved in this process. A phased approach provided researchers with the flexibility to retain their cesium-137 irradiators for up to a year after the installation of the new x-ray equipment to empirically assess the effects on their studies of converting from cesium-137 to x-rays. In some cases, additional funding for the comparison studies also was offered by the campus or hospital. Researchers were advised that if comparison studies were not successful, they would be allowed to retain their cesium-137 irradiator but would not receive the incentive funding provided by NNSA's Cesium Irradiator Replacement Program.

This initiative prompted the removal and replacement of 90 percent of UC's 42 cesium-137 devices (36 research irradiators and six blood irradiators) with x-ray devices. The removal and replacement will be executed over a three-year period to minimize the impact on research and operations.

4.4. Support for Cesium-137 Phase-outs from the California Department of Health

Like New York and Georgia, California is a Nuclear Regulatory Commission Agreement State, meaning that NRC regulations are implemented and enforced by state authorities. In the California case study, the California Department of Public Health Radiological Health Branch (RHB) played an important role in encouraging the use of alternative technologies. Working within the limits of NRC's rules, the state regulator provided information on cesium-137 licensing requirements and x-ray machine registration requirements to make the switch (forms, fees, inspection frequency, etc.). Upon the launch of this initiative, the radiological branch took the extra initiative to develop an internal tracking system for the number of cesium-137 devices to be permanently removed from California. If a new cesium-137 irradiator license application is received for regulatory approval or renewal, the state regulator (through the creation of a new licensing checklist) informs the licensee on available alternative technologies and requires a justification for use of cesium-137. If the use of cesium-137 is considered to be justified, licensees are urged to participate in NNSA's Voluntary Security Program and receive additional physical protection upgrades (above and beyond what is required to meet federal/state requirements under 10 CFR Part 37) prior to approval.

5. LESSONS TO PROMOTE AND CATALYZE CESIUM-137 REPLACEMENT

What does it take to successfully build consensus around replacing cesium-137 blood irradiators in hospital and research settings? Based on the models in California, Georgia, and New York, the authors have developed five key lessons which can be applied at the institutional, state, and federal levels for those interested in cesium-137 replacement.

5.1. Identify Local Advocates and Build Support Networks

Government officials and institutional administrators often share concerns about malicious use of radioactive material and the long-term costs of sustaining security of devices that use it. It is important to identify and support the efforts of those who are looking for ways to reduce their organizations' exposure to risk. As the case studies from New York City and California show, these advocates—whether a state official, a hospital administrator, or the leader of an institution--often face significant challenges when trying to overcome institutional complacency or skepticism from operators who may not understand the value of making a change.

One way to address challenges associated with replacement advocacy is to create a cesium-137 replacement advocacy network. This could be done at both the institutional and state levels. Leveraging the experiences of those who have already replaced radiological devices is invaluable for overcoming skepticism and institutional inertia. A network can be a powerful tool to amplify members' experiences and encourage peer-to-peer information sharing on the comparative research, equivalency, and application of alternative technologies. The New York City and Atlanta case studies show that leveraging the successes of premier hospitals or research facilities is key to influencing others to consider replacement. To ensure the long-term sustainability of a network, will depend on identifying an advocate inside or outside the system to provide logistical and organizational support, to articulate the regulatory and policy changes required, and to communicate the opportunities to eliminate public health and security risks through permanent risk reduction.

Visible support from political leaders and elected officials is also important. In New York City, Atlanta, and California, high-level politicians and government officials helped attract support from top administrators and officials who would make institution- or region-wide replacement decisions.

5.2. Improve the Dissemination of Information

There are many benefits to replacing cesium-137 irradiators with alternative technologies, and the shift from hardening security to risk elimination through replacement makes even more sense when the enhanced capabilities of alternative technologies are considered—among them, greater precision in dosing and imagery.

Regrettably, available information about alternative technologies is not always readily accessible to those contemplating the switch; studies on their performance should be made more accessible by public and regulatory health officials, manufacturers, and published studies by institutions that have made the switch through regulations.

Meanwhile, vendors are best positioned to instruct potential customers and operators on the specifications and uses of their products. In Atlanta, officials at Emory requested that vendors meet individually with departments to introduce their x-ray devices. In New York, facilities met with manufacturers to obtain cost, performance, and warranty information. The UC system provided price quotes and comparison charts for all x-ray models to research departments.

Newly funded research with findings published in peer-reviewed journals would increase understanding of the benefits and limitations of conversion. Publishing comparative studies also would help overcome scientific uncertainty around alternative technologies. Both New York City and the University of California convened multiple meetings to discuss the technical issues involved in converting research and blood irradiators. UC established a Faculty Technical Working Group to provide technical recommendations and advise university leaders how to proceed. New York held numerous technical workshops and developed an analytic tool with a confidential survey to obtain information from their licensed community.

The University of California also built support by creating a phased approach to allow users to keep both technologies for a brief period (six-to-nine months) to validate their work and conduct their own side-by-side comparison prior to removal of their cesium-137 irradiators. The data collected could be used to develop and publish standards for x-ray use.

5.3. Seek Consensus among Stakeholders

Achieving consensus within and among institutions involving stakeholders at all levels was crucial to success in each case. In city and state governments, this included state regulators, representatives from the governor's offices, local and state departments of health, and representatives from the Health Commissioners' offices. At institutions, it included operational decision-makers, environmental health and safety officers, security and liability risk managers, end users, researchers, and blood bank operators. Law enforcement and emergency response officials are also crucial to the consensus process, as they will be significantly impacted by changes in mindset from security risk management to risk elimination, as well as operationally involved in the cesium removals.

5.4. Identify Funding and Support at Institutional Level

Identifying funding at the institutional level is also important. Obtaining political support and financial resources requires active involvement by senior leadership at medical and research institutions, as well as operational decision-makers and risk managers who understand the need to protect public health, safety, as well as eliminate terrorism risk and potential liability. At the operational level, once a decision was made to move forward, facilities and institutions that participated in these federal programs established protocols to streamline and simplify the purchasing process and work with the federal government to obtain the subsidies. It was important to provide information about different manufacturers of x-ray technology, options and associated costs, as well as annual maintenance and warranty and license change requirements and costs.

5.5. Compare Cradle-to-Grave Costs

Although federal regulations govern the use and storage of both radioactive sources and x-ray irradiators, they are much more extensive and costlier for the former. To comply with NRC regulations, the use of high activity radioactive materials (including cesium-137) requires the supervision of a Radiation Safety and Security Officer (RSO) in handling the radioactive material and the installation of costly physical protection around the device, in addition to compliance with other regulations related to the operation of the device. Institutions also must establish training programs and procedures for all staff who have access to the devices, including fingerprinting and FBI background reviews and developing processes and adjudication procedures within human resource or legal departments. Users of x-ray irradiators must comply with regulations related to safety and shielding, but there are no onerous physical security requirements for the devices.

5.6. Increase Subsidies and Support at Federal Level

In each of the case studies, federal funding was critical to obtaining commitments to transition to x-ray devices. NNSA's CIRP provided a financial incentive toward purchasing replacement x-ray devices, which defrayed expenditures by hospitals and institutions. In addition to this cost-sharing model, DOE/NNSA has a long-standing program to assist with permanently removing radiological sources that are no longer needed due to a technology switch. This Off-Site Source Recovery Project organized the removal of the disused cesium-137 irradiators. Under these programs, participating institutions receive federal assistance for the removal and ultimate disposal of the cesium-137 irradiator, saving the institution $100,000–$200,000 per irradiator. Additionally, CIRP also provides a limited financial payment towards a new x-ray device, up to 50% of the purchase price. Under the terms of this subsidy program, the federal payment is disbursed when the cesium-137 device has been removed and the x-ray device has been installed. Given the costs of a radiological dispersal device involving cesium-137 could result in the economic losses in the billions of dollars in remediation and relocation costs, the government investment in replacement and permanent removal of the devices is cost-effective.

Unfortunately, these important programs are dependent on annual appropriations. Congress should commit to sustain or expand NNSA programs to accelerate the pace of technology substitutions and cesium-137 source removal and disposition. Congress also should approve language introduced in the 2019 Nuclear Defense Authorization Act (Subsection 3141) in future authorizations to meet the ambitious goal of phasing out all cesium-137 blood irradiators by 2027. While this "Sense of Congress" language would not constitute a regulatory requirement, it could help increase awareness about these programs and incentivize more facilities to voluntarily participate.

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

Although a voluntary, consensus-driven model outlined in the case studies can achieve risk reduction, legal requirements would be more effective. Several regulatory actions should be considered to meet the ambitious goals outlined in Subsection 3141 in terms both phasing out cesium-137 blood irradiators by 2027 and constraining the introduction of new devices:

- All regulatory agencies, specifically the NRC and FDA, should set deadlines for phasing out cesium-137 blood irradiators. For blood sterilization, there are multiple technologies in the U.S. marketplace that have received regulatory approvals through the FDA. Other countries are undergoing similar reviews. Moreover, replacement technologies are gaining acceptance by industry leaders as effective and equivalent alternatives.
- Regulators should strongly encourage the market to create no-risk solutions that meet the research and commercial goals of the end user. Currently, the NRC does not encourage rule-making and has not taken a proactive role in supporting regulatory changes to constrain the use of cesium-137 or to promote the broader use of alternative technologies. To meet the goals set out by Congress, the NRC should fully embrace a regulatory approach that prohibits use of high activity radioactive material except in specific justifiable cases. For cesium-137 devices associated with research applications, regulators should establish a pre-licensing justification requirement for end users to demonstrate that there is no viable alternative in the marketplace. Regulators should also mandate removal of all high-activity radioactive sources whose use is not adequately justified.
- Regulations should reflect the full lifecycle costs of cesium-137 use. Significant governmental resources are dedicated to licensing, security oversight, and disposal management of cesium-137 are not borne by those who receive the benefits of its use. Cradle-to-grave societal costs of cesium-137 devices should be fully reflected in the licensing costs and transferred to the end user.
- National policies must be consistent in supporting elimination as a public health prevention strategy. Conflicting policies among national agencies often lead to divisive and confusing policies among local regulators and other key stakeholders. Across Agreement State programs, some regulators encourage proactive, preventative policies while others follow the minimum federal requirement and play the role of code enforcement. The consistent promotion of public health prevention strategies also would support federal efforts to implement voluntary programs such as DOE's CIRP.