Designation: E3375 – 23

Standard Practice for Cone Beam Computed Tomographic (CT) Examination[1]

This standard is issued under the fixed designation E3375; 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.

1. Scope

1.1 This practice establishes the minimum requirements for computed tomography (CT) examination of components using cone beam systems. The purpose of this practice is to establish instruction, procedures, and equipment qualification to inspect a component for specified discontinuities.

1.2 This practice applies to systems with a Digital Detector Array (DDA) and an X-ray source. It does not cover the use of isotope sources.

1.3 There are sections in this practice that may require agreement between the purchaser and the supplier, or specific direction from the cognizant engineering organization (CEO). These items should be addressed in the purchase order or the contract. Generally, the items are application-specific, performance related, or both.

1.4 Applications for cone-beam CT are diverse. This practice is not intended to be limiting or restrictive. Refer to Guide E1441 for guidance on CT fundamentals and Guide E1672 for tradeoffs in selection of a CT system.

1.5 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* NCRP 144 or NIST Handbook 114, or both, may be used as guides to ensure that radiographic procedures are performed so that personnel shall not receive a radiation dosage exceeding the maximum permitted by the city, state, or national codes.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

E1441 Guide for Computed Tomography (CT)

E1672 Guide for Computed Tomography (CT) System Selection

E1695 Test Method for Measurement of Computed Tomography (CT) System Performance

E1817 Practice for Controlling Quality of Radiological Examination by Using Representative Quality Indicators (RQIs)

E2002 Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)

E2597/E2597M Practice for Manufacturing Characterization of Digital Detector Arrays

E2698 Practice for Radiographic Examination Using Digital Detector Arrays

E2767 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for X-ray Computed Tomography (CT) Test Methods

E3147 Practice for Evaluating DICONDE Interoperability of Nondestructive Testing and Inspection Systems

2.2 *ANSI Standards:*[3]

ANSI/ASNT CP 189 Standard for Qualification and Certification of Nondestructive Testing Personnel

SNT-TC-1A Recommended Practice - Personnel Qualification and Certification in Nondestructive Testing

2.3 *ISO Standards:*[4]

ISO 9712 Non-destructive Testing - Qualification and Certification of NDT Personnel

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.01 on Radiology (X and Gamma) Method.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

ISO/CIE 19476 Characterization of the Performance of Illuminance Meters and Luminance Meters

2.4 *AIA Standard:*[5]

NAS 410 National Aerospace Standard Certification and Qualification of Nondestructive Testing Personnel

2.5 *CEN Standard:*[6]

EN 4179 Aerospace Series - Qualification and Approval of Personnel for Non-destructive Testing

2.6 *Government Standards:*

NCRP 144 Radiation Protection for Particle Accelerator Facilities[7]

NIST Handbook 114 General Safety Standard for Installations Using Non-Medical X-ray and Sealed Gamma Ray Sources, Energies up to 10 MeV[8]

3. Terminology

3.1 *Definitions*—For definitions of terms related to CT used in this practice, refer to Terminology E1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cone beam, n*—a beam of radiation that is restricted to two dimensions in an areal extent with the area covering the detector array.

3.2.2 *contrast-detail-diagram (CDD), n*—describes the minimum relative contrast (in %) of a circular indication, required for the perception by human operators as a function of the indication diameter in voxels in a 2D CT slice on a monitor (see Guide E1441 and Test Method E1695).

3.2.3 *contrast discrimination function (CDF), n*—describes the influence of image noise on the detectability of a feature in an elsewhere homogeneous material neighborhood as a function of the size of this feature in voxels.

3.2.4 *modulation transfer function (MTF), n*—describes the transfer of a spatial modulation in an image signal (relative intensity variation, here by a CT system) as a function of the modulation's spatial frequency

3.2.4.1 *Discussion*—SR_b^{image} in volume CT is corresponding MTF 10 % established as per Test Method E1695. If calculated value is given in *LP/mm*, conversion in $\mu m = ½ \times [(1 / (MTF\ value\ LP/mm)]$

3.2.5 *purchaser, n—as used within this document*, the purchaser of computed tomographic services refers to the entity that requires the computed tomographic services; the purchaser may be a part of the same organization as the supplier, or an outside organization.

3.2.6 *supplier, n—as used within this document*, the supplier of computed tomographic service refers to the entity that physically provides the computed tomographic services; the supplier may be a part of the same organization as the purchaser, or an outside organization.

[5] Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, http://www.aia-aerospace.org.

[6] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[7] Available from National Council on Radiation Protection and Measurements (NCRP), https://ncrponline.org.

[8] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

4. Significance and Use

4.1 The purpose of this practice is to establish instruction, procedures, and equipment qualification to inspect a component for specified discontinuities. This practice is written so it can be specified on the engineering drawing, specification, or contract. This practice requires a detailed procedure delineating the technique or procedure requirements and shall be approved by the Cognizant Engineering Organization (CEO).

4.2 The requirements in this practice shall be used when placing a CT system into NDT service and establishing a baseline of system performance measures. Monitoring the system performance over time shall be performed, including detector correction procedures, performance measurements, and system maintenance.

4.3 For CT examinations where specified discontinuities are not known/identified/requested/available (that is, engineering analysis, engineering information only), portions of Section 7 – 9 requirements do not necessarily apply. For these types of examinations, the purchase order or contract shall specify the development of a specific procedure, approved by purchaser and supplier, to specify the requirements of this practice to be incorporated into the examination.

5. Basis of Application

5.1 The following items are subject to contractual agreement between the parties using or referencing this practice.

5.1.1 *Personnel Qualification*—Personnel performing examinations to this practice shall be qualified in accordance with NAS410, EN 4179, ANSI/ASNT CP 189, ISO 9712, or SNT-TC-1A and certified by the employer or certifying agency as applicable. Other equivalent qualification documents may be used when specified on the contract or purchase order. The applicable revision shall be the latest unless otherwise specified in the contractual agreement between parties.

5.1.2 If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Specification E543. The applicable edition of Specification E543 shall be specified in the contract.

5.1.3 *Procedures and Techniques*—The procedures and techniques to be utilized shall be as specified in the contractual agreement.

5.1.4 *Reporting Criteria*—Reporting criteria for the examination results shall be in accordance with this standard practice unless otherwise specified.

5.1.5 *Acceptance Criteria*—Any acceptance criteria shall be specified in the contractual agreement.

6. Equipment

6.1 Many different CT system configurations are possible, and it is important that the user understands the advantages and limitations of each (see Guide E1441 and Test Method E1695).

6.2 All CT systems have four major subsystems: radiation source, radiation detectors, mechanical handling system, and computer system. The following represents considerations for each subsystem for a CT examination.

6.2.1 *Source Setup*—The radiation source shall be selected to provide the maximum signal-to-noise ratio (SNR) and