The network of Russian analytical laboratories for support of Nuclear Forensics

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Abstract. Traditional forensics laboratories have not necessary experience in analysis of nuclear and radioactive materials, and they are not able to investigate the conventional evidence together with radioactive materials. Therefore involvement of laboratories which can provide appropriate analysis of nuclear and radioactive materials is necessary for achieving all possible objectives of criminal investigations with nuclear and any other radioactive materials or its trace amounts. Four organizations cover analytical nuclear forensics needs in Russia. No one of these analytical subdivisions can solve all analytical tasks on the highest level. But these four analytical subdivisions together are able to solve all analytical tasks for nuclear forensics with the best possible quality.

1. Introduction

Russia has a well developed system of forensics organizations in the Ministry of Justice, Ministry of the Interior and Federal Security Service. These organizations are staffed by the highly qualified experts and the system is capable to implement the wide range of expert investigations, such as fingerprints, biological traces, microparticles of natural and anthropogenic origin, gunshots and explosions traces, etc.

But investigations, which are usually being implemented by these organizations, not concern radioactivity. Therefore cooperation of these organizations with laboratories which can provide prosecution with appropriate results of analysis of nuclear and radioactive materials is necessary for the solution of entire the diversity of nuclear forensics tasks.

On the nuclear security summit in Haag the Russian minister of foreign affairs S. Lavrov stated that Russia is developing a system of forensic laboratories to identify nuclear and other radioactive materials and radioactive waste removed from illicit trafficking. The purpose of this paper is the clarification of the basic principles that inspired the creation of the system as well as description of this system content.

2. Basic principles of the creation of the system

Criminal prosecution of the incidents with unknown nuclear and other radioactive materials including illicit trafficking of these materials is organized in Russia in correspondence with national laws: criminal code, code of criminal procedure, law about forensic activity in Russian Federation, laws, which determine the handling of radioactive materials, as well as in correspondence with interdepartmental documents.

Nuclear forensic has obvious interdepartmental character because criminal prosecution is implemented by law enforcement agencies, but the expert functions should be provided by specialists in the field of nuclear and other radioactive materials. National model incident response plan designed to address the questions of interdepartmental relationship. Now some alignment of Russian response plan with Model plan, which is outlined by [1], is being implemented. This Response plan consists of several sections, including the section about the support of prosecution by the results of investigation of nuclear materials and other radioactive evidence.

The development of that section of the Response plan and possible scheme of analytical activity is based on several points:

- Illicit trafficking is inherent not only to nuclear and other radioactive materials. It is inherent to drags, weapons, explosives and other chemical reagents, etc. From the point of prosecution the crime investigations of the incidents with all these items are distinguished only by some evidence and consequently by technical experts, which should be involved in investigations.
- Analytical capability of the system should provide the possibility of the solution of any analytical task on the highest analytical level. Accordingly the provision of the record levels for each analytical method should be provided.
- Incidents with nuclear and other radioactivity materials occur relatively rare. It means that involving of high level analytics in the investigation is necessary not so often.

First of these points determines coordination of documents and procedures of nuclear forensics with ones developed for prosecution of illicit trafficking of other mentioned objects. Second point determines the necessity of the developing of any relevant analytical technique up to highest possible scientific level at least in one scientific laboratory. The same point together with understanding of rareness of the incidents mean that it is too expensive and not necessary to have one specialized laboratory, which could to implement any required for nuclear forensics goals analysis, and to use such laboratory exclusively for nuclear forensics analyses. A lot of time such laboratory and accordingly high qualified specialists would have to implement the training and wait the real work.

At the same time these high qualified specialists can implement useful work, which is not concern nuclear forensics, in their laboratories in cooperation with other specialists of their laboratories. Moreover specialists can support their qualification only by implementing real important works. Such works can not be replaced by a lot of trainings.

Therefore the decision was made in Russia – not collect all methods and specialists, necessary for nuclear forensics, in one laboratory, but develop corresponding techniques in laboratories, in which these techniques were developed earlier and are necessary for usual works. Some modifying of early developed techniques is requested in correspondence with possible specific of the evidence, but the major part of working time and efforts are spent by the laboratories and specialists for their routine work. In the case of nuclear forensic investigation the concrete techniques, which should be applied in investigation, are determined. Corresponding laboratories and specialists are involved in the investigation after such of determination.

3. Analytical tasks of nuclear forensics

Solution of the following basic analytical tasks can be required in the process of nuclear forensic investigations for achieving the all possible objectives of criminal investigations:

- Measurement of the content and isotopic composition of uranium, plutonium and other radioactive materials in samples – for identifying the materials and determination of the possible fields of their use;
- Determination of the elemental composition of nuclear and other radioactive samples, including elemental composition of impurities – for identification of possible manufacturer of the materials and, in some cases, designation of materials;
- Determination of morphological characteristics of nuclear material fragments – for identification of possible manufacturer of the materials;

- Detection of the trace amounts of nuclear and other radioactive materials on the clothing, household items, in samples, collected at the crime scene and at the suspected crime scene – for determination of the route of illicit trafficking and the circle of involved persons;
- Detection of the nuclear and other radioactive materials including their trace amounts on the body surface, in the biopsy, autopsy and in the metabolism products – for determination of the circle of involved persons;
- Measurement of isotopic composition of uranium and plutonium in microparticles – for identifying the materials and determination of the possible fields of their use;
- Determination of elemental composition and morphological characteristics of microparticles of nuclear and other radioactive materials – for determination of mechanism of microparticles formation and for determination of possible manufacturer of the materials;
- Measurement of the content of isotopes-chronographs in all types of specimens and samples, as well as in individual microparticles – for determination of the date of production of nuclear or other radioactive materials.

All these analytical tasks are solved by different Russian laboratories in their habitual works. These works concern the study of materials of nuclear technique, IAEA Safeguards, geology, mineralogy and even medicine, including disaster medicine. But laboratories, which demonstrate the highest level of corresponding techniques, should be chosen for the nuclear forensic applications.

4. Laboratories – members of Russian Network

Analytical capabilities of laboratories are the main component of country's capability in the field of nuclear forensics. These analytical capabilities determine country's ability to implement comprehensive investigation of any incident with illicit trafficking of nuclear materials.

Capabilities of analytical laboratories are determined by:

- Qualification of personal;
- Level of the used analytical equipment;
- Methodological support.

Four organizations cover analytical nuclear forensics needs in Russia. These are: Information and analytical center for identification of nuclear materials, founded on the base of analytical division of the Rosatom's Bochvar Institute, analytical laboratories of the Rosatom's Khlopin Radium Institute, analytical laboratories of the Federal Medical Biophysical Center of Russian FMBA, "Laboratory for Microparticle Analysis".

No one of these analytical subdivisions can solve all mentioned analytical tasks on the level of the highest world standards. But each of them possesses some unique analytical techniques, which correspond to the world level, and these four analytical subdivisions together are able to solve all analytical tasks for nuclear forensics with the best possible quality.

The Bochvar Institute is the main Rosatom's organization in all matters of nuclear materials and technologies, including the technologies of nuclear materials processing, the technologies of radiochemistry facilities and radioactive waste processing. The Bochvar Institute owns database of Russian and Soviet nuclear materials. Comparison of the results of analysis of

seized nuclear materials with some information about Russian and Soviet materials allows to determine possible samples for further comparative in-depth investigation.

Apart comparison of any information with information from database the Bochvar Institute can provide prosecution with following kinds of analytical investigation:

- Measuring of the content and isotopic compositions of uranium and plutonium in samples of nuclear materials;
- Determination of morphology characteristics of the fragments of nuclear materials;
- Analysis of external details, including inscriptions, symbols and signs, on the surface of the products from nuclear materials.

But analytical equipment of the Bochvar Institute and developed techniques designed first of all for the solution of technological tasks and analysis of relatively large amounts of materials.

For the solution of nuclear forensics analytical tasks, which are connected with characterization of the trace amounts of uranium and plutonium and other radioactive materials, laboratories of Khlopin Institute and “Laboratory for Microparticle Analysis” are designed. Both organizations are the members of IAEA Network of analytical laboratories for analysis of environmental samples. Therefore they are ready to work with the crime scene samples, which contain small amounts of sought-for materials.

Laboratories of the Khlopin Institute measure the content and isotopic composition of picogrammes and femtigrammes of uranium and plutonium. Detection limits for plutonium isotopes as well as for uranium-234 and uranium-236 are the units of femtogramme, for uranium-235 – dozen of femtogrammes, for uranium-238 – about 1 pg.

“Laboratory for Microparticle Analysis” investigates morphology characteristics and elemental compositions of individual particles with sizes down to 0.5 μm as well as isotopic compositions of uranium and plutonium and the content of isotopes-chronographs in particles. Moreover it determines impurities and the content of isotopes-chronographs in the small amounts of the uranium and plutonium materials.

Determinations of nuclear and other radioactive materials on the bodies of the people as well as in materials of biopsy and autopsy are implemented by Federal Medical and Biophysical Center. This Center posses unique experience of investigation of human organs, which were contaminated in the result of different incidents with nuclear and other radioactive materials. Specialists of this Center posses of information about possible accumulation of nuclides in specific human organs. Besides they have invaluable experience of analyses of biological samples by using different analytical techniques.

For some kind of nuclear forensic tasks these four laboratories organize and implement joint investigations, including Round Robins. The similar techniques as well as the different methods are used in these experiments for the determination of the same characteristics of nuclear and other radioactive materials.

REFERENCES

[1] “Nuclear Forensics Support”, IAEA Nuclear Security Series NSS-2, 2006