Designation: ~~E1161 – 09 (Reapproved 2014)~~ E1161 – 21

Standard Practice for ~~Radiologic~~Radiographic Examination of Semiconductors and Electronic Components[1]

This standard is issued under the fixed designation E1161; 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 provides the minimum requirements for nondestructive ~~radiologic~~radiographic examination of semiconductor devices, microelectronic devices, electromagnetic devices, electronic and electrical devices, and the materials used for construction of these items.

1.2 This practice covers the ~~radiologic~~radiographic examination of these items to detect possible defective conditions within the sealed case, especially those resulting from sealing the lid to the case, and internal defects such as extraneous material (foreign objects), improper interconnecting wires, voids in the die attach material or in the glass (when sealing glass is ~~used)~~ used), solder defects, or physical damage.

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, 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 supplier.

1.4 *Units*—The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this practice.

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~~ safety, health, and ~~health~~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:

[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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2.2 *ASTM Standards:*[2]

~~E94~~E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film
E431 Guide to Interpretation of Radiographs of Semiconductors and Related Devices
E543 Specification for Agencies Performing Nondestructive Testing
~~E801 Practice for Controlling Quality of Radiographic Examination of Electronic Devices~~
E666 Practice for Calculating Absorbed Dose From Gamma or X Radiation
E801 Practice for Controlling Quality of Radiographic Examination of Electronic Devices
E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing
E1000 Guide for Radioscopy
E1079 Practice for Calibration of Transmission Densitometers
~~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
E1411 Practice for Qualification of Radioscopic Systems
E1453 Guide for Storage of Magnetic Tape Media that Contains Analog or Digital Radioscopic Data
E1475 Guide for Data Fields for Computerized Transfer of Digital Radiological Examination Data
~~E1742~~E1742/E1742M Practice for Radiographic Examination
E1815 Test Method for Classification of Film Systems for Industrial Radiography
E1817 Practice for Controlling Quality of Radiological Examination by Using Representative Quality Indicators (RQIs)
E1936 Reference Radiograph for Evaluating the Performance of Radiographic Digitization Systems
E2002 Practice for Determining Total Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy
E2007 Guide for Computed Radiography
E2033 Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)
E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)
E2445/E2445M Practice for Performance Evaluation and Long-Term Stability of Computed Radiography Systems
~~E2597~~E2597/E2597M Practice for Manufacturing Characterization of Digital Detector Arrays
E2698 Practice for Radiographic Examination Using Digital Detector Arrays
E2736 Guide for Digital Detector Array Radiography
E2737 Practice for Digital Detector Array Performance Evaluation and Long-Term Stability

2.3 *ANSI Standards:*[3]

ANSI/ESD S20.20 ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
ANSI/NCSL Z540-3 Requirements for the Calibration of Measuring and Test Equipment

2.4 *ASNT Standard:*[4]

ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel
SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

2.5 *AIA ~~Documents:~~Document:*[5]

NAS-410 Certification and Qualification of Nondestructive Test Personnel

2.6 *Department of Defense (DOD) Documents:*[6]

MIL-PRF-28861 Performance Specification—General Specification for ~~Filters,~~ Filters and Capacitors, Radio Frequency/Electromagnetic Interference Suppression
MIL-STD-202 Test Method Standard Electronic and Electrical Component Parts
MIL-STD-202, Method 209 Radiographic Inspection
MIL-STD-750 Test Method Standard Test Methods for Semiconductor Devices
MIL-STD-750, Method 2076 ~~Radiography~~Radiographic Inspection
MIL-STD-883 Test Method Standard Microcircuits
MIL-STD-883, Method 2012 Radiography
MIL-STD-981 Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications

2.7 *Federal Standard:*[6]

FED-STD-595 Color (Requirements for Individual Color Chits)

[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 American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.
[5] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.
[6] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

2.8 *NCRP Documents:*[7]
NCRP 116 Limitation of Exposure to Ionizing Radiation
NCRP 144 Radiation Protection for Particle Accelerator Facilities

2.9 *ISO Standard:*[8]
ISO 9712 Non-destructive Testing – Qualification and Certification of NDT Personnel

2.10 *SMPTE Document:*[9]
SMPTE RP 133 Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras

3. Terminology

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

3.2 ~~*Abbreviations:*~~*Definitions of Terms Specific to This Standard:*

3.2.1 *controlling documentation, ~~—~~n—~~The~~*the document or standard that is specified by contractual agreement and lists such items as the examination requirements, number of views, and acceptance criteria. Controlling documentation may be in the form of a purchase order, engineering drawing, Military Standard, ~~etc.~~etc., or a combination thereof.

3.2.2 ~~*device(s)—*~~*device(s), n—~~*For*for the purpose of this practice*, the term "device" and "devices" shall be used to describe microcircuits, semiconductors, electromagnetic devices, electronic and electrical component parts. Microcircuits include such items as, monolithic, multichip and hybrid microcircuits, microcircuit arrays, and the elements from which these circuits are made. Semiconductors include such items as diodes, transistors, voltage regulators, rectifiers, tunnel diodes, and other related parts. Electromagnetic devices include such items as transformers, inductors, and coils. Electronic and electrical components include such items as capacitors, resistors, switches, and relays. This is not an ~~all inclusive~~ all-inclusive list, therefore, the term "device" or "devices" will be used throughout this practice to refer to the items which are the subject of the ~~radiological~~radiographic examination process.

3.2.3 ~~*micro-bubbles—*~~*micro-bubbles, n—*~~A~~a film defect where tiny bubbles in the film's emulsion create white dots on the processed radiograph. Micro-bubbles are unacceptable when they show up in the area of interest of a device because they can be interpreted as extraneous matter (foreign material).

3.2.4 *parallax error ~~effect—~~effect, n—~~For~~for the purpose of this practice*, the term "parallax error effect" will refer to a double image on the radiograph of the device's internal features such as wires or ball bonds. This is caused by the device being too far from the central X-ray beam where the angle of the X-rays creates a double ~~image on double emulsion film.~~image.

3.2.5 ~~*pick-off—*~~*pick-off, n—*~~An~~an automatic film processing artifact where tiny spots of emulsion are "picked off" of the radiograph as it is moving through the dryer. Pick-off artifacts are unacceptable when they show up in the area of interest of a device because they can be interpreted as extraneous matter (foreign material).

3.2.6 ~~*pre-cap—*~~*pre-cap, n—*~~Prior~~prior to capping or encapsulation.

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

3.3 *Abbreviations:*

3.3.1 *AWG*—American Wire Gauge

3.3.2 *CEO*—Cognizant Engineering Organization. The company, government agency, or other authority responsible for the design, or end use, of the device(s) for which ~~radiological~~radiographic examination is required. This, in addition to design personnel, may

[7] Available from National Council on Radiation Protection and Measurements (NCRP), 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095, https://ncrponline.org/.
[8] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.
[9] Available from SMPTE, White Plains Plaza 445 Hamilton Ave STE 601 White Plains NY 10601-1827, https://www.smpte.org.

include personnel from electrical engineering, material and process engineering, nondestructive testing (usually the certified Radiographic Level 3), or quality groups, as appropriate.

3.3.3 *CNR*—Contrast-to-Noise Ratio, as described in Guide E2007 and Practice E2698.

3.3.4 *CR*—Computed Radiography

3.3.5 *DDA*—Digital Detector Array. DDAs are described in Practice ~~E2597~~E2597/E2597M.

3.3.6 *DPA*—Destructive Physical Analysis

3.3.7 *DR*—Digital Radiography

3.3.8 *ESD*—Electrostatic Discharge

3.3.9 *ESDS*—Electrostatic Discharge Sensitive

3.3.10 *FDD*—Focal spot to Detector Distance

3.3.11 *FFD*—Focal spot to Film Distance

3.3.12 *FOD*—Focal spot to Object Distance (always measured to the "source side" of the object)

3.3.13 *PIND*—Particle Impact Noise Detection

3.3.14 *RAD*—Radiation Absorbed Dose, the dose causing 100 ergs of energy to be absorbed by one gram of ~~matter~~matter.

3.3.15 *SNR*—Signal-to-Noise Ratio, as described in Guides E2007 and E2736 or Practice E2737.

3.3.16 *TLD*—Thermoluminescence Dosimetry

4. Significance and Use

4.1 This practice establishes the basic minimum parameters and controls for the application of ~~radiological~~radiographic examination of electronic devices. Factors such as device handling, equipment, ESDS, materials, personnel qualification, procedure and quality requirements, reporting, records and radiation sensitivity are addressed. 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 (see ~~9.1~~10.1).

4.2 This practice does not set limits on radiation ~~dose,~~dose but does list requirements to limit and document radiation dose to devices. When radiation dose limits are an issue, the requestor of ~~radiological~~radiographic examinations must be cognizant of this issue and state any maximum radiation dose limitations that are required in the contractual agreement between the using parties.

5. Qualification

5.1 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations ~~to~~ in accordance with this practice shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ANST CP-189, SNT-TC-1A, NAS-410, ISO 9712, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used, and its applicable revision, shall be identified in the contractual agreement between the using parties. When examining devices to DOD requirements (see ~~2.5~~2.6), NAS-410 shall be the required standard.

5.2 ~~*Qualification of Nondestructive Testing (NDT) Agencies*~~—*Agency Evaluation*—~~When~~If specified in the contractual agreement,

Nondestructive Testing agencies shall be qualified and evaluated as described in ~~Practice~~ accordance with Specification E543. The applicable revision of Specification E543~~.~~ shall be specified in the contractual agreement.

~~5.2.1 *Safety*—The NDT facility shall present no hazards to the safety of personnel and property. NCRP 144, NCRP 116 may be used as guides to ensure that radiological procedures are performed so that personnel shall not receive a radiation dose exceeding the maximum safe limits as permitted by city, state, or national codes.~~

6. Environment and Safety

6.1 *Safety*—The NDT facility shall present no hazards to the safety of personnel and property. NCRP 144, NCRP 116 may be used as guides to ensure that radiographic procedures are performed so that personnel shall not receive a radiation dose exceeding the maximum safe limits as permitted by city, state, or national codes.

6.2 *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.

6.3 *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.

6.4 *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 film under examination.

6.5 *Digital Image Viewing Stations*—Image viewing stations shall be arranged in accordance with Practice E2698 to exclude any objectionable illuminance that could cause a reflective glare from the display monitor and shall have light controls to achieve ambient (background) lighting levels of no greater than 30 lux. Ambient light shall be measured at the viewing surface with the display monitor off. Luminance/illuminance light meters are procured and calibrated in accordance with Practice E1742/E1742M, Table 2.

7. Equipment

7.1 Different examination system configurations are possible. It is important that the user understands the advantages and limitations of each. All radiographic methods shall be conducted according to Practice E1742/E1742M.

7.2 *Radiation Source*—Only X-ray generating equipment shall be used. Such factors as focal spot size, inherent filtration, accelerating voltage, and tube current shall be considered when choosing the proper X-ray source. The X-ray source and exposure parameters shall not cause damage to the device(s) under examination. The suitability of these exposure parameters shall be demonstrated by attainment of the required ~~radiological~~radiographic quality level and compliance with all other requirements stipulated in this practice.

7.2.1 *Focal Spot*—The focal spot size shall be such that the ~~radiological~~radiographic quality level specified in ~~10.3~~11.3 can be achieved.

7.2.2 X-ray systems shall be characterized for their radiation dose rate using a calibrated dosimeter. The dose rate shall be identified at distances to be used during examination so safe limits can be established to ensure devices under examination are not subject to excessive levels of radiation. Dose rate characterization shall be performed with and without filters (see 7.9) to establish best practices between radiographic quality levels and total dose during examination. All exposure information shall be tracked and recorded in the examination record (see 12.1).

7.3 *Non-Film Systems*—~~Radioscopy systems~~ DDA-based systems and radioscopy systems designed specifically for the examination of electronic devices are generally the alternative to ~~film based radiography. However, DDA based systems may also be used.~~film-based radiography. Examinations using non-film techniques shall be in accordance with Practices E1255, E2033, or E2698 or a non-film specification approved by the CEO as required. Prior approval shall be obtained from the Radiographic Testing Level III of the CEO.

7.3.1 The suitability of any film or non-film ~~radiological~~radiography system shall be demonstrated by attainment of the required ~~radiological~~radiographic quality level and compliance with all other applicable requirements stipulated in this practice.

7.3.2 When specified in the controlling documentation, non-film radioscopy systems shall be operated in accordance with Practice E1255 and qualified in accordance with Practice E1411. Other types of non-film systems ~~operaating~~operating procedures and qualification procedures shall be agreed upon between the using parties.

7.3.3 ~~X-ray~~ For all non-film methods, system suitability shall be determined such that basic spatial resolution is acceptable for minimum requirements as defined in Practice E2002. CR systems shall be ~~characterized for their radiation dose rate using~~proven suitable as defined by Practice E2445/E2445M ~~a calibrated dosimeter. The dose rate shall be identified at distances to be used during~~and DDA systems shall be proven suitable as defined by Practices E2698 ~~examination so safe limits can be established to ensure devices under examination are not subject to excessive levels of radiation. Dose rate characterization shall be performed with~~ and E2737~~without filters (see . 6.13) to establish best practices between radiological quality levels and total dose during examination. All exposure information shall be tracked and recorded in the examination record (see 11.1).~~

7.4 *Film ~~Viewers—~~Radiography Systems:* ~~Viewers used for film interpretations shall meet the following minimum requirements:~~

~~6.3.1 The light source shall have sufficient intensity to enable viewing of film densities in the area of interest.~~

~~6.3.2 Film viewers procured to or meeting the requirements of Guide E1390 are acceptable for use.~~

~~6.3.3 Low intensity film viewers such as fluorescent 14 by 17-in. illuminators, shall be equipped with daylight fluorescent bulbs.~~

~~6.3.4 All film viewers shall be tested for and posted with the maximum readable density in accordance with Practice E1742, Figure 2 and subsection 6.27.4.~~

7.4.1 *Viewers—~~Film viewers shall be kept clean and viewing surfaces shall be free of scratches or other defects that will interfere with proper film interpretation.~~*Viewers used for film interpretations shall meet the following minimum requirements:

7.4.1.1 The light source shall have sufficient intensity to enable viewing of film densities in the area of interest.

7.4.1.2 Film viewers procured to or meeting the requirements of Guide E1390 are acceptable for use.

7.4.1.3 Low intensity film viewers such as fluorescent 14 by 17-in. illuminators, shall be equipped with daylight fluorescent bulbs.

7.4.1.4 All film viewers shall be tested for and posted with the maximum readable density in accordance with Practice E1742/E1742M, Figure 2 and subsection 7.27.4.

7.4.1.5 Film viewers shall be kept clean and viewing surfaces shall be free of scratches or other defects that will interfere with proper film interpretation.

7.4.1.6 *Magnifiers*—Magnifiers shall be available to provide magnification between 6× to 25× 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 E1742/E1742M.

7.4.2 *Lead-Topped Tables*—When performing film radiography, a lead-topped table with at least 0.062 in. of lead shall be used. The lead shall be smooth, and without any gouges or scratches that will cause undesirable image artifacts. Lead vinyl or lead rubber may be used in lieu of lead. Tape or other low-density materials used to cover the lead topped table shall not be allowed unless directly related to ESD protection.

7.4.3 *Film Holders*—Film holders and cassettes shall be light tight. They may be flexible vinyl, plastic, or other durable material. Vacuum cassettes are preferred in order to keep the device(s) as close to the film as possible. The suitability of any film holder shall be such as to comply with any special handling requirements including ESD precautions and their suitability shall be demonstrated by attainment of the required radiographic quality level and compliance with all other requirements stipulated in this practice. Film holders and cassettes should be routinely examined for cracks or other defects to minimize the likelihood of light leaks.

7.4.4 *Lead Foil Screens*—When ESD mats are used on top of the lead topped exposure table, the film holder shall be equipped with a lead foil back screen of adequate thickness to protect the film from backscatter. Lead foil backing screens shall be 0.010

in. minimum thickness. Lead foil screens shall be free of blemishes such as cracks, creases, scratches, or foreign material that will cause undesirable non-relevant image artifacts on the radiograph.

7.4.5 *Densitometer*—Where film radiography is performed, a densitometer shall be available to check film densities. The densitometer shall be capable of measuring the light transmitted through a radiograph with a film density up to the maximum allowed by 11.4 or any higher film densities determined suitable for use by the CEO. Densitometers shall be operated and calibrated in accordance with Practice E1079.

7.4.6 *Holding Fixtures*—Holding fixtures shall be capable of holding specimens in the required positions without interfering with the accuracy or ease of image interpretation. Holding fixtures shall not be made of materials that will create undesirable secondary radiation that will reduce image clarity. Holding fixtures shall be clean of debris that can interfere with image interpretation by appearing on the radiograph or radiological image and be confused with that of any defect. Holding fixtures shall not cause damage to the devices under examination and shall be compliant with any special handling requirements including ESD precautions.

7.4.7 *Digitizing Techniques*—The use of film digitizing techniques is acceptable when approved by the CEO as per Reference Radiograph E1936. The digital image shall retain the IQI sensitivity of the original film.

7.5 ~~*Holding Fixtures—Image Quality Indicators (IQIs)—*~~Holding fixtures IQIs shall be ~~capable of holding specimens in the required positions without interfering with the~~in accordance with Practice E801~~accuracy or ease of image interpretation. Holding fixtures shall not be made of materials that will create undesirable secondary radiation that will reduce image clarity. Holding fixtures shall be clean of debris that can interfere with image interpretation by appearing on the radiograph or radiological image and be confused with that of any defect. Holding fixtures shall not cause damage to the devices under examination and shall be compliant~~. RQIs may be used in place of IQIs and shall comply with 7.7~~any special handling requirements including ESD precautions.~~.

~~6.5 *Lead-Topped Tables*—When performing film radiography, a lead-topped table with at least 0.062 in. of lead shall be used. The lead shall be smooth, and with out any gouges or scratches that will cause undesirable image artifacts. Lead vinyl or lead rubber may be used in lieu of lead. Tape or other low density materials used to cover the lead topped table shall not be allowed unless directly related to ESD protection.~~

~~6.6 *Film Holders*—Film holders and cassettes shall be light tight. They may be flexible vinyl, plastic, or other durable material. Vacuum cassettes are preferred in order to keep the device(s) as close to the film as possible. The suitability of any film holder shall be such as to comply with any special handling requirements including ESD precautions and their suitability shall be demonstrated by attainment of the required radiological quality level and compliance with all other requirements stipulated in this practice.~~

~~6.7 *Lead Foil Screens*—When ESD mats are used on top of the lead topped exposure table, the film holder shall be equipped with a lead foil back screen of adequate thickness to protect the film from backscatter. Lead foil backing screens shall be 0.010 in. minimum thickness. Lead foil screens shall be free of blemishes such as cracks, creases, scratches or foreign material that will cause undesirable non-relevant image artifacts on the radiograph.~~

7.6 ~~*Image Quality Indicators (IQIs)—*~~*Shims*—~~IQIs~~Shims shall be ~~in accordance~~ used with ~~Practice~~IQI's ~~E801. RQIs may be used in place of IQIs~~in order to achieve the density requirements in 11.1 and 11.4~~shall comply with~~. Shims shall ~~6.9~~be made of stainless steel or radiographically similar material. Definition of radiographically similar IQI material is provided in Practice E1742/E1742M.

~~6.8.1 *Shims*—Shims shall be used with IQI's in order to achieve the density requirements in 10.1 and 10.4. Shims shall be made of stainless steel or radiographically similar material.~~

7.7 *Representative Quality Indicators (RQIs)*—When RQIs are used in place of IQIs, they shall be similar in construction to the device being examined. RQIs may have natural or artificial defects similar to those that are expected to occur in the device being ~~examined,~~examined or may be of acceptable construction with an AWG number 48 (0.001 in.) tungsten wire mounted across the body. RQIs that conform to Practice E1817 are acceptable for use. Details of the design of RQIs and all features that must be demonstrated on the ~~radiological~~radiographic images shall be documented, and these records shall be kept on file and available.

~~6.10 *Densitometer*—Where film radiography is performed, a densitometer shall be available to check film densities. The~~