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Approach for Establishing a National Nuclear Forensics System

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1. Introduction

Since the collapse of what was the Soviet Union in 1991, there have been an increasing number of nuclear and other radioactive materials reported to be stolen or lost in the IAEA data base[1]. The increasing number could give rise to posing a potential threat to national infrastructure which is very vulnerable to radiological sabotage with the materials. International community has been emphasizing the importance of nuclear forensics through the Nuclear Security Summit process as a countermeasure against nuclear terrorism.

Global Initiative to Combat Nuclear Terrorism(GICNT) and nuclear forensics International Technology Working Group(ITWG) suggest the establishment of national nuclear forensics system which has a law enforcement for forensic management and maintenance of nuclear forensics database including nuclear material and other radioactive materials.

We suggest the legal and institutional system through this paper in an effort to set up a multi expert group and the nuclear forensics DB which can contribute to effective Core capabilities.

2. Proposed response manual for nuclear forensics

2.1 Legal basis background

There are some act and regulations on forensics such as 'the Act on the use and protection of DNA identification information', 'Regulation on forensics for gene', 'Regulations on the forensics for drugs'(Prosecutor's Office established rule). I think it is not necessary to stipulate nuclear forensics in the act, because there is no possibility that the information on nuclear material violate human dignity and the privacy of individuals, unlike DNA. And it is appropriate for nuclear organization to be in charge of nuclear forensics, because loss and theft of nuclear material does not often occur as traditional crimes and nuclear forensics costs much. We have a plan to add a proposed manual for nuclear forensics to existing radiological terrorism response manual. Statistically, the main purpose of illicit trafficking of nuclear material is not financial gain but terrorism therefore we consider amending radiological terrorism response manual considering the proposed manual.

2.2 Response procedure and role of participant organizations

In the proposed manual, we will stipulate response procedure and role of participant organizations in each step. According to the manual, we could implement Table Top eXercise (TTX) to respond against illicit trafficking of nuclear material and terrorism in completing the manual.

Response procedures which could be applied to the manual are suggested as follows[2]:

a. Securing the incident site: Minimize any radiological hazards associated with the incident site and preserve both nuclear and associated traditional forensic evidence. KINS may be involved in this step.

b. On-site analysis: Categorize the suspected radioactive material using gamma ray spectrometry and neutron detection. We should be equipped with these instruments.

c. Collection of evidence and distribution: collect nuclear and traditional forensic evidence and distribute them to laboratory. We need to investigate the capability of each laboratory for nuclear analysis.

d. Nuclear forensic analysis : analyze the material including major, minor and trace constituents, match analytical data with existing information on sources and methods used to produce radioactive material and attribute the material including origin, method of production, probability that more of the material exist, transit route and the way that regulatory oversight was lost.

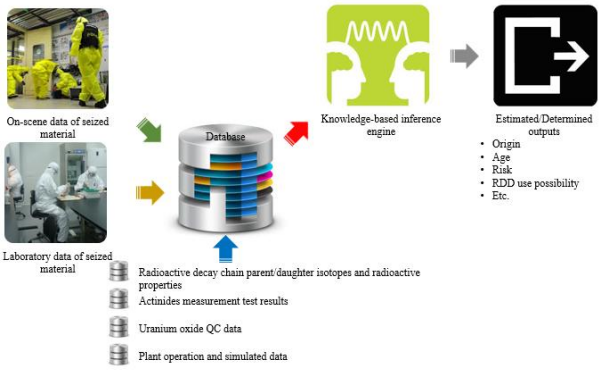

Fig. 1. Process of nuclear forensics

3. Necessity of radiological material library for nuclear forensics

It is necessary to establish a radiological material library for nuclear forensics like fingerprint registration system for identification of material. So we should amend nuclear authority's regulation so called 'Regulation on Reporting the Internationally Regulated Materials'. In the following, we will take the consideration into who, what, when and how information for the library should be provided.

3.1 Information providers

Any of organizations holding nuclear material should basically provide information to the library legally or institutionally. In terms of reporting the information regarding nuclear material to the authority in establishing some nuclear material libraries, the target of nuclear forensics is consistent with that of IAEA Safeguards whose library is call as Material Control & Accounting (MC&A). For the Safeguards, the information providers would be Korea Hydro & Nuclear Power Co. (KHNP), Korea Nuclear Fuel Co. (KNF), Korea Atomic Energy Research Institute (KAERI), Kyung-Hee Univ. operating educational research reactor and other companies handling small quantity of nuclear material. As shown below, the safeguarding entities should report to the government, Nuclear Safety and Security Commission (NSSC), through Korea Institute of Nuclear nonproliferation and Control (KINAC) which is responsible for nuclear security, safeguards and Ex-Import control.

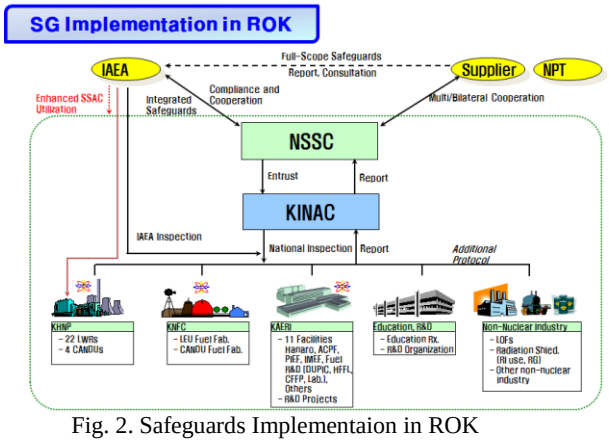

Fig. 2. Safeguards Implementaion in ROK

3.2 Scope of information

Safeguarding information is legally reported and collected for the MC&A as mentioned. In analyzing and identifying for the purpose of the nuclear forensics, the information should be extended to some extent as it does not contain some characteristics required for nuclear forensics. Physical and chemical characteristics, physical shape, etc would be required for the library for nuclear forensics. A little information can be accessible by any unauthorized person as most are trade secret, so the scope of information would be needed to adjust as shown below.

Characteristic	Characteristics-Data elements	Data discriminator	Notes
Physical characteristics	●Rod/plate/pellet information ●Density ●Surface roughness ●Dimensions of nuclear fuel pellets ●Cladding (material, thickness) ●Plans/drawings	High	Description of uranium fuel material to include features of rods, plates and pellets Density of nuclear fuel pellets expressed in g/cm³ Plans, schematic drawings of photographs of rods, plates and pellets
Item description	●Serial number format	High	-
Morphology	●Grain/particle size ●Shape ●Colour	Low	Particle size expressed in nanometers or millimeters and distribution of particle sizes (e.g. histogram) Descriptive shape of individual grains (e.g. round, oval, square)
Chemical form	●Compound name ●Compound composition	High	-
Uranium concentration	●Per cent uranium concentration ●Uranium concentration uncertainty	Medium	Expressed in mass per million
Trace element concentration	●Trace element name ●Trace element concentration ●Trace element concentration uncertainty	Medium	Expressed in parts per million To include thorium
Uranium isotopes	●Isotope ●Atom per cent abundance of each isotope ●Isotope abundance uncertainty	High	^{230}U, ^{235}U, ^{234}U, ^{233}U, ^{232}U, ^{236}U
Process information	●Process type ●Date and duration of the process ●Location of processing site	High	Process type (e.g. fuel pellet manufacture) Date and duration of processing and location of processing site

Fig. 3. Characteristics required for nuclear forensics

3.3 report period

Nuclear licensee should report any change of nuclear inventories within 15days from the end of the month when the change occurred according to the Nuclear Safety Act. The ultimate goal of nuclear forensics is to analyze and identify the origin of nuclear material of missing or stolen, while that of safeguards is to verify any potential diversion. Therefore, the monthly reporting for safeguards is too frequent for the library for nuclear forensics. If Quality Control (QC) information would be provided additionally by the licensees, quarterly reporting frequency could be enough to establish and manage the library for nuclear forensics.

4. Conclusion

Nuclear forensics is ultimately considered one of effective measures to prevent from nuclear terrorism. Legal base and relevant response manuals should be revised in consideration for combating terrorism before establishing the nuclear forensics library.

In order to set up legal base and relevant response manuals and advance in national nuclear forensics system at the early stage, it is better to run a multi-expert group comprising NSSC, National Forensics Service (NFS), KINAC, KINS, KHNP, KNF which can be extended to other relevant entities such as Korea Airport Corporation, Korea Seaport Cor. etc.

Also, the multi-expert group could be playing a key role in amending effective terror response manuals as current terrorism would be implicated in various factors such as finding travel baggage with nuclear material at air/sea port terminal.

Acknowledgement

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[2] Nuclear Forensics Support , IAEA Nuclear Security Series No.2, pp.13-20, IAEA, 2006.