15. The compliance to occupational radiation safety

by Ismi Rajiani

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The Compliance to Occupational Radiation Safety to the Baggage Fluoroscopy System in International Airport

Siti Daryati[1], M. Irwan Katili[2], Jeffri Ardiyanto[2], Rini Indrati[2], Gatot MW[2], Ismi Rajiani[3]

[1]Assistant Professor, [2]Associate Professor, Politeknik Kesehata Kementrian Kesehatan, Semarang, Indonesia; [3]Deputy to Chairman, STIAMAK Barunawati, Surabaya, Indonesia

ABSTRACT

Background: Radiation safety program applied on the X-ray fluoroscopic screening baggage unit at Airport is important to detect and identify any of the prohibited goods or things that thread the aviation's world. This study aims to evaluate on site dose rates and occupational dose when the fluoroscopic screening baggage is on duty.

Method: A total 25 sample of dose measurements obtained from the population by purposive random sampling. The radiation dose rates and occupational doses selectively monitored with the TLD incorporated with Survey meter. Descriptive statistics and interactive models were blended in analyzing the acquired data.

Results: The X-ray baggage unit at gate-1 contributes the minimum dose rates at 0.00017 mSv/h. The gate-5 shows the highest maximum value at 0.00133 mSv/h. Occupational doses (operator and metal detector personnel) were within the safe limit at 0.00001 mSv. The estimated occupational dose received by each worker/year was made up of 0.95 mSv.

Conclusion: Most employees who work in the X-ray baggage section had lack understanding about radiation safety and its biological effect on human cells. Possible biological effects could be reduced amongst responsible personnel in duty if they create the safety radiation program based on this study recommendations

Keywords: *Radiation safety program, dose rate, occupational dose, X-ray fluoroscopic baggage*

INTRODUCTION

The application of X-ray in radiography industry is closely similar to that of the medical field. One of the requests of industrial radiographic technic is the utilization of baggage fluoroscopy as X-ray device for passengers and crews' luggage safety at the airport. The implementation of X-ray used to baggage fluoroscopy is intended to detect passengers' baggage before entering the airport. Nevertheless, caution should be exercised when using baggage fluoroscopy due to its utilization of relatively high electromagnetic radiation (140 – 180 kV) which can cause biological effect toward the people surrounding the device[(1)]

Corresponding Author:
Siti Daryati,
Politeknik Kesehatan Kementrian Kesehatan Semarang, Indonesia

High doses of ionizing radiation apparently produce deleterious consequences in humans, including cancer induction[(2)]. Similarities in cellular effects lead to the assumption of a common mechanism and the DNA double strand break is identified as the severe radiation-induced lesion. A cancer model extends the cellular consequences of the main radiation risk confirming the dose effect for cancer at low doses[(3)].

Ahmad Yani International Airport of Semarang has six baggage X-ray devices, 2 for baggage and 4 for cabin materials wherein they are operated to monitor incoming things to the aircraft. These devices are operational from 06:00 AM WIB to 21:00 WIB, causing a big amount of radiation but the monitoring of the measurement of exposure and dosage rates is not yet to be optimized. Therefore this research is highlighting the compliance to the safety as regulated.

METHODOLOGY

This study was performed in quantitative and qualitative ways. The quantitative approach is used to measure the exposure rates on baggage cabin fluoroscopy and operators' occupational radiation doses. Radiation exposure rates of the five units of baggage fluoroscopy (two baggage X-ray, two domestic Cabin X-ray, and one international Cabin X-ray) were measured by survey meter (Babyland, USA) and occupational doses of 25 operators on duty were measured by personal dosimeter of Thermo Luminescence Dosimetry (TLD) Chip. The qualitative method was performed by conducting a deep interview to assess workers' knowledge about X-ray utilization. Five respondents were involved in giving information concerning operators' knowledge about X-ray use. The analysis outcome of exposure and dose rates of radiation workers was compared to an international publication[4] and national value of Dose Reference Limit (DRL) standard[5].

RESULTS

Dosage Exposure Rate: The measurement of radiation exposure was done on 5 scanner fluoroscopy devices with the following detail: 2 Baggage X-ray, 2 domestic Cabin X-ray, and 1 international Cabin X-ray. In Gate 1, the lowest exposure rate happened to F (passengers) which amounts to 0.00017 mSv/h and the highest exposure rate happened to E (scanner operators of outgoing goods) which amounts to 0.00067 mSv/h. The average of the five measurement points is 0.00047 mSv/h with a standard deviation of 0.00021 mSv/h resulting in the lowest average rate of 0.00038 mSv/h and highest average rate of 0.00088 mSv/h.

In Gate 2, lowest exposure rate happened to E (scanner operators of outgoing goods) which amounts to 0.00013 mSv/h, and the highest exposure rate happened to B (scanner operators of incoming goods) which amounts to 0.0008 mSv/h. The average of the five measurement points is 0.00041 mSv/h with a standard deviation of 0.00027 mSv/h resulting in the lowest average rate of 0.0004 mSv/h and highest average rate of 0.00107 mSv/h.

In Gate 3, the lowest exposure rate happened to C (scanner operators of outgoing goods) which amounts to 0.00010 mSv/h, and the highest exposure rate happened to D (scanner operators of incoming goods) which amounts to 0.00077 mSv/h. The average of the five measurement points is 0.00039 mSv/h with a standard deviation of 0.00026 mSv/h resulting in the lowest average rate of 0.00036 mSv/h and highest average rate of 0.00103 mSv/h.

Gate 4 is used for scanning hand-carries such as handbags, souvenirs, and hand-carried items.

The lowest exposure rate happened to A (baggage X-ray operator) which amounts to 0.00013 mSv/h, and the highest exposure rate happened to D (scanner operators of incoming goods) which amounts to 0.00093 mSv/h. The average of the five measurement points is 0.00036 mSv/h with a standard deviation of 0.00031 mSv/h resulting in the lowest average rate of 0.00044 mSv/h and highest average rate of 0.00124 mSv/h.

Gate 5 is the international flight scanner. To sum up, the summary of all measurement is shown in Table 1.

Table 1: Summary of the lowest and the highest exposure rates

No.	Measurement Location	Lowest Rate (mSv/h)	Highest Rate (m Sv/h)	Remark
1.	Gate 1	0.00017	0.00067	Baggage X-ray, 1-meter distance from X-ray source
2.	Gate 2	0.00013	0.00080	Baggage X-ray, 1-meter distance from X-ray source
3.	Gate 3	0.00010	0.00077	Domestic cabin X-ray 1-meter distance from X-ray source
4.	Gate 4	0.00013	0.00093	Domestic cabin X-ray 1-meter distance from X-ray source
5.	Gate 5	0.00010	0.00133	International cabin X-ray 1-meter distance from X-ray source

The average exposure rates at seven measurements are shown in Table 2.

Table 2: Exposure rate average

Location	
Gate 1	0.00047 ± 0.00021
Gate 2	0.00041 ± 0.00027
Gate 3	0.00039 ± 0.00026
Gate 4	0.00036 ± 0.00031
Gate 5	0.00039 ± 0.00053

The mean and standard deviation values resulting from the highest exposure rate measurement at Gate 1 (Astrophysics Baggage X-ray) show the value of (0.00047 ± 0.000212) mSv/h. The mean and standard deviation values resulting from the lowest exposure rate measurements at Gate 4 (Fiscan Domestic Cabin X-ray) show the value of (0,00036 ± 0,00031) mSv/h. Deviation value resulting from the measurement is quite low between (0,00021 ± 0,00053) mSv/h.

Table 1 shows that the Astrophysics Baggage X-ray (Gate 1) gets the highest minimum score of 0.00017mSv/h as compared to other gates (0.00010 – 0.00013 mSv/h). Gate 5 obtains the highest maximum score of 0.00133 mSv/h as compared to other gates (0.00067 - 0,00093 mSv/h). The highest mean and standard deviation of the exposure rate measurement at Gate 1 shows the value of 0,00047 ± 0,00021 mSv/h. The effective dosage outcome of the monitor and the metal detector operators using TLD dosimeter is 0,00001 mSv.

The minimum exposure rate of Gate 1 gets a high score because it has a device with voltage specification of 165-180 kV. Gate 1 scanner is utilized to check materials that are inside numerous items of baggage. Therefore a higher X-ray energy is required to penetrate them. Higher voltage produces potentially higher penetrating power so that the shield of the device is not sufficiently effective to protect the radiation scatters.

The measurement of exposure rate conducted at the area of 1-meter distance from the radiation source shows a leak of the X-ray around at a distance. Therefore, the operators should not stand too close to the scanner device. The mean of exposure rate as compared to the standard is 1 mGy/h which is still within the safe boundary. The effective radiation doses of the monitor and the metal detector operators worked for 1 month shows a much too small a value where the result of the effective dose score for Dosage Limit (DL) of 20 mSv/year [6] is still within a safe boundary.

Personnel Dosage: Personnel Dosage is measured using Thermo Luminescence Dosimetry (TLD) for 1 month toward 12 staffs of licensed operators and 13 outsourced (supporting) metal detector personnel, altogether 25 personnel. Based on the TLD reading of the airport 1274 001 T up to 1274 025 T series on staff using TLD on their waists.

The above result is collected by Safety Guide Test Method[6], and the element was read by TLD reader BARC type TL 1010. The reading was converted into the radiation dose based on appropriate calibration curve/factors.

Airport operators work daily for 8.5 hours for the morning shift and 7.5 hours for the afternoon shift, and the radiation collected is accumulative. Within 168.5 hours a month and 2022 hours a year under the mean score of 0.00047 mSv/h, the accumulated annual dosage is 0.95 mSv/year, and it is still below the safe boundary.

Operators Knowledge in X-ray Utilization: The operators' opinion during their work with X-ray so far are they work according to schedule, but they are not aware of the impact of the danger of X-ray to health. According to respondent, operator for X-ray monitor must have a license of Junior Av Sec while metal detector operator must have Basic Av Sec. Medical check-up for baggage and cabin X-ray operators is given once a year for each employee, consisting of blood and urine test, yet there is no first check-up for X-ray operators. Formerly radiation dosage Monitor was given to operators in the form of a filmed badge to be put on their trousers, but it has been 5 years they don't use it anymore because the company does not provide it anymore.

From the interview result it was found that operators' knowledge about radiation is still lacking, yet from the measurement outcome of the exposure rate and personal effective dosage, their dose levels are still within the safe boundary.

By the regulation [6] if a radiation operator receives excessive dosage, he/she should be given a break or transferred to radiation-free section. One of the efforts is by scheduling the work shift for each operator beginning with morning shift, afternoon shift and then taking an off day, in the attempt to minimize radiation dose received by the operator. Despite the existence of shield protection within the fluoroscopy device, new

Pb protection curtain should be provided for X-ray operators. Besides, at present situation operators are not using a radiation monitoring tool. This practice is against the regulation[6] that every radiation worker must use radiation monitoring tool and be periodically monitored.

CONCLUSION

The baggage X-ray at gate 1 (domestic passengers) of Ahmad Yani Airport, Semarang, Indonesia shows the highest level of average dose rates per hour (0.00047 ± 0.00021) compared to that of the rest baggage X-rays at gate 2-5. For all baggage X-rays, however, their average dose rates per hour are declared still within the safe boundary. Similarly, the effective personal dose of monitor and metal detector operators using TLD dosimeter device is 0.00001 mSv, which is also still within a safe edge.

Shortly, although all domestic and international baggage X-rays are run within recommended radiation dose limit, a relatively small radiation dose received by the operators would still have a potential danger to the human cells as it accumulates, absorbs and is deposited in the human tissues in the long term. Additional protective barriers should be placed appropriately around the baggage X-rays so that the low energy radiation levels would be absorbed by the barrier and protect the operators from stochastic biological effects.

Conflict of Interests: The authors have no conflict of interests related to the conduct and reporting of this research.

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Ethical Clearance: The research received permission of ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Semarang, Indonesia.

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15. The compliance to occupational radiation safety

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