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Poland Alternative Technology Program Implementation

AARON GALVAN
Pacific Northwest National Laboratory
Richland, United States
Email: aaron.galvan@pnnl.gov

ALLISON PARNELL
Pacific Northwest National Laboratory
Richland, United States
Email: allison.parnell@pnnl.gov

KURT LUKINS
Pacific Northwest National Laboratory
Richland, United States
Email: kurt.lukins@pnnl.gov

KAMIL CWIEK
Radioactive Waste Management Plant
ZUOP
Otwock Swierk, Poland
Email: kamil.cwiek@zuop.pl

DOROTA GAJDA
Radioactive Waste Management Plant
ZUOP
Otwock Swierk, Poland
Email: dorota.gajda@zuop.pl

ABSTRACT

The U.S. Department of Energy National Nuclear Security Administration's Office of Radiological Security (ORS) cooperates with partner countries throughout the world to enhance the security of radioactive sources. High activity cesium-137 (Cs-137) is the primary isotope used to irradiate blood for the prevention of Transfusion Associated Graft versus Host disease. This high activity Cs-137 can also present a danger to the public with the threat of it being used for a radiological dispersal device. The Cs-137 at public institutions may be accidentally released or stolen and later used in an act of terrorism. Facilities that have Cs-137 devices face the dilemma of providing security for the device or switching to newer X-ray technology. ORS is helping institutions with this dilemma by providing X-ray technology as part of its Alternative Technology Program instead of continued security. There is a compelling business case to be made for facilities in Poland to switch to alternative technologies for financial reasons. Cesium device procurement costs are similar to an X-ray device. End-of-life management costs also need to be considered as well as the cost of security system operation and maintenance for a Cs-137 device. The security system is not required when using a non-isotopic device such as an X-ray irradiator. Removing the Cs-137 device also reduces the risk of theft or accident with the radiological device. Permanent source reduction is a preferred method to reduce the risk of a radiological terror incident.

Poland is one of the countries where ORS's Alternative Technology Program has been successfully implemented. ORS's partner in Poland for this program is the Polish Radioactive Waste Management Plant (*Zakład Unieszkodliwiania Odpadów Promieniotwórczych* or ZUOP). The first facility in Poland to volunteer and transition to alternative technology recently completed the replacement and removal process. The installation of an X-ray device and corresponding removal to long-term storage for the cesium device took 2 years between planning and execution. The Cs-137-based blood irradiator was moved to ZUOP's storage facility for high-level disused radioactive sources in late summer 2020 for long-term storage. Several other sites in Poland are currently planned or in process with their replacements and radioactive source removals.

1. INTRODUCTION

The U.S. Department of Energy National Nuclear Security Administration's Office of Radiological Security (ORS) cooperates with more than 80 partner countries throughout the world to enhance the security of radioactive sources used for legitimate purposes. Most of these radioactive sources are within hospitals and universities. High activity cesium-137 (Cs-137) is one of the primary isotopes used to irradiate blood for the prevention of Transfusion Associated Graft versus Host Disease. This high activity Cs-137 can also present a danger to the public with the threat of it being used for a radiological dispersal device, which is more commonly known as a 'dirty bomb'. The Cs-137 at these public institutions may be accidentally released or stolen and later used in an act of terrorism. Sites that have Cs-137 devices face the dilemma of providing security for the device or switching to newer X-ray-based technology. ORS is helping countries and facilities with this dilemma by providing the X-ray technology to replace the Cs-137 device as a part of its Alternative Technology Program instead of continuing to secure high activity sources. ORS has been most active internationally with Poland on this program. ORS's partner in Poland for this program is the Polish Radioactive Waste Management Plant (*Zakład Unieszkodliwiania Odpadów Promieniotwórczych or ZUOP*).

2. ALTERNATIVE TECHNOLOGY PROGRAM

ORS provides financial incentives for the replacement of radioactive source-based devices with a non-radioisotopic alternative technology and source removal to secure long-term storage facilities. The Alternative Technology Program is a voluntary program for users of Cs-137 devices who are interested in replacing their cesium irradiator with a non-radioisotopic alternative, e.g., an X-ray based irradiator. ORS and ZUOP require each site to sign a disposition statement of their commitment to 1) operate the ORS-funded equipment appropriately and incorporate operational and maintenance procedures into their regular routine, 2) remove their cesium irradiator to a secure storage facility after the X-ray technology has been installed and the facility has fully transitioned to using the procured X-ray equipment, and 3) not make future plans to obtain a Cs-137 irradiator [1].

Recently ORS has seen many countries establish policies supporting the adoption of alternative technologies or implementing stricter regulations on licensing a radioisotopic device. For example, in the United States the John S. McCain Fiscal Year 2019 National Defense Authorization Act set a goal to eliminate the use of blood irradiation devices that rely on Cs-137 by December 31, 2027 [2]. At the National Security Summit in 2016, Norway announced they had finished phasing out the use of high activity sources in blood irradiators and replaced the devices with X-ray-based irradiators in 2015 [3].

In the case of Poland, there is a compelling business case to be made for facilities to switch to alternative technologies for financial reasons.

3. FIRST ALTERNATIVE TECHNOLOGY VOLUNTEER FACILITY IN POLAND

Over the last three years, ORS and its Polish partners have started to see a trend toward alternative technologies at hospitals and blood donation centers in Poland. This was achieved by supporting regulations, understanding the capabilities of X-ray devices, and education on device replacement considerations. The first facility in Poland to volunteer and adopt alternative technology was one of the regional blood donation centers, *Regionalne Centrum Krwiodawstwa i Krwiolecznictwa*, in March 2018. Overall, the project took 21 months from going under contract with Pacific Northwest National Laboratory to the delivery and commissioning of the X-ray device and removal of the old Cs-137 device.

Once the X-ray device was purchased it took approximately four months to be delivered and installed, which took place in April 2019. The facility fully transitioned to using the new X-ray device in June 2019. The facility reported they are irradiating three to four bags per cycle in less than 6 minutes, which is approximately 4 minutes shorter than their old Cs-137 device was irradiating. Due to the overall performance of the X-ray device and the facility operator's satisfaction, ZUOP successfully removed the Cs-137 device in August 2020 and it is currently in long-term storage at the ZUOP storage facility.

3.1 Procurement and Security Costs

In general, X-ray device procurement costs are similar to cesium devices. However, for Polish medical sites that participate in the Alternative Technology Program, the X-ray device purchase, delivery, installation, and commissioning are covered by ORS. In this circumstance, the "cost" for the site is taking on the role of being a pioneer by transitioning to an alternative technology instead of procuring or reloading a radioisotopic device. Due to the increase in quality and number of manufacturers providing X-ray blood irradiators globally, many of the new irradiators offer ancillary equipment at an additional cost. This means that facilities are finding alternatives to cesium for blood irradiation that meet or exceed their technical and operational requirements. The assumed period of device usage is at least 10 years. This assumption is based on the fact that cesium irradiators removed under the ORS program are over 10 years old. All installed X-ray equipment is approved for all blood and blood products with Conformité Européenne (or CE) marking or equivalent and licensed for distribution, installation, commissioning, and usage within Poland.

The costs of a security system also must be considered for operating and maintaining a Cs-137 device as these costs can be significant. An X-ray irradiator does not require security (or pose a threat) as the device does not contain a radioactive source, which according to Polish law shall be secured by a physical protection system. Additionally, facilities may face liability costs if a radioactive source were to be stolen and used as a radiological dispersal device.

3.2 Removal Costs

The end-of-life costs of an X-ray device is marginal when compared to a cesium device. The main difference is the radioactive source contained in a cesium device requires management for many years after its end of useful life. For facilities acquiring a new cesium source, Polish law requires an up-front payment that is held in escrow to be used for end-of-life radioactive source management if the source is not exported back to its supplier. However, what is held in escrow typically does not

cover the entire cost of removal and management. Considering the cesium device's end-of-life costs, choosing an X-ray blood irradiator is more financially beneficial for medical sites. Additionally, for Polish sites that participate in the Alternative Technology Program, the cost of removal and management of old cesium devices is supported by ORS.

The most important outcome of participation in the program is reduction of the risk of theft or accident that comes with the radiological device. Permanent source reduction is a preferred method to minimize the risk of a dirty bomb being used, which is beneficial for the entire society.

3.3 Irradiator Replacement Trends in Poland

Since the initial Alternative Technology Program meetings held in 2018 and 2019 in Poland, 13 of the 23 Polish medical facilities have volunteered to replace their cesium-based irradiators with an X-ray irradiator. The program has played a key role, but the partnership with ZUOP and success of the first replacement project have been instrumental in the growth of Poland adopting alternative technologies more broadly.

As of June 24, 2021, ORS has partnered with ZUOP to replace a total of five Cs-137 devices with X-ray irradiators. By September 2021, there will be a total of nine X-ray devices that will be purchased and installed and five new facilities under contract to replace their cesium irradiator in 2022. To date, three cesium sources have been removed and decommissioned under the program with two more devices scheduled in 2021.

4. REMOVAL AND MANAGEMENT OF DISUSED RADIOACTIVE SOURCES IN POLAND

ZUOP is a state-owned company, established to manage radioactive waste in Poland. ZUOP's experience in the end-of-life removal of high activity sources includes teletherapy sources (Theratron) and radioactive sources used in scientific research. Under the Alternative Technology Program, ZUOP is gaining experience with removing cesium blood irradiators, with three main device types present in Polish medical sites: IBL437C, Gammacell 1000, and Gammacell 3000. The removal is a complex process that includes analysis of each case, removal technology development, detailed process planning, and physical removal. After removal, the device containing the disused radioactive source is transported to the ZUOP facility and then stored long term. The main principle is to perform the work both safely and securely. ZUOP's approach is to improve and master the process by using the experience of personnel and lessons learned after each removal.

ZUOP owns two facilities dedicated to high activity disused radioactive sources storage. ZUOP is constantly working on improving storage technology and through the program there is a plan to enhance the security system in one of the above-mentioned facilities.

5. CONCLUSION

Radioactive cesium sources pose a national security threat due to their potential to be used in a dirty bomb. Facilities that use Cs-137 face the dilemma of providing security for the device or switching to newer X-ray technology, which provides permanent threat reduction. The Alternative Technology Program is assisting countries such as Poland by providing financial incentives for

procurement of an X-ray-based irradiator instead of continuing to secure high activity sources. Over the last three years, there has been a strong trend in adopting alternative technologies in Poland as demonstrated by the number of replacements through the program. ORS plans to continue using the program as a primary security strategy in Poland by partnering with ZUOP to ensure the secure end-of-life management of these sources and to educate radioactive source license holders about alternative technologies and device replacement considerations.

REFERENCES

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