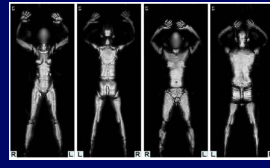


Risks of Exposure to Ionizing and Millimeter Radiation from Airport Security Scanners

John Moulder, Ph.D.

Radiation Oncology
Medical College of Wisconsin



Moulder/ AAPM, Aug-2011

1

What I am Going to Talk About

- What's out there in the USA right now
- What types of radiation they produce
 - How far it penetrates
 - What organ systems could be at risk
- What the exposure levels are supposed to be
 - And how good the dosimetry seems to be
- What the exposure standards are
 - And how well-accepted they are
- What the level of risk might be
 - What there might be to worry about
 - Public acceptance/fear of the technology

Moulder/ AAPM, Aug-2011

2

What I am NOT Going to Talk About

- What might be out there in other countries
 - And what might be deployed in the future
- Passive systems
 - Which may exist
- Privacy, consent, religious freedom issues
 - Which are very real for some people
- Usefulness
- Operator exposure

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3

What's Out There Right Now

Millimeter Wave Unit

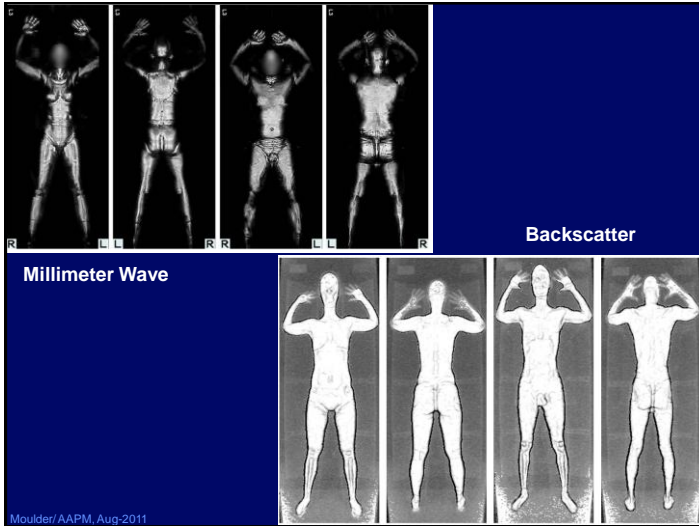


Backscatter Unit



Moulder/ AAPM, Aug-2011

4



How Do They Differ?

Issue	Backscatter	Millimeter Wave
Energy type	ionizing	
Publically-available specs	some	
Publically-available safety data	some	
Relevant safety standards	yes	
Publically-available dosimetry	yes	
Quality of dosimetry	good	
Analysis of failure modes	some	

How Do They Differ?

Issue	Backscatter	Millimeter Wave
Energy type	ionizing	non-ionizing
Publically-available specs	some	almost none
Publically-available safety data	some	almost none
Relevant safety standards	yes	yes
Publically-available dosimetry	yes	none
Quality of dosimetry	good	uncertain
Analysis of failure modes	some	uncertain

Federal Communications Commission DA 09-1966

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
SafeView, Inc.)
Request for Waiver of Sections 15.31 and 15.35 of) ET Docket No. 04-373
the Commission's Rules to Permit the Deployment)
of Security Screening Portal Devices that Operate)
in the 24.25-30 GHz Range)

ORDER

Adopted: September 2, 2009 Released: September 2, 2009

By the Chief, Office of Engineering and Technology:

1. By this Order, we grant the request for extension of waiver filed by L-3 Communications SafeView, Inc. ("L-3 SafeView") on August 1, 2008 to permit the marketing and operation of its ProVision 100 imaging device under Part 15 of the Commission's rules.¹ L-3 Communications SafeView, Inc. was formerly known as SafeView, Inc. and the ProVision 100 imaging device was formerly called SafeScout.² For the reasons discussed below, we find that there is good cause to grant L-3 SafeView a two year extension of its existing waiver of Sections 15.31(c) and 15.35(b), until August 3, 2010, to allow it to market a limited number of devices for an additional two-year period.³

How Do They Differ?

	Backscatter	Millimeter Wave
Energy level	50 kV	
Penetration depth (TVL in tissue)	~ 8 cm	
Scan time	8-15 sec	
Major organ systems at risk	Skin, cornea, testes?	
Mechanism of injury	DNA damage	
Could injury be cumulative?	Possible	

How Do They Differ?

	Backscatter	Millimeter Wave
Energy level	50 kV	24-30 GHz (like a radar gun)
Penetration depth (TVL in tissue)	~ 8 cm	~ 1 mm
Scan time	8-15 sec	2-10? sec
Major organ systems at risk	Skin, cornea, testes?	Skin, cornea
Mechanism of injury	DNA damage	Heating
Could injury be cumulative?	Possible	Unlikely

Dosimetry (Backscatter)

- **No peer-reviewed testing that I have found**
 - Even some implication that TSA will not allow such testing
- **Detailed and publically-available testing by:**
 - US Food and Drug Administration (2006)
 - Johns Hopkins Applied Physics Laboratory (2010)
- **Effective dose:**
 - 0.00003-0.00010 mSv/scan (ANSI, NCRP)
 - 0.00001-0.00005 mSv/scan (FDA)
 - 0.000015 mSv/scan (Johns Hopkins)

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- **Skin dose:**
 - 0.00005 mSv/scan (FDA)

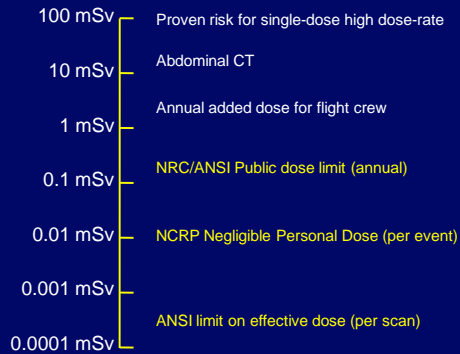
Safety Standards (Backscatter)

- **National Council on Radiation Protection (NCRP)**
 - The concept of negligible personal dose: 0.010 mSv/event
- **US Nuclear Regulatory Commission (NRC)**
 - Public dose from a source: 0.25 mSv/year
- **American National Standards Institute (ANSI)**
 - Limit on dose/screening: 0.00025 mSv/screen
 - Annual dose limit for screening: 0.25 mSv/year

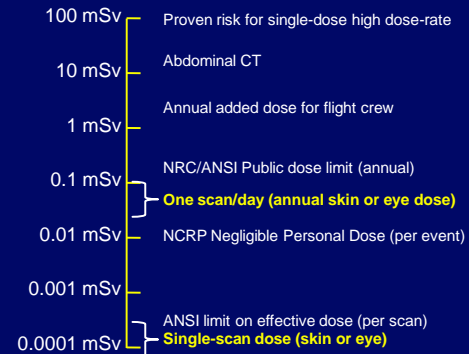
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 - Limit on dose/screening: 0.00025 mSv/screen
 - Annual dose limit for screening: 0.25 mSv/year
- **Standards are generally accepted, but some would argue that:**
 - "no amount is safe"
 - "no proven risks at this level"
 - "small amounts are good for you"

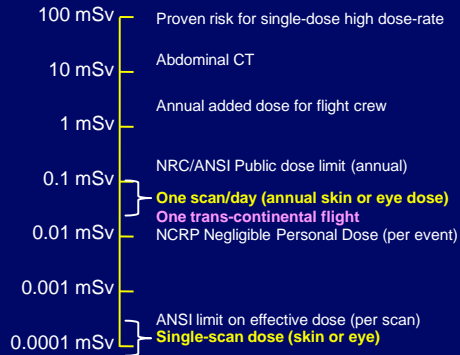
Safety Margin (Backscatter)



Safety Margin (Backscatter)



Safety Margin (Backscatter)



Dosimetry (Millimeter Wave)

- **Could not locate any well-documented dosimetry**
 - But it was done to meet FCC license requirements
- **The common millimeter wave safety standards are dose-rate (power density) standards in mW/cm².**
 - Safety standards assume that there are no cumulative effects.
- **Per DL McMakin (personal communication)**
 - 0.00001 – 0.0001 mW/cm²
- **Per GP Gallerano (personal communication)**
 - 0.00005 – 0.0006 mW/cm²

Safety Standards (Millimeter Wave)

- Safety standards assume that there are no cumulative effects.
- **ANSI/IEEE C95.1 - 1992**
 - Uncontrolled environments: 10 mW/cm² averaged over ~2.5 min
- **NCRP - 1986**
 - General Public Exposure: 1 mW/cm² averaged over 30 min
- **US Federal Communications Commission (FCC) – 1996**
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- **US Federal Communications Commission (FCC) – 1996**
 - General Public Exposure: 1 mW/cm² averaged over 30 min
- **The standards are more controversial than those for ionizing**
 - Note the recent IARC labeling of 2 GHz as a “possible carcinogen”

TRANSPORTATION SECURITY ADMINISTRATION

OFFICE OF SECURITY TECHNOLOGY

PROCUREMENT SPECIFICATION FOR ADVANCED IMAGING TECHNOLOGY (AIT) FOR CHECKPOINT OPERATIONS

3.1.10.1 General

The AIT system *shall* (163) not expose operators, passengers, or maintenance personnel to hot surfaces over 43.9 degrees Celsius (111 degrees Fahrenheit).

3.1.10.2 Radiation

The AIT system *shall* (164) comply with ANSI/HPS N43.17-2002 American National Standard – "Radiation Safety for Personnel Security Screening Systems Using X-ray."

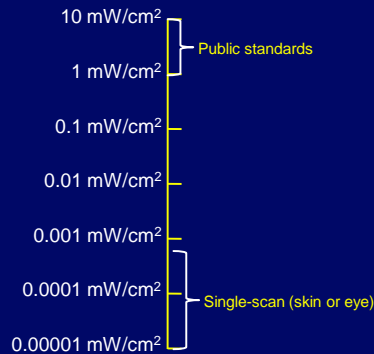
The AIT system *shall* (165) comply with OSHA Standard, 29 CFR 1910.1096, Ionizing Radiation, 1 January 2007.

The AIT system *shall* (166) comply with Institute of Electrical and Electronics Engineers (IEEE), C95.1 – 2005, Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, revision of C95.1-1991 (Active).

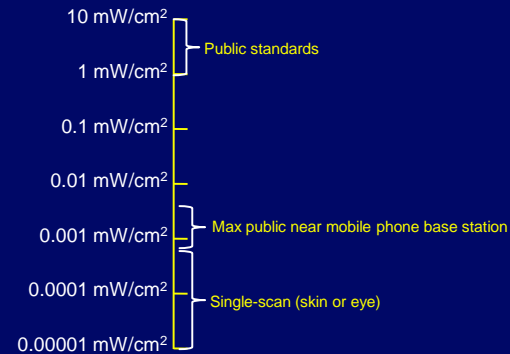
The AIT system *shall* (167) comply with International Commission on Non-Ionizing Radiation Protection (ICNIRP), Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 GHz). Health Physics 74 (4): 494-522, April 1998.

WARNING: This record contains Sensitive Security Information that is controlled under 49 CFR parts 15 and 1520. No part of this record may be disclosed to persons without a "need to know", as defined in 49 CFR parts 15 and 1520, except with the written permission of the Administrator of the Transportation Security Administration or the Secretary of Transportation. Unauthorized release may result in civil penalty or other action. For U.S. government agencies, public disclosure is governed by 5 U.S.C. 552 and 49 CFR parts 15 and 1520.

Safety Margin (Millimeter Wave)



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- If the currently-existing units in the US are operated as intended, it is difficult to imagine any real risk.

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 - Good operator training
- **It also assumes:**
 - Adequate analysis of failure modes

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- **But this assumes:**
 - Good dosimetry of installed (not prototype) units
 - Good quality control and maintenance
 - Good operator training
- **It also assumes:**
 - Adequate analysis of failure modes
- **And this assurance does not apply to future technology or to units deployed by other countries**

Public Acceptance

- **Personal experience is that these units are accepted,**
 - But widely disliked and sometimes feared
- **Problems:**
 - People are scared of "radiation"
 - People blank out when you get to "orders of magnitude"
 - There is some incredible junk science on the net

Public Acceptance

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 - But widely disliked and sometimes feared
- **Problems:**
 - People are scared of “radiation”
 - People blank out when you get to “orders of magnitude”
 - There is some incredible junk science on the net
- **Also not helping:**
 - Inadequate publicly-available information
 - **Some terrible public relations**
 - “less radio-frequency energy than a mobile phone”
 - “as safe to use as a cell phone”
 - “no risk because it is non-ionizing”

Bottom Line

- **Currently-deployed US versions are almost certainly safe:**
 - But safety is difficult to prove with publicly-accessible data

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- **Currently-deployed US versions are almost certainly safe:**
 - But safety is difficult to prove with publicly-accessible data
- **Disliked and somewhat feared:**
 - The veil of secrecy does not help.
- **Acceptance of current (and future) technology:**
 - More openness is needed
 - Widely-accepted safety standards are critical
 - Publically-accessible safety analysis is critical
- **The risk perception issues have not been handled well.**