A Self-Evaluation Tools for the Assessment of Nuclear Forensic Capability

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Abstract. Nuclear forensics is recognized as an important part of maintaining nuclear security in any country, regardless of whether the country utilised nuclear and other radioactive materials or not. It is an effective tool in determining the origin of detected nuclear and other radioactive materials, and in providing evidence for the prosecution of acts of illicit trafficking and malicious use. The objective of this study is to develop a questionnaire to be used as a tool to self-evaluate the existing national capability in nuclear forensics in order to provide analysis of weaknesses or gaps in the overall system that require attention. The questionnaire is developed based on the guideline of the International Atomic Energy Agency (IAEA) and is reviewed by experts from various countries for its completeness and usability. Although the questionnaire has been reviewed by experts from several Southeast Asia member states and is expected to be used especially by the ASEAN, it contains no country specific part and may be used by any country that needs to know its current capability.

1. Introduction
After the breakdown of Soviet Union in the early 1990s, there have been several reports of seizure of nuclear materials that unaccounted in other countries. Many cases of nuclear and radioactive material trafficking from unknown origin also been reported [1]. With the attack on the US World Trade Centre in 2001, nuclear security has become the topic of interest of the governments around the world. The utilization of nuclear and other radioactive materials have been seen at a risk that could threaten the global security and peace.

Even though there has been no direct threat to nuclear security in the Southeast Asia region so far, the region is a strategic location for trading and the existence of terrorist groups cannot be denied. Most counties in the region are now active user of nuclear and radioactive materials, and the demand for nuclear technology will continue to grow. The rising demand of energy in Southeast Asia region has also turned some of the countries to consider having a nuclear power plant to generate electricity. As there is increasing flow of nuclear and radioactive materials in this region, this can potentially increase the risk of someone causing malicious acts using these materials. It is crucial that each country in the Southeast Asia region establish its nuclear security regime in the country and work together in the future to enhance the regional nuclear security.

In this research, a questionnaire is developed to be used as a tool to self-evaluate the existing national capability in nuclear forensics in order to provide analysis of weaknesses or gaps in the overall system that require attention. The questionnaires is developed based on the guideline of the International Atomic Energy Agency (IAEA) and is reviewed by experts from various countries for its
completeness and usability. The current status of the nuclear forensics and nuclear security capabilities in Southeast Asia has also been reviewed. The questionnaire is then created based on these documents to be used as a tool for collecting data and self-evaluation. A feedback form is also developed to be used for evaluating the completeness, effectiveness, and usability of questionnaire. The questionnaire and the feedback form are then distributed to selected representatives of the governments of the countries in this region who work in the area of nuclear security through the Chemical, Biological, Radiological and Nuclear (CBRN) national focal point or the national nuclear energy and regulatory body. After certain informed time given, the set of questionnaires and feedback form distributed are collected. Analysis of the information is made, the information are characterized and organized properly as suggested by the guidance and support from both the documents and the experts so that the effectiveness of the questionnaire can be concluded.

2. Reviewing and Understanding
Research is started by reviewing and understanding the current published documents related to nuclear security and nuclear forensics. They are from the IAEA nuclear security series publications, IAEA technical documents and IAEA implementing guides. At the same time, the current status of the nuclear forensics within Southeast Asia also been reviewed.

2.1. Reviewing and understanding documents
The following list shows the documents that were referred for this research.

- **Nuclear Security Recommendations**
  - No. 15: Nuclear Security Recommendations on Nuclear and Other Radioactive Material out of Regulatory Control (2011)

- **Nuclear Security Implementing Guides**
  - No. 18: Nuclear Security Systems and Measures for Major Public Events (2012)
  - No. 21: Nuclear Security Systems and Measures for the Detection of Nuclear and Other Radioactive Material out of Regulatory Control (2013)
  - No. 22-G: Radiological Crime Scene Management (2014)

- **Technical Guidance (Reference Manuals)**
  - No. 2: Nuclear Forensics Support (2006)

- **TECDOC series**
  - No. 1730: Application of Nuclear Forensics in Combating Illicit Trafficking of Nuclear and Other Radioactive Material
  - No. 1313: Response to Events Involving the Inadvertent Movement or Illicit Trafficking of Radioactive Materials

- **Draft Implementing Guide**
  - NST014: Nuclear Forensics In Support Of Investigations (revision Of Nuclear Security Series No. 2) (DRAFT, February 2013)
  - NST018: Development Of A National Nuclear Forensics Library (DRAFT, February 2013)

2.2. Reviewing the status of nuclear security and nuclear forensic in Southeast Asia
Currently, none of the countries in Southeast Asia region has nuclear forensic capabilities in place, such that there are no possibility for a basic or a comprehensive characterization of intercepted material [2]. The capabilities for categorization of detected and intercepted material are also limited, however, exist at the locations where appropriate (portable) detection equipment was provided through the US Department of Energy's Second Line Defence (SLD) program [2].

Furthermore, the response plans in place are typically conceived for nuclear safety incidents and address emergency procedures and risk mitigation. The Joint Research Centre, Institute for Transuranium Elements (JRC-ITU) and the United States National Nuclear Security Administration (NNSA), at the present, implemented in partnership a project for capacity building in nuclear forensics
in South East Asia for developing sustainable response capabilities in this region and for initiating the networking of experts.

3. Creating Tools for Collecting Data

It was stated that nuclear forensic capabilities consists of four elements which are national frameworks, evidence management, materials analysis and interpretation and human capital [3]. The questionnaire developed by considering all of these elements and its components.

![Figure 1. Nuclear Forensic Capabilities](image)

3.1. Developing the questionnaire

The questionnaire derived based on the IAEA guidelines and been developed for self-evaluation purpose. The target group of this questionnaire is the national focal point of chemical, biological, radiological and nuclear (CBRN) of each member states of Southeast Asia, the nuclear regulatory body, and the government officers who are involved in nuclear security or specifically in nuclear forensic in each states (if any). As stated earlier, the questionnaire developed reflecting the four elements of the nuclear forensic capabilities and their components.

The questionnaire consists of six sheets in which the first sheet is “Introduction” that contains short instructions and brief explanation about the tool while the next four sheets correspond to the elements of nuclear forensic capabilities. In each of the sheet, there are nine columns, which provide information on criteria, description, question, scoring criteria, scoring, supporting information, notes and reference guidelines. There only two columns that are need to fill up by the respondents. The last sheet is the “Spider Chart”, where the total average score of each element is transfer to, picturing which element is lacking behind the others. Tables 1 to 4 show example questions from each of the 4 elements.
### Table 1. National Framework

| No | Criteria | Description | Question | Scoring Criteria | Scoring | Supporting Information | Notes | Reference Guidelines |
|----|----------|-------------|----------|-------------------|---------|------------------------|-------|-----------------------|
| 1  | Resources (availability of radioactive material) | The first thing the States are advised to do, when establishing nuclear forensic capabilities, is to make an inventory on existing resources. States should look into what is already available (e.g. research laboratories, universities, measurement instrumentation) and how these could be utilised in case of a nuclear security event. | There are nuclear and radioactive material available in the country? | 3 = Have both nuclear and radioactive material | 2 = Have radioactive materials and small amount of nuclear materials | 1 = Have only radioactive materials | 0 = Do not have any | State the relevant document: * By referring to the IAEA Nuclear Security Series No 2, Nuclear Forensic Support (Reference Manual), table 1 page 5 and 6. | Development of National Nuclear Forensic Library (Draft Implementing Guide) page 25 | 

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### Evidence Management

| No | Criteria                        | Description                                                                                                                                                                                                 | Question                                                                                                                                                                                                                                                                                                                                 | Scoring Criteria | Scoring | Supporting Information | Notes | Reference Guidelines                                                                 |
|----|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------|------------------------|-------|----------------------------------------|
| 1  | Radiological Crime Scene Management | The primary goals of a crime scene investigation are to establish what has happened (crime scene reconstruction), to collect and examine evidence in a timely manner in order to develop investigative leads to prevent potential additional crimes, and to identify and prosecute those involved or suspected. This is done by carefully documenting the conditions at a crime scene and recognizing all relevant physical evidence. | There are procedures establish for managing the radiological crime scene?                                                                                                        | 2 = Have clearly written and documented procedure for managing the radiological crime scene                                                                 | State the relevant document : | 1 = In the process of designing the procedure for managing the radiological crime scene | 0 = Do not have any yet | Radiological Crime Scene Management (page 4) |

Table 2. Evidence Management
Material Analysis and Interpretation

| No | Criteria                                      | Description                                                                                                                                                                                                 | Question                                                                                           | Scoring Criteria                  | Scoring                                                                 | Supporting Information                | Notes | Reference Guidelines                          |
|----|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------|----------------------------------------|-------|-----------------------------------------------|
| 1  | Categorisation (availability of trained and specialised personnel) | Categorisation is the on-scene non-destructive analysis of the nuclear or other radioactive material involved in a nuclear security event. The primary goals of categorization are to identify radionuclides present and estimate the quantities of those radionuclides. This typically requires training and expertise in the proper use of field-portable non-destructive analysis instrumentation, and in some cases, assistance from laboratory experts to properly interpret data | There are personnel for handling and performing the categorization process?                           | 2 = Have trained and specialised personnel for handling instrumentation for categorization process 1 = Have a personnel who can handled the instrumentation with basic knowledge 0 = Do not have any personnel | State available personnel position:                                                                 | Nuclear Forensics In Support Of Investigations (page 15) |       |                                               |

Table 3. Material Analysis and Interpretation
### Table 4. Human Capital

| No | Criteria            | Description                                                                 | Question                                                                                           | Scoring Criteria | Scoring | Supported Answer | Notes | Reference Document                          |
|----|---------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------|---------|------------------|-------|--------------------------------------------|
| 4  | Research and development | Nuclear forensics is an emerging science. In order to build confidence in nuclear forensic findings and evaluate the viability of nuclear forensic signatures to determine origin and history, research and development is essential | There are research and development activities on nuclear forensics?                                 | 3 = Have a RnD centre for nuclear forensic | 2 = Engaging in research and development that promotes the science of nuclear and radioactive material analysis | State the relevant initiative: Nuclear Forensics In Support Of Investigations (page 42) | | | | 1 = Preparing for research and development of nuclear forensic field | 0 = Do not have any yet | | | |
3.2. Developing the feedback form

Feedback form is the most important part in this research as it would determine whether or not this questionnaire can be practically used as a tool to support the establishment of national nuclear forensic capabilities in the future. In the feedback form, each respondent is asked to assess the questions in each of the four elements for the completeness, effectiveness, and usability, as well as to give their comments, opinions, recommendations, and further suggestions about the questionnaire. There are total of 8 question in that form for this purposes. Table 5 shows the feedback form which has been developed and used for the evaluation of this questionnaire.

| Description                                                                 | National Framework | Human Capital | Evidence Managements | Materials Analysis and Interpretation |
|----------------------------------------------------------------------------|--------------------|---------------|-----------------------|---------------------------------------|
| Each question is clearly asked                                            | 0                  | 1             | 2                     | 3                                     |
|                                                                            | 1                  |               |                       |                                       |
|                                                                            | 2                  |               |                       |                                       |
|                                                                            | 3                  |               |                       |                                       |
|                                                                            | 4                  |               |                       |                                       |
| Each question is easy to answer                                           | 0                  | 1             | 2                     | 3                                     |
|                                                                            | 1                  |               |                       |                                       |
|                                                                            | 2                  |               |                       |                                       |
|                                                                            | 3                  |               |                       |                                       |
|                                                                            | 4                  |               |                       |                                       |
| Questions asked are useful for evaluating the nuclear forensic capability  | 0                  | 1             | 2                     | 3                                     |
|                                                                            | 1                  |               |                       |                                       |
|                                                                            | 2                  |               |                       |                                       |
|                                                                            | 3                  |               |                       |                                       |
|                                                                            | 4                  |               |                       |                                       |
| All important question are covered                                        | 0                  | 1             | 2                     | 3                                     |
|                                                                            | 1                  |               |                       |                                       |
|                                                                            | 2                  |               |                       |                                       |
|                                                                            | 3                  |               |                       |                                       |

Table 5. Feedback Form
4. Conclusion

Nuclear forensics capability is still lacking in this part of the world, but it is one of the most important element in nuclear security needed for regional stability. In order to further enhance the nuclear forensics program in each country, the existing capability must be assessed. In this study, a questionnaire has been created, reflecting all of these elements and their component be used as a self-evaluation tool to support the establishment of the national nuclear forensics capability among the countries in the Southeast Asia region. Together with the feedback form, questionnaire was sent to test it and feedback is received from few countries.

Changes and improvement also have been made to the questionnaire, in respond to the comments and suggestion from the respondents. In addition with that, the questionnaire as overall should be revised, where there are still needed for more detailed criteria of required qualification that should be developed, as well as the scoring criteria should be improve more. However, its completeness, effectiveness, and usability are still needed to be further evaluated with help from the international community. As well as more cooperation from Southeast Asia member states also needed.
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