Designation: ~~E1030/E1030M – 15~~ E1030/E1030M – 21

Standard Practice for Radiographic Examination of Metallic Castings[1]

This standard is issued under the fixed designation E1030/E1030M; 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[2] provides a uniform procedure for radiographic examination of metallic castings using radiographic film as the recording medium.

1.2 This standard addresses the achievement of, or protocols for achieving, common or practical levels of radiographic coverage for castings, to detect primarily volumetric discontinuities to sensitivity levels measured by nominated image quality indicators. All departures, including alternate means or methods to increase coverage, or address challenges of detecting non-volumetric planar-type discontinuities, shall be agreed upon between the purchaser and supplier and shall consider Appendix X1 and Appendix X2.

1.3 The radiographic techniques stated herein provide adequate assurance for defect detectability; however, it is recognized that, for special applications, specific techniques using more or less stringent requirements may be required than those specified. In these cases, the use of alternate radiographic techniques shall be as agreed upon between purchaser and supplier (also see Section 5).

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 are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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 *ASTM Standards:*[3]

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings

E186 Reference Radiographs for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings

[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 ASME Boiler and Pressure Vessel Code applications see related Test Method SE-1030 in Section II of that Code.

[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**

E192 Reference Radiographs of Investment Steel Castings for Aerospace Applications
E272 Reference Radiographs for High-Strength Copper-Base and Nickel-Copper Alloy Castings
E280 Reference Radiographs for Heavy-Walled (4½ to 12 in. (114 to 305 mm)) Steel Castings
E310 Reference Radiographs for Tin Bronze Castings
E446 Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness
E505 Reference Radiographs for Inspection of Aluminum and Magnesium Die Castings
E543 Specification for Agencies Performing Nondestructive Testing
E689 Reference Radiographs for Ductile Iron Castings
E747 Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology
E802 Reference Radiographs for Gray Iron Castings Up to 4½ in. (114 mm) in Thickness
E999 Guide for Controlling the Quality of Industrial Radiographic Film Processing
E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography
E1079 Practice for Calibration of Transmission Densitometers
E1254 Guide for Storage of Radiographs and Unexposed Industrial Radiographic Films
E1316 Terminology for Nondestructive Examinations
E1320 Reference Radiographs for Titanium Castings
~~E1742~~E1742/E1742M Practice for Radiographic Examination
E1815 Test Method for Classification of Film Systems for Industrial Radiography

2.2 *ASNT/ANSI Standards:*[4]

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
CP-189 Qualification and Certification of Nondestructive Testing Personnel[4]

2.3 ~~*Other Standards:*~~*AIA Standard:*[5]

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

2.4 *ISO Standards:*[6]

ISO 5579 Non-Destructive Testing—Radiographic Testing of Metallic Materials Using Film and X- or Gamma-rays—Basic Rules
ISO 9712 Non-Destructive Testing—Qualification and Certification of NDT Personnel

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology E1316.

4. Significance and Use

4.1 The requirements expressed in this practice are intended to control the quality of the radiographic images, to produce satisfactory and consistent results, and are not intended for controlling the acceptability or quality of materials or products.

5. Basis of Application

5.1 The following items shall be agreed upon by the purchaser and supplier:

5.1.1 *Nondestructive Testing Agency Evaluation*—If specified in the contractual agreement, nondestructive testing (NDT) agencies shall be qualified and evaluated in accordance with Practice E543. The applicable version of Practice E543 shall be specified in the contractual agreement.

5.1.2 *Personnel Qualification*—Personnel performing examinations to this standard shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT 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.

5.1.3 *Apparatus*—General requirements (see 6.1 through 6.9) shall be specified.

5.1.4 *Requirements*—General requirements (see 8.1, 8.2, 8.5, and 8.7.4) shall be specified.

[4] Available from the American Society for Nondestructive Testing, (ASNT), 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228.
[5] Available from Aerospace Industries Association of America, ~~Inc.,~~ Inc. (AIA), 1000 Wilson Blvd Suite 1700, Arlington, VA 22209-3928.
[6] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

5.1.5 Procedure Requirements (see 9.1, 9.1.1, 9.3, 9.7.4, and 9.7.7) shall be specified.

5.1.6 *Records*—Record retention (see 12.1) shall be specified.

6. Apparatus

6.1 *Radiation Sources:*

6.1.1 *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 economically permissible exposure time. The suitability of these X-ray parameters shall be demonstrated by attainment of required penetrameter (IQI) sensitivity and compliance with all other requirements stipulated herein. Guide E94 contains provisions concerning exposure calculations and charts for the use of X-ray sources.

6.1.2 *Gamma Radiation Sources*—Isotope sources, when used, shall be capable of demonstrating the required radiographic sensitivity.

6.2 *Film Holders and Cassettes*—Film holders and cassettes shall be light-tight and shall be handled properly to reduce the likelihood that they may be damaged. They may be flexible vinyl, plastic, or any durable material; or, they may be made from metallic materials. In the event that light leaks into the film holder and produces images on the film extending into the area of interest, the film shall be rejected. If the film holder exhibits light leaks, it shall be repaired before reuse or discarded. Film holders and cassettes should be routinely examined to minimize the likelihood of light leaks.

6.3 *Intensifying Screens:*

6.3.1 *Lead-Foil Screens:*

6.3.1.1 Intensifying screens of the lead-foil type are generally used for all production radiography. Lead-foil screens shall be of the same approximate area dimensions as the film being used and they shall be in direct contact with the film during exposure.

6.3.1.2 Recommended screen thicknesses are listed in Table 1 for the applicable voltage range being used.

6.3.1.3 Sheet lead, with or without backing, used for screens should be visually examined for dust, dirt, oxidation, cracking or creasing, foreign material or other condition that could render undesirable nonrelevant images on the film.

6.3.2 *Fluorescent, Fluorometallic, or Other Metallic Screens:*

6.3.2.1 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, Appendix X1.)

6.3.2.2 *Screen Care*—All screens should be handled carefully to avoid dents, scratches, grease, or dirt on active surfaces. Screens that render false indications on radiographs shall be discarded or reworked to eliminate the artifact.

6.3.3 *Other Screens*—International Standard ISO 5579 contains similar provisions for intensifying screens as this practice. International users of these type screens who prefer the use of ISO 5579 for their particular applications should specify such alternate provisions within separate contractual arrangements from this practice.

6.4 *Filters*—Filters shall be used whenever the contrast reductions caused by low-energy scattered radiation or the extent of undercut and edge burn-off occurring on production radiographs is of significant magnitude so as to cause failure to meet the quality level or radiographic coverage requirements stipulated by the job order or contract (see Guide E94).

6.5 *Masking*—Masking material may be used, as necessary, to help reduce image degradation due to undercutting (see Guide E94).

6.6 *Penetrameters (IQI)*—Unless otherwise specified by the applicable job order or contract, only those penetrameters that comply with the design and identification requirements specified in Practices E747, E1025, or ~~E1742~~E1742/E1742M shall be used.

TABLE 1 Lead Foil Screens[A]

Energy Range/Isotope	Front Screen, in.[A]	Back Screen Minimum, in.	Front and
0 to 150 keV[C]	0.000 to 0.001	0.005[D]	0 to 0.15
151 to 200 keV	0.000 to 0.005	0.005[D]	0 to 0.15
201 to 320 keV	0.001 to 0.010	0.005	0.02 to 0.2
Se-75	0.001 to 0.010	0.005	0.1 to 0.2
321 to 450 keV	0.05 to 0.015	0.010	0.1 to 0.2
Ir-192	0.05 to 0.015	0.010	0.02 to 0.2
451 keV to 2 MeV	0.05 to 0.020	0.010	0.1 to 0.5
Co-60	0.05 to 0.020	0.010	0.1 to 0.5
2 to 4 MeV	0.010 to 0.020	0.010	0.1 to 0.5
4 to 10 MeV	0.010 to 0.030	0.010	0.5 to 1.0
10 to 25 MeV	0.010 to 0.050	0.010	1.0 to 2.0

TABLE 1 Lead Foil Screens[A]

kV Range	Front Screen[A]	Back Screen Minimum
0 to 150 kV[B]	0.000 to 0.001 in. [0 to 0.025 mm]	0.005 in.[C] [0.127 mm]
151 to 200 kV	0.001 to 0.005 in. [0.025 to 0.127 mm]	0.005 in.[C] [0.127 mm]
201 to 320 kV	0.001 to 0.010 in. [0.025 to 0.254 mm]	0.005 in. [0.127 mm]
Se-75	0.001 to 0.010 in. [0.025 to 0.254 mm]	0.005 in. [0.127 mm]
321 to 450 kV	0.005 to 0.015 in. [0.127 to 0.381 mm]	0.010 in. [0.254 mm]
Ir 192	0.005 to 0.015 in. [0.127 to 0.381 mm]	0.010 in. [0.254 mm]
451 kV to 2 MV	0.005 to 0.020 in. [0.127 to 0.508 mm][D]	0.010 in. [0.254 mm][D]
Co-60	0.005 to 0.020 in. [0.127 to 0.508 mm][D]	0.010 in. [0.254 mm][D]
Over 2 MV to 4 MV	0.010 to 0.020 in. [0.254 to 0.508 mm][D]	0.010 in. [0.254 mm][D]
Over 4 MV to 10 MV	0.010 to 0.030 in. [0.254 to 0.762 mm][D]	0.010 in. [0.254 mm][D]
Over 10 MV to 25 MV	0.010 to 0.050 in. [0.254 to 1.27 mm]	0.010 in. [0.254 mm]

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

[B] Lead screen thicknesses in accordance with ISO 5579 in SI units. For energy ranges of Co-60 and 451 keV to 4 MeV, steel or copper screens of 0.1 to 0.5 mm may be used. For energy ranges above 4 MeV to 10 MeV, 0.5 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 screen behind the cassettes.

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

[C] No No back screen is required provided the backscatter requirements of 9.5 are met.

TABLE 2 Unsharpness (Ug) Maximum

Material Thickness	Ug Maximum[A]
Under 1 in. [25.4 mm]	0.010 in. [0.25 mm]
1 through 2 in. [25.4 through 51 mm]	0.020 in. [0.50 mm]
Over 2 through 3 in. [over 51 through 76.0 mm]	0.030 in. [0.76 mm]
Over 3 through 4 in. [over 76.0 through 100 mm]	0.040 in. [1.00 mm]
Greater than 4 in. [greater than 100 mm]	0.070 in. [1.78 mm][B]

[A] Geometric unsharpness values shall be determined (calculated) as specified by the formula in Guide E94.

[D] The geometric unsharpness should be reduced to 0.050 in. [1.27 mm] if the required IQI sensitivity is not achieved. For Co-60 and the voltage range of 451 kV to 4 MV, steel or copper screens of 0.1 to 0.5 mm may be used. For the voltage range of 4 MV to 10 MV, 0.5 to 1.0 mm steel or copper or up to 0.5 mm tantalum screens are recommended.

6.7 *Shims and Separate Blocks*—Shims or separate blocks made of the same or radiographically similar materials (as defined in Practice E1025) may be used to facilitate penetrameter positioning. There is no restriction on shim or separate block thickness provided the penetrameter and area-of-interest optical density tolerance requirements of 9.7.6.2 are met.

6.8 *Radiographic Location and Identification Markers*—Lead numbers and letters are used to designate the part number and location number. The size and thickness of the markers shall depend on the ability of the radiographic technique to image the markers on the radiograph. As a general rule, markers 1/16-in. [1.5-mm] thick will suffice for most low-energy (less than 1 ~~MeV)~~ MV tube voltage) X-ray and Iridium-192 radiography; for higher-energy radiography, it may be necessary to use markers that are 1/8-in. [3.0-mm] or more thick.

6.9 *~~Radiographic~~Optical Density Measurement Apparatus*—Either a transmission densitometer or a step-wedge comparison ~~film~~radiograph shall be used for judging ~~film~~optical density requirements. Step wedge comparison films or densitometer calibration, or both, shall be verified by comparison with a calibrated step-wedge film traceable to the National Institute of Standards and Technology. Densitometers shall be calibrated in accordance with Practice E1079.

7. Reagents and Materials

7.1 *Film Systems*—Only film systems having cognizant engineering organization (CEO) approval or meeting the requirements of Test Method E1815 shall be used to meet the requirements of this practice.

8. Requirements

8.1 *Procedure Requirement*—Unless otherwise specified by the applicable job order or contract, radiographic examination shall be performed in accordance with a written procedure. Specific requirements regarding the preparation and approval of written procedures shall be dictated by a purchaser and supplier agreement. The procedure details should include at least those items stipulated in Appendix X1. In addition, a radiographic standard shooting sketch (RSS), Fig. X1.1, shall be prepared similar to that shown in Appendix X1 and shall be available for review during interpretation of the ~~film.~~radiograph.

8.2 *Radiographic Coverage*—Unless otherwise specified by a purchaser and supplier agreement, the extent of radiographic coverage shall be the maximum practical volume of the casting. Areas that require radiography shall be designated as illustrated in Figs. X1.2 and X1.3 of Appendix X1. When the shape or configuration of the casting is such that radiography is impractical, these areas shall be so designated on drawings or sketches that accompany the radiographs. Examples of casting geometries and configurations that may be considered impractical to radiograph are illustrated in Appendix X2.

8.3 *Radiographic Film Quality*—All radiographs shall be free of mechanical, chemical, handling-related, or other blemishes which could mask or be confused with the image of any discontinuity in the area of interest on the radiograph. If any doubt exists as to the true nature of an indication exhibited by the ~~film,~~radiograph, the radiograph shall be retaken or rejected.

8.4 *Radiographic Quality Level*—The applicable job order or contract shall dictate the requirements for radiographic quality level. (See Practice E1025 or Practice E747 for guidance in selection of quality level.)

8.5 *Acceptance Level*—Radiographic acceptance levels and associated severity levels shall be stipulated by the applicable contract, job order, drawing, or other purchaser and supplier agreement.

8.6 *~~Radiographic~~Optical Density Limitations*—~~Radiographic~~Optical density in the area of interest shall be within 1.5 to 4.0 for either single or superimposed viewing.

8.7 *Film Handling:*

8.7.1 *Darkroom Facilities*—Darkroom facilities should be kept clean and as dust-free as practical. Safelights should be those recommended by film manufacturers for the radiographic materials used and should be positioned in accordance with the manufacturer's recommendations. All darkroom equipment and materials should be capable of producing radiographs that are suitable for interpretation.

8.7.2 *Film Processing*—Guide E999 should be consulted for guidance on film processing.

8.7.3 *~~Film~~Radiographic Viewing Facilities*—Viewing facilities shall provide subdued background lighting of an intensity that will not cause troublesome reflections, shadows, or glare on the radiograph. The viewing light shall be of sufficient intensity to review optical densities up to 4.0 and be appropriately controlled so that the optimum intensity for single or superimposed viewing of radiographs may be selected.

8.7.4 *Storage of Radiographs*—When storage is required by the applicable job order or contract, the radiographs should be stored in an area with sufficient environmental control to preclude image deterioration or other damage. The radiograph storage duration and location after casting delivery shall be as agreed upon between purchaser and supplier. (See Guide E1254 for storage information.)

9. Procedure

9.1 *Time of Examination*—Unless otherwise specified by the applicable job order or contract, radiography may be performed prior to heat treatment and in the as-cast, rough-machined, or finished-machined condition.

9.1.1 *Penetrameter (IQI) Selection*—Unless otherwise specified in the applicable job order or contract, penetrameter (IQI) selection shall be based on the following: if the thickness to be radiographed exceeds the design thickness of the finished piece, the penetrameter (IQI) size shall be based on a thickness which does not exceed the design thickness of the finished piece by more than 20 % or ¼ in. [6.35 mm], whichever is greater. In no case shall the penetrameter (IQI) size be based on a thickness greater than the thickness to be radiographed.

9.2 *Surface Preparation*—The casting surfaces shall be prepared as necessary to remove any conditions that could mask or be confused with internal casting discontinuities.

9.3 *Source-to-Film Distance*—Unless otherwise specified in the applicable job order or contract, geometric unsharpness (Ug) shall not exceed the following in Table 2. The user should be aware that exposures utilizing the maximum geometric unsharpness permitted by Table 2 may not produce acceptable sensitivity and the unsharpness should be reduced in order to achieve the required sensitivity.

9.4 *Direction of Radiation*—The direction of radiation shall be governed by the geometry of the casting and the radiographic coverage and quality requirements stipulated by the applicable job order or contract. Whenever practicable, place the central beam of the radiation perpendicular to the surface of the film. Appendix X2 provides examples of preferred source and film orientations and examples of casting geometries and configurations on which radiography is impractical or very difficult.

9.5 *Back-Scattered Radiation Protection:*

9.5.1 *Back-Scattered Radiation*—(secondary radiation emanating from surfaces behind the film, that is, walls, floors, etc.) serves to reduce radiographic contrast and may produce undesirable effects on radiographic quality. A ⅛-in. (3.2-mm) lead sheet placed behind the film generally furnishes adequate protection against back-scattered radiation.

9.5.2 To detect back-scattered radiation, position a lead letter "B" (approximately ⅛-in. [3.2-mm] thick by ½-in. [12.5-mm] high) on the rear side of the film holder. If a light image (lower optical density) of the lead letter "B" appears on the radiograph, it indicates that more back-scatter protection is necessary. The appearance of a dark image of the lead letter "B" should be disregarded unless the dark image could mask or be confused with rejectable casting defects.

9.6 *Penetrameter (IQI) Placement*—Place all penetrameters (IQI) being radiographed on the source side of the casting. Place penetrameters (IQI) in the radiographic area of interest, unless the use of a shim or separate block is necessary, as specified in 9.7.6.

9.7 *Number of Penetrameters (IQI):*

9.7.1 One penetrameter (IQI) shall represent an area within which ~~radiographic~~optical densities do not vary more than +30 % to –15 % from the optical density measured through the body of the penetrameter (IQI).

9.7.2 When the ~~film~~optical density varies more than –15 % to +30 %, two penetrameters (IQI) shall be used as follows: if one penetrameter (IQI) shows acceptable sensitivity representing the ~~most dense~~ highest optical density portion of the exposure, and the second penetrameter (IQI) shows acceptable sensitivity representing the ~~least dense~~ lowest optical density portion of the exposure, then these two penetrameters (IQI) shall qualify the exposure location within these optical densities, provided the optical density requirements stipulated in 8.6 are met.

9.7.3 For cylindrical or flat castings where more than one film holder is used for an exposure, at least one penetrameter (IQI) image

TABLE 2 Unsharpness (Ug) Maximum

Material Thickness	Ug Maximum[A]
Under 1 in. [25.4 mm]	0.015 in. [0.381 mm]
1 through 2 in. [25.4 through 50.8 mm]	0.020 in. [0.508 mm]
Over 2 through 3 in. [over 50.8 through 76.2 mm]	0.030 in. [0.762 mm]
Over 3 through 4 in. [over 76.2 through 101.6 mm]	0.040 in. [1.016 mm]
Over 4 through 5 in. [over 101.6 through 127 mm]	0.050 in. [1.27 mm]
Over 5 through 6 in. [over 127 through 152.4 mm]	0.060 in. [1.524 mm]
Greater than 6 in. [greater than 152.4 mm]	0.070 in. [1.78 mm]

[A] Geometric unsharpness values shall be determined (calculated) as specified by the formula in Guide E94.

shall appear on each radiograph. For cylindrical shapes, where a panoramic type source of radiation is placed in the center of the cylinder and a complete or partial circumference is radiographed using at least four overlapped film holders, at least three penetrameters (IQI) shall be used. On partial circumference exposures, a penetrameter (IQI) shall be placed at each end of the length of the image to be evaluated on the radiograph with the intermediate penetrameters (IQI) placed at equal divisions of the length covered. For full circumferential coverage, three penetrameters (IQI) spaced 120° apart shall be used, even when using a single length of roll film.

9.7.4 When an array of individual castings in a circle is radiographed, the requirements of 9.7.1 or 9.7.2, or both, shall prevail for each casting.

9.7.5 If the required penetrameter (IQI) sensitivity does not show on any one ~~film~~radiograph in a multiple film technique (see 9.11), but does show in composite (superimposed) ~~film~~radiograph viewing, interpretation shall be permitted only by composite ~~film~~radiograph viewing for the respective area.

9.7.6 When it is not practicable to place the penetrameter(s) (IQI) on the casting, a shim or separate block conforming to the requirements of 6.7 may be used.

9.7.6.1 The penetrameter (IQI) shall be no closer to the film than the source side of that part of the casting being radiographed in the current view.

9.7.6.2 The ~~radiographic~~optical density measured adjacent to the penetrameter (IQI) through the body of the shim or separate block shall not exceed the optical density measured in the area of interest by more than 15 %. The optical density may be lighter than the area of interest optical density, provided acceptable quality level is obtained and the optical density requirements of 8.6 are met.

9.7.6.3 The shim or separate block shall be placed at the corner of the film holder or close to that part of the area of interest that is furthest from the central beam. This is the worst case position from a beam angle standpoint that a discontinuity would be in.

9.7.6.4 The shim or separate block dimensions shall exceed the penetrameter (IQI) dimensions such that the outline of at least three sides of the penetrameter (IQI) image shall be visible on the radiograph.

9.7.7 *Film Side Penetrameter (IQI)*—In the case where the penetrameter (IQI) cannot be physically placed on the source side and the use of a separate block technique is not practical, penetrameters (IQI) placed on the film side may be used. The applicable job order or contract shall dictate the requirements for film side radiographic quality level (see 8.4).

9.8 *Location Markers*—The radiographic image of the location markers for the coordination of the casting with the ~~film~~radiograph shall appear on the ~~film,~~radiograph, without interfering with the interpretation, in such an arrangement that it is evident that the required coverage was obtained. These marker positions shall be marked on the casting and the position of the markers shall be maintained on the part during the complete radiographic cycle. The RSS shall show all marker locations.

9.9 *Radiographic Identification*—A system of positive identification of the ~~film~~radiograph shall be used and each ~~film~~radiograph shall have a unique identification relating it to the item being examined. As a minimum, the following additional information shall appear on each radiograph or in the records accompanying each radiograph:

(1) Identification of organization making the radiograph,
(2) Date of exposure,
(3) Identification of the part, component or system and, where applicable, the weld joint in the component or system, and
(4) Whether the radiograph is an original or repaired area.

9.10 *Subsequent Exposure Identification*— All repair radiographs after the original (initial) shall have an examination status designation that indicates the reason. Subsequent radiographs made by reason of a repaired area shall be identified with the letter "R" followed by the respective repair cycle (that is, R-1 for the first repair, R-2 for the second repair, etc.). Subsequent radiographs that are necessary as a result of additional surface preparation should be identified by the letters "REG."

9.11 *Multiple Film Techniques*—Two or more films of equal or different speeds in the same cassette are allowed, provided prescribed quality level and optical density requirements are met (see 9.7.2 and 9.7.5).

9.12 *Radiographic Techniques:*