Designation: E3388 – 23

Standard Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy for High Energy Applications[1]

This standard is issued under the fixed designation E3388; 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

1.1 This practice covers the design and basic use of a gauge used to determine the image unsharpness and the basic spatial resolution of film radiographs or of digital images taken with CR imaging plates, digital detector arrays (DDA), or radioscopic systems (for example, with X-ray image intensifiers) for applications with Se-75, Ir-192, Co-60 and high energy sources with tube potentials ≥ 300 kV. The IQI may be used at lower tube potentials too, if the expected unsharpness is > 200 µm (SR_b^{image} or $SR_b^{detector}$ > 100 µm). For the measurement of lower unsharpness values, the usage of the gauge described in Practice E2002 is recommended.

1.2 This practice is applicable to radiographic and radioscopic imaging systems utilizing X-ray and gamma ray radiation sources.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 The gauge described can be used effectively if the duplex wire IQI of Practice E2002 does not provide sufficient contrast resolution.

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 *ASTM Standards:*[2]

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

E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography

E1316 Terminology for Nondestructive Examinations

E1815 Test Method for Classification of Film Systems for Industrial Radiography

E2002 Practice for Determining Image Unsharpness and Basic Spatial Resolution in Radiography and Radioscopy

2.2 *AIA/NAS Standard:*

NAS410 NAS Certification & Qualification of Nondestructive Test Personnel

2.3 *ASNT Standards:*

ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

2.4 *CEN Standards:*

EN 462-5:1996 Non-destructive testing – Image quality of radiographs – Part 5: Image quality indicators (duplex plate type), determination of image unsharpness value, not an active standard, but still used as a reference in companies' procedures.

2.5 *ISO Standards:*[3]

ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel

ISO/IEC 17050-1 Conformity assessment – Supplier's declaration of conformity – Part 1: General requirements

[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 June 15, 2023. Published August 2023. DOI: 10.1520/E3388-23.

[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 International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org/iso/home/store.html.

ISO 19232-5 Non-destructive testing – Image quality of radiographs – Part 5: Determination of the image unsharpness value using duplex wire-type image quality indicators

3. Terminology

3.1 Definitions of terms applicable to this practice may be found in Terminology E1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *basic spatial detector resolution – visual ($vSR_b^{detector}$), n*—determined with the duplex wire IQI directly on the detector with no object from the smallest number of the duplex plate pair, which is visually not separable in a film radiograph on a viewing station or on a monitor image for non-film applications.

3.2.2 *basic spatial image resolution – visual (vSR_b^{image}), n*—determined with the IQI on the object (side closest to X-ray source), beside the object or separately in the imaging plane from the smallest number of the duplex plate pair, which is visually not separable in a film radiograph on a viewing station or on a monitor image for non-film applications considering the magnification.

3.2.3 *detector unsharpness – interpolated ($iU_{detector}$), n*—two times the Basic Spatial Image Resolution – interpolated ($2 \times iSR_b^{detector}$)

3.2.4 *detector unsharpness – visual ($vU_{detector}$), n*—two times Basic Spatial Detector Resolution – visual ($2 \times vSR_b^{detector}$)

3.2.5 *duplex plate type image quality indicator, n*—duplex plate type IQI image quality indicator specifically designed to assess the image unsharpness and basic spatial image resolution of a radiograph or a digital image and composed of a series of pairs of plate elements made of high density metal.

3.2.6 *image unsharpness – interpolated (iU_{Im}), n*—two times the Basic Spatial Image Resolution – interpolated ($2 \times iSR_b^{image}$)

3.2.7 *image unsharpness – visual (vU_{Im}), n*—two times the Basic Spatial Image Resolution – visual ($2 \times vSR_b^{detector}$)

3.2.8 *linearized profile, n*—a graph, generated by an image processing software, which shows the pixel values, which are proportional to the radiation dose vs. a spatial position as, for example, duplex plate IQI length.

3.2.9 *linepair per mm (lp/mm) value, n*—determined from the duplex plate pair values, and corresponds to $1/U_{Im}$ (IQI on the object, beside the object or separately in the imaging plane) or $1/U_{detector}$ (IQI on the detector).

3.2.9.1 *Discussion*—The corresponding values are given in Table 1.

4. Summary of Practice

4.1 When it is determined necessary to evaluate and measure the image or detector unsharpness or the basic spatial resolution of an imaging system or a detector separately and apart from contrast sensitivity measurements, a tool or gauge as described in this practice can be used. Conventional IQIs as described in Practices E747 and E1025 combine the contrast sensitivity and resolution measurements into an overall figure of merit. Such figures of merit may not be adequate to detect subtle changes in the imaging system's performance. For example, in a high-contrast image, unsharpness can increase with almost no noticeable effect upon the overall image contrast, but the contrast sensitivity for fine details will be reduced. Similarly, in an application in which the imaging system provides a very sharp image, contrast can fade with little noticeable effect upon the overall image contrast. These

TABLE 1 Duplex Plate Number, Corresponding Image Unsharpness, Basic Spatial Resolution, Linepair Readings and Plate Widths and Spacings and its Tolerances[A]

NOTE 1—All unsharpness values are rounded to two digits after the dot. For conversion of the SR_b-values to µm, multiply values which are given in mm by 1000.

NOTE 2—If the IQI is located on the detector without object, the determined SR_b^{image} value is identical with the $SR_b^{detector}$ value and the image unsharpness U_{Im} corresponds to the inherent detector unsharpness $U_{detector}$.

Plate Material	Duplex Plate Number	Corresponding Unsharpness value U_{Im} (mm)	Corresponding Basic Spatial Resolution SR_b^{image} value (mm)[C]	Corresponding linepair value (lp/mm)	Plate Width and Spacing, d (mm)	Tolerance of Plate Width and Plate Spacing (mm)
W[B]	DP 10	0.20	0.100	5.00	0.10	±8 %
W	DP 9	0.26	0.130	3.85	0.13	
W	DP 8	0.32	0.160	3.13	0.16	
W	DP 7	0.40	0.200	2.50	0.20	
W	DP 6	0.50	0.250	2.00	0.25	±7 %
W	DP 5	0.64	0.320	1.56	0.32	
W	DP 4	0.80	0.400	1.25	0.40	
W	DP 3	1.00	0.500	1.00	0.50	
W	DP 2	1.26	0.630	0.79	0.63	±6 %
W	DP 1	1.60	0.800	0.63	0.80	

[A] This table is based on data provided by ISO 19232-5:2013. All unsharpness values are rounded to two digits after the dot.
[B] W = Tungsten.
[C] For conversion of the SR_b-values to µm, multiply values which are given in mm by 1000.