Promoting Radiation Protection and Safety for X-ray Inspection Systems

Harri P. Maharaj

Department of Health, Healthy Environments and Consumer Safety Branch, Consumer and Clinical Radiation Protection Bureau, Ottawa, Ontario, CANADA

ABSTRACT. This paper aims to present a regulatory perspective on radiation protection and safety relevant to facilities utilizing baggage x-ray inspection systems. Over the past several years there has been rapid growth in the acquisition and utilization of x-ray tube based inspection systems for security screening purposes worldwide. In addition to ensuring compliance with prescribed standards applicable to such x-ray systems, facilities subject to federal jurisdiction in Canada are required to comply with established codes of practice, which, not only are in accordance with occupational health and safety legislation but also are consistent with international guidance. Overall, these measures are aimed at reducing radiation risks and adverse health effects. Data, acquired in the past several years in a number of facilities through various instruments, namely, monitoring and surveillance, radiation safety audits, onsite evaluations, device registration processes and information developed, were considered in conjunction with detrimental traits. Changes are necessary to reduce radiation and safety risks from both an ALARA point of view and an accountability perspective. Establishing, developing, implementing and following a radiation protection program is warranted and advocated. Minimally, such a program shall be managed by a radiation safety officer. It shall promote and sustain a radiation safety culture in the workplace; shall ensure properly qualified individuals operate and service the x-ray systems in accordance with established and authorized procedures; and shall incorporate data recording and life cycle management principles. Such a program should be the norm for a facility that utilizes baggage x-ray inspection systems for security purposes, and it shall be subject to continuous regulatory oversight.

Keywords: radiation protection program, radiation risks, radiation safety, x-ray inspection system

1. Introduction

In the late 1960s, the commercial aviation industry first embarked upon utilization of inspection x-ray machines to identify weapons (e.g., guns) and prohibitive materials and items (e.g., knives, scissors) as a means of curbing aircraft hijackings and hostage taking incidents; these incidents are generally associated with terrorist activities aimed at causing undue harm and detriment to society. This application of x-ray machines rapidly gained acceptance worldwide with heightened interest whenever such incidents occurred.

Consequently, over the course of decades, transformations in the designs of x-ray machines have occurred in an effort to meet the needs of an aviation industry determined to mitigate harm and risks to its air-traveling clientele. Because of its apparent success, the application inevitably spawned a new industry whereby x-ray machines were touted as new technology for ‘security screening’ operations (e.g., bomb and contraband detection in parcels, mail, cargo, etc.) under the aegis of protecting society. This societal interest was probably exacerbated by the September 11, 2001 human tragedy in New York, USA, which apparently was associated with terrorist activities and commercial aviation. For these reasons, there has been rapid growth in the acquisition and utilization of x-ray tube based inspection systems for security screening purposes worldwide (herein referred to as the ‘practice’).
2. Materials and Methods

2.1 Rationale for standards

The hazards and risks associated with the use of x-rays are well known historically. Dating back to the early development of medical radiology which utilized x-ray machines that had very little, if any, safety features in combination with poor practices that led many British and American radiologists to develop leukemia and skin cancer from the whole-body exposures to x-rays [1, 2]. This in itself, in spite of the safety improvements of x-ray equipment that might have been realized, justified a need under the Radiation Emitting Devices Act (REDA) of 1970 [3] to promulgate in 1976 prescribed standards [4] that are specific to x-ray machines used for security applications (classed as baggage x-ray inspection devices). The prescribed standards indicate design, construction and performance criteria for such devices [4].

Aeronautics, which is a proclaimed federal undertaking, means that airports are federal facilities. They are therefore required to comply with established codes of practice [5], which not only is in accordance with federal occupational health and safety legislation [6], but also is consistent with international guidance [7]. From an altruistic safety perspective, the widespread use of baggage inspection x-ray machines warrants compliance with the established code of practice by all federal facilities or agencies that are subject to federal occupational health and safety legislation [6].

Enforcement of compliance under the REDA and occupational health and safety legislation is an effective measure aimed at reducing radiation risks and adverse health effects potentially associated with the practice.

2.2 Performance indicators for facilities in reducing risks

With the aim of reducing potential radiation risks and adverse health effects, a number of instruments were used depending on the nature and complexity of the practice in a particular facility.

For example, the post September 11, 2001 tragedy ushered enforced registration of baggage x-ray inspection machines under occupational health and safety legislation [6], particularly for novice owners and those having few such machines. In accordance with the established code of practice [5] certain key elements were relevant to device registration: acquisition of REDA compliant baggage x-ray machines; commissioning and installation procedures; radiation safety training of operators and maintenance personnel; authorized maintenance provider; on-site radiation surveys; use of properly calibrated survey meters; mandatory daily safety checks carried out by authorized personnel; problem reporting and resolution measures; emergency procedures and unplanned radiation exposure incidents; and device accountability on site.

Radiation safety audits [8], which were already established and typical for mature facilities that employ more than a dozen inspection x-ray machines encompassing a variety of operations and sites, provide useful information. Such facilities are expected to implement similar registration criteria and adopt a common quality assurance system for its operation sites.

On-site evaluations of facilities were generally carried out on a random basis. However, they could be triggered by informant sources or suspicions of improper operational rules or procedures.
3. Results and discussion

Drawing on the aforementioned instruments utilized over the past 5 years has revealed a number of issues that might compromise the intended goal of minimizing radiation risks and adverse health effects potentially associated with the practice. At the outset, it is worthwhile to point out that the issues identified, though not widespread or common, span novice and mature facilities engaged in the practice. This therefore merits concern and, as such, warrants resolution by the owner of the x-ray machine(s). Pursuant to federal legislation an owner of a baggage inspection x-ray machine is ultimately responsible for its safety [5,6].

The removal of shrouds or their modification (such as, making shroud lengths shorter) at the entrance and exit ends of the irradiation tunnels increases the probability of unnecessary and avoidable x-ray exposures to personnel and possibly other individuals in very close proximity to the openings of the tunnels. Thus direct access to high radiation fields (inside the irradiation tunnel) is not denied; hence, personnel and a member of the public can easily reach into the irradiation tunnel when x-rays are being produced in order to insert or retrieve an item. These events occur despite prior safety training of personnel and posting of radiation hazard warning signs on the x-ray machine that aim to alert the public. Some individuals (workers and members of the public) have expressed concerns about serious health effects apparently from alleged x-ray exposures incurred.

Committing voluntary acts that make inspection x-ray machines unsafe include: disposing sharp metal objects in areas where interconnecting cables are linked with critical components of the x-ray machines and imaging accessories, attempting to alter designed response times of safety mechanisms, deliberate removal or defacing radiation warning labels and signs. Such acts constitute violations of applicable regulations [4,5].

Resale or donation of old x-ray machines to novice agencies embarking on utilizing such technology in their line of business carries the risks of potentially defective or inoperable safety mechanisms, stray radiation levels in excess of regulatory requirements (0.5 milliRoentgen at 5.0 cm from any external surface of the device)[4], and usage by untrained personnel. Collectively, all of these significantly increase radiation exposure risks.

Improper radiation safety training of operating personnel, including casual workers who may be interactive with x-ray machines that are used in warehouses and cargo operations can lead to radiation exposures which are largely preventable. Poorly done or the absence of daily operational safety checks could lead to a false sense of x-ray machine safety by attendant users or operation personnel.

Inadequate documentation and retention of machine modifications, personnel training, maintenance records, radiation surveys, and radiation exposure incidents could potentially complicate liability issues for an owner of the inspection x-ray machine.

When considered collectively, the preceding issues and their potential detriments suggest that changes are necessary to reduce radiation and safety risks from an ALARA precept and a regulatory perspective. This therefore means that a facility engaged in such a practice needs to establish, develop, implement and follow a radiation protection program. Minimally, such a program shall be managed by a radiation safety officer. It shall promote and sustain a radiation safety culture in the workplace; shall ensure properly qualified individuals operate and service the x-ray systems in accordance with established and authorized procedures; and shall incorporate data recording and life cycle management principles. Such a program
should be the norm for a facility that utilizes baggage x-ray inspection systems for security purposes, and it shall be subject to continuous regulatory oversight.

4. Conclusion

A facility that utilizes inspection x-ray machines for security screening purposes should develop and implement a radiation safety program. The program shall be managed by a radiation safety officer and should be subject to regulatory oversight.

REFERENCES


