Management of Domestic Nuclear Information for NNFL Development

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ABSTRACT

The National Nuclear Forensics Laboratory of Thailand was established in 2013 by Office of Atoms for Peace (OAP) under the Project No.30, “Network of Excellence for Nuclear Forensics in South East Asia Region (2013-2014)”, supported by EU CBRN CoE. It is expected to develop The National Nuclear Forensics Library (NNFL) and increase the capability of the nation to overcome illicit trafficking of domestic radioactive and nuclear materials.

The nuclear materials in only location outside facilities (LOF), from total 93 facilities, were created as database in 2016. It was input as one of the information in the present developing Nuclear Forensics Database prototype. The nuclear knowledge which are planned to include, are legislative work, IAEA documents, ISO details, Nuclear Forensics analytical reports, inspection reports, and other useful/concerning information. The templates of each nuclear material/radioactive material are in on-going modification following the structures and formats available for NNFL, related to IAEA concepts and requirements.

The success of this nuclear knowledge management (NKM) will reduce the time wasting for nuclear forensics assessments whether the sized material is or is not consistent with the given process or activity. The concerning illicit activities can also be deterred. These attempts will assist the National Nuclear and Radiological Emergency Plan, as well as the country nuclear security and physical protection, related to SG/NPT, for the peaceful use of atomic energy.

1. Introduction

1.1 Background [1, 2, 3, 4]

The State Policies and the roles of Office of Atoms for Peace (OAP) were declared currently in 2016 Nuclear Security Summit in Washington D.C., USA. Thailand Prime Minister issued national statement in the topic, “National Actions to Enhance Nuclear Security”. His Excellency confirmed that it was a fundamental responsibility of the states to maintain effective security of nuclear and other radioactive materials as well as nuclear facilities under their control, including military ones. It was a priority to ensure nuclear security in all types of public and private facilities, where nuclear and radioactive materials are used, i.e. hospitals, factories, research laboratories, and nuclear waste disposal facilities.

For ASEAN, Thailand initiated the setting up of the ASEAN Network of Regulatory Bodies on Atomic Energy, or ASEANTOM, which was welcomed by the ASEAN Leaders in 2011 and has been functioning since 2012. It is a collaborative network of nuclear regulatory bodies and relevant agencies to share information, experiences, and best practices, as well as to discuss issues relevant to nuclear safety, security and safeguard. It is a confidence building measure within the region.

Since the 2014 Nuclear Security Summit, Thailand has strengthened nuclear security implementation and built up the global nuclear security architecture by strengthening Nuclear and Other Radioactive Material Security. OAP, as the national coordinating agency for all nuclear-related matters, takes part in two projects.

- The Project on Border Monitoring Activities in Thailand, which OAP has activities together with the European Commission Joint Research Centre (EC JRC), in collaboration with IAEA and the United States Department of Energy and National Nuclear Security Administration. The Project is aimed at strengthening national capability in countering illicit trafficking of nuclear and other radioactive materials, through capacity building of personnel and provision of equipment to the Thai authorities concerned, including Customs Department, Port Authority of Thailand, Airport Authority of Thailand, Thailand Post, Royal Thai Police, and Bureau of Immigration.

- OAP, together with Thailand Institute of Nuclear Technology (TINT), have also continued its collaboration efforts with EU CBRN projects, including the integrated national security system for nuclear and radioactive materials, Network of Excellence for Nuclear Forensics in Southeast Asia, and a course on Regional Human Resource Development for Nuclear Safety, Security and Safeguards Management under Chulalongkorn University's Masters Programme on nuclear non-proliferation.

All missions and activities are performed following 2nd strategy from "National Nuclear Energy Policies and Strategies, B.E. 2560-2569" and 5th strategy of "12nd National Economic and Social Development Plan". The national security is planned to develop related to international standards for sustainability related to OAP roadmaps to be the center of Regional Nuclear Safety Regulation. The effective nuclear and radiation systems are in ongoing development process for implementation of national security.

1.2 Objectives and Scopes [5, 6, 7, 8, 9]

a) Cataloguing characteristics and signatures of all nuclear and radioactive material holdings under regulatory control to provide their importance data, i.e. chemical and elemental compositions, isotopic ratio, together with associated traditional evidence for information of material origin and history.
b) Developing the prototype database of the National Nuclear Forensics Library (NNFL) in Thai-English, based on data related to nuclear materials and other radioactive materials, which are in OAP licensing systems, as well as the information access capability.
c) Management of nuclear knowledge information for defining the specific data that needs to be acquired for NNFL except information of nuclear and radioactive materials holdings, such as IAEA information, ISO, Nuclear Forensics Laboratory analytical reports, inspection reports, etc.
d) Transferring the technology and methodology developed to the responsible authorities after the establishment of the national framework of nuclear forensics in Thailand.

1.3 Legislative work and IAEA Roles

a) Domestic laws and enforcement [10, 11, 12, 13, 14, 15, 16, 17]

Before the national framework of nuclear forensics is established, it is necessary to have complete national security approach for the effective nuclear and radiation regulatory. One of the importance criteria is the legislation concerning for enforcement. It takes time for the whole processes to create these requirements and issue as the law, for example;

- Establish radiological crime scene control
- Implement nuclear forensics evidence collection plan and initiate chain of custody
- Collection, packaging, transit of evidence to the nuclear forensics laboratory

Some objectives of these requirements are: 1) Hazards risk assessment; 2) Reduce radiation hazards; 3) nuclear and radiological control; and 4) Preserve items of evidentiary value.

However, at present, there are some related legislative work applied for the regulatory of nuclear material and radioactive material.

Last year, 2016, the nuclear Energy Act, B.E. 2559(2016), in Thai, was issued on August 5, 2016, in Government gazette. There are the rule, regulation and requirements concerning nuclear materials, and radioactive materials, in Chapter IV (section 36-40) and Chapter III (Section 18-24), respectively.

For nuclear fuel, some requirements and regulation are described in Chapter V Nuclear Facility, Part 4 Commissioning and Operation, Section 63, as well as Chapter VII Spent Nuclear Fuel Section 87. Some requirement for Research Reactor Safety Analysis Report are storage and management of nuclear fuel, as in Regulation of the Atomic Energy Commission for Peace, "Research Reactor Safety Analysis Report", B.E. 2555.

More details and requirements of nuclear materials and radioactive materials (sealed source and unsealed source) can be obtained from other rules and regulations as Reference no. 13-17.

b) International instruments and IAEA [18, 19]

Thailand was the member of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) from December 7, 1972. Thailand signed and ratified Safeguards Agreement (SG) with International Atomic Energy Agency (IAEA) on May 16, 1974. Office of Atoms for Peace (OAP), as the national regulator, was the responsible group to co-operate with IAEA nuclear safeguards inspectors for annual nuclear materials inspection under SG. The main nuclear material (NM) is the spent fuel of 2 MW TINT nuclear research reactor and the others are some nuclear materials in a small amount of some locations outside facility (LOF).

From the Convention of the Physical Protection of Nuclear Material (CPPNM), states are required to protect NM on their territories and during international transport. However, States are not to undertake transport/transits unless NM is protected at the appropriate levels. However, Penalties are required under national law. At present, this CPPNM is ongoing process for cabinet approval to be concluded in national nuclear security plan.

As one of the United Nations members, Thailand has to follow "The resolution of United Nations Security Council 1540 (Non-Proliferation of Weapons of Mass Destruction)". It is necessary to set up the nuclear material regulatory system to control the manufacturing of nuclear, chemical, and biological weapons of mass destruction, as well as control of international transit and shipment.

From action plan for participating States in support of IAEA, in Nuclear Security Summit 2016, IAEA central roles are: 1) strengthening the international nuclear security architecture and 2) the leader in developing international nuclear security guidance. For nuclear forensics, IAEA assists the sustainability of the States' nuclear forensics capabilities, including through building upon the expertise of the Nuclear Forensics International Technical Working Group, i.e.

- Developing guidance documents
- Promoting international nuclear forensics cooperation
- Sharing experiences and knowledge, and
- Supporting the development of national nuclear material databases or national nuclear forensics libraries (NNFL).

2. OAP Experience on Radioactive and Nuclear Material Database

2.1 Conventional radioactive and nuclear material database [18, 20, 21]

At present, there are more than 1,000 radiation facilities where the radioactive materials are possessed and utilized. The domestic nuclear and radioactive material information, i.e. licensing, facility locations, quality/quantity, irradiation status, and etc., were collected and created as the database in OAP licensing systems. Their conventional database system is illustrated briefly in Figure 1.

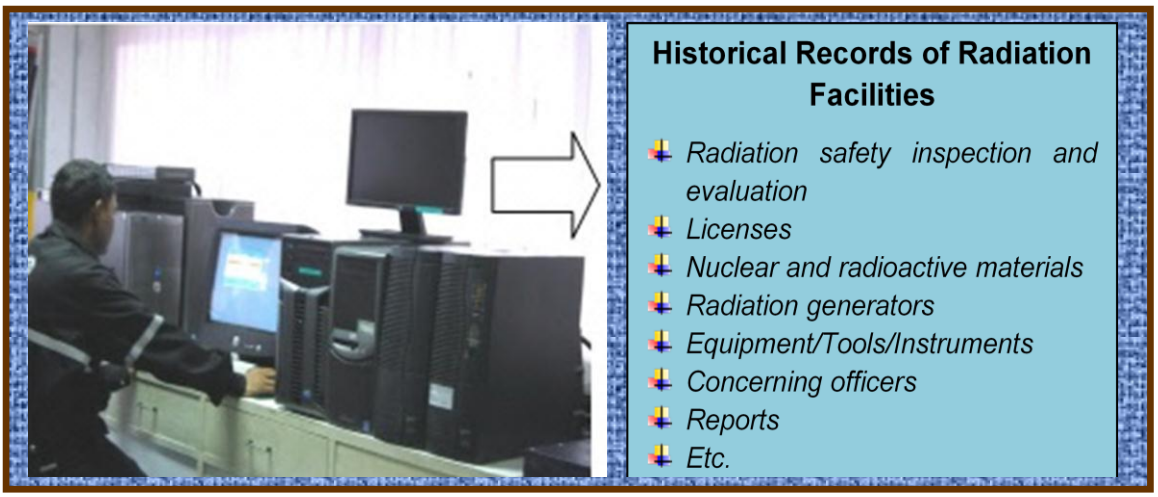

Fig 1 OAP Inspector at work with Radiation Safety and Security Evaluation

2.2 Microsoft Access 2010-LOF database developed in 2016 [18]

- In Thai fiscal year 2016, the author worked with nuclear material information management for accomplishment of domestic nuclear material database. The alternative Domestic NM database was created via Microsoft Access 2010 in Thai-English, as the following details.
  - The domestic nuclear materials information (i.e., licensing, facility locations, quality/quantity, irradiation status, and etc.) were selected and extracted from radioactive materials/sources/equipment database of Bureau of Radiation Safety Regulation (BRSR).
  - All information were identified, added more details/reports, etc. They were created and compiled in several Tables in the same file of Microsoft Access 2010.
  - Have a database available for the next fiscal years based on the starting fiscal year 2016 (2559 B.E.).
  - Have the options for the attachments of OAP inspection reports and some domestic/international legislative/technical information concerning LOF.
  - Can demonstrate and print out via Access 2010 in tables, reports, forms, and EXCEL 2010 spreadsheet.

3. Development of National Nuclear Forensics Library (NNFL) in Thailand

3.1 Nuclear Forensics Implementation [22, 23, 24, 25]

The National Nuclear Forensics Laboratory (Figure 2) was established in 2013 at OAP to enhance the national capability for combating illicit trafficking of nuclear and radioactive materials in Thailand. It was under the project no.30 of the CoE initiative entitled “Network of Excellence for Nuclear Forensics in South East Asia Region” and Thai Government budget.

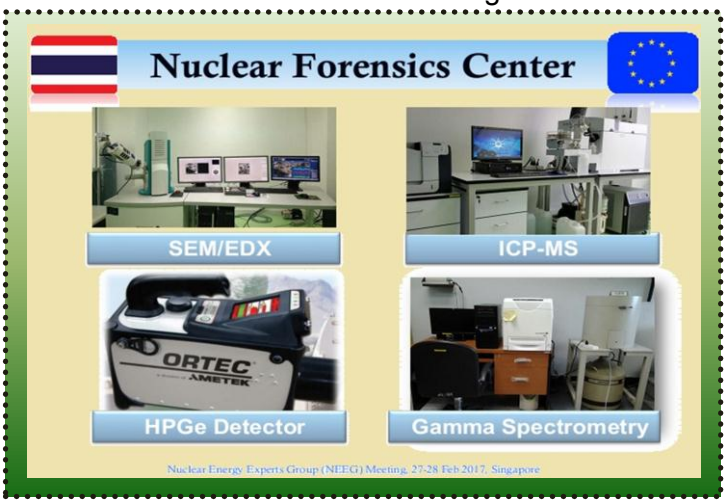

Fig 2 The Nuclear Forensics Laboratory at OAP

Nuclear forensics, as a key element of nuclear security, supports the investigations for criminal or unauthorized acts involving nuclear or radioactive materials. South East Asia is a region where the large amounts of good are transited but there are only few nuclear activities. To prevent illicit smuggling activities out of regulatory control, nuclear forensics should be applied to assist the States by providing information of immediate relevance to investigating authorizes.

The research and development of this laboratory is focused on signature analysis techniques to identify the production history and origin of these materials. The National Nuclear Forensics Library (NNFL) was also in their mission plan to establish, as well as its nuclear forensics database. Furthermore, the regional activities under ASEANTOM i.e. training courses/workshops by IAEA, EU, and US DOE, are helpful for higher competency of the specialists both in OAP and other concerning authorizations. Last year, December 20-23, 2017, there was a meeting on "Development of regulatory systems and standards for the competent authorizes", at Chiangmai, Thailand. One of the topics was "Global Initiative to Counter Nuclear Terrorism, Part I: Enhanced Nuclear Forensics Capabilities".

3.2 NNFL General Concepts [10, 26, 27, 28, 29]

Nuclear forensic science, referred to as "nuclear forensics", is a subset of forensic science. It is the examination of nuclear or other radioactive materials, or of evidence contaminated with radionuclides, for legal proceedings under international or national law related to nuclear security, as illustrated in Figure 3.

Nuclear forensics deals with the crimes involving nuclear or other radioactive materials. When these materials are seized, they will be sent to nuclear forensics laboratory for material characterization, i.e. chemical composition, physical characteristics, and isotope abundance. The nature and origin of the seized material, as well as any intent to use it, are identified. The preferred methodology is to compare the obtained results with those existing in nuclear forensics database, which is supposed to include in national nuclear forensics library (NNFL).

The NNFL gathers all information (measured or modeled) of nuclear and other radioactive material produced, used, stored, or transported within a nation. As a result, in the event of an actual investigation, materials data obtained with evidence is easily and quickly compared, traced, associated or even identified among materials data already cataloged. Each nation must decide what information is necessary to identify material consistent with those produced, used or transported within their borders.

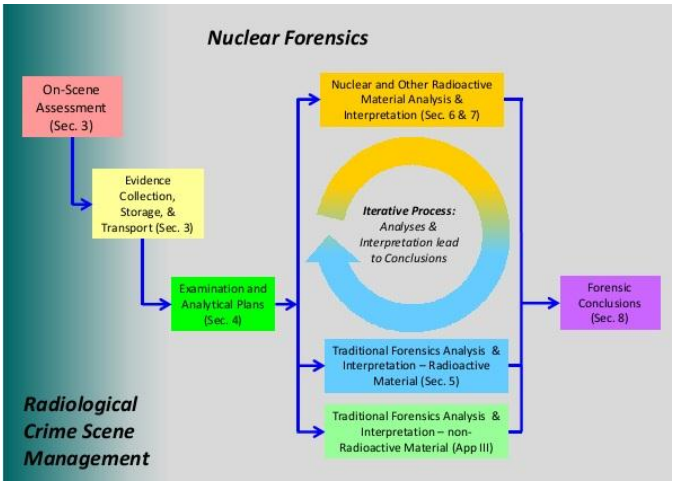

Fig 3 Model Action Plan in support of investigation of nuclear security event

Advantages of NNFL

- Critical for timely and informed nuclear forensics conclusions
- Assessing material history and possible origin for acceleration of material identification process

- Deter illicit activities involving nuclear material to enhance nuclear security
- Protects proprietary and national security information
- Builds international confidence

4. Methodology [6, 30, 31, 32]

4.1 NNFL Database structure and design

The database is a central and key component of any NNFL and provides a centralized structure for storing data and information that characterize nuclear and radioactive material holdings within a state. Because of less developed fuel cycles and small amount of materials in Thailand, a “flat file” database using a single table for data is useful and available. The relation between NNFL and the procedure, from nuclear security event though laboratory analysis, is shown simply as the example of Rokkasho (ROK) schemes in Figure 4, where the database is one part in NNFL.

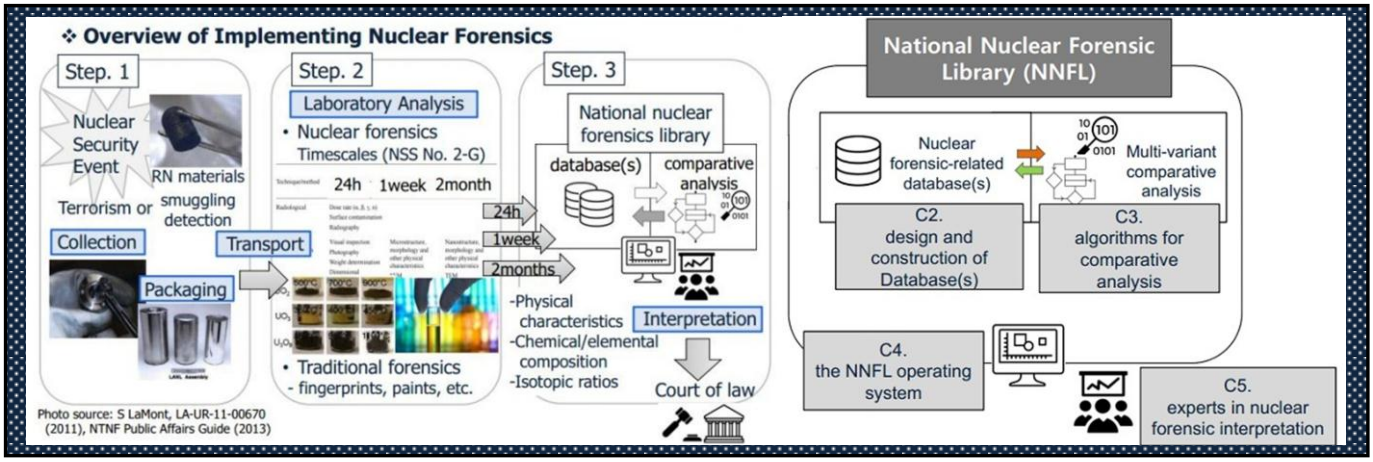

Fig 4 Implementing of nuclear forensics for nuclear security event investigation

To develop NNFL, the Nuclear Forensics Database prototype is planned to setup following these procedures.

- Data collection relating to OAP conventional radioactive and nuclear material database of licensing systems
- Storage functions using Microsoft Access 2010 software
- Proposed models for searching/comparative analysis, identification and reporting

The information on nuclear and other radioactive material in a NNFL is organized according to nuclear fuel cycle stages and types of radioactive sources, as an IAEA notional structure of NNFL in Figure 5. It consists of a material master index, domain expertise, and data and information summary in the library.

Fig 5 Notional structure of a national nuclear forensics library

The database software applied is Microsoft Access 2010 and Microsoft Word 2010, which are easier to use and are the popular programs for data/information management and processing. The architecture was designed as two main databases;

1) Additional nuclear forensics information (Figure 6), i.e. concerning articles, IAEA documents, ISO, legislative work, NM database 2559-2560 (2016-2017), nuclear forensics analytical summary report and templates

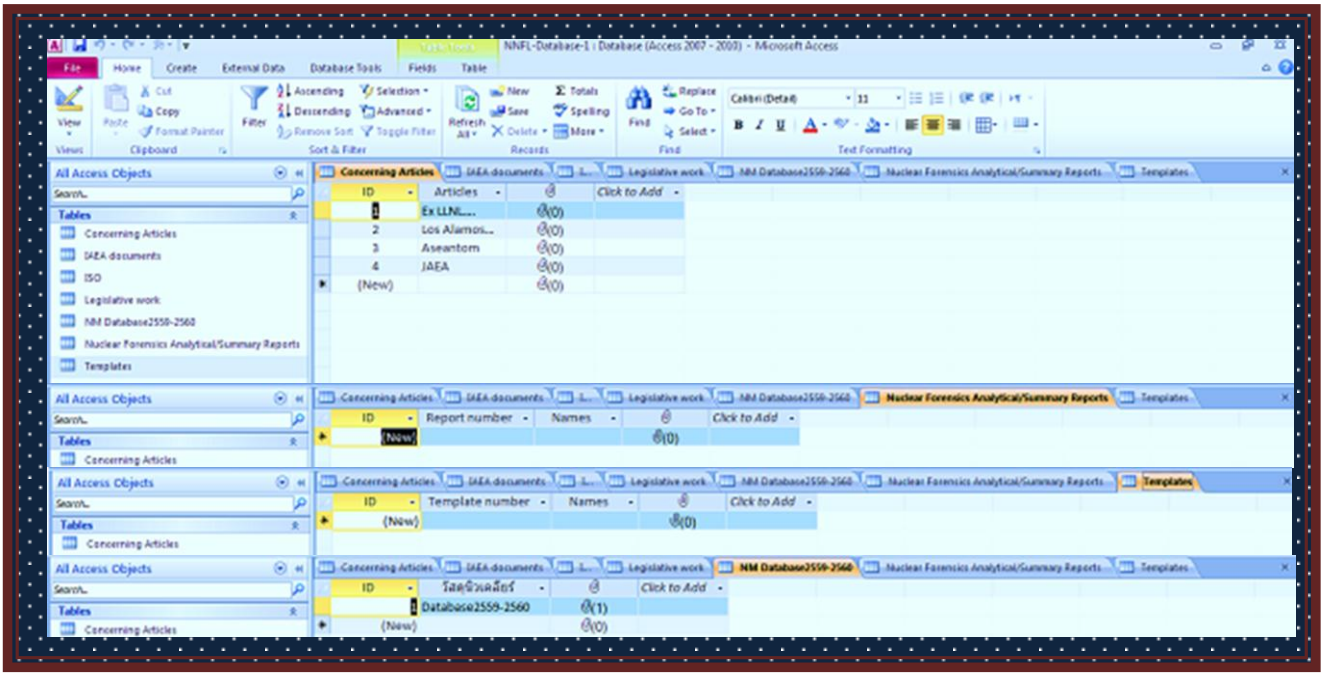

Fig 6 Database # 1: Additional nuclear forensics information

2) Nuclear and other radioactive materials related to OAP licensing systems (Figure 7) following an IAEA notional structure of NNFL (Figure 5). Because of only one nuclear facility in Thailand, the domain expertise, fresh and spent/irradiated nuclear fuel, can be recorded together as nuclear fuel element. The main rest are sealed and unsealed sources, which are either nuclear or radioactive materials. The Access 2010-Information Form examples of "Nuclear fuel element" and "Sealed source" are illustrated as Figure 8.

There is no Uranium manufacturing plant in Thailand but there are some work concerning in geology. The radioactive waste management is in responsibility of Thailand Institute of Technology (Public Organization) or TINT. Most of their wastes come from radiation facilities, i.e. hospitals, factories, research laboratories, and etc.

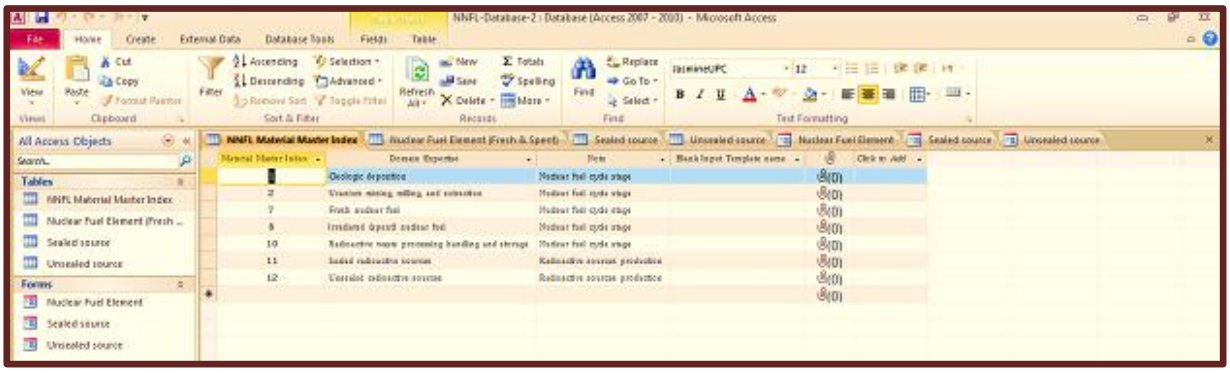

Fig 7 Database # 2: Nuclear and other radioactive materials information

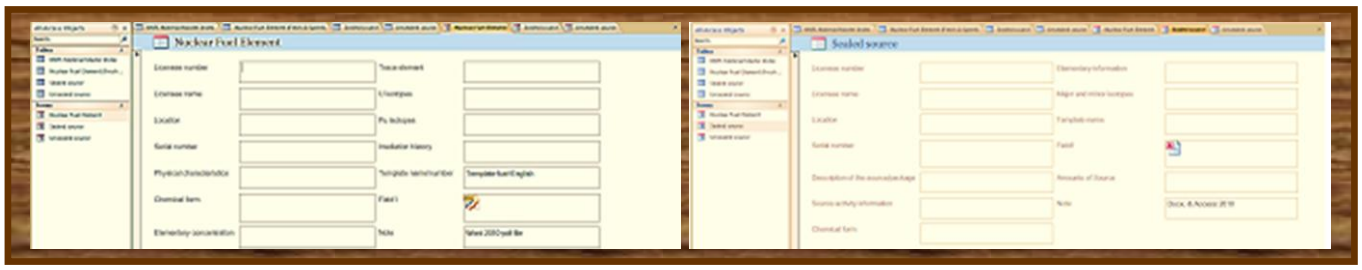

Fig 8 Examples of Access Form 2010 for “Nuclear fuel element” and “Sealed source”

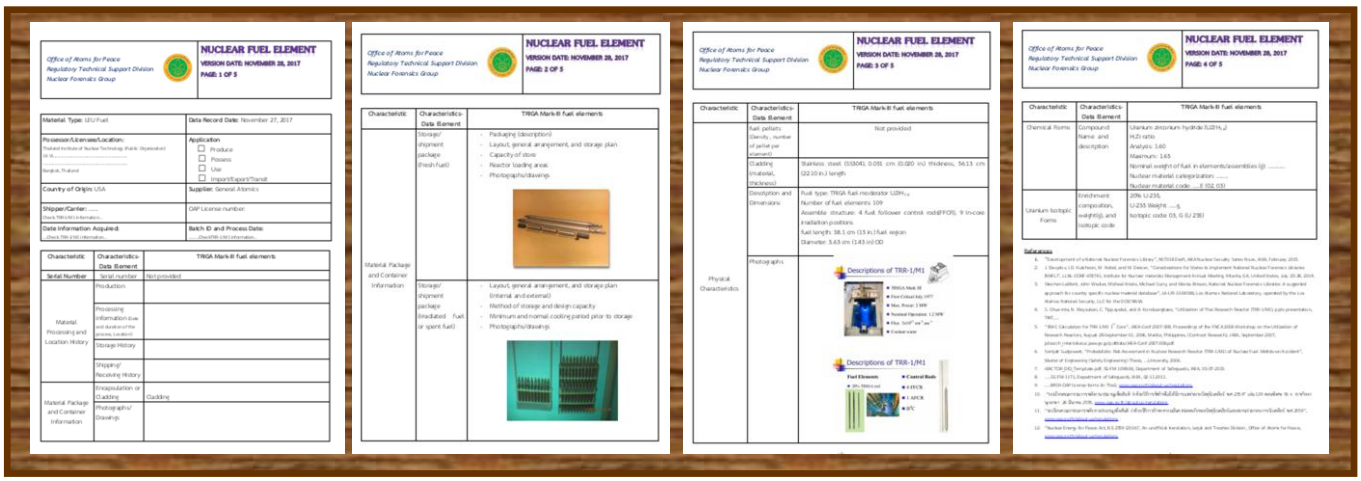

Fig 9 Example of Nuclear Fuel Element Detailed Template

The example of “Nuclear Fuel Element” template is presented as Figure 9. This template is created via Microsoft Word 2010 and is attached as the detail in Database # 2. Because there are a lot of sealed sources in one facility, in the same licensee number, the detail of each is collected together as another attached Access 2010 file (Figure 10).

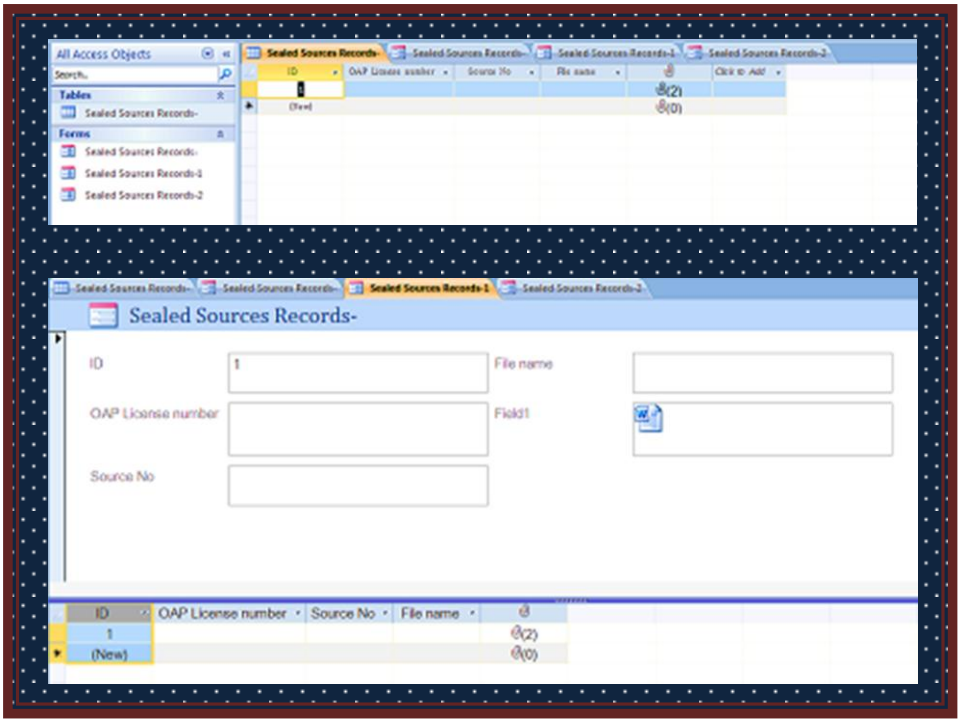

Fig 10 Example of Sealed source records database

This prototype database of NNFL was created from last May 2017 based on data/information related to nuclear materials and radioactive materials of OAP conventional licensing systems. Their architectures were developed as templates and Microsoft Access 2010 databases, which catalogues characteristics and signatures of all nuclear and radioactive materials holdings under regulatory control.

There is more work to continue for implementing nuclear forensics building capacities, i.e. data/information collection, access capability, and data interpretation and analysis, as the example of ROK NNFL-model in Figure 4. To support radiological crime scene control, some options are required, such as searching/comparative analysis, identification and reporting, for data interpretation and analysis following design and construction of databases.

5. Conclusions

The nuclear forensics science supports the investigations for criminal or unauthorized acts related to nuclear or radioactive materials to enhance the national nuclear security. There are some research and development in OAP nuclear forensics laboratory for signatures analysis to identify the production history and origin of these materials, following the ASEANTOM objective, the establishing NNFL and nuclear forensics database to increase the capability of the nation to overcome illicit trafficking of domestic nuclear and radioactive materials. It is also in the action plan of the national nuclear forensics laboratory of Thailand, which is assisted by EU CBRN CoE, under the project No. 30, “Network of Excellence for Nuclear Forensics in South East Asia Region (2013-2014)”.

To complete NNFL, there is another work to support their establishment functions, for example, the legislative work for the cooperation and integration between the responsible competent authorities. This article illustrates the starting milestone of the NNFL development via alternative prototype database. It takes time to develop technology and methodology to transfer to the responsible competent authorities in the future for the success of national actions to enhance nuclear security. All planned work is aimed to strengthen nuclear security missions for confidence building of the nation, as well as for ASEAN region.

6. Acknowledgement

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