Optimizing Maintenance of Handheld Detection Equipment for Front Line Officers in Ghana: A Systems Engineering Perspective

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Abstract

Front Line Officers in Ghana use handheld nuclear security detection equipment as both primary and secondary detection strategy, though X-ray scanners are not radiation detectors, these scanners are also used as primary equipment to inspect cargo shipments at the country's borders and ports of entry and exit. However, due to the extensive work shift conditions, some officers have found it quite challenging to maintain these equipment effectively. These handheld equipment help tremendously with detection; nevertheless, if they have functionality defects, they can lead to inadequate detection. In response to an ongoing IAEA Coordinated Research Project on Advancing Maintenance, Repair, and Calibration of Radiation Detection Equipment, the Nuclear Regulatory Authority's nuclear security team, propose using a systems engineering approach to guide the optimization process of maintaining these handheld security detection equipment used by FLOs at the country's borders. This technical measure is considered essential to enhance Ghana's nuclear security practices pertaining to equipment maintenance and improve the nuclear security regime.

1. Introduction

The Ghana Revenue Authority, Customs division is recognized as one of the key Front Line Officers who play a significant role in detecting radioactive materials at border entry points. These officers use handheld nuclear security detection equipment as both primary and secondary detection strategy, though X-ray scanners are not radiation detectors, these scanners are also used as primary equipment for inspecting cargo shipments at the country's borders and ports of entry and exit. However, due to the extensive work shift conditions, some officers have found it quite challenging to maintain these equipment effectively. These handheld equipment help tremendously with detection; nevertheless, if they have functionality defects, they can lead to inadequate detection of radioactive sources. In response to an ongoing IAEA Coordinated Research Project on „Advancing Maintenance, Repair, and Calibration of Radiation Detection Equipment", Ghana's Nuclear Regulatory Authority (NRA) believes it is critical to properly implement technical measures to enhance nuclear security practices pertaining to equipment maintenance optimization among the country's FLOs.

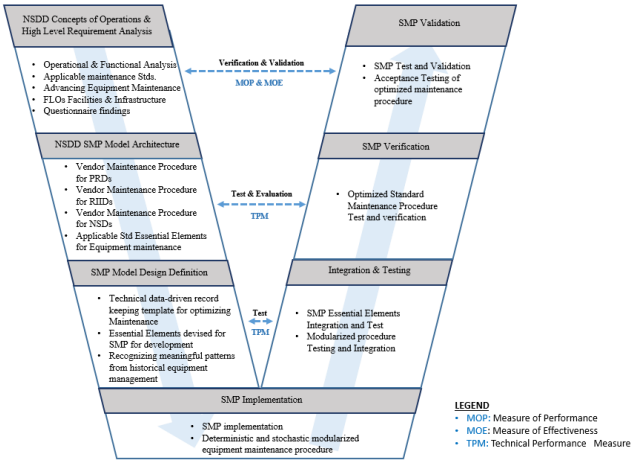
FLOs undergoing detection equipment training at the NSSC of Ghana

2. Objective of Work

This research is intended to devise optimal technical measures to provide relevant information for developing a Standard Maintenance Procedure (SMP) for optimizing the maintenance procedures of nuclear security handheld detection equipment.

3. Systems Engineering Approach

The International Council on Systems Engineering defines systems engineering as "a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, scientific, technological, and management methods."
Adopting this engineering approach targeting the design and analysis of effective nuclear security systems, provides a framework within which nuclear security technologies including instrumentation, system optimization algorithms and modeling, and analysis tools, can be implemented.
Additionally, as part of the CRP's positive impacts to member states, the NRA's nuclear security team, proposed using a systems engineering approach to guide the optimization process of maintaining the handheld security detection equipment used by FLOs at the country's borders. A systems engineering (V-Model) approach is adopted to guide the implementation process of the project goal. This method includes a detailed project definition, the project development process, and project testing and integration. The figure below depicts a model concept of the SMP development process.



SMP Development Process (V-Model)

4. Detection Equipment assessment findings based on field experience

As part of the project activities, the project team visited two ports in the country; a sea and land ports. Elubo, Takoradi sea port in the Western Region and Aflao border in the Volta Region where the custom officers facilities were sited. The status of equipment functionality and performance was assessed, and the data collected is currently being analyzed; however, a significant amount of data are yet to be collected; thus, more technical visits to other stakeholder sites in the country, are underway, where nuclear security detection equipment is used, as well as other border crossings.
The findings from the facilities visited so far, are as follows:

- Some FLOs do not examine the credibility of Personal Radiation Detector (PRD) alert modes (audio, vibration, and LED) during and after calibration before field usage, instead focusing on the screen displayed functionality.
- After field use, some FLOs forget to remove batteries from equipment.
- It was observed that no technical staff were trained to maintain, calibrate, and repair PRDs at any of the facilities (e.g., check battery voltage, change battery periodically, and clean battery compartment).
- It was observed that FLOs with a science background find device usage more flexible than FLOs without a science background (even after being trained on how to use it), and as a result, some of these officers do not use the PRDs at all, or as expected in field inspections.
- Some FLOs were spotted keeping the equipment in their drawer at all times, only using it when they have been notified of a suspicious cargo or when the cargo contained a radioactive source as indicated in the manifest.
- The project team noticed that some of the periodic dose rate records collected by FLOs at these facilities were inadequately managed, hence these officers sometimes regard the daily usage of the handheld detectors to be boring.
- The number of handheld detectors available to FLOs at the facilities was limited.

5. Conclusion and Acknowledgement

- It is critical that FLOs in Ghana recognize the functional purpose of these handheld detection equipment in the field, as well as how to properly maintain them. Prior to any further enhancement of Ghana's nuclear security practices pertaining to equipment maintenance optimization among the country's Front Line Officers, a standard maintenance procedure must be developed and adopted using systems engineering approach. In addition, Ghana must seek to improve its nuclear security regime by considering effective monitoring of nuclear security detection systems used for detecting nuclear and other radioactive material, as well as sustaining coordination among its stakeholders to address all its national and international nuclear safeguards, safety, and security obligations.
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