

A Study on Research Trend in Nuclear Forensics

Kyungmin Kim, Hobin Yim, Seungmin Lee, Yunjeong Hong, Jae Kwang Kim

Korea Institute of Nuclear Nonproliferation and Control, 1534 Yuseong-daero, Yuseong-gu, Daejeon, Korea 305-34

*Corresponding author: kmkim@kinac.re.kr

1. Introduction

The international community has recognized the serious threat posed by nuclear and other radioactive material out of regulatory control. To address these concerns, the Office of Nuclear Security of the international Atomic Energy Agency (IAEA) is developing, inter alia, guidance for nuclear forensics to assist Member States [1].

According to the IAEA Incident and Trafficking Database (ITDB) of the IAEA to record the illegal trade and trafficking incidents of nuclear material or other radioactive material, incidents of 2331 have been reported in 1993 to 2012 (Fig.1)[2].

These incidents mean that we are not safe for nuclear material. In order to solve the case generated by the illicit trafficking of nuclear material and the efficient management of nuclear material, the study of nuclear forensics is very important.

However, currently, the research level of nuclear forensics in the ROK, because it is at an early stage, it is essential to investigate the research trend of nuclear forensics.

In this study, we investigated the analytical techniques and the current status of nuclear forensics research.

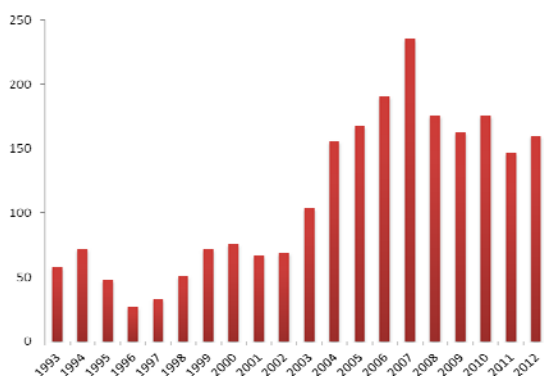


Fig.1. Incidents Reported to the ITDB, 1993-2012

2. Current Status of Nuclear Forensics Research

2.1 U.S.

National Institutes of U.S. DOE affiliation plays an important role in nuclear forensics activities. There are LLNL, New Brunswick, and Sandia, etc. The major laboratory is conducting research, such as the following.

2.1.1 LLNL

LLNL is studying chemical analysis of nuclear material that has been illegally trafficking, isotope, morphological analysis. And study characteristics of the isotopes of uranium, particle characteristics, and the fine structure. Also support the ITWG with IAEA. .

2.1.2 New Brunswick Lab

New Brunswick Lab is studying strategy nuclear material, nuclear materials control and accountability, development of analysis procedures, nuclear non-proliferation.

2.1.3 Sandia LAB

Sandia LAB carrying out development of radiation measuring instruments, radiochemical analysis, nuclear forensics scenario development.

2.2 IAEA

IAEA have developed a Nuclear Series No.2 based on Model Action Plan and carrying out the Coordinated Research Projects (CRP). CRP is studying the technology and procedure of nuclear forensics for trafficking prevention of nuclear material, Identification of the material that has been seized, Share of procedures and techniques.

3. Analytical technique in nuclear forensics

When the nuclear material of the unknown is found, it is possible through analysis of the laboratory and the field in the early time, as compared to a library of nuclear materials, to reveal the source of the nuclear material.

ITWG has developed a Model Action Plan in the procedure of nuclear forensics analysis (Fig.2). IAEA is suggested as shown in Table 1 The analysis method according to the reference date of the discovery of nuclear materials.

3.1 Physical measurement

The first step in the evaluation of the physical properties of the samples is to measure the color, size and mass of the test material, photographs, sample density, height generally. For example, sometimes nuclear fuel pellets can be produced in other forms. For

sealed sources it must be measured the material component size and the packaging container.

3.2 Chemical and elemental measurements

Chemical forms of the radioactive material or other (or intermediate product metal oxide) nuclear material can be used as important materials in accordance with the purpose, and the important information about the manufacturing process of the material. For example, in the case of intermediate products of uranium, it is possible to provide information about the process used to produce the material; the chemical compound form can be used to narrow down the candidate facilities which produced uranium.

3.3 Isotopic measurements

Measurement of the isotope is carried out to determine the abundance of isotopes of elements present in the nuclear material or other radioactive material. Isotopic ratios, provides information about its intended use and history of the sample. For example for use in nuclear weapons is possible, measurement of isotope composition ratio is very important nuclear fuel that has been reprocessed and highly enriched uranium.

Table.1. Laboratory methods and techniques with typical timescales for completion of analyses [3]

Techniques /Methods	24Hours	1Week	2Month
Physical characterization	Visual Inspection Radiography Photography Weight OM Dimension Density	SEM XRD	TEM
Elemental /chemical composition		ICP-MS Chemical assay FTIR IDMS	GCMS
Isotope analysis	α -spectroscopy γ -spectroscopy	TIMS ICP-MS	SIMS Radioactive counting technique

SEM: Scanning electron microscopy
TEM: Transmission electron microscopy
XRD: X-ray diffraction
ICP-MS: Inductively coupled plasma source mass spectrometry
FTIR: Fourier transforms infra-red spectrometry
IDMS: Isotope dilution mass spectrometry
TIMS: Transmission electron microscopy
GCMS: Gas chromatography mass spectrometry
SIMS: Secondary ion mass spectrometry
OM: Optical Microscopy

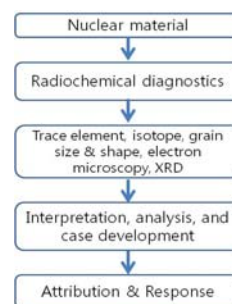


Fig.2. ITWG Nuclear forensics Model Action Plan [4]

5. Conclusions

In this study, we investigated the current status of research of nuclear forensics, procedures for analysis and nuclear forensics analysis technique. A result of the study, we have been found that the major institutes and laboratory actively research on analysis technique and nuclear forensics.

However, research on nuclear forensics is still in early stage, ROK is necessary preliminary survey of analysis technique and foundation of physical, chemical, and morphology characteristics of nuclear materials. Also additional studies, such as data mining methods and models for interpreting the data analyzed or analysis manual is required.

Acknowledgement

This work has been carried out under the nuclear research and development program supported by NSSC.

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