ICNIRP STATEMENT

ON HEALTH ISSUES ASSOCIATED WITH MILLIMETER WAVE WHOLE BODY IMAGING TECHNOLOGY

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ICNIRP STATEMENT—HEALTH ISSUES ASSOCIATED WITH MILLIMETER WAVE WHOLE BODY IMAGING TECHNOLOGY

International Commission on Non-Ionizing Radiation Protection*

INTRODUCTION

A NEW generation of whole-body image scanners has been installed in many airports and other security checkpoints worldwide. They are capable of detecting weapons or objects made of any type of material that are being worn or are concealed by clothing at a short range or at distances of a few meters, within a defined scanning zone.

Active scanners emit electromagnetic waves at frequencies in the tens of gigahertz (GHz or 10^9 Hz) or the microwave region and form an image by processing the waves scattered by the object or person being scanned. It is noteworthy that scanners designed to passively detect the broadband microwave radiation emitted by the human body do not expose the body to electromagnetic waves.

At the frequencies used by these scanners, the energy per photon (quantum energy of GHz radiation) is not sufficient to break chemical bonds or to ionize atoms or molecules. Thus, the scanners use non-ionizing radiation, unlike traditional x-ray backscatter machines, which use ionizing radiation.

The typical parameters of the active scanners involve 10 to 100 mW of total output power from antennas operating at 30 to 100 GHz. They take about 2 to 5 s to complete a multi-directional scan of the subject. These scanners are also referred to as millimeter wave (mm wave) body scanners because at this frequency the wavelength is between 3 and 10 mm in air.

These scanners can image through a subject's clothing and detect concealed weapons, explosives, or suspicious articles and display them along with detailed images of the surface anatomy. For the general public, the scans involve a brief exposure time. However, for occupational situations during manufacturing, testing and installation, repeated exposures or extended exposure durations may occur. The scientific data on possible effects and health implications of mm waves are sparse. Aside from thermal interactions, little is known about mm wave interactions with biological systems or the mechanisms that may govern any direct interaction.

The objective of this statement is to address the possible adverse health effects from exposure to mm waves used in whole body electronic security scanners. The statement includes an assessment of the applicability of currently available exposure guidelines.

INDUCED FIELDS AND ENERGY DEPOSITION

At the frequencies of mm waves, the induced fields and energy deposition in biological media can be determined in much the same manner as for other non-ionizing spectra if the permittivity of relevant tissues at these frequencies is known. Between 30 to 100 GHz, the behavior of relative permittivity follows those of the lower frequencies. Specifically, the real and imaginary parts of the complex relative permittivity for skin tissues decrease from 20 to 6 and 20 to 12, respectively.

However, the skin tissue is not homogeneous but consists of a multilayer of stratum corneum (SC), epidermis, and dermis and varies according to body location; for example, forearm and palm skin have thin and thick SC, respectively. In general, at mm wave frequency the permittivity of skin is governed by cutaneous free water contents.

The specific absorption rate (SAR) of the mm wave energy increases with frequency. Calculations of mm wave transmission for skin on the forearm showed an increase from 55% to 65% between 30 and 90 GHz (Alexseev and Ziskin 2007; Alexseev et al. 2008). It is noteworthy that a thick SC in the palm causes an increase in transmission as a result of the layer matching phenomenon at higher mm wave frequencies. Power transmission coefficient for skin on the forearm showed an

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increase from 55% to 65%. However, at the highest frequencies the SAR in the deeper regions of the skin may become lower because of the reduced penetration depth at these frequencies. For example, the penetration depth of a plane-wave field decreases from 0.8 to 0.4 mm and 1.2 to 0.7 mm for skin on the forearm and palm, respectively.

GUIDELINES FOR LIMITING EXPOSURE

The ICNIRP recommends guidelines for limiting human exposure that pertain to frequencies over the entire non-ionizing radiation spectrum (ICNIRP 1998, 2009). For radio frequency electromagnetic fields between 10 to 300 GHz, the existing guideline for the general public is 10 W m^{-2} averaged over a certain time interval that decreases with increasing frequency (6 min at 10 GHz and 10 s at 300 GHz). In addition, for pulsed fields, the peak incident power density averaged over the pulse width may not exceed 10 kW m^{-2}. The corresponding values are 50 W m^{-2} and 50 kW m^{-2}, respectively, for occupational exposures. These values are based on the avoidance of adverse effects caused by mild whole-body heat stress and/or tissue damage caused by excessive localized heating.

It is noted that mm wave body scanners operate in pulse modes. The power levels employed by these mm wave body scanners are low but can generate power densities up to 1.0 kW m^{-2} for a pulsed field averaged over the pulse width. The resulting human exposures are about a tenth of currently recommended guidelines for the general public.

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During the preparation of this statement, drafted under the leadership of the ICNIRP SC3 Chair, James C. Lin, the composition of the International Commission on Non-Ionizing Radiation Protection was as follows: P. Vecchia, Chairman (Italy), R. Matthes, Vice-Chairman (Germany), M. Feychting (Sweden), A. Green (Australia), K. Jokela (Finland), J. Lin (United States of America), K. Schulmeister (Austria), Z. Sienkiewicz (United Kingdom), A. Peralta (The Philippines), P. Söderberg (Sweden), B. Stuck (United States of America), A. Swerdlow (United Kingdom), E. Van Rongen (The Netherlands), B. Veyret (France), G. Ziegelberger, Scientific Secretary (Austria).

All ICNIRP members are requested to fill in and update as necessary a declaration of personal interests. Those documents are available online at www.icnirp.org/cv.htm.

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