DETERMINATION OF WARNING DETECTION PARAMETERS BASED ON DATA PORTAL DETECTION OF RADIATION IN PORT KLANG, MALAYSIA

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ABSTRACT

Radiation Portal Monitor (RPM) has been installed in Malaysia since 2006. The passive Radiation detection equipment are installed at the Malaysian border entrance such as airports, seaports and land borders with the aim of detecting illegal movement of nuclear or other radioactive materials. Each detection alarms from the RPM require secondary inspection aimed at confirming the presence and identification of radionuclides in the objects scanned by the RPM. It is known that other than nuclear and radioactive materials, materials containing naturally occurring radioactive material also emits radiation. This study was conducted to determine the parameters that can be used by border control authorities to distinguish between the types of detection by the RPM and to ensure that only certain detection alarm needs to undergo secondary inspection. This would help to save time, reduce cost and avoid disruption to existing seaport operations. This study only focused on gamma-ray detection based on the factor that the radiation has triggered a lot of detection alarms and that there are diverse materials containing naturally occurring radioactive material (NORM) in existence. This study showed that there are a large numbers of detection alarms triggered by RPM that could be differentiated between TRUE alarms or FALSE alarms. Observations of the peak radiation count rate shape and interval, as well as the uniformity in the calculated values at the detectors can be used as parameters in the alarm detection assessment at the West Port, Port Klang, Selangor, Malaysia.

ABSTRAK

Portal Pengesanan Sinaran (RPM) telah dipasang di Malaysia sejak tahun 2006. Peralatan pengesanan sinaran pasif ini telah dipasang di pintu-pintu masuk sempadan seperti lapangan terbang, pelabuhan dan sempadan darat bertujuan untuk mengesan sebarang pergerakan haram bahan nuklear dan radioaktif. Setiap amaran pengesanan daripada RPM memerlukan pemeriksaan sekunder bertujuan untuk pengesahan kehadiran dan pengenalpastian jenis radionuklid di dalam objek yang diimbas oleh RPM. Adalah diketahui bahawa selain daripada bahan nuklear dan radioaktif, sinaran turut dipancarkan oleh bahan yang mengandungi bahan radioaktif terhasil secara semulajadi (NORM). Kajian ini dijalankan untuk menentukan parameter yang boleh digunakan oleh pihak berkuasa di sempadan untuk membezakan jenis-jenis pengesanan yang dihasilkan oleh RPM dan untuk memastikan hanya amaran pengesanan tertentu perlu menjalani pemeriksaan sekunder. Ini akan membantu penjimatan masa, mengurangkan kos dan mengelakkan gangguan terhadap operasi sediada di pelabuhan. Kajian ini hanya memfokuskan kepada pengesanan sinaran gamma berdasarkan kepada faktor bahawa sinaran ini telah banyak mengaktifkan amaran pengesanan dan kewujudan secara meluas bahan yang mengandungi bahan radioaktif terhasil secara semulajadi (NORM). Daripada kajian ini didapati bahawa *sebahagian besar amaran pengesanan yang dihasilkan oleh RPM boleh dibezakan samada ianya adalah amaran BENAR atau PALSU. Pemerhatian terhadap puncak dan sela masa kadar kiraan sinaran serta keseragaman nilai kiraan pada pengesan boleh digunakan sebagai parameter di dalam proses penilaian amaran pengesanan di Pelabuhan Barat, Pelabuhan Klang, Selangor, Malaysia.*

Keywords: Radiation Portal Monitors, Detection Alarms, Secondary Inspection.

INTRODUCTION

Radiation Portal Monitor (RPM) are detection equipment designed to detect an unauthorized movement of nuclear and other radioactive materials in the country. RPM works on the basis of radiation counts when an object passes through and is distinguished by the level of background radiation count threshold that has been set. Gamma detectors for the RPM are made of plastic scintillator which is called *Polyvinyl Toluene Scintillator* (PVT) coupled with a photon multiplier tube. The main advantage of PVT is its low cost and best suited for efficient gamma-ray detection such as in primary portals where large numbers of vehicles need to be screened rapidly for the presence of gamma-ray source [1]. A common way to detect a source is to process the count rate signal from a detector and to trigger the alarm if the count rate exceeds a predefined level, based on the statistical fluctuation of the background [5]. The alarm and detection radiation count rate data calculated with the standard deviation were sent to the Central Alarm Station (CAS) that is operated by the relevant authorities for the purpose of analysis. Based on the data, the CAS operators evaluated and determined whether the detection is True Alarm or Innocent Alarm or False Alarm.

CURRENT ISSUES

RPM operation in Malaysia is the latest effort by the authorities to ensure that Malaysia is not used as an entrance and exit point for unauthorized movement of nuclear and other radioactive materials. Detection by the RPM is complicated by several issue considered quantitatively is vehicle shadow shielding, which lead to a suppression of the background [3]. Because all radiation alarms at a border crossing must be further investigate to determine if threat material are actually present, the occurrence of nuisance (innocent) alarms increases the cost and operational impact of radiation screening [4]. Due to the location of the RPM installation on the main and busiest seaport in Malaysia, there is greater concern that the presence of these devices will interfere with the efficiency of the current port operations. The need to conduct a secondary inspection for each detection alarm, triggered by RPM will take time for each container to be transported to a secondary inspection station. The use of this container carrier, will involve cost to be paid for, by provider. On average the relevant authorities handle 2,856 detections per month. Based on this number, a total of 95 secondary inspections need to be carried out. A number of these secondary inspections require a total of 48 hours if it is done in 30 minutes for each secondary inspection. Based on these challenges, this study was undertaken to determine the parameters that can be used by authorities to distinguish the types of recorded detection. The determination of these parameters will help the relevant authorities in making decision of whether to undergo the secondary examination or not. Based on the issues and challenges mentioned above, the study was conducted to identify commodity that commonly activate the RPM detection alarms; determine the detection patterns recorded by RPM, and lastly to determine the parameters for the purpose on deciding the type of detection triggered.

METHOD

In achieving the objectives stated earlier, the following methods were used in the study:

a) Data collection of samples for the types and the number of commodities that activate RPM alarms collected for 6 months. Collected samples was then classified to ceramics and glass, building materials, equipment, food, health, household items, materials and rocks and minerals processing industry as well. Data classification was intended to provide early information on RPM detection patterns;

b) The graph of radiation count rate plotted against time for the sample collection. This was intended for the determination of alarm pattern whether true, innocent or false. To obtain True alarm pattern, radionuclides Ir-192, Cs-137 and Se-75 were used as controlled samples, and

c) Identify parameters that can be used by the relevant authorities for the alarm assessment.

RESULTS AND DISCUSSION

Based on the methods described above, the results obtained were as follows:

a) Detection based on the number of categories that enable detection warning RPM.

From the Figure 1 below, 3 new categories were created such as empty containers, general goods and unknown. Empty containers are the containers not carrying any commodity but still activate a warning detection and general goods are transshipment commodity in the country that is shipped to a third country. Unknown category is the classification of the commodities that activates RPM detection alarm but the item declaration information cannot be confirmed due to the incomplete information or is waiting for confirmation from the relevant agency.

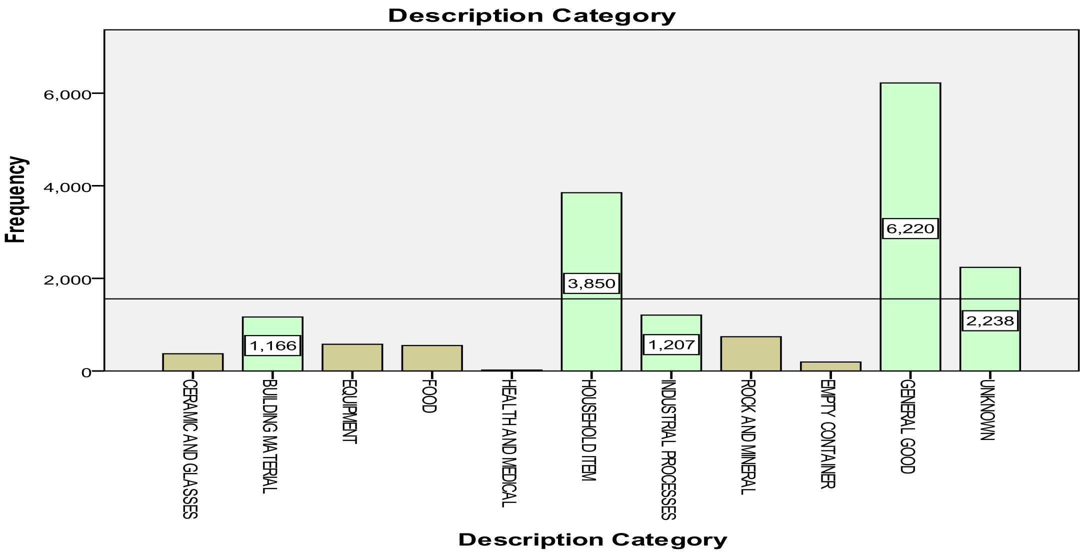

FIGURE 1: Frequency of Detection against Category

From the Figure, it is clearly shown that commodities in general goods category activate the highest detection alarms which is 36.30%. Due to the unavailability of information's, determination of the type of detection cannot be done. The second highest category is household items, which is 22.5% of the total detection at 6 months. Household items consist of steel, tableware, lighting mantle and smoke detectors. These commodities activate RPM alarms due to the presence of naturally occurring radioactive materials in the product such as Potassium-40, Radium-226 and Thorium-232 in the commodity itself.

b) Detection count rate pattern.

A total of 56 samples were collected for the purpose of the radiation count rate patterns analysis for each of the samples that triggered the RPM. From the data collected, graphs were plotted with the samples classified into

3 that are true alarm, innocent alarm and false alarm. For the purpose of comparison, the graph of the radiation count rate for the sample that passed by the RPM but did not trigger any detection alarms was also plotted.

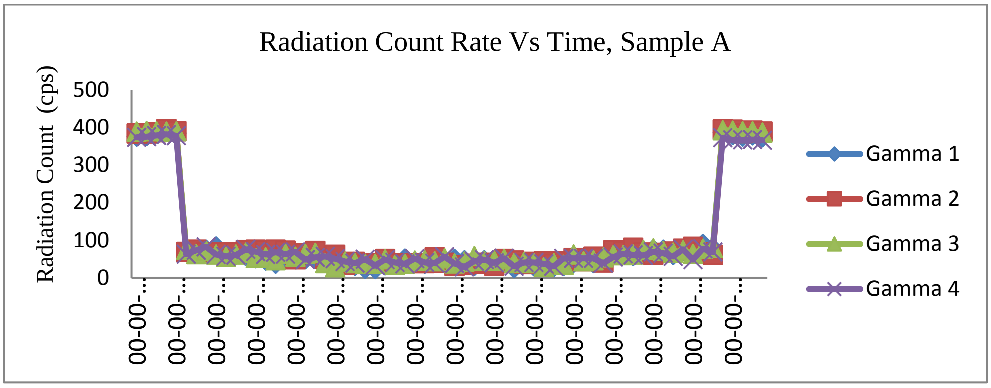

FIGURE 2a. Radiation Count Rate against Time for Sample A

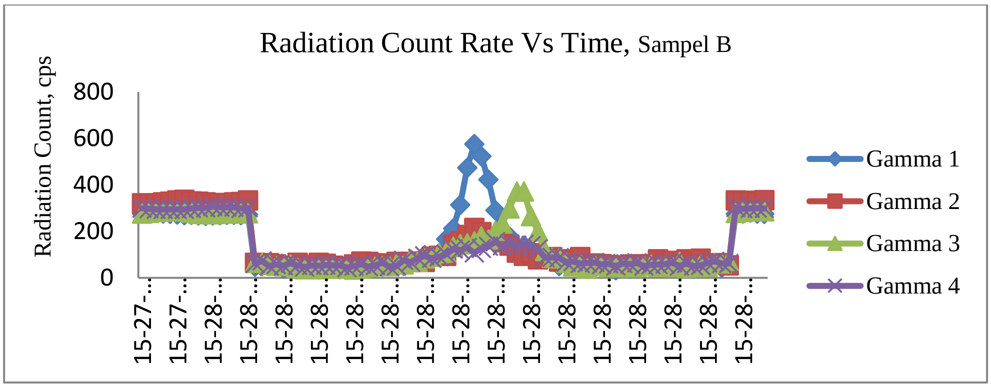

FIGURE 2b. Radiation Count Rate against Time for Sample B

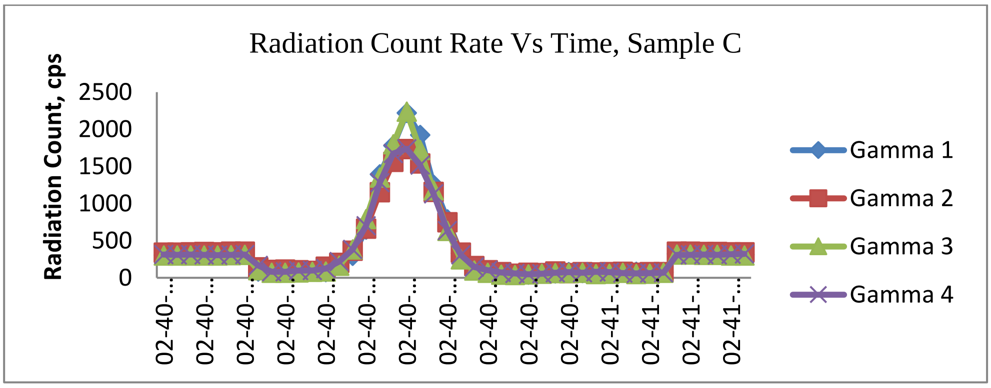

FIGURE 2c. Radiation Count Rate against Time for Sample C

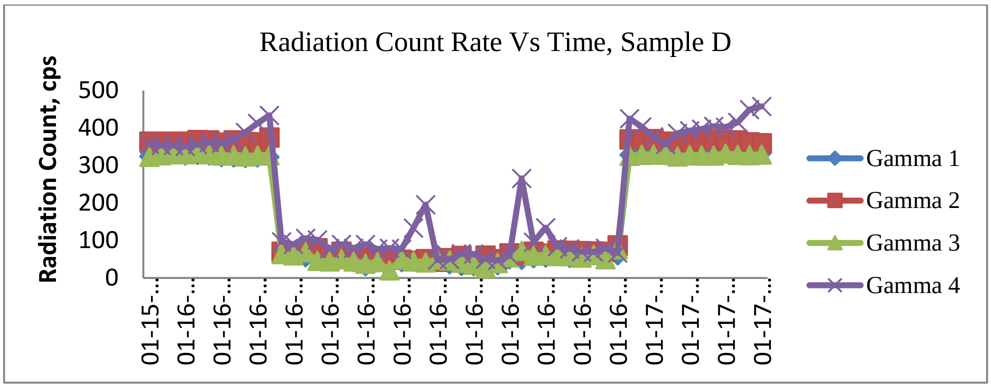

FIGURE 2d. Radiation Count Rate against Time for Sample D

Figure 2a, 2b, 2c and 2d above shows the pattern of the radiation count rate versus time for samples A, B, C and D. From the graph, it show that when the object pass through the RPM, the radiation count rate declines by up to 80% of the original count rate. This condition is called the background suppression. Background suppression suggests that either vehicles that carry or not, radioactive material, that lower the natural background readings are usually because of asphalt, concrete, and stone near the radiation detection portal. Due to the length and shape profile of the vehicles (size, shape, density and so on) different forms of pressure effect is different for every vehicle [2].

Sample B is a 40 feet container where two units of radioactive sources Ir-192 and Cs-137 were place at different positions. From the Figures, 2 radiation count rate peak were obtained at different time intervals marked with the point source present in the sample at different positions. To determine the position of each source, the highest peak count rate at each interval were also identified. The first radiation source close to the G1 gamma detection on the right side of sample B in Figure 2b, while the second radiation source close to the G3 to the left of the sample B in Figure 2b.

Comparisons made between sample B and Sample C, shows that both Figure 2b and 2c are nearly the same. But comparisons made against radiation count rate peak shape for both samples showed that Sample C has no sharp peak shape when compared with sample B. The next criterion to distinguish between samples C and B are in terms of the spread of radiation count rate. In Sample C, all four gamma detectors, showed the same count values. This indicates that the radiation is spread out evenly in the sample. Compared to sample B in Figure 2b, the peak count gamma detectors exist, but with no significant difference in the calculated values. This gave an early indication that sample C contains naturally occurring radioactive materials (NORM). To confirm the result, the reference to sample C declarations showed that Zirconium sand minerals transported in the vehicle. Under the category of mineral rocks, radioactive zirconium sand contains Thorium-232.

From the Figure 2d for sample D, it showed that the RPM detection alarm activation by the samples was detected from the radiation count rate performed of gamma detectors, G4. The radiation count rate increase of G4 exceeded the threshold, resulting in detection alarm. G4 gives a very noticeable count pattern differences when compared against other 3 gamma detector. These parameters can be used as a justification for RPM to undergo maintenance.

c) Determination of Parameter RPM detection analysis

Based on discussion above, it was found that each radiation count rate performed by RPM provides a specific patterns and shapes that could be used for in classifying the detection's types. The following parameters could be applied by the relevant authorities when performing detection analysis recorded by RPM. They are:

a) Observation of the radiation count rate peak shape;

b) Uniformity of the calculated values by each detector; and

c) Radiation peak count rate time intervals.

CONCLUSION

From this study, the challenges to combat the illicit trafficking of nuclear and radioactive materials not only focused on the threat that may arise, but also the need to take into account the cost and time involve so as not to affect the current operation of facilities. Detection alarm recorded by Radiation Portal Monitors was not only due to nuclear and radioactive material, but also due to the wide range existence of commodities containing naturally occurring radioactive material (NORM). Based on the high number of detection produced by RPM, the secondary inspection for verification purposes is expected to be costly and affect the operational efficiency of the relevant authorities and port operators.

Accordingly, the initial determination of the detection alarms based on the parameters that have been discussed are critical for the goal of border control operation to combat illicit trafficking of nuclear and radioactive materials can be implemented efficient, effective and sustainable.

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