



Designation: **E1814 – 96 (Reapproved 2007) E1814 – 14**

Standard Practice for Computed Tomographic (CT) Examination of Castings¹

This standard is issued under the fixed designation E1814; 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~~ Scope*

1.1 This practice covers a uniform procedure for the examination of castings by the computed tomography (CT) technique. The requirements expressed in this practice are intended to control the quality of the nondestructive examination by CT and are not intended for controlling the acceptability or quality of the castings. This practice implicitly suggests the use of penetrating radiation, specifically X rays and gamma rays.

1.2 This practice provides a uniform procedure for a CT examination of castings for one or more of the following purposes:

1.2.1 Examining for discontinuities, such as porosity, inclusions, cracks, and shrink;

1.2.2 Performing metrological measurements and determining dimensional conformance; and

1.2.3 Determining reverse engineering data, that is, creating computer-aided design (CAD) data files.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For specific safety statements, see Section 7, NBS Handbook 114, and 21 CFR 1020.40 and 29 CFR 1910.96.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[E543 Specification for Agencies Performing Nondestructive Testing](#)

[E1316 Terminology for Nondestructive Examinations](#)

[E1441 Guide for Computed Tomographic \(CT\) Imaging](#)

[E1570 Practice for Computed Tomographic \(CT\) Examination](#)

[E1672 Guide for Computed Tomography \(CT\) System Selection](#)

[E1695 Test Method for Measurement of Computed Tomography \(CT\) System Performance](#)

[E1935 Test Method for Calibrating and Measuring CT Density](#)

[E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation \(DICONDE\)](#)

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

2.2 *ASNT Documents:*³

[SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing](#)

[ANSI/ASNT CP-189 Standard for Personnel Qualification and Certification of Nondestructive Testing Personnel](#)

2.3 *Military Standards:*⁴

~~[MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification](#)~~

[NAS 410 Certification and Qualification of Nondestructive Test Personnel](#)

2.4 *Code of Federal Regulations:*⁵

~~[21 CFR 1020.40 Safety Requirements of Cabinet X Ray Systems](#)~~

~~[29 CFR 1910.96 Ionizing Radiation](#)~~

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 Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlington Ln., Columbus, OH 43228-0518, http://www.asnt.org.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil/http://assist.daps.dla.mil.

*A Summary of Changes section appears at the end of this standard

3. Terminology

3.1 *Definitions*—Definitions of terms applicable to this practice may be found in Terminology E1316 and Guide E1441.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *fixturing*—the mounting hardware used to place the object in the CT system.

~~3.2.2 *representative quality indicator (RQI)*—a real part, or a fabrication of similar geometry in radiologically similar material to a real part, that has features of known characteristics that represent all of the features for which the parts are being examined.~~

3.2.2 *scan plan*—scan locations and the system configuration parameters for a specific part examination.

~~3.2.4 *object*—a part or specimen being subjected to CT examination.~~

4. Significance and Use

4.1 CT may be performed on an object when it is in the as-cast, intermediate, or final machined condition. A CT examination can be used as a design tool to improve wax forms and moldings, establish process parameters, randomly check process control, perform final quality control (QC) examination for the acceptance or rejection of parts, and analyze failures and extend component lifetimes.

4.2 The most common applications of CT for castings are for the following: locating and characterizing discontinuities, such as porosity, inclusions, cracks, and shrink; measuring as-cast part dimensions for comparison with design dimensions; and extracting dimensional measurements for reverse engineering.

4.3 The extent to which a CT image reproduces an object or a feature within an object is dictated largely by the competing influences of spatial resolution, contrast discrimination, ~~and the specific geometry and material of the object itself, and artifacts of the imaging system.~~ Operating parameters strike an overall balance between image quality, examination time, and cost.

4.4 Artifacts are often the limiting factor in CT image quality. (See Practice E1570 for an in-depth discussion of artifacts.) Artifacts are reproducible features in an image that are not related to actual features in the object. Artifacts can be considered correlated noise because they form repeatable fixed patterns under given conditions yet carry no object information. For castings, it is imperative to recognize what is and is not an artifact since an artifact can obscure or masquerade as a discontinuity. Artifacts are most prevalent in castings with long straight edges or complex geometries, or both.

5. Basis of Application

5.1 The following items shall be agreed upon between the purchaser and the supplier and specified in the contract or job order:

5.1.1 *Nondestructive Testing Agency Evaluation*—The use of a nondestructive testing (NDT) agency, as defined in Practice E543. If a systematic assessment of the capability of the agency is specified, a documented procedure, such as that described in Practice E543, should be used as the basis for evaluation.

5.1.2 *Personnel Qualifications*—All CT examination personnel shall be qualified and certified in accordance with a written procedure conforming to ANSI/ASNT CP-189, SNT-TC-1A, MIL-STD-410, NAS 410, or a similar document. The written procedure shall include training that addresses CT issues specifically.

5.1.3 *General Requirements*—General requirements shall be specified in accordance with Section 8: (1) written procedure, 8.1; and (2) CT system validation measurements, 8.3.

5.1.3.1 Specific requirements regarding preparation and approval of the written procedures should be agreed upon in advance by the purchaser and the supplier.

5.1.4 *Fixturing*—The object fixturing shall be determined by agreement between the purchaser and the supplier in accordance with 9.2.

5.1.5 *Image Processing*—Image processing routines used in analysis of the CT data shall be specified in accordance with 6.2: (1) dimensional measurements, 6.2.1; and (2) discontinuity characterization, 6.2.2.

5.1.6 *Discontinuity Types*—A listing of the expected kinds of discontinuities shall be provided or referenced, and the acceptance and rejection criteria shall be stipulated.

5.1.7 *Records*—Records requirements shall be specified in accordance with Section 10.

6. Apparatus

6.1 The success of the CT application depends on the overall system configuration and the selection of appropriate subsystem components. Guidance on the selection of sub-system components and the overall system configuration is provided in Guide E1672. Guidance on the initial ~~qualification and periodic requalification~~ system performance evaluation for baseline and periodic system performance check of the CT system is provided in Test Method E1695. Guidance on calibrating and measuring CT density measurements is provided in Test Method E1935. The suitability of the CT system shall be demonstrated by attainment of the required image quality and compliance with all other requirements stipulated herein.

6.2 *Computer/Image Processing System—Software*—Image processing ~~systems~~software may be used for image enhancement operations that will facilitate dimensional measurements and discontinuity detection or characterization.