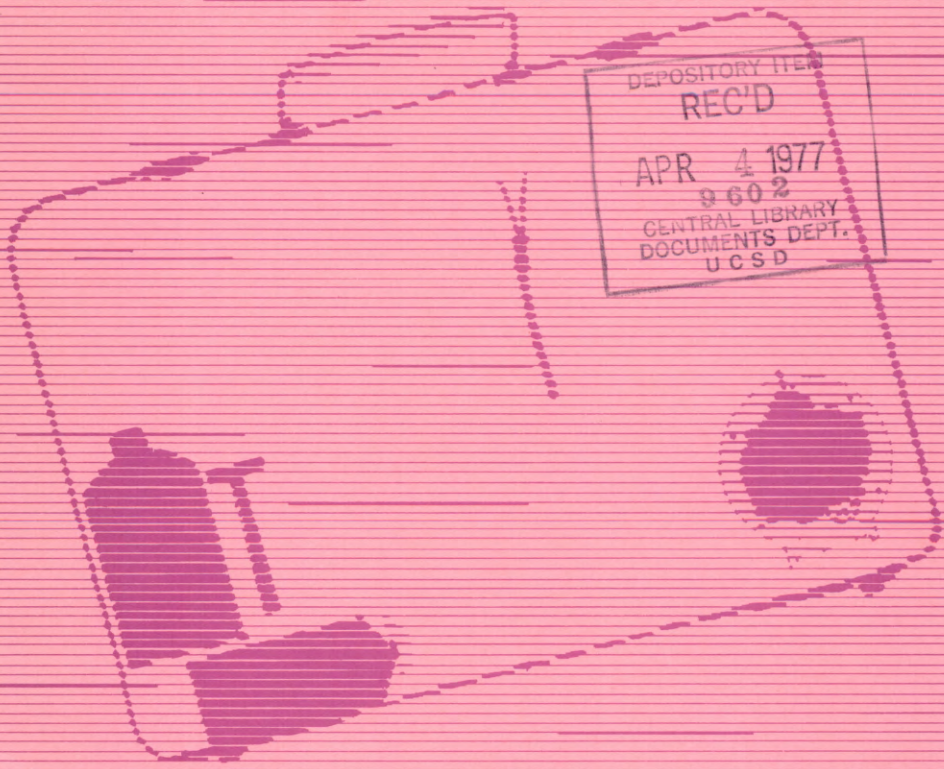
DOCUMENTED PERSONNEL EXPOSURES from AIRPORT BAGGAGE INSPECTION SYSTEMS



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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ABSTRACT

This study documents whole-body and wrist exposure to x-radiation from airport baggage inspection systems. Specially designed badges were worn by 72 security personnel for 2-week intervals at 5 major United States airports. At least one model of each baggage x-ray system in use during the study was investigated. The data represent the total exposure received by security personnel under normal working conditions. Measurements of the x-ray exposures over the 2-week period ranged from 0 to 16.4 milliroentgen (mR) with little difference noted between whole-body and wrist exposures. The results indicate that no measured dose equivalent exceeded the limits specified in the Occupational Safety and Health Administration (OSHA) standard for ionizing radiation.

ACKNOWLEDGMENTS

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INTRODUCTION

As a result of an increased number of armed hijackings and attempted bombings of commercial airlines in the early 1970's, the Federal Aviation Administration (FAA) instituted a requirement for preboarding security examinations of all passengers and carry-on baggage. This action, as well as an increase in commercial traffic, necessitated the development of an examining method that was fast, effective, and capable of screening a large volume of carry-on baggage of varying size and contents. Specially enclosed, pulsed x-ray fluoroscopic examination systems offered the advantages of increased speed for inspection, minimal cost, passenger acceptance, and improved effectiveness of the actual physical search. One possible disadvantage of the system was the potential radiation exposure to personnel performing the examinations.

In 1974, a cooperative study was proposed by the airlines, represented by the Air Transport Association (ATA), and the National Institute for Occupational Safety and Health (NIOSH) to investigate and document whole-body and extremity radiation doses received by airport personnel performing the inspections. The study was conducted by NIOSH's Division of Biomedical and Behavioral Science with assistance from the ATA and FAA. Baggage units used by 10 domestic airlines at 5 major U.S. airports were investigated. The airports were selected on the basis of number and types of inspection units in use and air traffic passenger volume. Specially developed personnel monitoring badges to measure low energy x-radiation were provided by Harshaw Chemical Company. This report presents a description of the typical baggage x-ray system in use, procedural information of the study, results, discussion, and conclusions.

DESCRIPTION OF TYPICAL BAGGAGE X-RAY UNIT

Although several variations in design are available from different manufacturers, generally, the baggage system consists of an x-ray generator and an electronic radiation detector on opposite sides of a chamber. Baggage is placed in the chamber either manually or by conveyor. Signals from the detector are used to generate a video display of the baggage contents. All systems utilize some form of image amplification to minimize the intensity of radiation required to produce a suitable display. To protect both the employees and the public, systems are shielded to reduce emission of x-rays outside the units. Interlocks prevent operation of the system if the shielding is not in the proper position.

Operation of the systems requires at least two persons, one to load the baggage and one to monitor the video display. Airports with a large volume of traffic have as many as five additional employees working with a single unit. Figure 1 shows a typical baggage x-ray unit in operation. Note the position of security personnel during examination of the baggage.

Baggage x-ray inspection units present an unusual occupational radiation exposure situation because the units are operated by security personnel rather than by trained radiation workers. Personnel working with these units are required to wear a whole-body monitoring device such as a film badge or thermoluminescent dosimeter. Extremity monitoring badges are often used in addition, because of the need for manual baggage handling. Existing film badge records were not sufficient to establish operator radiation exposure levels. Since commercial personnel monitoring badges are not capable of measuring low energy x-ray exposures below 50 mR, it was therefore necessary to develop more sensitive badges.

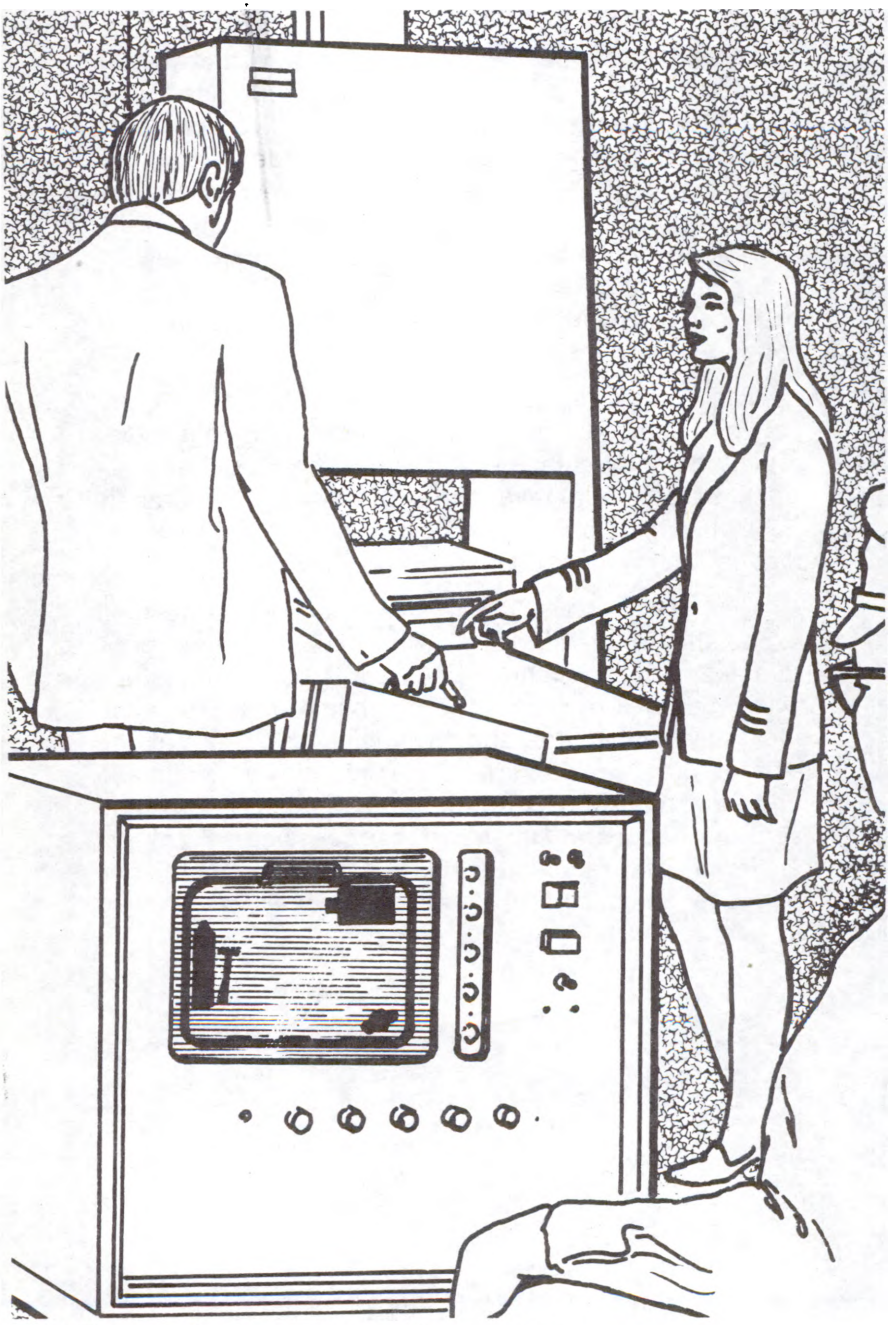

FIGURE I. A typical baggage x-ray unit in operation.

PROCEDURE

Airports were selected on the basis of the models of baggage units in use and the anticipated passenger volume. At least one unit from each manufacturer was included in the study. Seventy-two security personnel from 10 airlines at 5 airports in the United States were monitored for a 2-week period. All participants were provided with two badges—one to be worn on the wrist (extremity badge) and the other at waist level (whole-body badge). Badges were designated for a particular baggage x-ray inspection unit.

The badges, designed by Harshaw Chemical Company, contained four thermoluminescent dosimeter (TLD) chips, two lithium flouride and two calcium fluoride. Detection of extremely low x-ray exposures is possible with this badge since corrections can be made for the energy dependence of the TLD's.

Each airline security supervisor received a detailed explanation of the study by a NIOSH staff member prior to actual implementation. Each participant in the study was requested to record the number of hours worked, the x-ray unit model, and the inclusive dates. At the end of the 2-week period, the supervisors collected and forwarded to NIOSH the requested information and sent the badges to Harshaw for processing. To reflect environmental radiation levels not associated with the baggage units, control badges were also maintained at each airport.

RESULTS AND DISCUSSION

Two radiation protection standards are applicable to radiation exposure levels from x-ray baggage units. The Food and Drug Administration's (FDA) product safety standard pertains to all types of cabinet x-ray systems and is enforced by FDA under the Radiation Control for Health and Safety Act PL 90-802[1]. The FDA standard states that radiation exposure from a baggage x-ray inspection system shall not exceed 0.5 mR in 1 hour at a distance of 5 centimeters from any external surface. The Occupational Safety and Health Administration's (OSHA) occupational standard limits an employee's exposure to no more than 5000 mR in any one year, and no more than 3000 mR in any one quarter.

The information submitted by security personnel as well as the magnitude of the x-ray exposures received by the badges is summarized in Table 1. Average whole-body and extremity x-ray badge exposures for the 2-week study at all airports were very low. Since this study included all types of baggage units operated under various conditions by personnel at several airports, the low x-ray exposure limits were not exceeded.

The maximum documented whole body x-ray exposure recorded in this study was 10.8 mR bi-weekly (Table 1). This exposure level represents an annual value of 270 mR which is considerably lower than both the OSHA and FDA regulations. In fact, the FDA cabinet x-ray standard does not permit exposure levels to exceed 4.4 R annually at 5 cm. from any exposed surface. This figure assumes continuous operation (24 hours per day each day) and, therefore, any individual employee should not be exposed to more than one-third this level.

TABLE 1

OBSERVATIONS FOUND AT AIRPORTS

ITEM	AIRPORTS				
	A	B	C	D	E
Number Airlines Monitored	2	5	3	1	4
Number of Manufacturers Baggage Units	2	3	3	1	4
Number of Machines	2	4	3	4	6
Number of Personnel Involved	9	15	15	15	18
Range of Time Badges Worn in Hours	192-219	32-239	126-198	2 wks.	45-138
Intra Study Rank of Airport Traffic Volume	5 least	4	2	1 greatest	3
Avg. Whole Body X-Ray Exposure To All Badges (mR) in 2 Weeks	2.9	0.1	0.6	0.6	0.8
Avg. Extremity X-Ray Exposure To All Badges (mR) in 2 Weeks	2.9	0.1	0.6	0.8	0.8
Range of Exposure (mR):					
Whole Body	0-10.8	0-0.4	0-3.0	0-2.8	0-3.9
Extremity	0-16.4	0-0.7	0-2.2	0-3.9	0-4.7

In all but one case, the range of extremity exposures was slightly greater than the corresponding whole-body exposure range. This finding seems reasonable due to the design of the units and the method of handling baggage. No correlation existed between badge exposures and airport traffic volume.

Although the magnitude of x-ray exposure from the baggage units was of prime importance in this study, it should be noted that additional radiation exposure was recorded on both whole-body and extremity badges at two airports. Due to the nature of the badges, this additional exposure was determined to be gamma radiation. In one instance, after correcting for background, this additional exposure reached a level of 48 mR for the 2-week period. Such a level is difficult to explain merely as an inherent error associated with the processing of the special badges. No effort was made to determine the source of this gamma radiation. However, its presence gives some cause for concern if the total x-ray and gamma radiation field is incident on security personnel. Since many explanations could be offered for this additional exposure, it is evident that additional studies would be required to determine the source and significance of this gamma radiation.

CONCLUSIONS

No documented over-exposures were found with the badges worn by personnel in the vicinity of typical baggage x-ray systems in airports.

The recorded whole-body and extremity exposures indicate that x-ray units are operating well within acceptable limits. In the five airports studied, which covered all models of baggage x-ray units, there were no violations of occupational exposure standards.

Measurements made during this study were not directed at proving compliance with FDA product standards since the badges were worn by the operating personnel. However, the low personnel exposures support the effectiveness of this standard.

It is recommended that the use of personnel monitors should continue until a one-year history of use without personnel over-exposures is recorded. Since this report only looked at large airports, it may be that situations exist at other airports which require more history and data collection.

Although most of the x-ray systems surveyed in the study were reasonably new, it is recommended that periodic maintenance programs be instituted to check the effectiveness of shielding after continued use of the units.

REFERENCES

1. Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968. DHEW Publication No. (FDA) 76-8035, January 1976.
2. Occupational Safety and Health Standards Code of Federal Regulations, Part 1910, Vol. #39, No. 125, June 27, 1976.
3. Mr. A. C. Lucas, Harshaw Chemical Company, Solon, Ohio.

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