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RELIABILITY OF RADIATION PORTAL MONITOR USING FALSE ALARM TESTING

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ABSTRACT

To improve security and safety in the nuclear facility area, The Center for Nuclear Facility Engineering, National Nuclear Energy Agency of Indonesia (PRFN-BATAN) has developed a system for measuring Radiation Portal Monitor (RPM). This facility will be installed at the entrance and exit gates in the nuclear facility area which aims to monitor the safety of radioactive substances in vehicles entering and leaving the nuclear facility area. To ensure the reliability of the radiation portal monitor that has been made, testing and certification of the equipment must be carried out in accordance with the reference standard SNI IEC 62244:2016. One of the radiation characteristics requirements of the standard is to perform a false alarm test with the requirement that no unexplained alarms occur during a 100 hours operating period with the monitor in a stable background. The testing activity was carried out in the Serpong Nuclear Area - National Nuclear Energy Agency of Indonesia, behind Building 71. The test was carried out for 5 days by monitoring the detection of false alarms at RPM which was operated for 100 hours. The results of background testing for 5 days obtained an average count of 745 cps. However, no alarm data is activated (background or occupation). There was an increase in the count due to rain, but it did not activate the alarm.

Keyword: Radiation Portal Monitor; Testing; False Alarm; Security; Safety

INTRODUCTION

In the area of the nuclear facility with radioactive material and radioisotopes, it is very necessary to payattention to the security and safety factor. This is because there is a huge potential for dangerous risks such as illegal transfer of goods, work accidents, and terrorist attacks. One of the preventive measures is to install a radiation portal monitor in the nuclear facility area. The Center for Nuclear Facility Engineering, National Nuclear Energy Agency of Indonesia (PRFN-BATAN) has developed a system for measuring Radiation Portal Monitor (RPM). The system will be installed at the entrance and exit gates in the nuclear facility area to monitor the safety of radioactive substances in vehicles entering and leaving the nuclear facility area. The

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specifications of the radiation portal monitor that have been developed are listed in Table 1.

To ensure the reliability of the radiation portal monitor, testing and certification of the equipment must be carried out in accordance with the reference standard SNI IEC 62244:2016. The results of the PMR prototype design were expected to have an increase in RPM detection sensitivity and reduction of detection threshold for special nuclear materials to provide dependable radiation monitoring in physical protection systems of nuclear facilities. Improvement of the detection sensitivity depends on parameters like source position and self-shielding of the vehicle [1]. It also can be done by improving the technical features of RPM, optimal design of complex solutions. Software algorithms are effective, modern electronic devices with low noise and new materials, the physical principles and technology must be applied [2]. Radiation portal monitor must operate in the absence of other radiation contamination, so it must be installed and operated in an area with a low radiation background [3].

Table 1. Radiation Portal Monitor Specification

Dimensions	2 pillars per lane, each with dimensions: Height: 2200 mm; Width: 257; mm Depth: 257 mm; Height plus 450 mm with alarm indicator.
Detection Performance	According to SNI-IEC 62244:2016
Data Output	Conform to SNI-IEC 62244:2016; TCP/IP communication protocol; report for each alarm or occupancy; provides alarm classification, alarm status, gamma count rates, and background count rates directly to user interfaces.
Gamma Detectors	0.3 liter (50 mm x 125 mm) NaI(TL) with integrated MCA (multichannel analyzer). The detectors provide gamma radiation sensitivity in the energy range from 30 keV to about 3 MeV. Automatic background compensation. Collimator ±30º vertically, ±30º horizontally.
Measurement Cycle	Minimum 0,5 s
Alarm Categorization	Background mode and Occupancy mode
Peripherals	Occupancy sensors (current loop and optical); optional: CCTV, audible/visual alarm annunciation.
Operating Temperature	-25°C - 55°C
Operating Humidity	40% - 95%
Power	220 VAC/50 Hz (main supply) include surge impulse and static protection; 24 VDC (without main supply)
Ingress Protection	IPX5

Addition, this test aims to establish uniformity in the indication format and alarm recording so that the radiation portal monitor can be used in different locations [4]. There are five requirements in SNI IEC 62244:2016, namely radiation characteristics, electrical characteristics, electromagnetic compatibility, mechanical characteristics, and environmental characteristics. In the radiation characteristics there is a false alarm test with the requirement that no unexplained alarms occur during the 100 hours operating period with the monitor in a stable background. With this test, the radiation performance of the portal monitor can be assessed from the probability of false negatives and positives alarms occurring. It is intended that the sensors used can maximize the probability of threat detection and maintain a low probability of false alarms [5].

METHODS

This testing activity was carried out in the Serpong Nuclear Area - National Nuclear Energy Agency of Indonesia behind the 71 Area where the location does not have background exposure. The test was conducted out by identifying the test requirements according to SNI IEC 62244:2016, and then determining the parameters and operating conditions of the test.

For radiation detection applications, false alarm threshold requirements may be directed by user needs, standard requirements, or acquisition requirements. The drive to set minimal false alarm threshold requirements must be balanced with the radiation detection capability of each type of technology. The tradeoff between false alarms and true alarms plays an important role in defining performance requirements for a radiation detection system [6]. A common requirement in ANSI standards in terms of occurrences is to have a probability of false alarm no greater than one alarm in 1000 occupancies [6],[7]. Alarms are often triggered by naturally occurring radioactive materials, therefore, an algorithm is needed to reduce the number of false alarms. The most commonly used algorithm is the windowing algorithm, which is based on the calculation of the ratio between the radiation intensity in the low and high energy windows of the observed scintillation spectrum [8]. For detection of moving radioactive sources, algorithm detection based on the time correlation between channels has been developed [9].

In accordance with the requirements of the radiation characteristics test from SNI IEC 62244:2016, the test was carried out for 5 days by monitoring the detection of false alarms at RPM which was operated for 100 hours. After that, the data were processed and analyzed for acceptability with the standards. The stages of the method are shown in Figure 1.

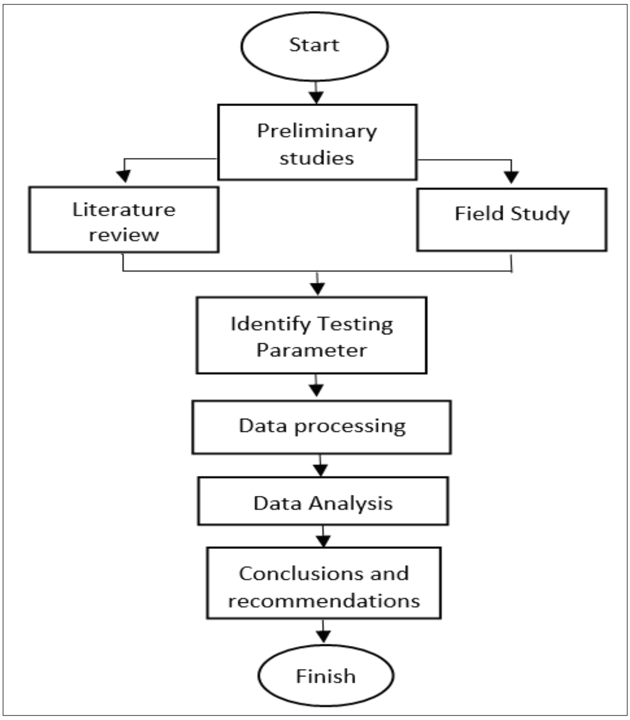

Figure 1. Stages of the Method

RESULTS AND DISCUSSION

The false alarm test was carried out by operating the RPM by measuring the background for 100 hours with a certain period to see the stability of the count results according to environmental conditions, as in Table 2.

Table 2. RPM Specifications Setting

Parameter	Spesification
Amplifier Settings	R = 1100 Ω I = 0,9 mA
Alarm Settings	Without occupation 2 x BG Background settings follow the conditions

For the false alarm test, RPM is isolated by installing a safety line, as shown below:

Figure 2. Setting Location For Testing

For 100 hours there was no alarm data activated (both background and occupation), when viewed from the recorded count (< 2 times the background count). There was an increase in the count, but it did not activate the alarm (< 2 counts due to background). The increase in background activity associated with rain [10].

The results of background testing for 5 days obtained an average count of 745 cps. Background count measurement of against the time function for 100 hours, can be seen in Figure 3 (a) to (e).

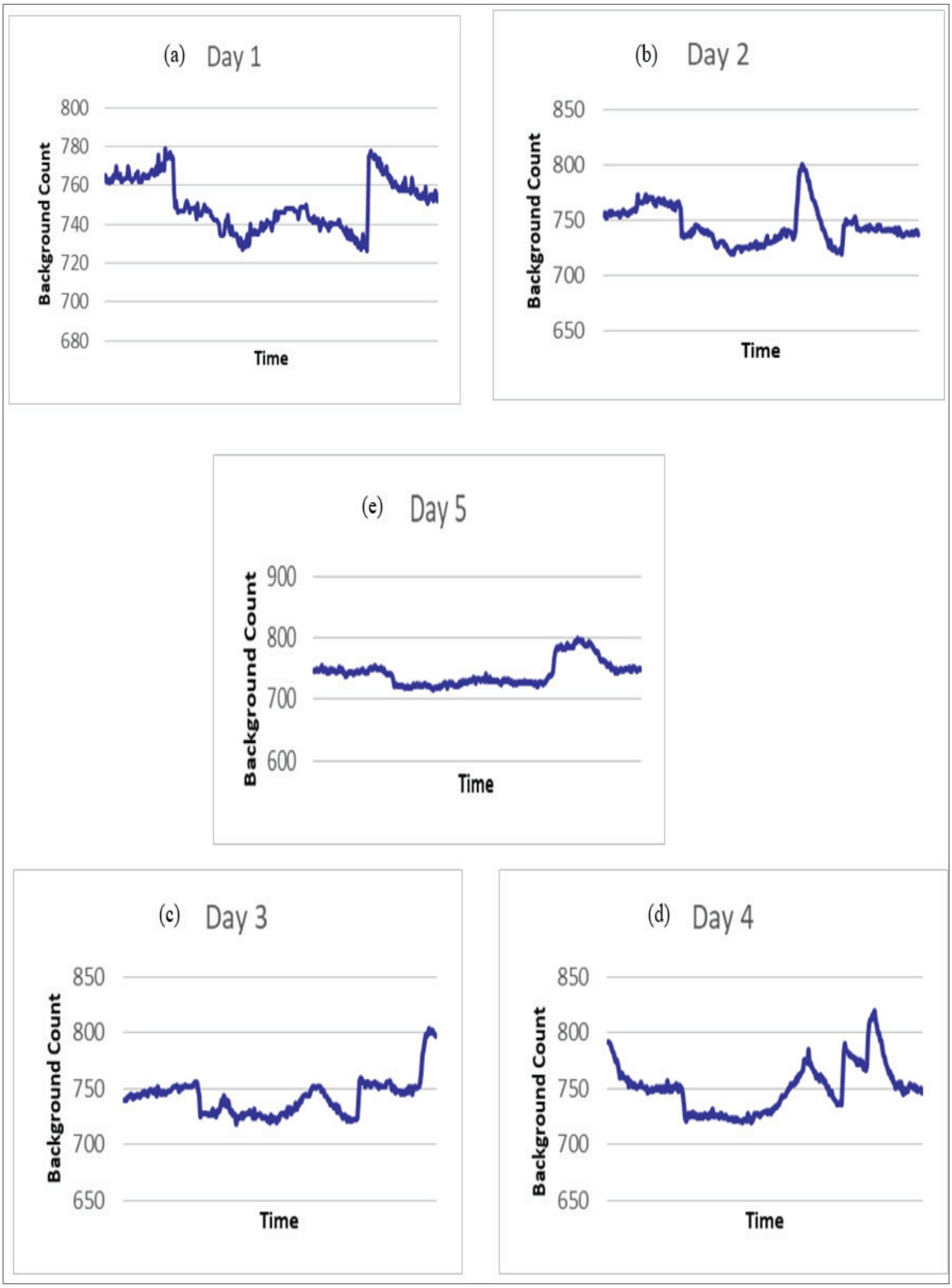

Figure 3. Background Count Measurement From Day 1 to Day 5

CONCLUSION

One of the tests on the RPM is the false alarm. No unexplained alarm should occur during the 100 hours operating period with the monitor in a stable background. For 100 hours no alarm data was activated (background or occupation), there was an increase in the count due to rain, but it did not activate the alarm. Based on these results, it can be concluded that testing the radiation characteristics of the false alarm meets the requirements according to the standard SNI IEC 62244:2016. Furthermore, RPM will continue other tests in order to meet IEC standards and can be used in nuclear facilities.

REFERENCES

[1] T. Schroettner, P. Kindl, and G. Presle, "Enhancing sensitivity of portal monitoring at varying transit speed," *Elsevier*, vol. 67, p. 1878–1886, 2009.

[2] A. Halevy, *Accreditation and Quality,* vol. 8, p. 286, 2003.

[3] Y. Jaeryong, et al., "Evaluation of performance characteristics of portal monitor for radiation emergency," *Elsivier Applied Radiation and Isotopes*, vol. 156, 2020.

[4] M. Tinker, "Standardisation of Radiation Portal Monitor Controls and Readouts," *Radiation Protection Dosimetry*, vol. 141, no. doi:10.1093/rpd/ncq183, p. 305–308, 2010.

[5] T. Burr, et al., "Alarm criteria in radiation portal monitoring," *Elsevier Applied Radiation and Isotopes*, vol. 65, no. 2007, pp. 569–580, 2006.

[6] D. D. Leber and L. Pibida, "False Alarm Testing for Radiation Detection Systems," *NIST Technical Note*, p. 2118, 2020.

[7] M. Paff, "Performance of a EJ309 organic liquid scintillation detector pedestrian radiation portal monitor prototype at the 2nd SCINTILLA benchmark campaign," in *Institute of Nuclear Materials Management 55th Annual Meeting*, 2014.

[8] G. T and S. D, "On the ratio distribution of energy windowing algorithms for radiation," *Elsavier*, vol. 132, no. https://doi.org/10.1016/j.apradiso.2017.12.005, pp. 195–199, 2018.

[9] R. Coulon, et al., "Moving Sources Detection Algorithm for Radiation," *Transactions on Nuclear Science*, vol. 61, p. 2189, 2016.

[10] R. Livesay, "Rain-induced increase in background radiation detected by Radiaton Portal Monitors," *Journal of Environmental Radioactivity*, vol. 137, pp. 137–141, 2014.