Major Lifecycle Cost Considerations for Cesium-137 Irradiators and X-ray Irradiators

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Hospitals and research centers in the United States and around the world are addressing concerns about radiological security, safety, and liability by replacing irradiators that use radioactive cesium-137 with safe and effective X-ray technology. This paper outlines major lifecycle cost considerations for making the switch. Use the worksheet template at the end of this document to help you decide if replacing cesium-137 irradiators with x-ray technology is the right step for you.

What are the purchase costs for the change?

The replacement costs for exchanging a cesium-137 blood irradiator with a new cesium-137 device or an X-ray irradiator are roughly comparable, but the purchase price can vary for each depending on the make, model, size of the irradiators and transportations costs. Each also require delivery costs. However, the costs for transporting Cesium-137 are much higher due to the increased regulatory requirements for transporting the devices mandated by the federal Department of Transportation and the Nuclear Regulatory Commission (NRC). Additional factors include the location of the institution in relation to the vendor and security required by the municipality/State. For example, in a city such as New York, streets must be closed down when the device is being transported and police escorts are required. Institutions using Cesium-137 blood irradiators also must pay licensing and annual fees which do not apply to the use of X-ray devices. The licensing price for different devices can vary depending on the specific licence request, but the licenses are costly and the expenses are recurring (e.g. if an institution holds more than one license, the total annual fee assessed will be the cumulative total of the annual fees applicable to each license held). More information can be found on the NRC website under regulations 10 CFR 171.16 Annual Fees.

The Cesium Irradiator Replacement Project (CIRP), offered by the National Nuclear Security Administration's Office of Radiological Security, offers a financial incentive towards the purchase price of a new X-ray device to qualified sites. Institutions can receive up to 50% of the purchase price for a new X-ray device.

Another important consideration is the useful remaining life of the radioactive source-driven device. Although the expected lifespan of both technologies should also be considered as part of the cost (e.g. cesium-137 irradiators are generally operable for 30 years, while the anticipated life of the proposed alternative replacement is 12-plus), all lifecycle costs should be considered as part of this cost-benefit analysis. Although they don't last as long, X-ray units require far less security and shielding, and they require no expensive disposal at the end of the machine's life-cycle. That makes replacement more cost effective than increasing security around radiological sources, and it completely eliminates the threat, also eliminating liability. The summary below highlights key cost factors.

What are the facility modification costs for the change?

There are facility infrastructure requirements and associated costs for both Cesium-137 irradiators and X-ray technology.

Rooms that typically house cesium-137 are in dedicated spaces with strict access controls (iris reader, card access) and other security surveillance equipment (cameras, alarms, radiation detection equipment, remote monitoring systems). The extreme weight of shielding devices also necessitates costly facility upgrades.

X-ray technology does not require such costly and burdensome physical security requirements. However, the technology may need accommodations for increased power consumption, cooling water or additional air conditioning. In some cases, facility modifications may be needed to compensate for the increased weight or noise generated by the new X-ray equipment. However, recent innovations in X-ray technology have led to newer models, such as the Rad Source 3400, that have eliminated the need for water filtration and decreased the number of X-ray tubes, affecting power source and overall room configuration requirements. Because some hospitals may install X-ray machines in room(s) or facility areas (blood banks) already equipped to handle these issues and the two devices take up similar amounts of space, it is difficult to compare costs for making a switch. Regardless X-ray technologies generally provide more flexibility in room placement and remove significant facility modification costs.

What are the operating costs for the change?

Cesium-137 irradiators must comply with costly NRC regulations. An institution may receive federally funded security upgrades through the NNSA/Office of Radiological Security Program, but it will be responsible for operating costs in maintaining the new security infrastructure after the warranty period. Again, the capital costs for the equipment represents on a small percentage of the costs for sustaining the equipment and the training over the life-cycle of an irradiator's use.

Both cesium-137 and X-ray devices also require service contracts for preventative maintenance, calibration and the replacement of parts if needed. Many manufacturers' service contracts for X-ray machines are appealing to users because they cover replacement parts and calibration.

cesium-137 irradiator operators also carry service contracts, and they tend be less expensive because the machines require fewer replacement parts.

Taken together, however, the overall operating costs of sustaining the necessary security architecture for cesium-137 irradiators combined with their service contracts can be just as expensive, or more expensive, than service contracts for X-ray devices.

What are the staff and training costs for the change?

In accordance with NRC regulations, the use of Category 1 & 2 radioactive sources requires the supervision of a Radiation Safety and Security Officer (RSO) who is trained in handling the radioactive material, management of the safety and security requirements of the device, and implementation of other federal regulations concerning its operation. Institutions also must establish training programs and procedures for all staff with access to the devices (including the validation of trustworthy and reliability (T&R) requirements involving fingerprinting and FBI background reviews) and establish adjudication procedures for T&R requirements within Human Resource (HR) or Legal Departments.

X-ray irradiator users also must comply with regulations involving safety and shielding requirements, but these regulations are limited. Moreover, the kinds of security requirements associated with cesium-137 sources don't exist, nor do associated costs of salaries, compliance officers, and security training.

What are the regulatory costs for the change?

The costs for protecting high-activity radiological sources such as cesium-137 from malicious intent are very high and recurring (e.g. capital investment, maintenance, testing, training). New regulatory security requirements may occur during several phases in the lifecycle of sources including: (1) in transit to installation, (2) during service life; (3) in transit after service life and (4) in disposal or long-term storage. Each stage of use has associated regulations and costs, as well as annual license fees. In contrast to the NRC requirements around high-activity radiological sources, the use of X-ray technologies does not come with significant regulatory burdens. X-ray use also reduces licensing activities, regulatory inspections, and sealed-source inventory reporting, as well as a variety of other mandatory security requirements.

What are the termination costs for the change?

Users have limited options for the disposal of their cesium-137 irradiators: on-site storage, return to the supplier/manufacturer (if available), or transfer of ownership to the federal government through the National Nuclear Security Administration's Office Site Source Recovery Program (OSRP). The public costs of termination (OSRP's transport and disassembly costs, purchase and use of specialized containers, and long-term permanent storage costs at a licensed federal

facility) are very high and not currently reflected in full lifecycle costs of owning and using a CsCl irradiator.

The NRC is currently reviewing a new rule, that if approved by the Commission, will require financial assurance for disposition of Category 1 & 2 Radioactive Sealed Sources (RSS). This would mean licensees possessing these sources must prove are financially prepared for the costs of end-of-life dispositioning, dispositioning costs would have to be borne by those who receive the associated economic benefits from the use of these sources, timely disposition would be required when radioactive sealed sources become disused or unwanted, and consideration for alternative technologies would be encouraged. Such a regulatory change would significantly impact lifecycle costs – shifting significant costs back to commercial users. This would likely influence future purchase and replacement decisions.

What are the liability/insurance costs for the change?

The cost of the risk posed by radiological devices is seldom used to justify replacing cesium-137 irradiators, but the intentional misuse of a cesium-137 or any other high-activity radiological source could result in significant economic damages. The liability costs related to sealed source possession and use should be factored into an institution's decision to continue using or to replace a radiological source with an available alternative technology. In the United States for example, very few user facilities have insurance coverage (general liability and excess policies cover) for this contingency and are not aware that their institution could potentially be held liable for hundreds of billions of dollars. The purchase of insurance coverage, if available, is very costly, leaving most facilities exposed to first party and/or third-party liability if a cesium-137 irradiator was stolen from a medical or research institution for malevolent intent. Institutions that don't have insurance to cover such a devastating event could have to pay huge damages and might face bankruptcy. This liability exposure is completely removed if a facility switches to a non-gamma-based technology, such as X-ray.

Irradiator Replacement Costs Estimate Worksheet Template

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