

Determination of sensitive organs doses due to X-Ray of Body Scanner (BS) systems using TLD and Rando phantom

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Introduction

One of the most common methods for transferring illicit drugs or forbidden items via air traveling is hiding them inside the body cavities or attached them to the some parts of body. now a days, body scanner (BS) system is going to find a common use as a body checking equipment at the entrance borders. It is possible to detect these items using BS system which is operating based on the imaging of whole body using X-Ray generator. Considering the ALARA principles, it is necessary to determine the sensitive organs and whole body doses which are scanned by such systems. This research work have been conducted to measure received doses to the body and dose rate around a typical BS system in common use

Materials and Method

The following instruments have been used in this research:

- Soter BS system (Figure1)
- LiF: Mg,Cu,P (GR-200) TLD pellet inside a teflon capsule
- Rando phantom (Figure2)
- Harshaw TLD reader model 4000(Figure3)
- Smart ion chamber dose rate meter(Figure4)

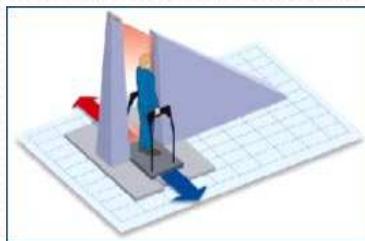


figure1

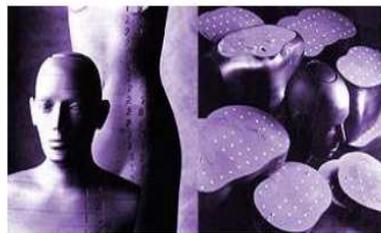


figure2



figure3



figure4

Method

The effective doses of sensitive organ due to the scanning via BS systems were measured as following procedure:

- TLD dosimeters were implanted at surface, mid and deep parts of the phantom at location of sensitive organs.
- The phantom with the implanted TLD dosimeters was placed in front of the X-ray generator of the BS system with the scanning time of 10 seconds.
- The scanning procedure was repeated 100 times to build up doses for higher accuracy.
- The gamma dose rates around the X-ray generator were also measured at different distances (figure5).

Results and discussions

The organ doses during each scanning procedure are calculated using equation 1:

$$H_T = \frac{\sum TL_n \cdot ECC_n \cdot CF}{100 \cdot n} \cdot \frac{(\frac{\mu_{en}}{\rho})_{Tissue}}{(\frac{\mu_{en}}{\rho})_{Air}} \quad (1)$$

- TL is the TLD pellet reading value
- ECC is the element correction coefficient of each pellet
- CF is calibration factor
- n is the number of implanted pellets at each organ
- (μ_{en}/ρ) is the mass absorption coefficient [2].

The results obtained for organ doses are presented in table 1.

The total effective dose is calculated using equation 2:

$$E = \sum_T H_T \cdot W_T \quad (2)$$

Results

Table1. The organ doses per scan

Main organs	Weighting Factor	dose ($\mu\text{Sv}/\text{scan}$)
Gonads	0.2	0.9
Bone- narrow	0.12	0.5
Colon	0.12	0.2
Lung	0.12	0.21
Stomach	0.12	0.22
Bladder	0.05	0.22
Breast	0.05	0.18
Liver	0.05	0.15
Oesophagus	0.05	0.12
Thyroid	0.05	0.17
Bone surface	0.01	0.02
Skin	0.01	0.04
Reminders	0.05	0.14

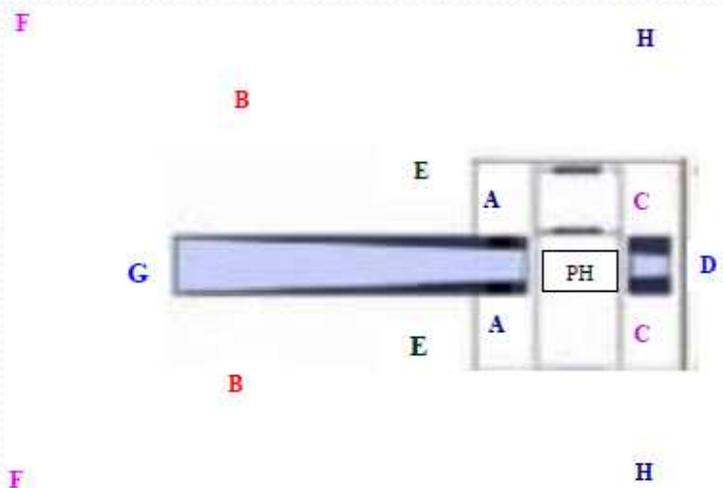


Figure5. The dose rate distribution around X-ray generator of BS system (at different points of A-H)

Table2. gamma dose rate around BS system

Measuring points	Distance from generator (cm)	Dose rate ($\mu\text{Sv/h}$)
A	50	>50
B	200	13
C	50	16
D	Back of detector	6
E	80	40
F	300	4.5
G	Back of generator	6
H	200	9

Results and discussions

- The whole body effective dose was measured to be $3.08 \mu\text{Sv}$ per scan which is significantly lower than 1 mSv per year recommended for public exposure.
- The dose received to the lens of eyes was measured to be $3.96 \mu\text{Sv}$ per scan.
- The gamma dose rates around the BS system were measured 4.5 to more than $50 \mu\text{Sv.h}^{-1}$ at the different points within 300 cm to 40 cm distance from the X-ray generator (table 2).

Conclusions

Considering sensitive organ and whole body doses, it can be concluded that:

- BS systems in general could be a safe device for the operators and people who are scanned.
- using of such systems should be justified for any persons and special cares should be taken for children and pregnant ladies.
- BS system should be used just in case of people who are suspicious of carrying drugs.
- A minimum distance of the operator position; 3 meter, from the system should be kept for the radiation safety of the operator.