Tek84
Engineering Group

December 2, 2010

The Honorable Rush Holt
United States House of Representatives
Washington, DC 20515

re: Misinformation on airport body scanner radiation safety

Dear Representative Holt:

I am the inventor of the x-ray body scanner now being introduced into U.S. airports. More specifically, I developed the SECURE 1000 body scanner in 1991 and subsequently commercialized the technology through several companies. In 1997 this product was sold to Rapiscan Security Systems, which now manufactures the units being purchased by TSA. I have spent the majority of my working career over the last 20 years developing various types of body scanners. This includes the CastScope™ system for examining casts, bandages and artificial limbs, now used in about a dozen U.S. airports. It also includes the CarScan™ system for detecting car bombs, stowaways and contraband in occupied automobiles. Over the last year I have developed the next-generation airport body scanner, called AIT84. This new product will be only five feet wide, compared with nine feet for the current systems. In addition, it will have better detection capability, including a built-in shoe scanner. This may allow passengers to keep their shoes on during the screening. I think it is safe to say that I am widely regarded as the foremost technical expert in the engineering and science of airport x-ray body scanners. I hold a Master's degree in Physics and a Ph.D. in Electrical Engineering. Before graduate school I was a full-time police officer for five years.

I am writing to you because of continuing misinformation about the safety of these devices. This is typified by the comments made by Dr. Brenner that you reference in your recent letter to the TSA. Similar comments have been made by professors at UCSF and other universities. In particular, these professors argue that the body scanner radiation only penetrates a few millimeters into the body, resulting in the radiation dose to the skin being far higher than the average dose to the entire person. This line of reasoning has lead to a variety of inaccurate claims:

- The FDA has seriously miscalculated the radiation safety of these devices.

- The skin dose is 20 times higher than the effective dose to the entire body.

- It is inappropriate to use the techniques of medical radiography to regulate body scanners, since the x-rays used in medical imaging penetrate deep into the body.

- It is inappropriate to compare background radiation to body scanners, since background radiation also penetrates deep into the body.

- The radiation from body scanners is blocked by clothing, resulting in most of the exposure being to the skin of the face and head. This presents an elevated risk of skin cancer.

All of these claims are incorrect, a result of misunderstanding the physics involved. In particular, Dr. Brenner and the other professors have confused Dose Penetration with Imaging Penetration, which are two completely different things. In the attached figures I show measurements taken on a body scanner to help explain this difference.

Dose Penetration is a measurement of how deeply the energy from the x-ray beam is deposited into the body. A simple way to define and measure this parameter is illustrated in Figure 1. As shown, a radiation meter is placed at the subject location within the body scanner. A certain thickness of plastic, simulating overlying body tissue, is placed in front of the meter and the radiation measurement taken. This procedure is then repeated with other thicknesses of plastic. Figure 4 presents the result of such an experiment, which I conducted a few days ago in preparation for this letter. As shown by the solid curve drawn through the data points, placing 5 mm of plastic in front of the meter reduces the intensity of the x-ray beam from 100% to about 95%. In other words, only about 5% of the total energy of the beam is deposited in the first 5 mm of depth into the body. Likewise, the curve drops to 50% with a total plastic thickness of about 50 mm. This means that about one-half of the body scanner radiation is deposited within 50 mm of the skin, and one-half is deposited deeper than 50 mm into the body.

In comparison, **Imaging Penetration** describes how deep into the body the acquired image can detect objects. This depends highly on the imaging configuration, that is, where the x-ray source and detectors are placed in relation to the subject. Airport body scanners use *backscatter imaging*, meaning that they create an image from x-rays that reflect from the first few millimeters of the surface of the body. Only a small fraction of the x-rays that strike the body are used to form this image, with the remaining x-rays being deposited into the body. Figure 2 shows a photograph of a test object used to explain this concept. This consists of 16 small squares of copper, placed between 16 sheets of 1.588 mm thick plastic. The upper-left copper square is on the surface of the test object. The copper squares immediately to the right are behind 1, 2, and 3 sheets of plastic respectively. On the second row the copper squares are behind 4, 5, 6 and 7 sheets of plastic, respectively, and so on.

Figure 3 shows an image of this test object taken on a body scanner. The key feature is that a copper square is less visible in the image as it is placed deeper into the phantom. The lower curve in Figure 4 shows a graph of these data. The upper-left square, having no overlying plastic, is assigned a darkness value of 100%. The upper-right square, covered by 3 sheets of plastic (4.76 mm), is 77% as dark. About 10 mm (6-7 sheets) of plastic is required to reduce the darkness of the copper square to 50%.

Let me emphasize that there are many different ways that the above experiments could be carried out. I selected these as simple examples to explain the concepts involved. The FDA has conducted detailed evaluations of this technology for radiation safety. Likewise, the TSA has throughly evaluated the detection capabilities. The data I present in this letter should be used for explanatory purposes only, deferring to the Government evaluations for decision making.

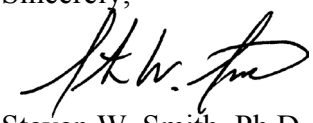
The primary concern with using body scanners in airports is the unclothed appearance of the acquired image. It is therefore not surprising that the TSA states that the radiation penetrates only a few millimeters

into the skin. That is, they answer the question based on Imaging Penetration, explaining why the image looks the way it does. Unfortunately, Dr. Brenner and the other professors have misconstrued this statement to mean Dose Penetration. This leads them to erroneously conclude that the energy of the x-ray beam is deposited mostly into the skin. All of the body scanner studies conducted by these professors have been theoretical; none of these professors have had the opportunity to take direct measurements on the actual products.

Every major radiation protection organization in the United States has endorsed the safety of x-ray body scanners. This includes the FDA, National Council on Radiation and Protection, American College of Radiology, Interagency Steering Committee on Radiation Standards, Health Physics Society, and three National Laboratories.

Of course, please do not hesitate to contact me if I can provide more information. I have taken the liberty of forwarding this letter to the FDA, TSA, and other interested parties.

Sincerely,



Steven W. Smith, Ph.D.
President
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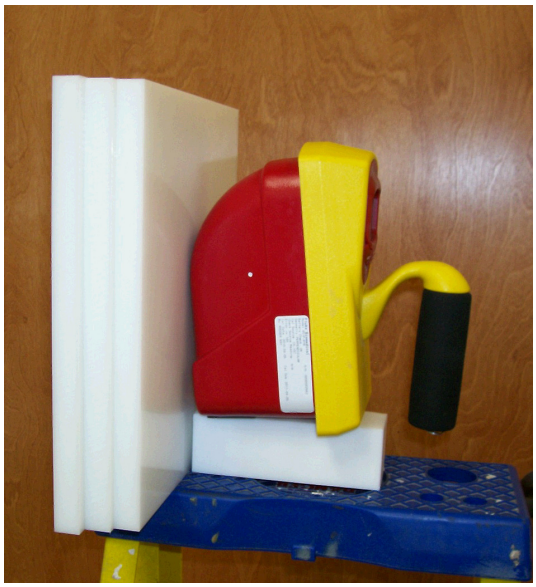

Figure 1. Photograph of a test procedure used to measure Dose Penetration.

Figure 2. Photograph of a test object used to measure Imaging Penetration.

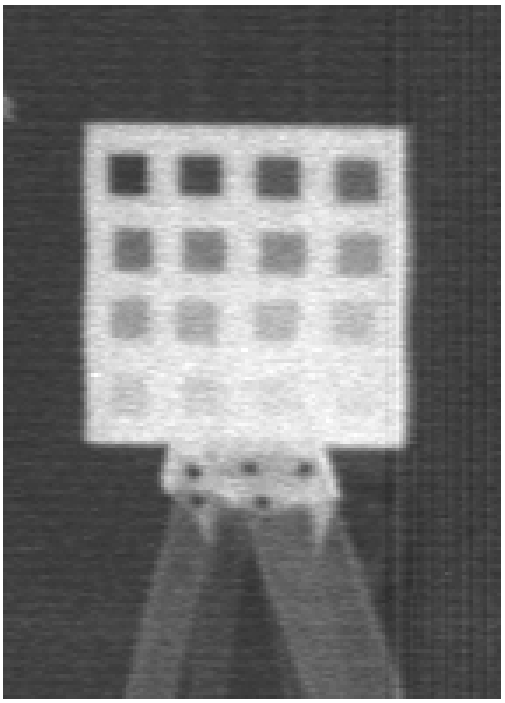

Figure 3. A scanned image of the test phantom shown in Fig. 2.

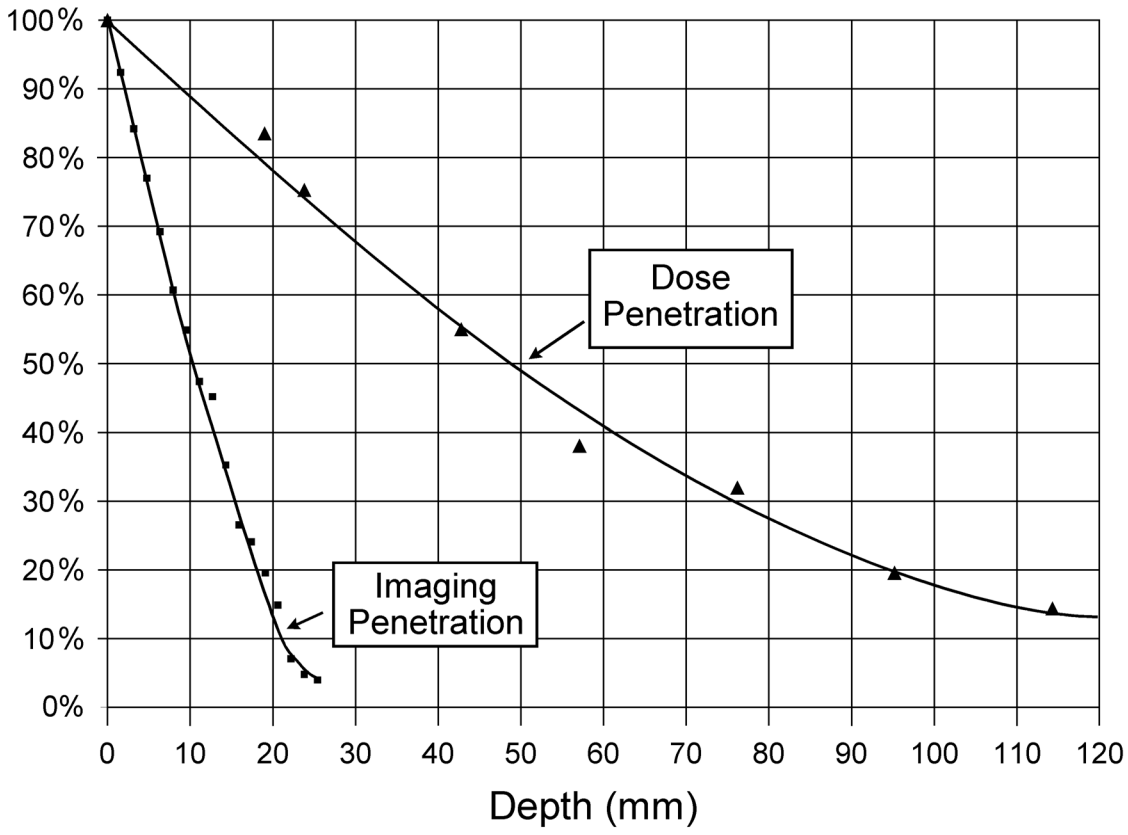

Figure 4. Measured Dose Penetration and Imaging Penetration.