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AMERICAN SOCIETY FOR TESTING AND MATERIALS  
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## Standard Test Method for Measurement of Low Level X-Radiation Used in X-Ray Security Screening Systems<sup>1</sup>

This standard is issued under the fixed designation F 1039; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

<sup>e1</sup> NOTE—Keywords were added and Footnote 3 was corrected editorially in April 1993.

### 1. Scope

1.1 This test method establishes the procedures for measuring the ionizing radiation inside the radiation chamber of a low level X-ray security screening system.

1.2 This test method establishes minimum requirements for the radiation detector used to measure this ionizing radiation inside the radiation chamber.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this test standard to establish appropriate safety and health practices prior to use. Specific hazards statements are given in Section 7.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

F 792 Practice for Design and Use of Ionizing Radiation Equipment for the Detection of Items Prohibited in Controlled Access Areas<sup>2</sup>

#### 2.2 Federal Standard:

21 CFR Performance Standards for Ionizing Radiation Emitting Products, Cabinet X-Ray Systems, Section: 1020.40 Radiation Equipment for the Detection of Items Prohibited in Controlled Access Areas<sup>3</sup>

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *broad beam X-ray*—the full cone of radiation emitted from the X-ray tube without collimators or other restrictions in the X-ray beam except those necessary to confine the X-radiation within the exposing chamber.

3.1.2 *line scanning*—a thin curtain of X-radiation produced by placing a slit collimator in the X-ray beam and impinging this curtain of X-radiation on an aligned array of X-ray sensors. The item being screened is passed over this sensor array.

3.1.3 *low level X-ray*—one milliroentgen or less of X-ray exposure per screening cycle.

3.1.4 *pulse*—a short burst of X-radiation; may be as long as a few milliseconds or as short as a few nanoseconds.

3.1.5 *radiation chamber*—the X-ray shielded enclosure in which an item is exposed to X-radiation.

3.1.6 *scatter block*—a block of X-ray scattering material used to create a worst case condition when measuring radiation levels.

3.1.7 *spot scanning*—similar to line scanning except that a slot spinning in front of the X-ray tube window forms a small spot of radiation which continuously moves to scan the item being screened as it passes over the sensor.

### 4. Significance and Use

4.1 This test method is meant to be used by the manufacturers and users of low level X-ray security screening systems located at controlled access screening points in airports, transportations terminals, public buildings, or other high security areas where the safety of items sensitive to low level X-radiation exposure is of concern (See Practice F 792).

4.2 This test method is not intended to establish safe exposure levels for any radiation sensitive items but to accurately measure the radiation exposure to the item during the X-ray security screening procedures.

4.3 The most significant attribute of this test method is the test procedure and the description of the instrumentation to be used to accurately measure the X-ray exposure to items being screened in low level X-ray security systems.

### 5. Interference

5.1 Take extreme care in handling the radiation monitor to prevent possible electrostatic and microphonic effects from causing erroneous readings. Exposed surfaces of the radiation sensitive element of some radiation monitors must not be touched, brushed, or vibrated after setting the instrument and before making a measurement. Follow the manufacturer's

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<sup>2</sup> Annual Book of ASTM Standards, Vol. 15.07.

<sup>3</sup> Code of Federal Regulations. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

recommendations for the care and handling of the instrument.

## 6. Apparatus

6.1 The following are minimum requirements for the radiation monitor used to perform these measurements:

6.1.1 *Energy Dependence*,  $\pm 10\%$  over a range of 30 to 200 keV.

6.1.2 *Exposure Range*, 0.01 to 10 mR minimum.

6.1.3 *Resolution*, 0.01 mR.

6.1.4 *Drift*, less than 0.01 mR/min.

6.1.5 *Accuracy*,  $\pm 10\%$  over the range of 0.1 to 10 mR, excluding the effects of energy dependence, drift and RF fields.

6.1.6 *RF Field Interference*—RF field of  $1\mu\text{ W/cm}^2$  (0.1 MHz) or  $5\mu\text{ W/cm}^2$  (30 to 500 MHz) shall not cause a change of greater than 0.05 mR/minute or 5 % of the meter reading per minute, whichever is greater.

6.1.7 *Temperature (Operating Range)*, 32 to 122°F (0 to 50°C).

6.1.8 *Humidity (Operating Range)*, 0 to 90 %, noncondensing.

6.1.9 *Maximum Exposure Rate*, greater than 100 R/h.

6.1.10 *Precision*, 0.02 mR or 2 % of the reading, whichever is greater.

6.1.11 *Cable Noise*—If probe and meter are cable connected, noise generated by cable flexing shall not be greater than 0.01 mR.

6.1.12 *Dimensions*, (maximum) 20 by 20 by 10 in. (508 by 508 by 254 mm).

6.1.13 *Battery*, minimum 50 h life.

6.1.14 *Indicators*—Meter shall be equipped with a “low battery” indicator.

6.1.15 *General*—Manufacturer shall specify radiation test source to be used to check operability of the instrument.

## 7. Safety

7.1 No part of the body shall be inserted in the radiation chamber while X-rays are being produced.

7.2 All safety circuits and safety interlocks shall be in good operating condition and be functioning when the tests are being performed.

7.3 Prior to testing, it shall be determined that the unit being tested meets the requirement of 21 CFR, Section 1020.40.

## 8. Calibration

8.1 Calibrate the radiation monitor at least once each year, in accordance with a standard traceable to the National Bureau of Standards or equivalent.

## 9. Procedure

9.1 Check the radiation monitor for operability with a radiation source recommended by the instrument manufacturer and a battery test to determine battery strength. Make these tests immediately prior to use and at least once each day the instrument is used.

9.2 Place the radiation monitor or the radiation sensing element (if the monitor and sensing element are cable con-

nected) on a scatter block such as one made of soft wood (pine, redwood, or another in a position that allows the radiation sensing element to face the radiation source. The scatter block shall be approximately 12- by 12- by 3-in. (305- by 305- by 75-mm) thick.

9.3 When testing horizontal beam units or vertical beam units having the X-ray tube mounted on the top, position the radiation monitor in the exact center of the conveyor belt with respect to width, and mount on the scatter block to position it vertically at least 6 in. (152.4 mm) above the conveyor belt. On vertical beam units having the X-ray tube mounted at the bottom, place the radiation monitor at the center of the width of the radiation chamber and as close to the floor of the radiation chamber as possible. Align the active area of the radiation detector relative to the X-ray tube according to the instrument manufacturer's instructions and in such a way that it is fully covered or fully scanned by the X-ray beam.

9.4 When measuring the radiation exposure on conveyorized units, the radiation monitor shall travel the entire length of the radiation chamber at normal conveyor speed. If the conveyor speed is operator variable, utilize the slowest speed. On non-conveyorized units, position the radiation monitor in accordance with 9.3. If the exposure time is operator adjustable, set it for the longest possible exposure.

9.5 Set all other adjustments accessible to the operator, such as kilovoltage, milliamperage, filter, or timer, to values that will result in the maximum exposure in the radiation chamber.

9.6 When measuring the radiation exposure on pulse, line scanning or spot scanning units, pass the radiation monitor through the radiation chamber at least ten times.

9.6.1 The variation between any of the readings taken shall not be more than 0.05 mR or 10 % of the average reading, whichever is greater.

9.6.2 The average of the ten readings constitutes the exposure for each item each time it is screened in that particular machine.

9.7 When measuring the radiation exposure on broad beam units, pass the radiation monitor through the radiation chamber or expose for screening cycles at least five times.

9.7.1 The variation between any of the readings taken shall not be more than 0.05 mR or 10 % of the average reading, whichever is greater.

9.7.2 The average of the five reading constitutes the exposure for each item each time that it is screened in that particular machine.

## 10. Precision and Bias

10.1 A statement on precision and bias cannot be made at this time due to a lack of adequate test data.

## 11. Keywords

11.1 ionizing radiation measurement; low-level x-radiation; radiation chamber; radiation detector; security screening; security screening systems; x-ray security screening