Designation: E1815 – 18 (Reapproved 2023)

Standard Test Method for Classification of Film Systems for Industrial Radiography[1]

This standard is issued under the fixed designation E1815; 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 test method covers a procedure for determination of the performance of film systems used for industrial radiography. This test method establishes minimum requirements that correspond to system classes.

1.2 This test method is to be used only for direct exposure-type film exposed with lead intensifying screens. The performance of films exposed with fluorescent (light-emitting) intensifying screens cannot be determined accurately by this test method.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.4 *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.*

1.5 *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]

E94 Guide for Radiographic Examination Using Industrial Radiographic Film

E1316 Terminology for Nondestructive Examinations

2.2 *ISO Standards:*[3]

ISO 5-2 Photography Density Measurements—Part 2: Geometric Conditions for Transmission Density

ISO 5-3 Photography and Graphic Technology—Density Measurements—Part 3: Spectral Conditions

ISO 7004 Photography—Industrial Radiographic Films, Determination of ISO Speed, ISO average gradient and ISO gradients G2 and G4 When Exposed to X and Gamma Radiation

ISO 11699-1 Non-Destructive Testing—Industrial Radiographic Film—Part 1: Classification of Film Systems for Industrial Radiography

ISO 11699-2 Non-Destructive Testing—Industrial Radiographic Film—Part 2: Control of Film Processing by Means of Reference Values

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

2.3 *European CEN Standard:*[3]

EN 584-1 Non-Destructive Testing—Industrial Radiographic Film—Part 1: Classification of Film Systems for Industrial Radiography

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology E1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *characteristic curve*—curve showing the relationship between the common logarithm of exposure logK, and the optical density *D*.

3.2.2 *diffuse density*—quantitative measure of film blackening (optical density) as determined by a densitometer. It is the sum of all transmitted and scattered light into the half sphere behind the film.

3.2.3 *film gradient G*—the slope of the characteristic curve at a specified optical density, *D*, and a measure of the contrast of the film system.

[1] This test method 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 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.

TABLE 1 Limiting Values for Gradient, Gradient/Granularity Ratio, and Granularity

ASTM System Class	Minimum Gradient G at $D = 2.0$ above D_o	Minimum Gradient at $D = 4.0$ above D_o	Minimum Gradient/ Granularity Ratio, G/σ_D, at $D = 2.0$ above D_o	Maximum Granularity, σ_D, at $D = 2.0$ above D_o
Special	4.5	7.5	300	0.018
I	4.1	6.8	150	0.028
II	3.8	6.4	120	0.032
III	3.5	5.0	100	0.039
W-A	3.8	5.7	135	0.027
W-B	3.5	5.0	110	0.032
W-C	<3.5	<5.0	80	0.039

The classification is only valid for the complete film system. In general, the classification for X-rays as described in 7.1 can be transferred to other radiation energies and metallic screen types as well as films without screens and single coated films.
A certificate shall contain the following information:
–reference to this standard
–date
–measured values of gradient at $D = 2$ and $D = 4$ above fog and base
–measured granularity at $D = 2$ above fog and base
–calculated value of (D/σ_D) at $D = 2$ above fog and base
–Dose K_S for $D = 2$ above fog and base
–Processing conditions:
–Manual or automatic
–Type of chemistry
–Developer immersion time
–Developer temperature
–Classification in accordance with Table 1
Table 2 gives an example for a classification result of different film types, a developer system and given developing conditions.

3.2.4 *film system*—the film and associated film-processing requirements in accordance with the criteria established by the manufacturers of the film and processing chemicals.

3.2.5 *film system class*—classification taking into account of limiting values given in Table 1.

3.2.6 *gradient/noise ratio*—ratio of the gradient G and the granularity σ_D. It relates directly to the signal/noise ratio. All further parameters determining the signal, such as the modulation transfer function or the energy of the radiation, are considered to be constant.

3.2.6.1 *Discussion*—The limiting values given in this standard are related to fixed radiation energies and specified screens.

3.2.7 *granularity, σ_D*—stochastic fluctuation in a radiographic image, superimposed on the image of the object and typically caused by random, statistical groupings of individual silver particles in processed film.

3.2.8 *ISO speed S*—reciprocal value of the dose K_S measured in Gray, which results in a specified diffuse optical transmission density $D - D_0 = 2$ on the processed film, where D_0 is the fog and base density:

$$S = \frac{1}{K_S} \quad (1)$$

3.2.9 *signal/noise ratio*—in industrial radiography, the ratio of a local film density to the granularity σ_D at this density level. It is correlated to the gradient/noise ratio.

3.2.10 *specular density*—quantitative measure of film blackening (optical density) when light passing the optics of a microdensitometer transmits the film.

4. Significance and Use

4.1 This test method provides a relative means for classification of film systems used for industrial radiography. The film system consists of the film and associated processing system (the type of processing and processing chemistry). Section 9 describes specific parameters used for this test method. In general, the classification for hard X-rays, as described in Section 9, can be transferred to other radiation energies and metallic screen types, as well as screens without films. The usage of film system parameters outside the energy ranges specified may result in changes to a film/system performance classification.

4.1.1 The film performance is described by contrast and noise parameters. The contrast is represented by gradient and the noise by granularity.

4.1.2 A film system is assigned a particular class if it meets the minimum performance parameters: for Gradient G at $D - D_0 = 2.0$ and $D - D_0 = 4.0$, and gradient/noise ratio at $D - D_0 = 2.0$, and the maximum performance parameter: granularity σ_D at $D = 2.0$.

4.2 This test method describes how the parameters shall be measured and demonstrates how a classification table can be constructed.

4.3 Manufacturers of industrial radiographic film systems and developer chemistry will be the users of this test method. The result is a classification table as shown by the example given in Table 2. Another table also includes speed data for user information. Users of industrial radiographic film systems may also perform the tests and measurements outlined in this