Relevant Facts Regarding the Use of Ionising Radiation Screening Devices in Airports

An Information Paper from the
Inter-Agency Committee on Radiation Safety (IACRS)[1]

Introduction

The objective of the Inter-Agency Committee on Radiation Safety (IACRS)[2] is to promote consistency and co-ordination of policies with respect to areas of common interest in radiation protection and safety. Areas of common interest to the members of the IACRS, who are represented by experts in the different fields of radiation safety, include applying principles, criteria and standards of radiation protection and safety and translating them into regulatory terms; coordinating research and development; advancing education and training; promoting widespread information exchange; facilitating the transfer of technology and know-how; and providing services in radiation protection and safety.

The IACRS has for some time been aware of issues concerning the radiological protection aspects of using X-ray body scanners, and discussed these at previous IACRS meetings, most recently January 2010. As a result, the IACRS has consolidated the following relevant facts and information for internal use of its member organizations, which may also make it available to interested governments responsible for taking decisions concerning the use of such scanners. Further detail concerning a few significant approaches to guidance is provided in annex.

Background

The failed attempt to blow up a plane from Amsterdam to Detroit on 25 December 2009 by the use of explosive powder sewn into his underwear has sparked new calls to step up security at airports. Much of the attention has focused on the new or increased use of body scanners that can reveal objects concealed beneath a passenger's clothing. Within the remit of radiation protection it should be considered whether those body scanner technologies using ionizing radiation represent a health risk to the individuals being scanned and the operating personnel. In terms of possible public health impact, the global airport traffic statistics indicate that the total number of air passengers is over 4.8 billion per year, and that international passenger traffic accounts for 42 percent of that global traffic. Therefore, the number of individuals who could be exposed to radiation might be significant, including screened people, employees who operate the security screening systems, employees who happen to work nearby and other members of the general public.[3]

Description of Commonly Available Technologies

Four types of body scanners are capable of detecting concealed items worn on a person's body, and of indicating detection by means of an alarm. Two systems use machine-generated X-rays, the third uses machine-generated high-frequency, non-ionising radio-waves, and the fourth does not use any machine-generated radiation but detects the non-ionising radio-waves naturally generated by the human body. In all cases, a human operator may be an integral part

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[1] This document is an IACRS product and may not necessarily represent the official position of any participating organisation.

[2] For information concerning the IACRS please consult the web site: http://www.iacrs-rp.org/

[3] Airport Council international (ACI) member airports, representing approximately 98 percent of global airport traffic, report that the total number of passengers rose marginally in 2008 to 4.874 billion passengers, compared to 4.869 billion in 2007, according to ACI Annual World Airport Traffic Reports (WATR)

of the system, but newer systems process images automatically and humans need only be involved if suspicious objects are detected causing an alarm.

Individual body scanners based on two types of X-ray devices have been available for decades. Back-scattered X-rays are used to image objects concealed beneath the passenger's clothing while transmission X-rays can also image objects concealed within the body (e.g. swallowed, hidden in body cavities or implanted under the skin). Both technologies can produce high-quality still images in about 20-30 seconds.

The other types of commonly used body scanners are based on non-ionising technologies and are currently available and have been in test-use for some time. The current technologies include different non-ionizing techniques using radio-waves (millimetre-wave and THz imaging), or thermal and multi-band imaging. These techniques can only detect objects concealed beneath clothing. At present, the most developed and wide-spread technology is the millimetre-wave, which can provide high-quality still images, in 3D, in about 2 to 3 seconds.

Radiation Exposure from X-ray Body Scanners

Body scanners based on non-ionising technologies do not expose the people being scanned to ionizing radiation. X-ray body scanners will expose the people being scanned, although the dose to the scanned person is very low. Generally, the radiation dose to the scanned individual from a backscatter system will be much lower than the dose from a transmission system. Typically a single scan of an individual will result in the person receiving a radiation dose of 0.1 μSv from a backscatter X-ray scan, and about 5 μSv from a transmission X-ray scan. Radiation doses are cumulative, so an individual’s total dose will depend on the number of scans performed (some passengers require 4 scans per screening procedure) and on the frequency with which the individual travels. To put this into perspective, during any single year, every individual on earth will be exposed to natural, background radiation to a level of, on average, about 3000 μSv. In flight, galactic cosmic rays (GCRs) are a major source of radiation exposure to the aircrew and passengers, with dose rates significantly higher than at ground level. In-flight doses vary with flight path (latitude, altitude and duration) but, for the sake of comparison, the typical total effective dose due to GCRs for a transatlantic flight (e.g. from Europe to North America) is on the order of 50 μSv. In this context, radiation protection issues related to the use of X-ray body scanners should be assessed and balanced against the direct and indirect benefits of such scans as input to government decisions concerning the justification of use of such scanners.

Privacy Issues

Privacy issues are a major concern in the use of body scanners, particularly in the case of backscatter systems since this technology produces an image of the naked human body. Measures are being taken to resolve these concerns by situating the personnel interpreting the images in a separate location, without contact with the person under inspection, and through the implementation of software to mask faces and private areas (in these cases image analysis may be automated). In some countries the screener and the screened person have to be of the same gender, and in some countries children are not screened.

Radiation Protection Issues

In assessing the possible use of X-ray body scanners, three radiation protection issues may be of relevance with regard to the government decision whether or not to justify their use. First, although the individual exposures are very low, the exposure experienced by the scanned

population as a whole will depend on whether all passengers are systematically scanned, or alternatively whether passengers are selected for scanning randomly or on the basis of specific criteria. The manner in which passengers would be selected would be needed in order to appropriately assess the full radiological protection impact of scanner use.

Second, the use of X-ray body scanners on sensitive groups, such as pregnant women and children, could be assessed separately during government consideration of justification.

Thirdly, an activity causing radiation exposure can be viewed as justified if its net benefit is greater than its net detriment.

Requirements for X-ray Body Scanner Use in the International Basic Safety Standards (BSS)[4]

The current draft text of the International BSS addresses non-medical imaging of humans in all its guises, including security screening. The default position is that such deliberate exposure of persons is normally deemed to be not justified, but that there may be exceptional circumstances in which a country may wish to consider such radiation use. For such circumstances, the requirements in the draft BSS set out a framework to ensure appropriate radiation protection for all parties, including persons being irradiated.

First and foremost the proposed use of radiation, such as security screening at an airport, would be subject to the process of justification, with the responsibility for this process lying with government. If after due process the decision by government is made that a particular practice of non-medical imaging of humans is appropriate, then each instance of such a practice would be subject to authorization with appropriate conditions and would be subject to regulatory control. In particular, for the case of security screening, exposed persons would be protected through optimization, with dose constraints, and the application of the public dose limits.

There is a further requirement on standards of equipment performance, and another on the need to inform persons that they may choose an alternative technique that does not use ionizing radiation, if available (e.g hand search).

Trends in X-ray Body Scanner Use

Several organisations and countries have implemented requirements and policies regarding the use of X-ray scanners in airports. The information presented below has been collected by the IACRS for this information paper and is not exhaustive. It is simply intended to provide some examples of the various approaches adopted in different regions/countries.

The European Union[4]

The European Commission was given a mandate by the European Parliament to establish common rules for civil aviation security following the 11 September 2001 terrorist attacks in the United States. Rules were upgraded in 2008 to better address concealed liquids. However, an attempt by the Commission to implement more specific rules regarding body screening techniques was rejected by the European Parliament due to concerns related to health, privacy and data protection.

[4] Further discussion of this guidance is provided in Annex

Such techniques are not explicitly addressed in the current EURATOM BSS, but any use of ionising radiation is subject to requirements for justification, optimization and dose limitation. The draft EURATOM BSS establishes requirements similar to those of the draft International BSS, including requirements for justification, regulatory control, dose constraints and dose limits and availability of alternative techniques. Transmission scanning systems are not used for aviation security in the EU, and while some EU Member States recently announced plans to install body scanners at airports they are mostly opting for a non-ionizing technology.

The United States[5]

In the United States, there are no specific legislative requirements for the justification and use of body scanners using ionising radiation. The Interagency Steering Committee on Radiation Standards (ISCORS) is an interagency body made up of those federal organisations having regulatory authority with respect to radiation protection issues. The agencies represented on the committee include the U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, U.S. Department of Energy, U.S. Department of Defense, U.S. Department of Homeland Security, U.S. Department of Transportation, the Occupational Safety and Health Administration of the U.S. Department of Labor, the U.S. Department of Health and Human Services, and any successor agencies. In July 2008 the ISCORS developed a guidance document to assist Federal agencies in determining when the use of ionizing radiation for security screening of humans is warranted.

The recommendations presented in this guidance are based on the three basic principles of radiation safety: (1) justification of the use of ionizing radiation, (2) optimization of radiation exposure, and (3) limitation of the radiation dose.

Japan

Security screening using ionizing radiation is neither performed nor planned in Japanese airports.

Germany

The German Federal Office for Radiation Protection (BfS) conducted an evaluation on aspects of radiation protection for whole-body scanners available (in the German language) on: http://www.bfs.de/de/elektro/papiere/body_scanner.html

In the evaluation BfS distinguishes between:
1) Backscatter technology with X-rays;
2) Passive scanners that make use of millimetre/terahertz radiation emitted by the body itself;
3) Active backscatter scanners based on millimetre/terahertz radiation.

BfS favours the use of passive scanners (2) over the use of backscatter technologies that add artificial radiation to improve the contrasts in the picture - either in the millimetre/terahertz range (3) or X-rays (1). The BfS rejects the use of X-rays for this purpose.

[5] Further discussion of this guidance is provided in Annex

The Czech Republic

The Czech regulatory body has rejected the request for installation of whole body (X-ray backscatters) scanners at the airports in the country. The justification for this decision is that:

- There is non-negligible risk associated with radiation involved, mainly for frequent flyers, and the problem of scanning of children and pregnant women is not solved
- Alternative techniques (body search) may satisfy an equivalent level of security

References

- ANSI / HPS Standard: N43.17-2009: Radiation Safety for Personnel Security Screening Systems Using X-Ray or Gamma Radiation, American National Standards Institute, Inc. Approved August 2009
- National Council on Radiation Protection and Measurements. Screening of Humans for Security Purposes Using Ionizing Radiation Scanning Systems, NCRP Commentary No. 16. (National Council on Radiation Protection and Measurements, Bethesda, Maryland) (2003).
- International Electrotechnical Commission. Radiation protection instrumentation - X-ray systems for the screening of persons for security and the carrying of illicit items. (IEC 62463) In preparation. 2009.
- US ISCORS Technical report 2008-1, Guidance for security screening of humans utilizing ionizing radiation (2008)..
- R. Bütikofer, E.O. Flückiger, B. Pirard, and L. Desorgher, Effective radiation dose for selected intercontinental flights during the GLEs on 20 January 2005 and 13 December 2006, In Proc. 21st European Cosmic Ray Symposium, 2009.
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ANNEX
Further Details on Guidance from the Draft International Basic Safety Standards, from the European Union, and from the United States

Draft Requirements from the DRAFT International Basic Safety Standards Pertaining to Non-Medical Imaging of Humans

3.20 Human imaging using radiation for the detection of concealed objects for security or anti-smuggling purposes shall normally be deemed to be not justified. If, in exceptional circumstances, the justification of such imaging is to be considered, the requirements of paras 3.60 to 3.67 shall apply.

3.60. The government shall ensure that the use of ionizing radiation in the imaging of humans for purposes other than medical diagnosis or treatment be subject to the system of protection and safety as required by these Standards.

3.61. The government shall ensure that the measures described in para. 3.16 for the justification of practices are applied to any imaging procedure that exposes humans to radiation not intended for diagnostic or therapeutic purposes. The justification process shall consider, inter alia,

(a) Appropriateness of the radiation equipment for the proposed use.
(b) The use of alternative techniques that do not utilize ionizing radiation.
(c) The benefits and detriments of implementing the procedure.
(d) The benefits and detriments of not implementing the procedure.
(e) Evaluation of various radiation technologies available, including the effectiveness and limitations of the procedures.
(f) Availability of sufficient resources to safely conduct the imaging procedure during the intended period of use.
(g) The impact of any legal or ethical issues which may be raised by the use of the technology.

3.62. If it has been determined through the process specified in para 3.60 that a particular practice of human imaging is justified, then, such a practice shall be subject to regulatory control.

3.63. The regulatory body, in cooperation with other relevant authorities, agencies and professional bodies as appropriate, shall establish the requirements for regulatory control of the practice, including periodic review of the justification.

3.64. For human imaging conducted by medical staff using medical radiological equipment, which exposes humans to radiation for occupational, legal or health insurance purposes without reference to clinical indications:

(a) The government shall ensure, as a result of consultation between other relevant authorities, professional bodies and the regulatory body, the establishment of dose constraints for such human imaging procedures.
(b) The registrant or licensee shall ensure that the appropriate optimization requirements for medical exposures specified in paras 3.162 to 3.178 are applied, with the exception that dose constraints as set in (a) are to be used instead of diagnostic

reference levels.

3.65. Inspection procedures , using inspection imaging devices, which intentionally expose humans for the purpose of detection of concealed weapons, contraband or other objects on or within the body shall be considered as giving rise to public exposure, and registrants and licensees shall ensure that the requirements for public exposure in planned exposure situations are met and, in particular, that optimization of protection and safety is subject to any dose constraints set by the government or regulatory body.

3.66. Registrants and licensees shall ensure that all persons that are about to be exposed to radiation for inspection procedures, are informed about the possibility of choosing an alternative technique that does not use ionizing radiation, where available.

3.67. The registrant or licensee shall ensure that, whether imported into or manufactured in the country where it is used, any inspection imaging device used for the detection of concealed objects and for security purposes conforms to applicable standards of the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO) or to equivalent national standards.

European Union

EC legislation regulating the use of body scanners at airports

Following the events of 11 September 2001, the Commission has been given a mandate in the field of aviation security. In result, Regulation (EC) No 2320/2002 of the European Parliament and of the Council of 16 December 2002 establishing common rules in the field of civil aviation security was adopted. In 2008 the EC legislation was updated (Regulation (EC) No 300/2008), one of the main reasons being the need to detect liquids held in hand baggage and on the human body. Commission's proposal (DG TREN, Directorate F) for addressing the detection of liquid explosives carried on a person's body relied on the introduction of the appropriate body screening techniques in the list of optional screening methods provided by the EC legislation. This proposal has been rejected by the European Parliament due to concerns related to health, privacy and data protection.

EURATOM legislation regulating the use of body scanners

X-ray body scanners are not explicitly considered in the current EURATOM legislation but, as with any other technique applying ionizing radiation, they fall under the provision of the Council Directive 96/29/EURATOM (BSS) and the radiation protection requirements for justification, optimization and dose limitation apply. Non-ionizing radiation techniques (like the millimetre-wave) fall out of the scope of the EURATOM BSS.

In the latest draft of the recast EURATOM BSS the body scanners are grouped together with other deliberate exposures of humans for non-medical reasons under the new definition of 'Non-medical imaging exposures'. Special emphasis is put on the need for justification and regulatory control of those practices. Exposure from body scanners is categorized as public exposure and the dose limit and the requirements for optimization with the use of dose constraints apply. The draft EURATOM BSS requires that alternative techniques, which do not involve exposure to ionising radiation, are available to the exposed individuals where the exposure is routinely carried out for security purposes.

Guidance from the United States

The guidance provided by the IACORS anticipates that the decision to perform security screening of humans will be made by an authority at the appropriate organizational level, and in accordance with the legal authorities of that agency. The guidance also clearly notes that the decision involves many factors in addition to radiation protection. The overall benefit must outweigh the risks associated with the chosen security screening method. Prior to conducting security screening of humans, the responsible executive should obtain legal advice and consider the operation, the current threat assessment, physical security, and cultural/social issues, to determine when security screening of humans is justified. An institution should gather sufficient information and data to properly carry out each of the following assessments:

1) Define the need
2) Evaluate options
3) Evaluate privacy concerns
4) Assess radiation risks from the technology and the net benefit of implementation
5) Evaluate agency's ability to implement the practice

After due consideration of the findings from the five steps listed above, the agency should document its decision process.

If a Federal agency decides to implement a security screening practice that uses ionizing radiation, it should establish and maintain an effective radiation safety program. The scope of any radiation safety program should be commensurate with the potential risks associated with the security screening practice. In particular, the adoption of limited-use systems requires a significantly higher level of control and documentation than general-use systems. Therefore, each agency (or organization within an agency) will need to tailor their radiation safety program to their specific needs.

In the United States, the radiation protection programs in each of the States have jurisdiction with regard to most machine produced radiation, including X-rays. Thus the States may also have responsibilities, depending on the arrangements in place at an airport within a particular State.

For the use of state and federal organizations regulating these devices, the American National Standards Institute, in association with the American Health Physics Society, has issued standards regarding the use of these security screening systems based on the radiation dose to the screened individuals as follows:

- ***General-use systems*** should adhere to an effective dose of 0.1 μSv or less per scan, and can be used mostly without regard to the number of individuals scanned or the number of scans per individual in a year For a system to be general-use it must incorporate adequate engineering controls to assure the dose limit is never exceeded.
- ***Limited-use systems*** include all other ionizing radiation scanning systems that require effective doses per scan greater than 0.1 μSv and less than or equal to 10 μSv.

This standard also established a limit of no more than 0.25 mSv (250 μSv) annual effective dose to an individual from any one security screening venue. From a radiation protection standpoint, these systems should be used with discretion in terms of the number of individuals scanned and the number of scans per individual in a year.