Designation: E1742/E1742M – 23

Standard Practice for Radiographic Examination[1]

This standard is issued under the fixed designation E1742/E1742M; 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[2] covers the minimum requirements for radiographic examination for metallic and nonmetallic materials.

1.2 *Applicability*—The criteria for the radiographic examination in this practice are applicable to all types of metallic and nonmetallic materials. When specified, it may be used for radiographic inspection of metallic or non-metallic materials, weldments, castings, and brazed materials. The requirements expressed in this practice are intended to control the quality of the radiographic images and are not intended to establish acceptance criteria for parts and materials.

1.3 *Basis of Application*—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 or the contract.

1.3.1 DoD contracts.
1.3.2 Personnel qualification, 5.1.1.
1.3.3 Agency qualification, 5.1.2.
1.3.4 Digitizing techniques, 5.4.5.
1.3.5 Alternate image quality indicator (IQI) types, 5.5.3.
1.3.6 Examination sequence, 6.6.
1.3.7 Non-film techniques, 6.7.
1.3.8 Radiographic quality levels, 6.9.
1.3.9 Optical density, 6.10.
1.3.10 IQI qualification exposure, 6.13.3.
1.3.11 Non-requirement for IQI, 6.18.
1.3.12 Examination coverage for welds, A2.2.2.
1.3.13 Electron beam welds, A2.3.
1.3.14 Geometric unsharpness, 6.23.
1.3.15 Responsibility for examination, 6.27.1.
1.3.16 Examination report, 6.27.2.
1.3.17 Retention of radiographs, 6.27.8.
1.3.18 Storage of radiographs, 6.27.9.
1.3.19 Reproduction of radiographs, 6.27.10 and 6.27.10.1.
1.3.20 Acceptable parts, 6.28.1.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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.*

1.6 *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 The following documents form a part of this practice to the extent specified herein:

2.2 *ASTM Standards:*[3]

E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film
E543 Specification for Agencies Performing Nondestructive Testing
E747 Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology
E801 Practice for Controlling Quality of Radiographic Examination of Electronic Devices
E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing

[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.

Current edition approved Dec. 15, 2023. Published January 2024. Originally approved in 1995. Last previous edition approved in 2018 as E1742/E1742M – 18. DOI: 10.1520/E1742_E1742M-23.

[2] This practice replaced MIL-STD-453.

[3] 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.

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

E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography
E1030/E1030M Practice for Radiographic Examination of Metallic Castings
E1032 Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film
E1079 Practice for Calibration of Transmission Densitometers
E1165 Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging
E1254 Guide for Storage of Radiographs and Unexposed Industrial Radiographic Films
E1255 Practice for Radioscopy
E1316 Terminology for Nondestructive Examinations
E1390 Specification for Illuminators Used for Viewing Industrial Radiographs
E1416 Practice for Radioscopic Examination of Weldments
E1815 Test Method for Classification of Film Systems for Industrial Radiography
E2033 Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)
E2698 Practice for Radiographic Examination Using Digital Detector Arrays

2.3 *AWS Document:*
AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination[4]

2.4 *NCRP Documents:*[5]
NCRP 116 Limitation of Exposure to Ionizing Radiation
NCRP 144 Radiation Protection for Particle Accelerator Facilities
NCRP 147 Structural Shielding Design for Medical X-ray Imaging Facilities

2.5 *ANSI/ISO Standards:*[6]
ANSI/NCSL Z540-3 Requirements for the Calibration of Measuring and Test Equipment
ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment
ISO 5579 Non-Destructive Testing-Radiographic Examination of Metallic Materials by X-and Gamma-Rays-Basic Rules

NOTE 1—*DoD Contracts:* Unless otherwise specified, the issues of the documents that are DoD adopted are those listed in the issue of the DoDISS (Department of Defense Index of Specifications and Standards) cited in the solicitation.

NOTE 2—*Order of Precedence:* In the event of conflict between the text of this practice and the references cited herein, the text of this practice takes precedence. Nothing in this practice, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

[4] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.
[5] Available from National Council on Radiation Protection and Measurements, NCRP Publications, 7910 Woodmount Ave., Suite 800, Bethesda, MD 20814.
[6] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3. Terminology

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

3.1.1 *Optical density* is the correct term for assessing the developed film obtained from a penetrating radiation film inspection. Historically, the terms *film* or *radiographic density*, or both, have been used to describe the measurements taken from viewing the images, but the current definition of *film density*, in Terminology E1316, is "the quantitative measure of diffuse optical light transmission (optical density, blackening) through a developed film." In addition, with the advent of digital radiography, these historical terms may cause confusion to those utilizing more than the film technique. For standards purposes, the correct term is *optical density* and has been replaced throughout this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *component, n*—the part(s) or element of a system, assembled or processed to the extent specified by the drawing, purchase order, or contract.

3.2.2 *energy, n*—a property of radiation that determines its penetrating ability. In X-ray radiography, energy machine rating is determined by kilovolts (keV), million electronvolts (MeV). In gamma ray radiography, energy is a characteristic of the source used.

3.2.3 *like section, n*—a separate section of material that is similar in shape and cross section to the component or part being radiographed, and is made of the same or radiographically similar material.

3.2.4 *material group, n*—materials that have the same predominant alloying elements and which can be examined using the same IQI. A listing of common material groups is given in Practice E1025.

3.2.5 *NDT facility, n*—the NDT facility performing the radiographic examination.

3.2.6 *radiographic quality level, n*—the ability of a radiographic procedure to demonstrate a certain IQI sensitivity.

4. Significance and Use

4.1 This practice establishes the basic parameters for the application and control of the radiographic method. This practice is written so it can be specified on the engineering drawing, specification, or contract. It is not a detailed how-to procedure to be used by the NDT facility and, therefore, must be supplemented by a detailed procedure (see 6.1). Practices E1030/E1030M, E1032, and E1416 contain information to help develop detailed technique/procedure requirements.

5. General Practice

5.1 *Qualification:*

5.1.1 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations to this practice shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard and certified by the employer or certifying

agency, as applicable. The practice or standard used shall be identified in the contractual agreement between the using parties.

5.1.2 *Agency Evaluation*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated in accordance with Specification E543. The applicable revision of Specification E543 shall be specified in the contractual agreement.

5.2 *Laboratory Installations:*

5.2.1 *Safety*—The premises and equipment shall present no hazards to the safety of personnel or property. NCRP 147, NCRP 116, and NCRP 144 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 city, state, or national codes.

5.2.2 *Radiographic Exposure Areas*—Radiographic exposure areas shall be clean and equipped so that acceptable radiographs may be produced in accordance with the requirements of this practice.

5.2.3 *Darkroom*—Darkroom facilities, including equipment and materials, shall be capable of producing uniform radiographs free of blemishes or artifacts, which might interfere with interpretation in the area of interest.

5.2.4 *Film Viewing Area*—The film viewing room or enclosure shall be an area with subdued lighting to preclude objectionable reflective glare from the surface of the radiograph under examination (see 6.27.6).

5.3 *Materials:*

5.3.1 *Film*—Film selection for production radiographs should be based on radiation source energy level, part thickness/configuration, and image quality. Only film systems having cognizant engineering organization approval or meeting the class requirements of Test Method E1815 shall be used.

5.3.1.1 *Nonfilm Recording Media*—Other recording media may be used when approved by the cognizant engineering organization.

5.3.2 *Film Processing Solutions*—Production radiographs shall be processed in solutions capable of consistently producing radiographs that meet the requirements of this practice. Solution control shall be in accordance with Annex A4. Guide E999 should be consulted for guidance on film processing.

5.4 *Equipment:*

5.4.1 *Radiation Sources:*

5.4.1.1 *X-Radiation Sources*—Selection of appropriate X-ray voltage and current levels is dependent upon variables regarding the specimen being examined (material type and thickness) and exposure time. The suitability of these exposure parameters shall be demonstrated by attainment of the required radiographic quality level and compliance with all other requirements stipulated herein.

5.4.1.2 *Gamma Radiation Sources*—Isotope sources that are used shall be capable of demonstrating the required radiographic quality level.

5.4.2 *Film Holders and Cassettes*—Film holders and cassettes shall be light tight, constructed of materials that do not interfere with the quality or sensitivity of radiographs, and shall be handled properly to reduce damage. In the event that light leaks into the film holder and produces images on the radiograph, the radiograph need not be rejected unless the images obscure, or interfere with, the area of interest. If the film holder exhibits light leaks it shall be further repaired before use, or discarded. Film holders and cassettes should be routinely examined for cracks or other defects to minimize the likelihood of light leaks.

5.4.3 *Intensifying Screens:*

5.4.3.1 *Lead Foil Screens*—When using a source greater than 150 keV, intensifying screens of the lead foil type are recommended. Screens shall have the same area dimensions as the film being used and shall be in intimate contact with the film during exposure. Recommended screen thicknesses are listed in Table 1 for the applicable voltage range being used. Screens shall be free from any cracks, creases, scratches, or foreign material that could render undesirable nonrelevant images on the radiograph.

5.4.3.2 *Fluorescent, Fluorometallic, or Other Metallic Screens*—Fluorescent, fluorometallic, or other metallic screens may be used. However, they must be capable of demonstrating the required penetrameter (IQI) sensitivity. Fluorescent or fluorometallic screens may cause limitations in image quality (see Guide E94/E94M, Appendix X1).

5.4.4 *Film Viewers*—Viewers used for final interpretation shall meet the following requirements:

5.4.4.1 The viewer shall contain a variable control to allow the selection of optimum intensities for radiographs with varying optical densities.

5.4.4.2 The light source shall have sufficient intensity to enable viewing of optical densities in the area of interest (see 6.27.4).

TABLE 1 Lead Screen Thickness[A]

Energy Range/ Isotopes	Front Screen	Back Screen Minimum	Front and Back Screens[B]
	in.	in.	mm
0 keV – 150 keV[C]	0.000 to 0.001	0.005[D]	0–0.15
151 keV – 200 keV	0.000 to 0.005	0.005[D]	0.02–0.15
201 keV – 320 keV	0.001 to 0.010	0.005	0.02–0.2
Se-75	0.001 to 0.010	0.005	0.1–0.2
321 keV – 450 keV	0.005 to 0.015	0.01	0.1–0.2
Ir-192	0.005 to 0.015	0.01	0.02–0.2
451 keV – 2 MeV	0.005 to 0.020	0.01	0.1–0.5
Co-60	0.005 to 0.020	0.01	0.1–0.5
2 MeV – 4 MeV	0.010 to 0.020	0.01	0.1–0.5
4 MeV – 10 MeV	0.010 to 0.030	0.01	0.5–1.0
10 MeV – 25 MeV	0.010 to 0.050	0.01	1.0–2.0

[A] The lead screen thickness listed for the various energy ranges are recommended thicknesses and not required thicknesses. Other thicknesses and materials may be used provided the required radiographic quality level, contrast, and optical density are achieved.

[B] Lead screen thicknesses in accordance with EN 444 and ISO 5579 in SI units. For energy ranges of Co-60 and 451 keV to 4 MeV, steel or copper screens of 0.1 mm to 0.5 mm may be used. For energy ranges above 4 MeV to 10 MeV, 0.5 mm to 1.0 mm steel or copper or up to 0.5 mm tantalum screens are recommended. Additional back scatter shielding may be achieved by additional lead screens behind the cassettes.

[C] Prepackaged film with lead screens may be used from 80 keV to 150 keV. No lead screens are recommended below 80 keV. Prepackaged film may be used at higher energy levels provided the contrast, optical density, radiographic quality level, and backscatter requirements are achieved. Additional intermediate lead screens may be used for reduction of scattered radiation at higher energies.

[D] No back screen is required provided the backscatter requirements of 6.22 are met.

5.4.4.3 The light enclosure shall be designed to provide a uniform brightness level over the entire viewing screen.

5.4.4.4 The viewer shall be equipped with a suitable fan, blower, or other means to provide stable temperature at the viewing port to avoid damaging the radiographic film while viewing.

5.4.4.5 The viewer shall be equipped with a translucent material front in each viewing port, except for localized high-intensity viewing of high-optical-density radiographs areas through separate viewing ports, apertures, or other suitable openings.

5.4.4.6 A set of opaque masks, an iris-type aperture, or any other method to reduce the viewing area to suit the size of the area of interest shall be provided.

5.4.4.7 Illuminators procured to, or meeting the requirements of, Specification E1390 are acceptable for use.

5.4.5 *Digitizing Techniques*—The use of film digitizing techniques is acceptable when approved by the cognizant engineering organization.

5.4.6 *Densitometers*—The densitometer shall be capable of measuring the light transmitted through a radiograph with an optical density up to 4.0 with a unit resolution of 0.02. When optical densities greater than 4.0 are permitted, a densitometer capable of measuring optical densities up to the maximum optical density permitted is required.

5.4.7 *Film Viewing Aids*—Magnifiers shall be available to provide magnification between 3× and 10× to aid in interpretation and determine indication size, as applicable. The specific magnifier used should be determined by the interpretation requirements. Devices used for determining defect size shall be calibrated as scheduled in Table 2.

5.4.8 Luminance/illuminance light meters are procured and calibrated in accordance with Table 2.

TABLE 2 Process Control Checks

Check	Frequency	Paragraph
Discontinuity Image Measuring Device	[A,B]	5.4.7
Image Quality Indicators:		
Certified	When procured	5.5.4
Check (Condition)	prior to use[C]	5.5.4
Automatic Processing:		
Processor Performance	Daily[D]	A4.2.1
Base Fog	Daily[D]	A4.2.5
Developer Temperature	Prior to use[C]	A4.2.3
Replenishment Rate	[E]	A4.2.2
Transport Speed	[F]	A4.2.4
Manual Processing:		
Processing Performance	Daily	A4.3.1
Base plus Fog	Monthly	A4.2.5
Developer Temperature	Prior to use[G]	A4.3.2
Densitometer:		
Verification Check	Each shift[H]	6.27.5
Calibration Check	3 months[I]	6.27.5
Light Meters	Annual	6.27.4/6.27.6
Viewer Light Intensity		6.27.4
Thermometer Calibration	6 months[B]	A4.2.3
Ambient Visible Light	6 months[J]	6.27.6
Stepwedge Calibration	Annual	6.27.5

[A] *Optical Devices*—When procured; mechanical devices (see Footnote *B*).
[B] Calibrated and recorded in accordance with ANSI Z540-3, or ISO 10012, as applicable.
[C] Documentation of this check not required.
[D] May be extended to weekly when substantiated by actual technical/reliability data and approved by the cognizant engineering organization.
[E] Measured and recorded when solutions are changed during preventative maintenance or repair.
[F] Measured and recorded during preventative maintenance or repair.
[G] Temperatures shall be checked prior to each use. Daily documentation of this check is required.
[H] Each shift or when maintenance is performed (bulb or aperture changed).
[I] Every three months or whenever the densitometer verification check is not within tolerance.
[J] Fixed viewing locations with acceptable and controlled ambient lighting conditions need not be re-verified as long as those conditions are maintained.

5.5 *Image Quality Indicators (IQIs):*

5.5.1 *Image Quality Indicators (IQIs)*—The IQIs shall be in accordance with contract requirements. Hole-type IQIs in accordance with this practice, Practice E1025, or the alternate design of Annex A1, or wire-type IQIs in accordance with Practice E747, shall be used when IQIs are required. If wire IQIs are used, they shall be correlated to hole-type radiographic quality levels in accordance with Practice E747. For the radiography of electronic devices, Practice E801 shall be used.

5.5.2 *Radiographically Similar IQI Material*—Materials shall be considered radiographically similar if the following requirements are satisfied. Two blocks of equal thickness, one of the material to be radiographed and one of the material of which the IQIs are made, shall be exposed together on the same film at the lowest energy level to be used for production radiographs. If the optical density of the material to be radiographed is within the range from 0 to +15 % of the IQI material (that is, the IQI is slightly more attenuating), the IQI material shall be considered radiographically similar and may be used to fabricate IQIs for examination of the production material. The optical density readings shall be between 2.0 and 4.0 for both materials. An IQI with a lower radiation attenuation may be used.

5.5.3 *Alternate IQI Types*—The use of other types of IQIs, or modifications to types specified in 5.5.1, is permitted upon approval of the cognizant engineering organization. Details of the design, materials designation, and thickness identification of the IQIs shall be in the written procedure, or documented on a drawing that shall be referenced in the written procedure (see 6.1).

5.5.4 *IQI Control*—The IQIs shall be procured or fabricated to the requirements of Practice E1025, or the alternate design of Annex A1, as applicable, with a manufacturer's certification of compliance with respect to alloy and dimensions. Users shall visually inspect IQIs for damage, chamfering, and cleanliness in accordance with Table 2.

6. Detail Requirements

6.1 *Written Procedure*—It shall be the responsibility of the NDT facility to develop a workable examination technique recorded as a written procedure that is capable of consistently producing the desired results and radiographic quality level. When required by contract or purchase order, the procedure shall be submitted to the cognizant engineering organization for approval. The written procedure shall contain, as a minimum, the following information:

6.1.1 A drawing, sketch, or photograph of the component showing the location of the film and IQI with respect to the radiation source for each exposure.

6.1.2 The angle of the radiation beam in relation to the component, the source-to-film distance, and any blocking or masking, if used.

6.1.3 Part zones, if applicable, should be included (see 6.2). This may be accomplished through drawings and tables or by reference to documents where such information is found.

6.1.4 The nominal exposure for X-ray machines, the voltage, milliamps, time (or rads as applicable), and effective focal spot size. For radioisotope sources, the isotope type, source strength (curies), exposure time, and source size.

6.1.5 Film designation (for example, brand, type, and processing parameters), intensifying screens (for example, type and thickness of screens), or filters (for example, filter material, thickness, and location) if used, film loading instructions (for example, when using multiple film exposure techniques), and the desired optical density range.

6.1.6 Thickness and type of material.

6.1.7 The IQI size and type, and the required radiographic quality level. If alternate IQIs are used (see 5.5.3), include details of the design or reference to documents where such information is found.

6.1.8 Thickness and type of material for shims or blocks, or both, if used.

6.1.9 Name and address of the NDT facility and the date, or revision, of the procedure.

6.1.10 Radiographic identification scheme used to correlate part-to-film. If the examination procedures are similar for many components, a master written procedure may be used that covers the details common to a variety of components. All written procedures shall be approved by an individual qualified and certified as a Level III for radiography in accordance with 5.1.1.

6.2 *Acceptance Requirements*—When examination is performed in accordance with this practice, engineering drawings, specifications, or other applicable documents shall indicate the criteria by which the components are judged acceptable. Complex components may be divided into zones and separate criteria assigned to each zone in accordance with its design requirements. When used, direct references to ASTM reference radiographic standards shall include the grade level for each type of discontinuity permitted for each part or zone.

NOTE 3—Information on reference radiographs can be obtained from the *Annual Book of ASTM Standards*, Vol 03.03 or from ASTM Headquarters.

6.3 *Surface Preparation*—Components may be examined without surface preparation or conditioning except as required to remove surface conditions that may interfere with proper interpretation of radiographs.

6.3.1 Castings, forgings, and weldments may be radiographed in the as-cast, as-forged, or as-welded conditions provided the following requirements are met.

6.3.1.1 For castings and forgings, the surface condition shall not interfere with evaluation.

6.3.1.2 Accessible surfaces of welds shall be prepared in accordance with A2.1.

6.4 *Radiographic Identification*—Each radiograph shall carry the identification or serial number of the component and view number, when multiple views are taken. Each radiograph shall also carry the identification of the NDT facility examining the component and the date of the examination. Radiographs of a repair area shall be identified with *R1, R2, R3*, and so forth, indicating the number of times that repairs were attempted. Alternative schemes may be used for identification of repair radiographs so long as each film is clearly identified to relate to a particular repair area. For explosives and propellants, the conditioning temperature shall be identified on each X-ray film if the ordnance has been conditioned to a temperature other than facility ambient for purposes of examination.

6.5 *Examination and Coverage*—The number of parts examined, and the radiographic coverage of each part shall be as specified by drawings, radiographic techniques, radiographic manuals, handbooks for aircraft technical orders, or other specifications, as applicable. Areas to be examined shall be identified on the drawing by using the symbols in accordance with AWS A2.4 or other systems of designations that are easily identified on the drawing. If the number of parts to be examined and the amount of coverage of each part is not specified, all parts shall be examined and shall receive 100 % radiographic coverage.

6.6 *Examination Sequence*—The sequence for radiographic examination in the production operation should be specified in the manufacturing or assembly process specification, contract, or purchase order. If not specified, radiographic examination shall be performed at a stage in the process of manufacturing or assembly at which discontinuities can be detected. Radiographic examination may be performed before heat treatment, provided liquid penetrant or magnetic particle examinations are performed after heat treatment.

6.7 *Nonfilm Techniques*—When permitted by purchase order, contract, or specification, radioscopic/radiological examinations using nonfilm techniques shall be in accordance with Practices E1255, E2033 or E2698 or a nonfilm specification approved by the cognizant engineering organization as required. Prior approval shall be obtained from the Level III radiographer of the cognizant engineering organization (see 5.1.1).

6.8 *Multi-Film Techniques*—Film techniques with two or more films of the same or different speeds in the same film holder, to be used in either single or superimposed film viewing, shall be permitted provided that the applicable radiographic quality level, and optical density requirements (see 6.9 and 6.10), are achieved for the area of interest.

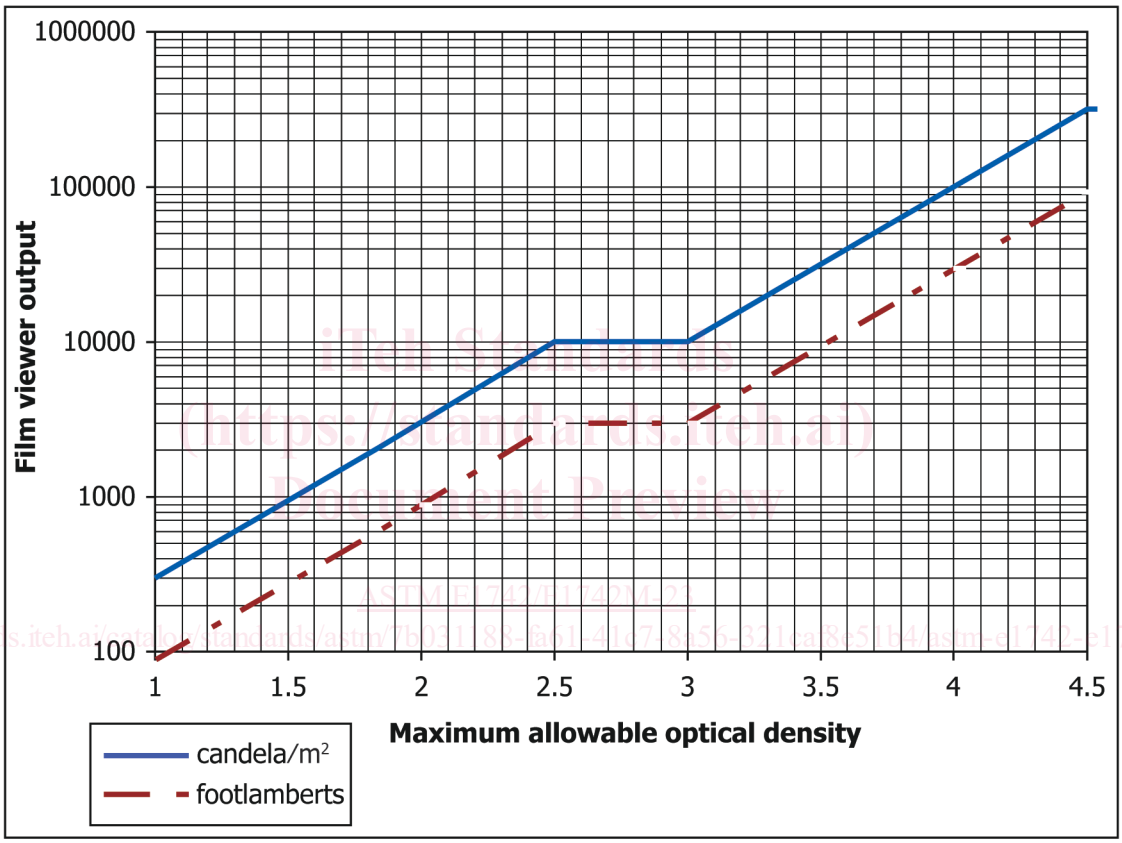
6.9 *Radiographic Quality Levels*—The five quality levels listed in Table 3 may be assigned on the basis of IQI thickness and the perceptibility of one, two, or three holes in the hole-type IQI image on the radiograph. If the quality level is not specified on the drawing or other applicable documents, it shall be Level 2-2T. Unless otherwise specified by the cognizant engineering organization, hole-type IQIs used for examination of material 0.25 in. [6.35 mm] or less in thickness shall be 0.005 in. [0.127 mm] minimum thickness.

TABLE 3 Quality Levels of Examination

IQI Designation	Radiographic Quality Level	Maximum IQI Thickness, %[A]	Minimum Hole Diameter[B]	Equivalent IQI Sensitivity, %[C]
00	1–1T	1	1T	0.7
0	1–2T	1	2T	1.0
1	2–1T	2	1T	1.4
2	2–2T	2	2T	2.0
3	2–4T	2	4T	2.8

[A] Expressed as a percentage of material thickness.
[B] Expressed as multiple thickness of IQI.
[C] Equivalent IQI sensitivity is that thickness of the IQI expressed as a percentage of the specimen thickness in which a 2T hole would be clearly visible under the same radiographic conditions.

6.10 *Optical Density*—For single-film viewing, the optical density shall be ≥1.5 in the area of interest. Where superimposed radiograph viewing is used, the optical density of the superimposed radiographs shall be from 2.0 in the area of interest, and each individual radiograph shall not have an optical density below 1.0 in the area of interest. Optical densities above 4.0 are permitted when agreed upon between the cognizant engineering organization and the NDT facility (see Note 1 of Fig. 1). In no case shall the maximum optical density exceed 4.5. For single-film viewing, optical densities less than 1.5 are permitted only when items not requiring an IQI (see 6.18) are examined. The maximum readable optical density depends on the film viewer used and its maximum



NOTE 1—This figure is a depiction of the abscissa axis: Maximum Allowable Optical Density versus ordinate axis: Candela/m^2 and footlamberts in graphical format from tabular data derived from Specification E1390 and ISO 5580 (also known as EN 25580). Conversion from tabular data to a graph accounts for the step in the line. For Film Viewer Output of 10 000 candela/m^2 (2919 Footlamberts), the Maximum Allowable Optical Density shall be 3.0. Regarding the ordinate axis: Candela/m^2, the minimum luminance level required for the average human eye to achieve photopic eye response (that is where maximum resolution and contrast discrimination occurs) is at 10 candela/m^2. At levels below this value the eye responds scotopically which means lower contrast discrimination and resolution. While photopic vision typically occurs at a threshold of 10 candela/m^2 for the average human eye, this curve takes advantage of the fact that at lower optical densities most viewers can achieve an amount of light that guarantees that virtually all operators will be viewing film in the photopic vision mode, that is 30 candela/m^2 for optical densities <2.5. A theoretical advantage of this curve is that it compensates for the reduced contrast sensitivity of radiographic film at lower optical densities.

NOTE 2—NDT film systems, classified corresponding to Test Method E1815 system classes "Special, I and II," with or without lead screens, are suitable for the extended viewing range above an optical density of 4, due to their high gradient ($G_{D\text{-}D0\,=\,4}$ >6) at D = 4 above fog and base. These double sided NDT film systems have a high silver content and do not saturate as early as medical and classes III, W-A, W-B and W-C film systems. The basic advantage of increasing the optical density is the increase of contrast with optical density. Since the contrast/noise ratio also increases (with the square root of optical density), the perception of indications of small flaws improves significantly with higher optical density. The operator should mask all film areas of lower optical density to avoid blinding (dazzling). Blinding reduces the eye perception and requires longer eye adaptation time. High brightness viewing stations also heat up films depending on the optical density and viewing time. The operator shall prevent overheating to protect the film integrity.

FIG. 1 Maximum Allowable Optical Density with Film Viewer Output