



Designation: E801 – 21

Standard Practice for Controlling Quality of Radiographic Examination of Electronic Devices¹

This standard is issued under the fixed designation E801; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice relates to the radiographic examination of electronic devices for internal discontinuities, extraneous material, missing components, crimped or broken wires, and defective solder joints in cavities, in the encapsulating materials, or the boards. Requirements expressed in this practice are intended to control the quality and repeatability of the radiographic images and are not intended for controlling the acceptability or quality of the electronic devices imaged.

1.2 There are areas in this practice that may require agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization. These items should be addressed in the purchase order, contract, or inspection technique. Specific applications may require adherence to this practice in part or in full. Deviations from this practice shall be enumerated in inspection plan and approved by both cognizant engineering organization and the supplier.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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.*

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. Referenced Documents

2.1 *ASTM Standards:*²

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

3. Terminology

3.1 *Definitions*—Definitions relating to radiographic examination, which appear in Terminology E1316, shall apply to the terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *detector, n*—film, radiosopic detector, or digital detector array (DDA).

4. Significance and Use

4.1 This practice establishes the basic minimum requirements for establishing quality control in radiographic examination of electronic components or devices, or both. Considerations addressed herein include definition of image quality indicator (IQI) features, procedures for imaging of IQI, and reporting.

4.2 This practice is written so it can be specified on the engineering drawing, specification, or contract. It is not a detailed how-to procedure and must be supplemented by a detailed examination technique/procedure.

5. Qualification

5.1 *Agency Evaluation*—If specified in the contractual agreement, Nondestructive Testing agencies shall be qualified and evaluated as described in accordance with Specification E543. The applicable revision of Specification E543 shall be specified in the contractual agreement.

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.

6. Direction of Radiation

6.1 When not otherwise specified, the direction of the central beam of radiation shall be as perpendicular ($\pm 5\%$) as possible to the surface of the film or detector.

7. Image Quality Indicators (IQI's)

7.1 The quality of all levels of radiographic examination shall be determined by IQI's conforming to the following specifications:

7.1.1 The IQI's shall be fabricated of clear acrylic plastic with steel covers, lead spheres, gold or tungsten wires, and lead numbers. The steel covers serve as shims.

7.1.2 The IQI's shall conform to the requirements of Fig. 1.

7.1.2.1 Wires are denoted as A, B, C (horizontal) and D, E, F (vertical);

7.1.2.2 Particles are denoted as G, H, I (top) and J, K, L (bottom).

7.1.2.3 Distance of features from the top of the IQI are labeled a-f where:

- (1) a is the position of particles G, H, I;
- (2) b is the position of Wire A;
- (3) c is the position of Wire B;
- (4) d is the position of Wire C;
- (5) e is the position of particles J, K, L;
- (6) f is the position of the bottom edge of IQI.

7.1.2.4 Distance of features from the right edge of IQI are labeled g-m where:

- (1) g is the position of Wire F;
- (2) h is the position of Wire E;
- (3) i is the position of Wire D;
- (4) j is the position of particles I and L;
- (5) k is the position of particles H and K;
- (6) l is the position of particles G and J;
- (7) m is the position of the left edge of the IQI.

7.1.2.5 The IQI's shall be permanently identified with the appropriate IQI number as shown in Fig. 1. The number shall be affixed by mounting a 0.125-in. (3.18-mm) tall lead number on the flat bottom of a 0.250-in. (6.35-mm) diameter hole. The identification number shall be located as shown in Fig. 1 and shall be of sufficient contrast to be clearly discernible in the radiographic image.

7.1.2.6 Each semiconductor IQI will have a serial number permanently etched or engraved on it. Each serial number will be traceable to the calibration image supplied by the manufacturer. The manufacturer shall radiograph the IQI with lead markers identifying the serial number. See Fig. 2.

8. Application of the Image Quality Indicator (IQI)

8.1 The application of the IQI's shall be made in such a manner as to simulate as closely as possible the device being examined. To accomplish this objective, a set of eight IQI's is provided. These provide a range of cover thickness (of steel shim stock) that is radiographically equivalent to the range of devices from glass diodes or plastic-encapsulated circuits (number one) to large power or hybrid circuit devices (number eight). Wire size increases with shim stock thickness because higher power devices that have thicker coverings normally use larger interconnecting wires than small signal devices that use

thin coverings. Particle size is normally independent of device type, so these remain constant.

8.2 The IQI used shall be the one with a radiographic density or pixel value nearest to that of the electronic device being examined. The radiographic density or pixel value is measured on an area of the IQI image that contains no wire or particle images. It shall be measured using a calibrated densitometer in the case of film, or by pixel value in the case of non-film examination. When necessary to meet the requirements of 10.1.1, additional shim stock shall be used. The shim(s) shall be of the same type of steel as in the IQI and shall be placed under the IQI. The additional shim(s) shall exceed the IQI outside dimensions by at least 0.125 in. (3.18 mm) on at least one side. The thickness of the shims shall be noted with lead numerals placed adjacent to the shimmed IQI or documented on the radiographic technique.

NOTE 1—Radiographic film densities shall be measured with a calibrated densitometer. When films are exposed simultaneously in one film holder, density variations should be determined on the single or combined films, depending on the manner in which they are read and interpreted. Radiographic film density shall be in the range of 1.0 to 3.5, unless otherwise specified.

8.3 The image distortion shall not exceed 10 % unless a higher or lower percentage is agreed upon between the purchaser and the supplier. Measurements for computation of image distortion shall be made in the grid formed by the crossing wires.

8.3.1 Determine percent image distortion (Note 2) as follows:

$$D = [(S_M - S_A)/S_A] \times 100$$

where:

D = percent distortion,
 S_M = wire spacing as measured on the radiograph, and
 S_A = actual wire spacing.

NOTE 2—Distortion may be positive or negative.

8.4 Particles G through L shall be visible in the image when IQI's 1 through 7 are used and particles G through K shall be visible in the image when IQI number 8 is used.

8.4.1 If shims are required, the number and size of particles that can be resolved shall be agreed on between the purchaser and the supplier.

9. Positioning of IQI's

9.1 The IQI's shall be placed so that the plane of the IQI is normal to the radiation beam.

9.1.1 The IQI's used for each exposure or field of view shall be positioned at the outer edges of the film or field of view but not impeding the area of interest being examined.

10. Number of IQI's

10.1 Two IQI's shall be used for each radiograph as shown in Fig. 3. The IQI's shall be located at diagonally opposite corners of the film as shown in Fig. 3. In non-film examinations, IQI qualification is required at least once during examination of similar parts. The procedure for non-film IQI qualification shall be established to subject the IQI's to the same image magnification and distortion as the parts will be