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AIRPORT SECURITY SCANNERS & IONISING RADIATION

A Joint Report from The British Institute of Radiology and The Royal College of Radiologists

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Introduction

Recent security threats to aircraft have led to the installation and testing of whole-body scanning equipment in airports in the UK, other European nations and the USA. There has been concern voiced both in the lay press and scientific literature regarding both the amount of radiation to which travellers might be exposed by these scanners and the intrusion on personal privacy resulting from their use for screening. In order to assess the radiation safety issues raised by both air travellers and airline/airport staff, a working group was convened with representatives from the British Institute of Radiology (Radiation Protection Committee), The Royal College of Radiologists and interested UK advisory and regulatory bodies.

Body scanners developed for security screening were first employed in 1998 and were trialled at Heathrow airport as far back as 2003. It is the Group's understanding that body scanners are currently being trialled by the Department for Transport to improve security while discussions continue within the EU. Key factors to be considered in such implementation are the net benefit to society and the "ALARA" principle (as low as reasonably achievable) while achieving the desired objective.

The remit of the Group was to review the available published literature regarding radiation dose produced by this technology issued both by the manufacturers and national radiation safety agencies.

Scanning Equipment, Electromagnetic Radiation and Dose

Currently there are two types of body scanner being tested in the UK and abroad.

1. Backscatter X-ray scanners which emit ionising radiation albeit in very low dose. The "Rapiscan Secure 1000" is the scanner currently being trialled in the UK.

2. Millimeter wave scanners which use radiowave frequencies within the 24–30 GHz frequency range. There are two types of this technology. Firstly, active where a machine emits radio waves to produce an image and secondly, passive whereby the scanner receives natural radiation emanating from the person being scanned.

A third type of scanner, the transmission X-ray system, is currently in use for examination of suspected smugglers on entry into the country to identify objects concealed within the body. This type of technology is not within the remit of the Group.

Legislation

The Justification of Practices Involving Ionising Radiation Regulations 2004 requires that any practices involving exposures of persons to radiation provide benefits to society or the individual which outweigh the detriment from the exposure. The guidance to the regulations provides a list of existing practices. The use of backscattered imaging for the detection of concealed items on a person is one of the practices on that list.

The European Union Council Directive 96/29/Euratom covers basic safety standards for the protection of the health of workers and the public against the risks of exposure to ionising radiation.

The Ionising Radiation Regulations 1999 mainly implement the directive requirements and cover exposures arising from work with ionising radiation, including exposure of the public. They require the employer to restrict doses to employees and other persons.

In 1993 the National Radiological Protection Board [1] (NRPB, now part of the Health Protection Agency, HPA) issued a recommendation that there should be a public dose constraint of 0.3 mSv/annum from a controlled source and the use of this value is recommended by Health and Safety Executive (HSE) in the non-statutory guidance to IRR99 (L121, para 134). Up to 5000 examinations (2–3 scans per examination) per year would be required to reach the NRPB dose constraint for members of the public.

In January 2010 the Department for Transport issued an "Interim Code of Practice for the Acceptable Use of Advanced Imaging Technology (Body Scanners) in an Aviation Security Environment".

In the US, the American National Standards Institute Standard N43.17-2009 [2], which is a consensus

standard and not a regulatory requirement, limits the effective dose delivered to the subject to 0.25 mSv/ year based on dose per screening being less than 0.1 microSievert. The National Council on Radiation Protection and Measurements (NCRP) commentary 16 [3], published in 2003, states that general use systems should adhere to an effective dose of 0.1 μSv or less per scan. At this dose it would require 2500 scans of an individual annually without exceeding the NCRP recommended administrative control of 0.25 mSv for exposure of a member of the general public to a single source or set of sources under one control, that is at one or more security checkpoints at a given venue.

There is currently no specific legislation relating to protection of the public from millimeter wave emissions. There is a European Council Recommendation (1999/519/EC) which has been accepted by the UK government as a framework for managing public exposures. This is numerically equivalent to guidelines for general public exposure published by the International Commission on Non-Ionising Radiation Protection and recommended by the HPA for UK use. It is recommended that incident power density should be limited to 10 W/m^2 averaged over any 20 cm^2 of exposed area and any $68/f^{1.05}$ minute period (approximately 1.9 minutes for millimetre wave scanners). Spatial maximum power densities averaged over any 1 cm^2 should not exceed 200 W/m^2.

Exposure Levels

In January 2010, the HPA [4] was commissioned formally to assess ionising radiation doses from backscatter scanners. Small doses of ionising radiation can be measured using ionisation chambers. Doses are usually measured in millisieverts (mSv). A person living in the UK receives on average a dose of approximately 2.7 mSv from naturally occurring radiation and medical exposure. HPA estimated that travellers passing through the Rapiscan Secure 1000 machine in the UK receive a dose of 20 nano Sv per scan (0.00002 mSv). However, two to three scans might be required for a complete examination resulting in a total dose of 60 nano Sv. To put this into perspective, the average dose from exposure to cosmic rays on a transatlantic flight is 0.05 mSv. The dose from passing through a backscatter system is therefore 100,000 times less than the annual dose a person receives in the UK.

The dose from the more recent dual cabinet X-ray backscatter systems is even lower at around 10 nano Sv per examination. In recent months there has been interest in the absorbed skin dose from these newer scanners. The calculated absorbed skin dose from a scan using the dual cabinet Rapiscan system is around 20 nSv per scan. This should be seen within the context of the annual skin dose limit for the public of 50000000 nSv. It is estimated that a worker in the immediate vicinity of these scanners receives 0.04 mSv per annum.

The instrument currently in use at French airports is the “Provision 100” millimetre wave body scanner. This machine has been assessed by the French Agency for Environmental and Occupational Health Safety (AFSSET) [5]. There is no exposure to ionising radiation. During a scan, the individual is exposed to an electromagnetic field for a time not exceeding 2 secs. The published surface power densities measured during a scan are low [6,7,8], measured in microwatts per m^2, and vary between 59.7 $\mu W/m^2$ to 640 $\mu W/m^2$.

The data collected from manufacturers and from measurement reports provided by the French Civil Aviation Technical Service indicate that exposure to individuals is well below that found in current

regulations (Decree 2002-775; 3 May 2002). The interaction of millimetre waves is associated with the absorption of energy by free water in superficial skin tissues and the eye. This could potentially lead to biological effects. Under normal operating conditions, a millimetre wave body scanner operates with surface power densities well below those required to produce tissue heating. AFSSET concluded that based on current knowledge there are no proven health risks from exposure to the frequency range shown. In addition, no significant incompatibility issues have been identified with implanted medical devices.

Issues for Consideration

1. As far as we are aware there are currently no signs displayed at airports to indicate to an individual that they are about to be scanned. Information from the Department of Transport indicates that scans are not currently compulsory in the UK but this position may change in the future. It is worth noting that in the US, currently, a passenger will not be allowed to fly if a scan is refused.

2. Based on HPA advice the scanning areas are currently designated as supervised areas and therefore must be kept under review (hence a requirement for monitoring), although based on risk assessments it is inconceivable that a person could receive a dose greater than 1 mSv/annum (without substantial abuse of the system), therefore an argument for no designation could be put forward. This should reassure users and those being scanned that the systems deliver a low dose.

3. Is there a requirement for quality assurance assessment?
   A draft BS standard is currently under consideration which will cover image quality aspects, "Radiation Protection Instrumentation–measuring the Imaging Performance of X-ray and Gamma-ray Systems for Security Screening of Humans". This will allow consistency when different and new machines are checked against the standard.

4. Should repeat scans be required, what governance issues are in place?

Recommendations

1. Passengers should be informed of the fact that they are going to be exposed to radiation by the use of notices and leaflets, but also reassured about safety of the machines in use. This action is supported by a position statement issued by the Health Physics Society.

2. There must be no capacity for workers to adjust the machine.

3. Non-statutory guidance in IRR 99 comments that other techniques which do not utilise ionising radiation should be considered. This is a view which the Group endorses.

Conclusion

On the evidence available, the Group concludes that at current radiation dose levels and surface power densities, the scanner machines in use are safe both as far as the travelling public are concerned and aircrew who may be exposed more regularly as part of their occupation.

References

1. Statement by the National Radiological Protection Board:1990 Recommendations of the International Commission on Radiological Protection. Documents of the NRPB, Vol 4, No 1 1993 ISBN 0-85951-360-2

2. American National Standard ANSI 43. 17-2002, "Radiation Safety for Personnel Security Screening Systems Using X- Rays"

3. National Council on Radiation Protection and Measurements. Screening of humans for security purposes using ionising radiation scanning systems. NCRP commentary no. 16. Bethesda, MD: NCRP 2003.

4. Assessment of comparative ionising radiation doses from the use of Rapiscan Secure 1000 x-ray backscatter security scanner. HPA Feb 2010.

5. Note of the French Agency for Environmental and Occupational Health safety - relating to the "Provision 100 "millimeter" wave bodyscanner". Feb 2010.

6. Apace. (2008). RF/DIV/130 – Electromagnetic field measurements for the Provision 100 millimeter wave scanner.

7. Mitch. (2010). Test report R-032-PTA-10-100225-1

8. Transportation Security Administration (TSA). (2009). TSA Whole Body Imaging. July 2009