Removal of Disused Radioactive Sources and Materials from Transdniestria: A Case of Successful International Cooperation in Contested Territories[1]

Margarita Kalinina-Pohl, George Moore, Miles Pomper, Edward Kendall

James Martin Center for Nonproliferation Studies (CNS), Monterey, CA, USA.

ABSTRACT

The control of radioactive materials in "contested territories" has proved highly challenging for local, national, regional, and international authorities. This is especially true for countries of the former Soviet Union, some of which have experienced conflict, including ethnic strife, and armed clashes. Contested territories in these countries may also house a significant number of radioactive sources and stockpiles of radioactive materials, without appropriate procedures for security, accounting, disposal, and/or removal. The paper details how approximately 2,700 disused radioactive sources were removed from the contested Transdniestria Region of the Republic of Moldova for safe storage and disposal. A section in this paper is dedicated specifically to the complex removal process of the Issledovatel-1 (hereinafter, Researcher -1) irradiator that was a part of these efforts. Although these radioactive sources and materials were in a contested territory where effective governance by an International Atomic Energy Agency (IAEA) member state has been hindered, the Republic of Moldova, unrecognized Transdniestrian authorities, the Organization for Security and Cooperation in Europe (OSCE), and other stakeholders contributed to the success of this collaborative removal operation. This paper describes diplomatic efforts that made this project successful, and it analyzes the significant legal and technical factors that contributed to the success of this multiyear mission. While recognizing that each country and conflict is unique, this case study may serve as a useful model of cooperation and confidence building for reducing radiological risks in contested territories around the world.

INTRODUCTION

Radioactive materials, such as cesium-137 and cobalt-60, are present in every region of the world. They are used widely for medical, scientific, and industrial purposes—but can also be used maliciously as the key ingredients in radiological dispersal devices (RDDs). Colloquially known as "dirty bombs" when the dispersion is explosively driven, RDDs disperse radiological material over an area to contaminate people and/or property in an attempt to cause economic damage, bodily harm, and/or public panic.

Though responsibility for the development and enforcement of regulations pertaining to the safety, security, and full cycle management of radioactive sources rests with state authorities, thousands of radioactive sources today exist in areas where states are prevented from exercising effective control. Such areas, referred to as "contested territories,"[2] are often characterized by conflict and rampant criminal activity. In such territories political authority is unclear because of "frozen" or active conflicts aggravated by territorial, religious, political, or other disputes. These territories can be ungoverned or administered by self-proclaimed authorities not formally recognized by the international community.

International and regional organizations face a range of political and legal challenges in helping secure radioactive materials in contested territories. Addressing the safety and security of these

materials requires stakeholders to navigate uncharted legal issues and adopt creative roles to secure these materials and transport them to safer areas.

This paper covers one of the few success stories involving the removal of dangerous radioactive sources from a contested territory. It describes and assesses the lessons learned from the Republic of Moldova's removal of approximately 2,700 disused radioactive sources and materials from the breakaway Transdniestria region. Though these materials were in a territory that is not *de facto* governed by an International Atomic Energy Agency member state, creative diplomacy by the Republic of Moldova, the unrecognized Transdniestrian authorities, the Organization for Security and Cooperation in Europe (OSCE), and other stakeholders contributed to the success of this removal operation.

The paper describes these diplomatic efforts and analyzes the significant political, legal, and technical factors that contributed to the success of this multiyear mission. A portion of this article is specifically devoted to the description of certain unique removal arrangements, including special transportation arrangements made for the Researcher-1 gamma irradiator, with a focus on this device's physical removal from the site, its packaging, and its transportation.

The research methodology for this paper included a combination of data collected from (1) stakeholders who were directly or indirectly involved in various stages of removing radioactive sources from Transdniestria, as well as technical consultations with various experts; and (2) publicly available sources, such as academic and technical literature.

The authors believe that Moldova's experience with the removal of disused radioactive sources and materials from the Transdniestria region and the important facilitating role played by the OSCE, can serve as a successful model of cooperation and confidence building for other countries grappling with radioactive materials in contested territories. While recognizing that each country and conflict is unique, countries and relevant territories can adapt and apply these lessons to their own national mechanisms to secure and remove radioactive, and other dangerous materials from contested territories.

BRIEF HISTORY OF THE TRANSDNIESTRIA CONFLICT

The Republic of Moldova is located between Romania and Ukraine, with its breakaway Transdniestria region occupying a thin but long strip of land along the Moldovan-Ukrainian border east of the Dniester River. There are various interpretations of the causes of the conflict in the Transdniestria region, the analysis of which is beyond the scope of this paper. Conflict erupted in March – July 1992 between ethnic Russian separatists supported by Russian troops and Moldovan government forces. The toll of the 1992 Transdniestria conflict resulted in the loss of at least 1,000 lives, and the displacement of more than 100,000 people.[3]

The Russian language serves as a *lingua franca* between ethnic groups. Residents of Transdniestria can freely travel within Moldovan government-controlled territory and may hold both Moldovan, Russian, Ukrainian, and unrecognized Transdniestrian passports. Although political tensions continue on both sides of the Dniester River, the Republic of Moldova and unrecognized Transdniestrian authorities maintain dialogue on several important social, economic, and security issues.

Transdniestria was a hotbed of criminal activities throughout the 1990s. Although criminal activities in Transdniestria have receded in recent years, and it is no longer the smuggler's paradise it was once described as, there remain concerns over porous borders which continue to attract smugglers and other criminal elements trading in potentially dangerous commodities and goods. The most notable cases involving nuclear and other radioactive material—highly enriched uranium (HEU) and cesium-137—took place in or near disputed territories or involved material that allegedly came from these territories. For example, in 2015, three men were arrested in Moldova for attempting to sell cesium to an undercover police officer "posing as a middleman for the Islamic State group."[4] Prior to that, national authorities made several seizures of HEU on the Bulgaria–Romania border in 1999; in Georgia in 2003, 2006, and 2010; and in Moldova in 2011.[5] The 2011 Moldova case was especially emblematic of the relevance of disputed territories, as it allegedly involved the attempted sale of uranium-235 between a Russian citizen living in the Transdniestria region and an intermediary for a buyer in Sudan.[6]

Russia's war on Ukraine has accentuated the protracted conflict in the Transdniestria region, where Russia had raised "the prospect of using Transdniestria to open a second front against Ukraine and to pressure Moldova" during the early days of the full-scale invasion.[7]

CHALLENGES TO RADIATION SAFETY AND SECURITY IN THE TRANSDNIESTRIA REGION

After the collapse of the Soviet Union, many enterprises in the Transdniestria region continued to use devices with Soviet-era legacy and also retained disused radioactive sources that were taken out of commission and were unsuitable for further use. These devices were, for example, smoke detectors, liquid level gauges, and densitometers, etc. In its statement at the 63rd IAEA General Conference in Vienna in 2019, the Republic of Moldova's representative indicated that legacy radioactive sources on the territory of the Transdniestria region pose a major challenge to the country.[8]

The unrecognized Transdniestrian authorities have established radiation safety measures, including regulations on radiation protection for its population and assigned functions of radiation control, monitoring, response, and licensing to several institutions in the Transdniestria region.[9] Unrecognized Transdniestrian authorities nevertheless, do not have the independent technical capacity to dismantle and dispose of disused radioactive sources. During the Soviet period, such processes were carried out at special centralized enterprises located outside of the Transdniestria region, presumably at the disposal facility outside the city of Chisinau in central government-controlled territory. There is also no prior record of a precise inventory of radioactive sources carried out in the Transdniestria region. Moreover, the Transdniestria region lacks sufficient numbers of technical specialists to independently assess and conduct an inventory of these sources, which further undercuts the unrecognized Transdniestrian authorities' ability to implement radiation safety and security laws and regulations. Contributing to the complexity of this situation is that from a legal standpoint, the Republic of Moldova retains the de jure right to exercise regulatory control over these materials.

The combined lack of these technical and human resources, as well as some political and economic factors, laid the foundation for an initiative which resulted in a successful removal of many disused radioactive sources from the Transdniestria region for safe and secure disposal at the facility near Chisinau, the capital of the recognized government of the Republic of Moldova.

REMOVAL OF DISUSED SEALED RADIOACTIVE SOURCES AND MATERIALS FROM THE TRANSDNIESTRIA REGION

Between 2012 and 2019, more than 20 missions were conducted by Moldovan representatives and experts, with support by their counterparts from the Transdniestria region, to assess, dismantle, package, and transport approximately 2,700[10] disused and orphaned radioactive sources from current sites in the Transdniestria region to the designated storage facility of the National Radioactive Waste Management Company "Special Facilities 5101, 5102" outside Chisinau.

These removals are summarized in Table 1 which was compiled with the help of secondary data. Secondary data collection included online searches, and academic and technical literature reviews, including technical reports, conference proceedings, technical specifications, contracts, and international standards.

Table 1. Summary of isotopes removed from the Transdniestria region, 2012-2019[i]

Source type (isotope)	Number of removed units	
	According to Moldovan experts and open research	According to Transdniestrian experts
Cs-137 and Sr-90 (estimated number)[ii]	125+	61
Co-60	41	52
Am-241	10	11
Pu-239	2,137	2,262
Ra-226	3	12
Miscellaneous	4	18[iii]
Unknown	200+	5
Total	2,520+	2,421

[i] These isotopes and numbers of units (sources) are approximate and based on open-source research and information received during consultations/interviews with Moldovan experts and the head of the Radiation Monitoring Laboratory (RML) at the Regional Center for Hygiene and Epidemiology in Transdniestria. Given some substantial discrepancies between data provided by Moldovan and Transdniestrian experts as to the isotopic composition of the sources and recognizing that it may not be feasible to engage both parties to compare and verify data, the list presents technical details provided by the two sides in separate columns. The actual total numbers of removed sources are likely to be higher, about 2,700, as found in technical reports by Moldovan experts.

[ii] Devices containing these two isotopes were listed together making it impossible to identify specific numbers of each isotope removed. It is likely that the majority of them were caesium-137, as devices using that element are more commonly used.

[iii] The head of the RML provided information on the following sources that the authors of the present report included in the "miscellaneous" category: one dust particle measuring device containing promethium-147, one dust particle particle measuring device containing C 14 and 16 thickness gauges with Kr-85. It should also be mentioned that an expert that was reached out to by the authors shared some doubts as to the feasibility of use of the latter two isotopes for the reported purposes.

As Table 1 demonstrates, the removed sources encompassed a wide range of isotopes, including cesium-137, strontium 90, americium-241, and plutonium-239. While it was not always possible to find specific data about activity levels for many of the sources, the sources are likely to be categorized as IAEA Category 2-5 sources.[11] It is also known from technical reports and consultations that 36 cobalt-60 sources from the Researcher-1 gamma irradiator were Category 2 sources, and two medical cobalt-60 sources were Category 4 sources at the time of their removal. The largest number of sources removed were low-activity radioactive sources containing very small amounts of plutonium-239.

As specified in Table 2, the largest number of units, 1,052, were removed in 2016, but the most notable and well-documented removal mission took place in October 2019. It involved the removal of the Researcher-1 irradiator, containing 36 cobalt-60 IAEA Category 2 sources from the Transdniestrian Research Institute for Agriculture. This removal will be used as a case study in the remainder of this paper. It involved a high activity source that required special transportation and other arrangements, such as dismantling of a portion of a building where it was stored.

Table 2: Summary of removals by year, including information about funders[i]

Date	Number of Units	Funder
March 15, 2012	100+[ii]	OSCE
April, July 24, 2013	924[iii]	OSCE
April 28-29, 2015	198[iv]	OSCE
March 25, 2016	1,052	OSCE
July 17, 2018[v]	15	Swedish Radiation Safety Authority (SSM)
August 21-22, October 17, 2019	250	SSM, IAEA

[i] As with the previous table, the information used for composing this table was obtained through open-source research, as well as interviews with Moldovan experts and the head of Transdniestria's Radiation Monitoring Laboratory (RML). Given some discrepancies in information supplied by the latter two sources, the table features information provided by the Moldovan side and footnotes data from the RML if it differs from what was reported by the Moldovans. PMR authorities additionally indicated that 194 smoke detectors containing plutonium-239 were removed to Special Facilities 5101 and 5102 in 2008. This information was not verified with Moldovan authorities.

[ii] RML reported 10 units.

[iii] RML reported 914 units.

[iv] RML reported 195 units.

[v] RML does not mention this removal mission.

STAGES OF THE REMOVAL EFFORTS

The process of removing disused sealed radioactive sources and materials from the Transdniestria region occurred in three stages: a working-level initiative, a political commitment, and implementation.

Stage I: Working-Level Initiative

In November 2008, the State Enterprise Pridnestrovian (Transdniestrian) Research Institute for Agriculture ("Agriculture Institute") in Tiraspol and National Agency for Regulation of Nuclear and Radiological Activities (NARNRA) of the Republic of Moldova exchanged formal letters regarding the Soviet-era gamma irradiator Issledovatel-1, which was no longer in use. This led to a site visit by NARNRA experts to assess the technical condition of the Issledovatel-1 irradiator to ensure that it met safety requirements for the transportation of radioactive materials and did not leak radiation. At that time, the removal of any radioactive sources from the Transdniestria region would not have been possible without political backing and financial commitment. The idea of removal of radioactive sources from the Transdniestria region required political endorsement by both sides. Having secured

a pledge from the Agriculture Institute to receive a delegation of Republic of Moldova experts, NARNRA informed the Republic of Moldova Ministry of Environment of its intent to send a delegation to the Transdniestria region. NARNA and the ministry then reached out to the OSCE office in Tiraspol, which in turn notified unrecognized Transdniestrian authorities. That pledge led to the formation of a working group. The working group included representatives from both sides, including Republic of Moldova and unrecognized Transdniestrian chief negotiators, the Republic of Moldova Ministry of Agriculture, the Republic of Moldova Ministry of Environment, NARNRA, the unrecognized Transdniestrian Security Service, and the unrecognized Transdniestrian Sanitary and Epidemiological Service. The short-lived working group was instrumental in drafting an agreement that would lay the foundation for the removal of radioactive sources from the Transdniestria region.

Stage II: Political Commitment

As working-level communications with technical details advanced through the political hierarchy of the potential arrangement, political stakeholders from both sides became more actively involved, including unrecognized Transdniestria and Republic of Moldova officials who served as the chief negotiators of this arrangement. One should not disregard another factor that benefited the unrecognized Transdniestrian authorities in particular—the economic factor. By engaging in a removal process facilitated and funded by international stakeholders, the unrecognized authorities could solve the problem of disused radioactive sources without incurring significant financial costs, as these removals came at no cost to the operators and authorities in Transdniestria. Moreover, disposing of disused sources in a safe manner would also enable facilities in the Transdniestrian region to import new radioactive sources for future use.

Stage III: Implementation

Despite the different types of sources and facilities involved in these processes, all participating entities followed the order and procedures as prescribed in the "Protocol Decision on the order and procedures of the removal of ionizing radiation sources (IRS) located on the territory of Transnistria." Subsequently, all missions were carried out in compliance with these procedures and followed certain regulations and international guidelines as set by the IAEA. Often, one mission combined removals of radioactive sources from several locations. Removal of disused radioactive sources was a multilayered process: each mission required several months of planning and utilized a wide range of technical competencies, varying with the type of source(s) to be removed.

KEY STAKEHOLDERS AND THEIR ROLES

The removals of radioactive sources from the Transdniestria region required the efforts of a wide range of stakeholders on the technical, political, and international levels. This section summarizes the roles and responsibilities of some key entities that were directly involved in this complex and politically sensitive removal process.

The Republic of Moldova:

- National Agency for Regulation of Nuclear and Radiological Activities of the Republic of Moldova

  The National Agency for Regulation of Nuclear and Radiological Activities of the Republic of Moldova (NARNRA) is the regulatory body of the Republic of Moldova in the sphere of nuclear and radiological activities. NARNRA conducted assessment visits and issued all

necessary permits for the removal of the radioactive sources from Transdniestria. NARNRA specialists closely coordinated, monitored, and participated in the removal process.

- General Inspectorate for Emergency Situations

The General Inspectorate for Emergency Situations is part of the Ministry of Internal Affairs of the Republic of Moldova. Following the provisions of the law on civil defense, the inspectorate is responsible for protecting people and property in emergency situations. A special team of the inspectorate escorted trucks that transported radioactive sources and materials from Transdniestria to the RWMC's special storage facility, which is also administered by the inspectorate.

- "Special Facilities 5101, 5102" of the National Radioactive Waste Management Company (RWMC) of the General Inspectorate for Emergency Situations

State Institution of Special Purpose "Special Facilities 5101, 5102" is a state-owned company under the administration of the General Inspectorate for Emergency Situations (Ministry of Internal Affairs). It is the sole licensed company in the country responsible for safe management of radioactive waste, including disused sealed radioactive sources. Established in 1960 as an entity operating a Soviet RADON-type near-surface disposal facility,[12] it has participated in dismantling and decommissioning radiological facilities and devices, transporting radioactive materials, storing radioactive waste, and conducting assessments and surveys of radiological facilities and sites. The company carried out "the assessment, repacking and transportation of the waste from Transdniestria" to Chisinau and placed it in its storage facility.[13]

Entities of the Transdniestria region

-Republic's Center for Hygiene and Epidemiology of Transdniestria

The Republic's Center for Hygiene and Epidemiology (a part of the unrecognized Transdniestrian State Sanitary and Epidemiological Service) is responsible for the development, implementation, and enforcement of policy and regulations in the field of public health and epidemiology.

-Civil Protection Command Center

The Civil Protection Command Center of the unrecognized Transdniestrian authorities is part of the General Directorate of Emergency Situations within the Ministry of Interior. This entity is responsible for the fulfilment of civil protection tasks as stipulated in the Civil Defense Regulation. Unrecognized Transdniestrian authorities' law enforcement and the Civil Defense Department escorted convoys with radioactive sources to the Security Zone separating the sides.

- Interagency Working Group on the removal of sources of ionizing radiation for disposal outside of Transdniestria

The Interagency Working Group was created for the supervision and coordination of the removal of sources of ionizing radiation for disposal outside of Transdniestria. It comprised representatives of various unrecognized Transdniestrian authorities, such as the Ministry of Foreign Affairs, the Civil Protection Command Center, and the Republic's Center for Hygiene and Epidemiology.

Additional Stakeholders:

-Joint Control Commission

> The Joint Control Commission (JCC) is a supervisory body for the Joint Peacekeeping Forces, which were established after the cessation of hostilities in Moldova in July 1992. The commission was notified of each removal of radioactive sources and devices from the Transdniestria region.

-Organization for Security and Cooperation in Europe

> The OSCE Mission to the Republic of Moldova was established in 1993 to help facilitate a comprehensive and sustainable political settlement of the Transdniestrian conflict. The OSCE describes its role as follows: "The OSCE Mission to Moldova facilitated the necessary contacts between the sides, and monitored that Moldovan experts were able to perform their tasks and effectively perform the removal. The OSCE Mission had no responsibility or obligation regarding the process and was effectively just a facilitator in the confidence-building measure process."[14] It also coordinated the project and "provided financial resources to ensure the implementation of the project's activities."[15] The Mission administered technical, financial and procurement aspects of the project according to OSCE Rules, Regulations and Instructions. The OSCE Mission to Moldova maintained active communication with the project counterparts on the progress and outcomes of the activities under the Project. The Mission Project Team carried out frequent monitoring of implementation and regularly submitted progress reports to the Head of Mission, donors and the OSCE Secretariat." The OSCE's long experience in the region and on-the-ground presence made it an invaluable facilitator trusted by both sides. Its role as a confidence-building forum made it a natural body through which to channel funds to carry out the mission.

International funders of this project to date have included the OSCE and the International Atomic Energy Agency (IAEA), as well as the Swedish Radiation Safety Authority.

The Republic of Moldova authorities engaged contractors to help with removals, including the Center for Scientific Technical Development and *Energotel Grup*.

REMOVAL ARRANGEMENTS FOR THE RESEARCHER-1 GAMMA IRRADIATOR

This section offers an overview of some unique removal arrangements, including special transportation arrangements, made for the Issledovatel-1 gamma irradiator, with a focus on the device's physical removal from the site and its packaging and transportation. The procedure was carefully designed and executed with safety and security precautions that minimize the risk of accidental radiation leaks and contamination or the potential for theft or sabotage.

Since NARNRA did not detect elevated levels of radiation on the device's surface or leakage during its initial assessment of the Issledovatel-1 irradiator, the agency did not require the use of the additional lead shielding or transport containers that are typically required for transporting radioactive sources. The type, size, and weight of the device called for the use of additional equipment—a crane and a cargo truck, which were provided by contractors (INOTEH and Energotel Grup) to perform such tasks. This was the only removal that required the engagement of external parties. This process required lifting a roof off the building storing the device, extracting the device through the roof opening, and then replacing the roof to restore the building to its original condition.

This process was described in the technical proposal as "special arrangement transportation" consistent with the IAEA's Regulations for the Safe Transport of Radioactive Material."[16] The clause on special arrangements in this document states that the "competent authority may approve special arrangement transport operations for a single consignment or a planned series of multiple consignments. The overall level of safety in transport shall be at least equivalent to that which would be provided if all the applicable requirements in these regulations had been met. For consignments of this type, multilateral approval shall be required." NARNRA, as the competent authority in this removal process, usually issued permits for, and authorized activities under, this arrangement. It also conducted a radiological survey of the building before the device was packaged and transported and then conducted a contamination check of the truck after the device was unloaded. In addition to that, the technical proposal noted that RWMC organized the necessary insurance for civil liabilities and other contingencies.

Transportation is one of the most vulnerable stages in handling radioactive sources and materials and requires strong safety and security measures. In addition to the required safety procedures, stringent security measures were implemented during the entire transportation stage by both sides and the OSCE. The convoy was escorted by unrecognized Transdniestrian law enforcement and the unrecognized authorities' Civil Defense Department to the Security Zone, and afterwards by Republic of Moldova patrol police, the Republic of Moldova General Inspectorate for Emergency Situations, and other relevant agencies. The OSCE accompanied the convoy for the entire route, from the Agriculture Institute in Tiraspol to the specialized storage facility near Chisinau.

LESSONS AND CONCLUSIONS

The process of removing disused radioactive sources from the contested territory in the Republic of Moldova has demonstrated that cooperation between the two sides of the ongoing conflict is possible under certain conditions. As a result, other countries of the former Soviet Union, such as Azerbaijan, Georgia, and Ukraine[17] that are addressing similar challenges within contested spaces with radioactive materials can draw some practical lessons from the experience in the Transdniestria region, as summarized below.

Technical matters may sometimes serve as a catalyst for collaboration between the parties to a conflict, especially if the parties have a shared concern about risks and threats. This was the case with the risks posed by radiological materials outside of effective regulatory control and the lack of a radioactive materials disposal facility in the Transdniestria region. This combination led to the successful removal of 2,700 radioactive sources from the breakaway region of Transdniestria o a centralized storage facility outside the city of Chisinau. What started as a working-level exchange between the radioactive source operator in Tiraspol and the Republic of Moldova national regulator evolved into a sustained effort that was supported by leading political authorities on both sides of the Transdniestrian conflict and was facilitated and funded by international stakeholders. The early spadework at the working level ensured that cooperation continued unhindered amid political turbulence. One of the tactics that made this endeavor successful was the use by both sides of what they called a pragmatic approach to the removal of sources. While the ultimate goal was to secure and remove the Researcher-1 irradiator with Category 2 sources (cobalt-60), initial removals started with radioactive sources that were smaller and easier to handle. This allowed the parties to test the waters and build a more solid foundation for the removal of larger, higher-activity sources. Experts from both sides began with solving simple issues, then moved to more complex ones, gradually

accumulating experience, building mutual trust, and jointly working on the technical issues involved in such removals. When a trusting relationship between the two sides was established, it was much easier to resolve all technical issues, which ultimately made it possible to remove the Researcher-1 irradiator.[18]

The effort described in this paper may have particular implications for the current conflict in Ukraine. Even before the Russian full-scale invasion, the regulator in Ukraine reported that their control over many radioactive sources in conflict areas of eastern Ukraine and Crimea had been lost and that these radioactive sources may have fallen out of regulatory control. The full-scale Russian invasion has raised the continued prospects of such a loss of control and has broadened the geographic area of concern in Ukraine. In the postwar period, radiological control will need to be reestablished over radioactive materials in previous conflict areas in Ukraine**.** The model described in this paper may provide some guidance as to how organizations such as the OSCE may help to establish cooperation among the stakeholders in the region and effect return of control either by reinstating control and/or removing radioactive materials from areas where the establishment of permanent control is unlikely.

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[1] This paper is based on a recently published report titled "Radiological Security in Contested Territories: The Successful Case of the Removal of Disused Radioactive Sources and Materials from Transdniestria" (February 2023). An earlier version of this report was presented at the INMM & ESARDA Joint Virtual Annual Meeting (2021). This paper provides updates including final results and conclusions.

[2] For the purposes of this report, the authors use the term "contested territories," as defined by Leon Ratz et al.: "geographical areas, the political jurisdiction of which is contested between two or more parties." (see Leon Ratz, L. Ratz, J. Bufford, C. Gustavson, I. Iliopulos, L. Rockwood "Radioactive Sources in Contested Spaces: Assessing the Political and Legal Dimensions of International Response to Radioactive Sources in Areas with Weak or Non-Existent Regulatory Controls," July 14-18, 2019, 60th Annual INMM Meeting, Palm Springs, CA.

[3] Moldova/Transnistria (1990-Present), https://uca.edu/politicalscience/dadm-project/europerussiacentral-asia-region/moldovatrans-dniester-1990-present/

[4] Kelsey Davenport, "Smugglers Arrested in Moldova," Arms Control Today, November 2015, www.armscontrol.org/act/2015-11/news-briefs/smugglers-arrested-moldova

[5] Lyudmila Zaitseva and Friedrich Steinhäusler, "Nuclear Trafficking Issues in the Black Sea Region," EU Non-Proliferation Consortium Non-Proliferation Papers No. 39, April 2014, www.sipri.org/sites/ default/files/EUNPC_no-39.pdf

[6] 7 Petru Urasche, "Dosarul nr. 4-1re-172/2014," Supreme Court of Justice of the Republic of Moldova, May 2014, http://jurisprudenta.csj.md/search_plen_penal.php?id=395.

[7] Philip Remler, " Transdniestria, Moldova, and Russia's War in Ukraine," August 2, 2022, https://carnegieendowment.org/2022/08/02/transdniestria-moldova-and-russia-s-war-in-ukraine-pub-87609

[8] Ion Apostol, Statement by the Republic of Moldova at the 63nd IAEA General Conference Vienna, September 16-20, 2019, https://www.iaea.org/sites/default/files/19/09/gc63-republic-of-moldova.pdf

[9] The State Institution "Regional Center for Hygiene and Epidemiology" under the Ministry of Health, including its Laboratory of Radiological Control and the Radiation Safety Department; the Main Directorate for Emergency Situations of the Ministry of Internal Affairs; the Transdniestrian Customs Service; and the State Institution "Registration Chamber" of the Ministry of Justice.

[10] The first number 2,241 was listed in a written response to the questionnaire submitted by a representative of the Transdniestrian Regional Centre of Hygiene and Epidemiology on 23 September 2020. Another number, 2440, was reported by unrecognized Transdniestrian authorities on their official website: http://mfa-pmr.org/ru/node/7765. Moldovan experts reported the removal of 2,700 in the Technical proposal (Rev.1). Dismantling and transportation of Disused Sealed Radioactive Sources in the Republic of Moldova", RFP: 235316-DTE, 21 June 2019, p. 4-5, http://amp.gov.md/contentrepository/downloadFile.do?uuid=f3351cae-b664-40e4-8acb-b3e435fa4b9f.

[11] IAEA, Categorization of Radioactive Sources, Safety Guide, No. RS-G-1.9, Vienna, 2005, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1227_web.pdf

[12] The RADON system was established in the Soviet Union in the1950s and 1960s for the collection, transport, processing and near-surface disposal of "low and intermediate level institutional radioactive waste including disused sealed radioactive sources." See Alexander Smetnik, "The Safety Case and Safety Assessment for Radioactive Waste Retrieval from Historical RADON-Type Storage," in IAEA, International Conference on Radioactive Waste Management: Solutions for a Sustainable Future. Book of Abstracts, CN-294, Vienna, 2021, p. 177, https://www.iaea.org/sites/default/files/21/10/cn-294_book_of_abstracts.pdf.

[13] OSCE, email to authors, August 5, 2020.

[14] OSCE, email to authors, August 5, 2020

[15] Ibid.

[16] IAEA, Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series, 2018 edition, "Specific Safety Requirements," No. SSR-6 (Rev.1) (Vienna: IAEA, 2018), p. 17, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1798_web.pdf.

[17] If areas of the internationally recognized territory of Ukraine remain outside central government control at the conclusion of the current Russian-Ukrainian conflict, lessons from this report may be especially relevant for understanding how any cooperation on mutually beneficial issues (such as radiological security) might be conducted in the resulting heavily contested environment.

[18] Margarita Kalinina-Pohl, Artem Lazarev, Miles Pomper, George Moore, and Edward Kendall, " Radiological Security in Contested Territories: The Successful Case of the Removal of Disused Radioactive Sources and Materials from Transdniestria," CNS Occasional Paper # 57, February 2023, https://nonproliferation.org/wp-content/uploads/2023/02/radiological_security_in_contested_territories.pdf