Nuclear Forensics Sustainability and Cooperation: Inter-laboratory Exercises and International Cooperation on Nuclear Forensics

Liz Dallas, Oak Ridge National Laboratory

Olga Belyaeva, Center for Ecological-Noosphere Studies of NAS Republic of Armenia

Nona Movsisyan, Center for Ecological-Noosphere Studies of NAS Republic of Armenia

Aleksandre Dadianidze, Ministry of Internal Affairs, Forensics-Criminalistics, Georgia

Dimitri Lashkhi, Ministry of Internal Affairs, Forensics-Criminalistics, Georgia

Konstantin Pyuskyulyan, Armenian Nuclear Power Plant- Nuclear Forensics Laboratory

Stephen LaMont, Los Alamos National Laboratory

Lisa Hudston, Los Alamos National Laboratory

Michael Harris, Los Alamos National Laboratory

Klaus Mayer, European Commission Joint Research Center

Abstract

The U.S. Department of Energy's National Nuclear Security Administration's Office of Global Material Security (DOE/NNSA/GMS) and European Commission's Joint Research Centre (EC-JRC) have a long-standing cooperation in the area of nuclear security, including cooperative regional nuclear forensics capacity-building initiatives. Within the framework of the International Science and Technology Center (ISTC), GMS and EC-JRC collaborated with Armenian and Georgian partners to develop a project designed to support sustainable nuclear forensics capacity in each country, and to exchange best practices between countries. This project commenced in September 2021 and has a performance period of 3 years.

The implementation of the project over the past year has seen several significant collaborative engagements between nuclear forensics experts in Georgia and Armenia. Through tight coordination between scientific institutions and the government agencies of Armenia and Georgia, high-level interregional/international collaboration (USA, EU, South Caucasian countries) became a real possibility. By identifying the strength of each partner, project work has enabled the sharing of the best practices in the field of nuclear forensics, including organizing practical trainings, development and adoption of documentation, and sharing experience for reinforcing regional cooperation and international partnerships. These regional partners represent an excellent model for collaboration; this paper will describe the project work and collaborative approach.

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Introduction

The United States National Nuclear Security Administration's Office of Nuclear Smuggling Detection and Deterrence (NSDD) and European Commission's Joint Research Centre (EC-JRC) and have a long-standing cooperation in the area of nuclear security, including regional nuclear forensics capacity-building initiatives.

In 2010, Armenian Nuclear Power Plant (ANPP) received Civilian Research Defense Fund (CRDF) grant titled "Establishment of the Laboratory for Technical and Forensic Analysis of Nuclear and Radioactive Materials (Armenian FL) in the Republic of Armenia." In 2017, the newly founded Armenian FL received modern stationary and portable gamma spectrometers, an iMatic™ alpha/beta counting system and an alpha spectrometer. Administrative documents and technical operating procedures were also developed for the laboratory.

Department of Radiation Protection of ANPP has been cooperating with the Center for Ecological-Noosphere Studies (CENS) in the field of radiation monitoring since 2016. In 2020, this successful cooperation enlarged and enabled CENS to participate in supporting Armenian FL activities.

In Georgia, nuclear forensics is the responsibility of the Forensic Criminalistics Department of Ministry of Internal Affairs of Georgia (FCD MIA). Accordingly, the nuclear forensics unit is an integral part of FCD's operation. A dedicated nuclear forensics unit was formed in 1996 as part of the state security service of Georgia. In 2004 the state security service and the Ministry of Internal Affairs underwent a restructuring. As a result, responsibilities of the Forensic-Criminalistic division of MIA were expanded and it was rebranded as the Forensic-Criminalistics department of MIA. Among the responsibilities of newly formed FCD was nuclear forensics and Nuclear Forensics Division that was working under SSSG has been transferred to FCD.

Within the framework of the International Science and Technology Center (ISTC), NSDD and EC-JRC collaborated with Armenian and Georgian partners to develop a project designed to support sustainable nuclear forensics capacity in each country and exchange of best practices between countries. This project commenced in August 2021 and has a performance period of 3 years.

Concept and methodology of AM-2541 project

The overall concept of the project is based on deep understanding of strengths and weaknesses of participants, identifying both the opportunities and threats that participating institutions experience in their respective states. The implementation of the project over the past year has seen several significant collaborative engagements between NF experts in Georgia and Armenia. By identifying the strength of each partner and engaging in both self-training and external training opportunities, these regional partners represent an excellent model for collaboration.

The results of SWOT analysis for Armenian FL and FCD MIA suggested the Strengths, Opportunities and Threats for both of organization are rather similar, meanwhile the identified Weaknesses differed considerably (Table 1).

In Armenia, the main challenges are related to imperfections in regulations that specify relationships between state agencies, law enforcement bodies and FL experts involved in radiological crime scene management. This creates significant concern for all parties about the investigations involving nuclear or radioactive materials, or radioactively contaminated physical evidence. Moreover, Armenian FL continue to experience brain drain through retirement of senior personnel, while recruitment and training new staff is time-and-resource-intensive process.

In Georgia, challenges include lack of equipment, inadequate laboratory space, insufficient personnel, and inadequate training opportunities. Furthermore, the Nuclear Forensics Division has struggled to establish strong relationships with other laboratories outside the country, thereby limiting its ability to adopt best practices and develop standardized operating procedures. These challenges have negatively affected the development of Georgia's nuclear forensics analytical capabilities and the potential to enhance nuclear security not only within the country, but also regionally and eventually globally.

In response to these issues, Armenian FL and the Forensic Criminalistics Department has been engaged in numerous international projects, including the AM-2541 project, aimed at strengthening joint nuclear forensic capabilities between two neighboring countries.

Based on the SWOT analysis results, several action strategies addressing main knowledge and organizational gaps were developed (Table 2). Individual and overall gaps in the field of Nuclear Forensics were addressed for both states. In Armenia main activities should focus on improving interagency cooperation. Development of agreed protocols are a condition to successful domestic, multi-agency field operations and crime scene management. In Georgia, the main gap is related to the lack of a specialized testing laboratory and experience in specific procedures (e.g., alpha spectroscopy and radiochronometry, etc.), thus priorities were identified to enhance technical capabilities and expertise. Common for both countries were gaps in radiation safety measures during work with nuclear materials and radioactive sources at the crime scene and in the laboratory.

Table 1: Results of SWOT analysis in brief

Armenian FL		
Internal factors	STRENGTHS ✓ Skilled staff ✓ Resources: Analytical facilities; Software; Calibration Sources and Reference Material ✓ Combination of key capacities: Research + Education + Technical capacities capabilities	WEAKNESS ✓ Imperfection of interagency relation regulations ✓ No accreditation by ISO 17025 and incomplete QMS ✓ Lack of experience in Radiological Crime Scene Management ✓ Lack of experience alpha spectrometry ✓ Lack of participation PT ILC
External factors	OPPORTUNITIES ✓ International treaties in the field of illicit trafficking of nuclear and radioactive materials signed by Armenia ✓ Technical support from Los Alamos and Oak Ridge National Laboratories, JRC Karlsruhe ✓ PT, ILC; Spectral Flavor, etc.	THREATS ✓ Political instability ✓ Lack of budgetary financing ✓ Lack of regulations of Armenian FL relations with authorities: ANRA, MES, Police, Customs Service, etc. ✓ Absence of response plan ✓ Brain drain

Table 1, continued: Results of SWOT analysis in brief

Forensic-Criminalistic Department of MIA, Georgia		
Internal factors	STRENGTHS ✓ Qualified staff ✓ Quality Management System (QMS) implemented within the organization in compliance with the requirements of ISO17025:2017 standard ✓ Implemented QMS is ensuring further expansion of the scope of ISO17025 accreditation and continual improvement of the provided services	WEAKNESS ✓ Lack of specialized testing laboratory for examination of nuclear-radioactive materials ✓ Lack of the certified reference materials and standards. ✓ Overall lack of financial resources and mostly dependent on funding of the international donors.
External factors	OPPORTUNITIES ✓ Fundraising ✓ Networking and information sharing ✓ Continued education and staff training	THREATS ✓ Brain drain ✓ Political instability ✓ COVID-19 pandemic

Table 2: Action strategies

Factors	Opportunities external positive	Threats external, negative
Strengths internal positive	Strength-Opportunity strategies ✓ Implementation of trainings, development of internal documentation	Strength-Threat strategies ✓ International cooperation and networking
Weaknesses internal, negative	Weakness-Opportunity strategies ✓ International and interagency communication ✓ Enhancement of international cooperation	Weakness-Threat strategies ✓ Promoting needs of National NFLs international donors and through the broader NF network

International cooperation: knowledge transfer and sustainability

Within the framework of the ISTC AM-2541 and with tight coordination between scientific institutions and government agencies of Armenia and Georgia, high-level interregional/international collaboration (USA, EU, South Caucasian countries) became a real possibility. A long-term project to assist Armenia and Georgia with establishing laboratory capabilities for characterizing nuclear materials by alpha spectrometry began in 2015. The initial stage was the assessment of laboratory facilities at ANPP by LANL, NSDD, followed by the acquisition of instruments, calibration sources, and standard reference materials. The project continued over the next two years. The next milestone was in 2018, when Armenian scientists

received practical training on alpha spectrometry at LANL. The fruitful cooperation within the ISTC AM-2541 project enabled the inclusion of FCD MIA in the next round of training on "Alpha spectrometry Applications to Nuclear Forensics and Radiochronometry", which was held at the ANPP laboratory and taught by specialists from Los Alamos National Laboratory (LANL), USA (Dr. S. LaMont, Dr. M. Harris, Ms. L. Hudson) in 2022. Before this two-week course on alpha spectrometry, the scientific infrastructure in Armenian FL laboratory was established and all the necessary materials and reagents were acquired. The course included both lectures and laboratory modules designed to give students practical experience necessary to determine key forensic characteristics of uranium samples, including isotopic composition and radiochronometric model ages.

The AM-2541 project has been a major success, enabling procurement of the new equipment (alpha spectrometer and accessories) for FCD MIA and providing multiple training opportunities for new and existing personnel.

The AM-2541 project also covers the training on gamma spectrometry for project participants. Before the AM-2541 project implementation, Armenian specialists from ANPP and CENS were already familiar with the gamma spectrometer, which was used for environmental radioactivity measurements. During AM-2541 project, Armenian specialists implemented a three-stage training on gamma spectrometry application to nuclear forensics through mutual visits to Armenian FL and MIA, Georgia. Four participants from MIA attended these trainings that were based on the training-of-trainers concept, with the idea that participants would be able to train additional personnel. The training agenda was developed by CENS and ANPP with the continuous consultation with MIA's leading staff. Training modules included both theoretical and the practical parts. For the practical part of the project, IAEA-447 certified reference material, point radioactive sources, environmental samples were used. Several cases and scenarios for applying gamma spectrometry to nuclear forensics were discussed. Special attention was paid to quality assurance procedures. The opportunities to conduct intercomparison measurements between laboratories have additionally contributed to building expertise within both Armenian FL and MIA, leading to a greater understanding of the complex and multidisciplinary nature of the nuclear forensics.

This collaboration has already resulted in the sharing of best practices in the field of nuclear forensics, including organizing practical trainings, development, and adoption of documentation, sharing experience for reinforcing regional cooperation and international partnerships. Additionally, the project has facilitated the sharing of experiences, allowing the Forensic Criminalistics Department to learn from other laboratories and to improve its capabilities in nuclear forensics.

Development of documentation

ISTC AM-2541 project has fostered cooperation between inter-country laboratories, leading to significant improvements in development of the standardized operating procedures based on internationally recognized methods and best practices.

Since 2010 more than forty documents and standard operating procedures were prepared by ANPP for Armenian FL, regulating and describing the activities of laboratory and nuclear crime scene management. Currently, the existing documents are undergoing review, moreover new documents are being developed by Armenian specialists. This new documentation also includes the analytical methods for the determination of individual nuclear and radioactive materials as well as the examination of evidence contaminated with radionuclides using analytical techniques, specific equipment and software used in the nuclear forensic analysis. All the prepared documents are

transferred to the Georgian partners for legal adaptation in accordance with local legislative base, translation and application.

Concluding remarks

Collaborative work under AM-2541 has led to significant new regional nuclear forensics capacity in the Caucasus. The success of the AM-2541 project has highlighted the importance of establishing a specialized nuclear forensics laboratory in Georgia. The Forensic Criminalistics Department has fully acknowledged the need for such facility and is actively working to facilitate its eventual construction.

The success of the regional Georgian-Armenian collaboration can serve as a model for future mutual projects between laboratories, further strengthening regional and global nuclear security. The effective practical courses on alpha and gamma spectrometry for all parties, especially for young participants provided an opportunity to deepen knowledge and acquisition of the skills, as well as creating the prerequisites for the regional development of the nuclear forensics field in general.

INMM NF Working Group could serve the AM-2541 project as a mechanism for exposing Armenian and Georgian participants to other countries' strategies for growing their NF programs. Of particular interest in terms of lessons learned are: the development of law/policy that supports NF analysis of interdicted material; the development of a National Nuclear Forensics Library to a level appropriate for each country; the ability to categorize material to determine the appropriate level of analysis required; and the ability to characterize interdicted material to a level appropriate for that country.