



American National Standard for Evaluating the Image Quality of X-ray Computed Tomography (CT) Security-Screening Systems

Accredited by the American National Standards Institute

Developed by the
National Committee on Radiation Instrumentation, N42

ANSI N42.45-2021
(Revision of ANSI N42.45-2011)

STANDARDS

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Developed by the

National Committee on Radiation Instrumentation, N42

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American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

Approved 22 December 2021

American National Standards Institute

Abstract: Standard test methods for the evaluation of image quality of computed tomography security-screening systems are established in this document. The quality of data for automated analysis is the primary concern. The system's ability to use this image data to automatically detect explosives or other threat materials, which is typically verified by an appropriate regulatory body, is not addressed in this standard.

Keywords: ANSI N42.45, computed tomography, contraband, detection, explosives, image quality, luggage, screening, security, technical performance

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Introduction

This introduction is not part of ANSI N42.45-2021, American National Standard for Evaluating the Image Quality of X-ray Computed Tomography (CT) Security-Screening Systems.

This standard is the responsibility of the Accredited Standards Committee on Radiation Instrumentation, N42. The standard was approved by N42 letter ballot.

Contents

1. Overview	12
1.1 Scope	12
1.2 Purpose	12
1.3 Word usage	13
2. Normative references	14
3. Definitions, acronyms, and abbreviations	14
3.1 Definitions	14
3.2 Acronyms and abbreviations	16
4. General test-performance requirements	16
5. Description of the test articles	17
6. Test procedures for image quality	19
6.1 General	19
6.2 Manually recorded data	19
6.3 Object length accuracy	24
6.4 Path-length CT value and Z_{eff}	28
6.5 Noise equivalent quanta (NEQ)	30
6.6 CT value consistency	33
6.7 CT value uniformity and X-ray energy spectrum consistency	34
6.8 Streak artifacts	36
6.9 Slice sensitivity profile (SSP)	38
6.10 Image registration	40
Annex A (informative) Bibliography	45
Annex B (normative) Detailed test article drawings	46
B.1 General	46
B.2 Commercial parts	46
B.3 Outer enclosure	46
B.4 Detailed drawings of custom components	47
Annex C (informative) Sample report	71
Annex D (informative) Statistical guidance on multiple scans, summary statistics, and comparison of results	75

American National Standard for Evaluating the Image Quality of X-ray Computed Tomography (CT) Security-Screening Systems

1. Overview

1.1 Scope

This document establishes standard test methods and test objects for measuring the imaging performance of X-ray computed tomography (CT) security-screening systems. The quality of data for automated analysis is the primary concern. This document does not address the system's ability to use this image data to automatically detect explosives or other threat materials, nor is it intended for vendor-to-vendor comparisons of threat-detection performance. This standard does not purport to address radiation safety and health practices associated with CT security-screening systems; users are advised to determine the applicability of regulatory limitations prior to use.

Four annexes are included. Annex A is a bibliography (informative). Annex B (normative) provides mechanical drawings of the imaging test objects that compose the test article. A sample test report form is given in Annex C (informative). Finally, Annex D (informative) offers statistical guidance on multiple scans, summary statistics, and comparison of results.

1.2 Purpose

Security screening systems are generally used to scan parcels, including luggage, for the presence of illicit items such as explosives, drugs, or other contraband. Many of the screening systems currently used, particularly in transportation security applications, are based on CT imaging technology. Generally, as the parcel is transported through the system, the system collects a CT image of the parcel. These data are then subjected to automated analysis to determine whether a threat may be present or the parcel is considered clear. If the automated analysis determines a threat may be present, the image is often presented to a system operator who can override the automated decision, clearing the parcel, or referring it for further processing such as opening it and manually searching for threats.

Historically, government regulators have established evaluation procedures to determine whether a system's automated detection performance is adequate for use in applications within their borders. Typically, a vendor submits a copy of their product, including their software to the regulator's facility. The regulator runs a wide variety of parcels with threats inside through the system as well as parcels without threats that represent the typical stream of commerce. Detection and false alarm rates are determined and compared against performance criteria. If the criteria are met, the system is approved for use. This testing assures that the system is capable of meeting the required criteria, but how does one assure that all copies of the system meet the criteria? Normal manufacturing variability, quality control issues, or aging of the

equipment may degrade performance versus what was observed on the article tested by the regulator. Replicating the original test on each machine in question is impractical. Transporting the regulator's threat set to a factory site or to locations where the machines are in use, presents significant security and in some cases safety concerns. This standard seeks to address this issue by specifying a suite of test methods that can be carried out on site without need for hazardous materials.

The performance testing carried out by the regulators essentially evaluates the combination of the system's ability to produce an image of the parcel along with its automatic analysis of that image data to reach a decision of threat or clear. The second part of this sequence, the analysis, is implemented through software. It should be noted that the regulators generally require that this software be designed so as to not evolve through use. The software used at all locations in the field must perform the same as the software did at the time of evaluation by the regulator. Configuration management of such software is a well-known and straightforward art. Therefore, the real opportunity for performance variation comes from the imaging system that provides the data to the analysis software. If one can quantitatively validate that the quality of the image produced by the system in question is statistically equivalent to the image produced by the article evaluated by the regulator, one can be highly confident that the performance of the system in question is the same as what was approved by the regulator.

Purchasers of CT systems for security screening applications are generally not CT experts. Inconsistencies in methods for measuring seemingly standard image quality values (resolution, signal-to-noise, etc.) can confuse the potential user of such CT systems. Other standards exist for testing aspects of CT image quality, particularly in the medical field. This standard specifies a set of methods to apply in assessing CT image quality geared towards security screening. An application of this standard would be in the factory acceptance testing of equipment. The standard could be used to indicate whether the unit offered for sale produces the equivalent image quality as the unit that was tested by the cognizant regulatory agency. Since various image quality metrics can be traded off against one another and achieve similar levels of threat detection, it is generally not valid, in contrast to medical CT, to make model-to-model or manufacturer-to-manufacturer comparisons of individual test results for CT systems used for security-screening.

This document does not address image quality presented to the operator. The image quality provided to the operator is not necessarily at the same level as that used by the automated analysis. The data may be degraded before presenting to the operator to decrease resources required for rendering the image on the screen. Conversely, the data used in the automated analysis may be intentionally degraded to control the computational loading of the analysis computer. The user of this standard may want to separately assess the quality of the images presented to the system's operator. A wide range of methods is available for this purpose including the use of visual line pair gauges and ASTM F792 [B1].⁶

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{7,8}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

⁶ The numbers in brackets correspond to numbered references within the bibliography in Annex A.

⁷ The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

⁸ The use of the word *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ASTM D6100, Standard Specification for Extruded, Compression Molded and Injection Molded Polyoxymethylene Shapes (POM).⁹

ASTM E1695, Standard Test Method for Measurement of Computed Tomography (CT) System Performance.

SAE AMS4027: Aluminum Alloy, Sheet and Plate, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061; -T6 Sheet, -T651 Plate) Solution and Precipitation Heat Treated.¹⁰

SAE AMS4117: Aluminum Alloy, Rolled or Cold Finished, Bars, Rods, and Wire and Flash Welded Rings 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061; -T6, -T651).

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.¹¹

computed tomography (CT): The process of rendering a three-dimensional image of a volume based on X-ray projection data.

coronal image: A two-dimensional image produced by summing a three-dimensional volume image along the y-axis.

NOTE—Axes are defined in Figure 1.¹²

CT value: Value reported by computed tomography (CT) systems on a per voxel basis that is a function of the material's density and atomic number.

effective atomic number (Z_{eff}): A material property that represents the atomic number of a theoretical element that, if the material were replaced by the element, would produce the same X-ray attenuation characteristics.

NOTE— Z_{eff} measurements can be scanner-dependent and should not be considered absolute values.

mean: For n quantities, $x_1, x_2, \dots, x_n$, the quotient of the sum of the quantities by n :

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

⁹ ASTM publications are available from the American Society for Testing and Materials (<http://www.astm.org/>).

¹⁰ SAE publications are available from the Society of Automotive Engineers (<https://www.sae.org/>).

¹¹ *IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

¹² Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

modulation transfer function (MTF): A frequency-dependent measure of an imaging system's resolution or ability to reproduce object contrast. In one dimension it is computed from the system's response to an edge of high contrast using ASTM E1695.

NOTE—See ASTM E1695 is Clause 2.

multi-energy: An X-ray imaging system that collects image data at more than one X-ray energy spectrum.

NOTE—This can be accomplished, for example, by varying the X-ray tube voltage, introducing filtration, using an energy discriminating detector, or using multiple sets of detectors with differing energy response.

noise equivalent quanta (NEQ): A spatial-frequency-dependent measure of noise, interpreted as the number of quanta (radiation exposure) that an ideal detector would have needed to yield the same signal-to-noise ratio as an actual imaging system. It is computed from measurements of average computed tomography (CT) value in an imaged object, the system's modulation transfer function and noise power spectrum.

noise power spectrum (NPS): The spatial-frequency-dependent variance of an imaging system's noise, computed using the Fourier transform of uniform noise-limited images.

polyoxymethylene (POM): The acetal copolymer $(\text{CH}_2\text{O})_n$ of which the test objects of this standard are fabricated.

projection image: An X-ray image created by detecting the X-ray intensity transmitted through the subject, resulting in an image in which all the subject's components appear to be projected onto a single image plane.

registration: The spatial relationship between the coordinate systems of multiple imaging subsystems. It determines the ability to accurately correlate observations from one image to the others.

slice: A cross-sectional image of the inspected object.

NOTE—The normal of the plane of the image is in the direction of the conveyer belt motion (z axis).

slice sensitivity profile (SSP): A frequency-dependent measure of CT image resolution along the direction of conveyer belt motion (z axis).

standard deviation: The *sample* standard deviation, σ_n , of n quantities, $x_1, x_2, \dots, x_n$ given by:

$$\sigma_n = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

where $\bar{x}$ is the mean of the n quantities and defined above.

standard mode of operation: A mode of operation normally recommended by the manufacturer for inspection of parcels.

NOTE—Some systems have special modes for collecting extra data for training. This would not be considered a standard mode of operation.

test article: An item, to be imaged by the system, containing multiple test objects in a specific geometric layout.

NOTE—As used in this standard, test article refers to the specific items defined in Clause 5.

test object: An individual object having specific properties (size, shape, materials, etc.) that when imaged by the system allows a certain image quality evaluation to be carried out.

voxel: Minimum indivisible element of the three-dimensional image of an object, characterized by a position (X, Y, Z) and values at that position, which include CT value and other optional values, such as Z_{eff} .

3.2 Acronyms and abbreviations

CT	computed tomography
DFT	discrete Fourier transform
MTF	modulation transfer function
NEQ	noise equivalent quanta
NPS	noise power spectrum
POM	polyoxymethylene
ROI	region of interest
SNR	signal-to-noise ratio
SSP	slice sensitivity profile

4. General test-performance requirements

These tests shall be conducted under ambient temperature and humidity conditions defined as $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ($73.4\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$) and non-condensing humidity. The temperature and relative humidity shall be reported with the testing results.

If performance is required outside of the above specified environmental conditions, the user should not assume that reported image quality performance metrics are equivalent to those reported under ambient conditions. The user may wish to require testing outside of ambient conditions or request engineering analysis to gauge performance in the field.

System components and adjustments should be as for the standard commercial product in normal security screening operation mode; any deviations shall be noted by the evaluators in the manually recorded data. If the system is approved to operate under more than one configuration, the user may want to request the test be carried out at all appropriate settings. Evaluation is to be based on images or other data normally used in standard mode of operation. The exposure time and level shall be chosen as that used when the CT system is operated for the intended use in the security screening application. A calibration of the CT system shall be carried out prior to any testing. Any recalibration of the CT system shall be allowed according to the standard operation of the system. In order to assure that the system is using a configuration approved by the appropriate regulatory agency, the user may wish to request that the vendor provide the specific settings used during the evaluation such as: tube voltage(s), amperage, voxel size, belt speed, etc. Changes in CT image reconstruction software should be followed by gathering a new baseline measurement set. Alternatively, new baseline results may be recomputed offline if the data are available.

The test articles (see Clause 5) shall be presented to the system in a controlled position and orientation. The main axis of each test article should be parallel to the conveyor belt motion direction and the front of the article shall enter the system first (front designated via labeling). The test method described in 6.3 determines the angle of rotation and side to side offset of the test articles relative to the centerline of the system conveyor. Results for rotations more than 2 degrees off parallel from conveyor centerline shall be rejected. This standard requires that the test articles be measured at the center of the belt, directly on the belt, within $\pm 2\text{ cm}$ of the conveyor centerline. If the user decides to also run the test articles off centerline, the parallel requirement shall still be met, and the data shall be segregated and treated separately.

For reference, Figure 1 shows the coordinate system that shall be used for all procedure descriptions. The z axis is aligned along the direction of the conveyor motion. The y axis is in the vertical direction and the x axis is across the belt. The positive/negative direction of the axis system is immaterial as used in this standard.

Not all the methods stated are applicable to all CT systems. Each method shall identify whether it is applicable to all CT types or only a subset.

Each of the test methods specified in this standard can include required procedures and examples of optional techniques for achieving the required results. This is necessary because of the range of implementations used in security CT equipment. Each test method identifies where latitude for deviation from the analysis techniques exists. Any deviation from provided example techniques shall be documented including rationale for deviating from the suggested standard method of analysis. Such documentation shall be provided to the end user of the image quality evaluation.

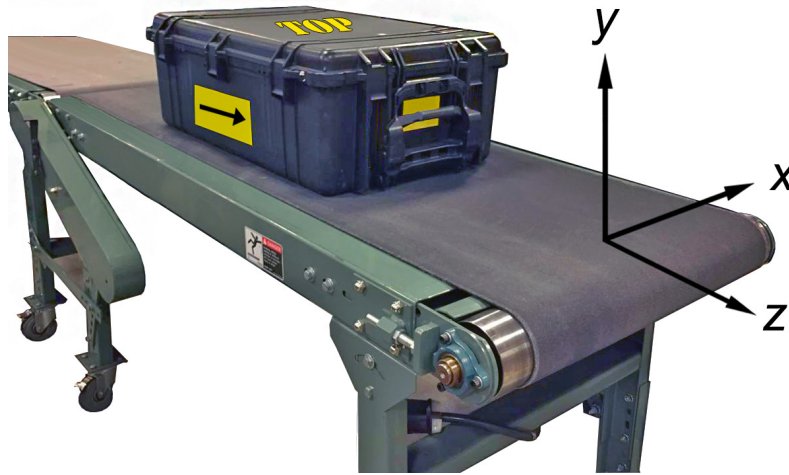


Figure 1—Reference axes for procedures

5. Description of the test articles

Execution of this standard requires two test articles. They are designated “test article A” and “test article B,” and are represented in Figure 2 and Figure 3, respectively. The articles consist of several test objects supported in a machined frame within a commercial or custom-built carrying case. The placement of the test objects has been selected to minimize artifacts from one test object interfering with the image of another test object.

When fabricating test articles for use in this standard, the test objects and the supporting structural frame shall be built in accordance with the detailed drawing package included in Annex B. The outer case should be selected for durability. It shall be large enough to contain the specified support structure. If commercial encasements are used, they may need to be modified to remove any metal structures (hinges, handles, fasteners, etc.) from the sides, top, and bottom. Removing structures on the front and back surfaces (facing the z direction) is optional. If a commercial case is used, it shall be modified to remove any significant plastic structure along the sides, top, and bottom that might interfere with the imaging of the test object. Comparison of testing results, across time for example, shall be made using the same test article enclosure; if the enclosure is changed or modified, then a new baseline measurement must be completed.

To ensure that the test article is oriented on the conveyor belt of the screening system in accordance with the designators “FRONT” and “TOP” in Figure 2 and Figure 3, the exterior of the test article encasements shall include signage such as “belt direction” and “this side up.”

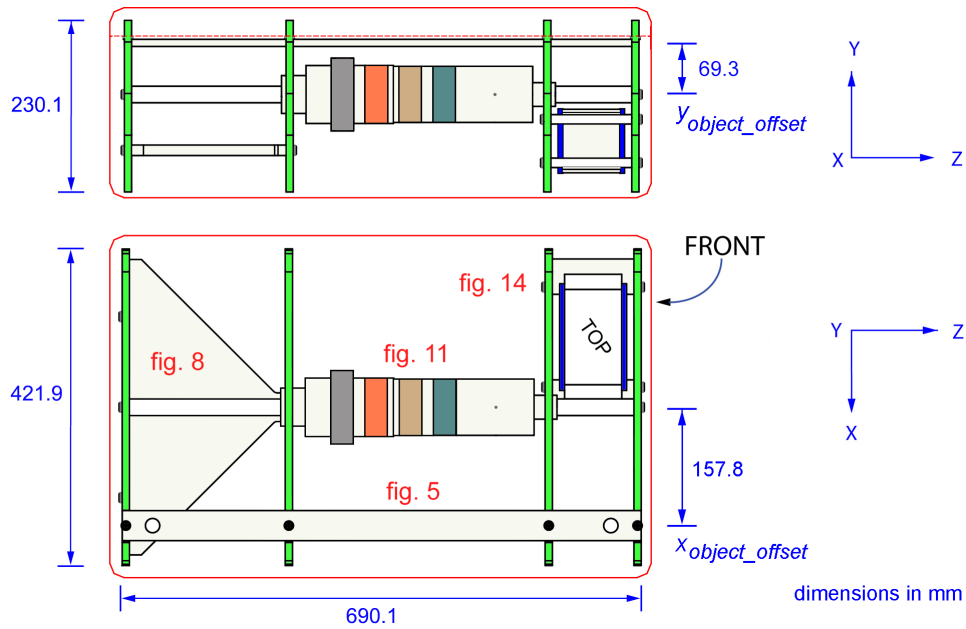


Figure 2—Test article A

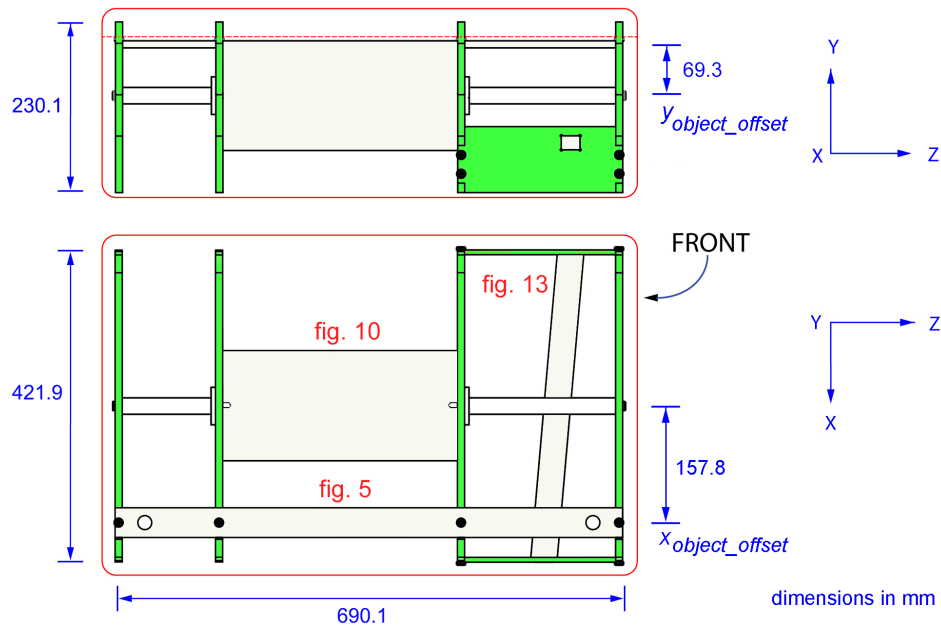


Figure 3—Test article B

To ensure that the test article is oriented on the conveyor belt of the screening system in accordance with the designators “FRONT” and “TOP” in Figure 2 and Figure 3, the exterior of the test article encasements shall include signage such as “belt direction” and “this side up.”

The outer case may be outfitted with appropriate low-density foam inserts to hold the test article support structure firmly in place, parallel to the bottom plane of the case and aligned with its centerline. The detailed dimensions of the individual test objects and their relative positions within the test article are given in the drawing package of Annex B.

Test article A contains the test objects for the methods covered in the following subclauses:

- Subclause 6.3 Object length accuracy (Figure 5)
- Subclause 6.4 Path-length CT value and Z_{eff} (Figure 8)
- Subclause 6.7 CT value uniformity and X-ray energy spectrum consistency (Figure 11)
- Subclause 6.8 Streak artifacts (Figure 11)
- Subclause 6.10 Image registration (Figure 14)

Test article B contains the test objects for the methods covered in the following subclauses:

- Subclause 6.3 Object length accuracy (Figure 5)
- Subclause 6.5 Noise equivalent quanta (NEQ) (Figure 10)
- Subclause 6.6 CT value consistency (Figure 10)
- Subclause 6.9 Slice sensitivity profile (SSP) (Figure 13)

6. Test procedures for image quality

6.1 General

This standard specifies procedures for measuring a wide range of image quality indicators. Table 1 provides a list of the test procedures, the image quality indicators they measure, and the test object they use.

In addition to carrying out the cited image quality methods, it is important to manually record certain data about the system being tested and the environment of the test. The manual data to be collected are specified in 6.2. The following subclauses (6.3 to 6.10) discuss each method, detailing how the measurements are to be made.

6.2 Manually recorded data

6.2.1 Purpose

Manufacturers may produce a number of models under the same general product name, and they may perform differently under different environmental conditions. When looking at results from this evaluation method, it is important to be sure one is comparing similar machines under similar conditions. Subclause 6.2 specifies the minimum data that shall be manually recorded about the system and the evaluation conditions.

Table 1—List of test methods and indicators measured

Test procedure	Image quality indicator	Test object	Test article
Object length accuracy	Length of objects relative to their expected values	POM ^a plate with machined hole in each end	A & B
Path-length CT value and Z_{eff}	Consistency of density and Z_{eff} measured along a variable X-ray path length	POM triangle	A
Noise equivalent quanta (NEQ)	In-plane spatial resolution of the system normalized by the system's noise	POM cylinder	B
CT value consistency	(a) Measurement of the average CT value for a reference object (b) Variance of CT values within reference object	POM cylinder	B
CT value uniformity and X-ray energy spectrum consistency	Measurement of CT values for one or more X-ray spectra through different thicknesses of attenuating metals	POM cylinder wrapped with layers of aluminum, copper, tin, and lead	A
Streak artifacts	Level of variation in a nominal Z_{eff} material induced by the presence of a high Z_{eff} material in close proximity	POM cylinder with imbedded tungsten alloy pins	A
Slice sensitivity profile (SSP)	Resolution of the image along the direction of belt movement	POM rectangular bar presented at 5°	B
Image registration	Physical alignment between imaging subsystem frames of reference	POM and aluminum plates arranged to form a box with a diagonal POM plate	A

^a FULL SPECIFICATION: Use acetal copolymer (polyoxymethylene or POM) that conforms to the specifications of ASTM D6100 and designation therein: S-POM0211,LP (copolymer, unfilled class, general purpose grade, low porosity). This is a thermoplastic, with a density near 1.4 g/cm³. It does not include fillers, impact modifiers, or other additives including colorant, fiber, chemical lubricant, or heavy metals. Before construction of the NEQ test object, the core of the delivered POM rod should be verified for low centerline porosity using the procedure specified in ASTM D6100. The POM parts should be fabricated on machines used only for plastics to avoid cross-contamination with metals and machine oils.

6.2.2 System data

The following data are available from the manufacturer of the system, or in some cases, provided by the system itself. It is intended that the evaluation team will record, but not measure, the items required in 6.2.2.

6.2.2.1 General information

- a) Test method: State that the evaluation was carried out in accordance with this standard.
- b) Manufacturer: Record the name of the company producing the system.
- c) Model: Record the full model name/number for the system.
- d) Serial number: Record the unique serial number for the system under evaluation.
- e) Configuration: Describe the configuration of the system under evaluation. Is it set up for in-line use or stand-alone use?
- f) Scanning mode: Describe the system's mode of scanning (helical scan, static slice, non-rotating gantry, etc.).
- g) Belt speed: Record the speed of the system's conveyor belt based on manufacturer specification. If the system operates at multiple speeds during the evaluation, state the maximum speed and any speeds applicable for actual scanning.

6.2.2.2 X-ray source information

- a) X-ray source type: If multiple sources are used, state how many. Describe source characteristics, such as anode material, multi-anode, multi-cathode, continuous emission or voltage grid controlled, scanning beam, nominal inherent filtration (if provided by the manufacturer), and any additional filtration specified by the manufacturer. If more than one source type is used, describe all applicable types and state the number of each type.
- b) X-ray source voltage: State voltage in kilovolts. If more than one voltage is used, state all.
- c) X-ray source current: State current in milliamperes. If more than one current is used, state all.
- d) Number of hours: If the system records the number of hours of operation for the X-ray source, record it here. Otherwise, state not applicable (N/A). If data are available for more than one source, record all available.

In some systems, multiple sources may be used. In those cases, the total number of sources should be stated and descriptions of unique operating conditions should be provided. For example, if a system has six sources of the same type and running at the same current, but two run at 100 kV and four at 180 kV, then the description would be as follows:

Type: 6 tungsten cathode, continuous emission source
Filtration: 6 mm of Al
Voltage: 2 at 100 kV and 4 at 180 kV
Current: 10 mA
Number of hours: Tubes 1, 3, 4, 5, 6 – 2122 h, Tube 2 – 135 h

6.2.2.3 Reconstruction information

- a) Reconstruction method: Record the method for reconstruction (filtered back projection, Fourier inversion method, iterative, etc.).
- b) Voxel spacing: State the distance between reconstructed voxels in millimeters in the x, y, and z direction.

6.2.2.4 System software

Record the manufacturer's version numbers for each of the following elements of software. If the manufacturer does not separate out a particular element, state what software element it is included within.

- a) Display: Software controlling the operator display.
- b) Reconstruction: Software that converts projection data into CT images.
- c) System control: Software that manages control of the system, driving system state, hardware control, interaction with baggage handling system, etc.
- d) Operating system: Operating system(s) for the computers of the system (e.g., Windows Vista®, Fedora Core 6 Linux, etc.).¹³

¹³ This information is given for the convenience of users of this standard and does not constitute an endorsement by the IEEE of these products. Equivalent products may be used if they can be shown to lead to the same results.

6.2.3 Evaluation environment data

The following data are related to the environment in which the evaluation was carried out. In general, the evaluation is based on single scanning of each test article and reporting results. In cases where many scans would be run, such as establishing a baseline expectation for a particular scanner, the environmental data, listed below, should be recorded before and after the testing program.

The evaluators shall provide the following data:

- a) Local date: Record the local date in year/month/day format.
- b) Local time: Record the local time for the start of the evaluation in hours:minutes format, where hours run from 0 to 24.
- c) Location: Record the full address of the location where the scanning for the evaluation was carried out.
- d) Ambient temperature: Record the temperature of the environment surrounding the system in degrees Celsius.
- e) Ambient humidity: Record the relative humidity of the environment surrounding the system.
- f) Detector temperature: If the system provides temperature readings for its detector array(s), record the value after the system has been allowed to warm up and just before scanning the test articles. If the system provides multiple detector readings, record the max, min, and median values. Record in degrees Celsius.
- g) Personnel: Record the full names and affiliations of the personnel who carried out the evaluation.
- h) Telephone number: Record a telephone number where the lead of the evaluation team may be contacted in case of questions about the evaluation.
- i) Test article manufacturer: Record the manufacturer of the test articles used in the evaluation.
- j) Test article serial numbers: Record the unique serial numbers for each of the test articles used for the evaluation.

6.2.4 Comments

Under the comments section, the evaluators should note any issues or problems encountered while running the evaluation. If the system tested differed from the standard commercial product used in normal security screening operation mode, the evaluators shall note those differences here (e.g., “system was operated without its air conditioner running to simulate operation in a hotter climate”).

6.2.5 Deviations from specified methods

Some of the test methods described in this standard explicitly allow the evaluator to use alternate approaches to calculating their values. Under the deviations section, the evaluators shall note any deviations from the test methods as specified in this standard. The notation shall specify which specific methods were modified and describe the modifications and the reasons for each.

In multi-energy systems, the corresponding energy slices may not be properly aligned. The degree of this misalignment could be large enough to affect some calculations. To measure this misalignment, correspondences between test article features located at the corners of a case enclosure (Case A or B) could be used to determine and quantify any misalignment of images acquired with different spectra. Matching features could be located interactively, or using an automatic algorithm (e.g., followed by the normalized cross correlation [B2]). Next, possible two-dimensional transformations could be estimated (e.g., by computing the least-squares estimation of transformation parameters between the corresponding features [B5]).

6.2.6 Presentation of results

The manually recorded data shall be attached to the corresponding results of the other image evaluation methods specified in this standard. The data should be grouped in the same fashion as it is covered in the previous text. Figure 4 shows an example format, but other logical formats for the data presentation would be acceptable as well. Annex D offers statistical guidance on multiple scans, summary statistics, and comparison of results.

Image Quality Report	
Evaluated in accordance with ANSI N42.45 American National Standard for Evaluating the Image Quality of X-ray Computed Tomography (CT) Security-Screening Systems	
Manual Data Record	
<u>System Under Evaluation</u>	
Manufacturer: _____	Reconstruction Method: _____
Model: _____	
Serial Number: _____	Voxel Spacing:
Configuration: _____	x: _____
Scanning Mode: _____	y: _____
Belt Speed: _____	z: _____
X-ray Source	Software Versions
Type: _____	Display: _____
Voltage: _____	Reconstruction: _____
Current: _____	System Control: _____
Filtration: _____	Operating System: _____
Number of Hours: _____	
<u>Evaluation Conditions</u>	
Local Time: _____	Scanning Personnel: _____
Date: _____	_____

Location: _____	Telephone Number: _____

Ambient Temperature: _____	Test Article Manufacturer: _____
Ambient Humidity: _____	Test Article S/Ns: _____
Detector Temperature: _____	
Comments: _____	

Deviations from Specified Methods: _____	

Figure 4—Format example for manually recorded data