The use of ionising radiation screening devices in airports

by T. Lazo*

Although the NEA generally focuses on radiological protection at nuclear power plants and related facilities, it also addresses other areas of radiological protection of interest to member countries. A particular subject of recent importance concerns the use of ionising radiation screening devices as part of airport security efforts.

Modern body scanners can produce human images that can be used to detect weapons that may be hidden beneath a person's clothing. Heightened concerns over terrorist threats to airline flights have prompted many countries to consider the use, or expanded use of body scanners. The use of such devices raises a wide series of questions, some of which concern the radiological protection of those who might be scanned. As such, the Inter-Agency Committee on Radiation Safety (IACRS),[1] an expert body in which the NEA works together with several other international organisations addressing radiological protection issues, recently developed a joint information paper laying out the key radiological protection and other issues that should be or have been considered when making decisions as to whether ionising radiation body scanners should be deployed in airports. This article provides an overview of the information paper.

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 the perpetrator's 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 radiological protection it should be considered whether those body scanner technologies using ionising radiation represent a health risk to the individuals being scanned and the operating personnel. In terms of possible public health impact, 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% 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 work nearby and other members of the general public.[2]

Key issues to be considered

From a radiological protection standpoint, any action or process that does or could cause radiation exposure of the public, workers or the environment must be justified, that is, must result in more good than harm, or it should not be allowed. Then, if it is justified, protection must be optimised: the amount of good that the action or process brings should be maximised with respect to the amount of harm it does or could cause by implementing protective actions.

In the particular case of airport body scanners, the radiological protection principle of justification suggests that a broad judgement will need to be made with respect to the balance between the radiological and other harms that may be caused, and the increased security that their use may bring. The harms to consider include radiological risks and social detriments. In terms of radiological risks, these include considerations of risks to those scanned, to workers operating the equipment, but also to "frequent flyers" and aircrew members who might be scanned frequently. Non-radiological harms to be considered include such questions as personal privacy or boarding efficiency issues. In addition, it may be relevant to consider the availability of security techniques that do not involve radiation exposure, yet could accomplish the same objective.

In terms of optimising protective actions, approaches that should be considered would include minimising the individual exposures received during a scan and choosing an "appropriate" frequency for scanning passengers. The latter might involve scanning all passengers systematically, scanning some fraction of passengers systematically or scanning a smaller number of passengers randomly.

Overall, these judgements tend to be very country-specific, and there is at this time no common view on whether the use of ionising radiation body scanners is or is not justified in a radiological sense. The following information, however, does provide a broad factual basis that can be used by governments and their regulatory organisations when deciding whether such scanners should be used.

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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. A third system uses machine-generated, high-frequency, non-ionising radio waves. A 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 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. Backscattered 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 (for example 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. They are currently available and have been in test use for some time. The current technologies include different non-ionising techniques using radio waves (millimetre-wave and terahertz imaging), or thermal and multi-band imaging. These techniques can only detect objects concealed beneath clothing. At present, the most developed and widespread technology is the millimetre wave, which can provide high-quality, still images in 3D in about 2-3 seconds.

Radiation exposure from X-ray body scanners

Body scanners based on non-ionising technologies do not expose the people being scanned to ionising 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 four 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 3 000 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 their use.

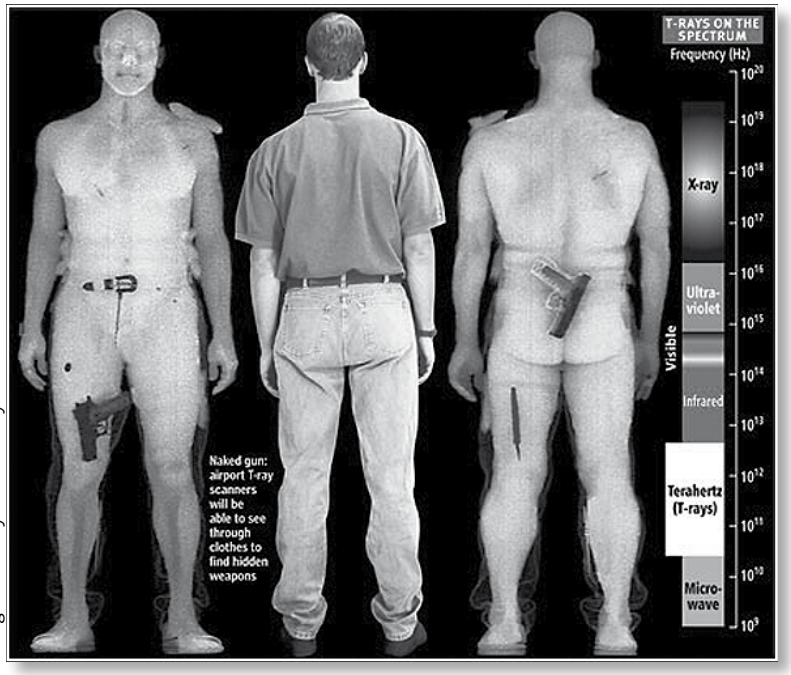

Image courtesy of the Daily Mail

Images from a terahertz scan showing the detection of hidden weapons.

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.

Radiological protection issues

In assessing the possible use of X-ray body scanners, there are two significant radiological protection issues that may be of relevance with regard to the government decision whether their use is justified. 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 need to be known 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 considered to present other hazards, and as such the use of scanners on these sensitive groups could be assessed separately during government consideration of justification.

Conclusions

It is not possible to make general statements about the rationale adopted when making national decisions to use X-ray body scanners or not. It can be said that most countries appear to have chosen not to use X-ray body scanners, but rather to use non-ionising radiation body scanners or other more "standard" search techniques (e.g. metal detectors, pat-down searches, etc.). In all these national choices, it appears that privacy issues have posed problems with these devices, irrespective of whether they use ionising radiation. It also appears that the simple fact that X-ray body scanners use radiation, even at extremely low individual levels, can raise significant concerns, which are being addressed by national radiological protection authorities. The IACRS information paper on this subject has clearly helped raise awareness of the pertinent issues and inform the debate.

Notes

1. The IACRS was established in 1990 to promote consistency and co-ordination of policies with respect to areas of common interest in radiological protection and safety. Areas of common interest to the IACRS members include applying principles, criteria and standards of radiological 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 radiological protection and safety. For further information concerning the IACRS, see www.iacrs-rp.org/.
2. Airport Council International (ACI) member airports, representing approximately 98% of global airport traffic, have reported in the ACI Annual World Airport Traffic Reports (WATR) that the total number of passengers rose marginally in 2008 to 4.874 billion passengers, compared to 4.869 billion in 2007.

References and national and international standards for the use of X-ray body scanners

ACI Annual World Airport Traffic Reports, available online at www.airports.org/.

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.

International Electrotechnical Commission (2010), "Radiation protection instrumentation – X-ray systems for the screening of persons for security and the carrying of illicit items", IEC 62463.

National Council on Radiation Protection and Measurements (2003), "Screening of Humans for Security Purposes Using Ionizing Radiation Scanning Systems, NCRP Commentary No. 16", National Council on Radiation Protection and Measurements, Bethesda, Maryland.

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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