



Designation: **E3168–20** E3168 – 20a

Standard Practice for Determining Low-Contrast Visual Acuity of Radiographic Interpreters¹

This standard is issued under the fixed designation E3168; 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 details the procedure for determining the low-contrast visual acuity of a radiographic interpreter by evaluating the ability of the individual to detect linear images of varying radiographic noise, contrast, and sharpness. No statement is made regarding the applicability of these images to evaluate the competence of a radiographic interpreter. There is no correlation between these images of slit phantoms and the ability to detect cracks or other linear features in an actual radiographic examination. The test procedure follows from work performed by the National Institute of Standards and Technology presented in NBS Technical Note 1143, issued June 1981.

1.2 The visual acuity test set consists of five individual plates, each containing a series of radiographic images of 0.5 in. (12.7 mm) long slits in thin metal shims. The original radiographs used to prepare the illustrations were generated using various absorbers, geometric parameters (unsharpness, slit widths), and source parameters (kV, mA, time) to produce images of varying noise, contrast, and sharpness. Each radiographic image has a background density of 1.8 ± 0.15 . The images are viewed in a radiographic interpretation environment as used for the evaluation of production radiographic films, for example, illuminators and background lighting as described in Guide E94 and Specification E1390, and without optical magnification.

1.3 Each visual acuity test plate consists of 25 individual image areas. The images are arranged in 5 rows and 5 columns as shown in Fig. 1. Each image area is 2 in. x 2 in. (51 mm x 51 mm). All identification is on the back side of the plate. Each plate can be viewed from any of the four orientations (that is, it can be viewed with any of the four edges “up” on the illuminator). Since there are five different plates in the set, this makes for a total of 20 different patterns that can be viewed. The identification of which of the five plates and which of the four orientations were viewed in any given test can be determined from the designation on the back side.

1.4 Within the image areas, the slit image may appear in any of five locations, that is, in any of the four corners of the image area, or near the center. No more than one slit image will appear in any one image area. The slit image may be horizontal, vertical, slant left, or slant right. Several of the plates include one or more image areas in which there is no slit image.

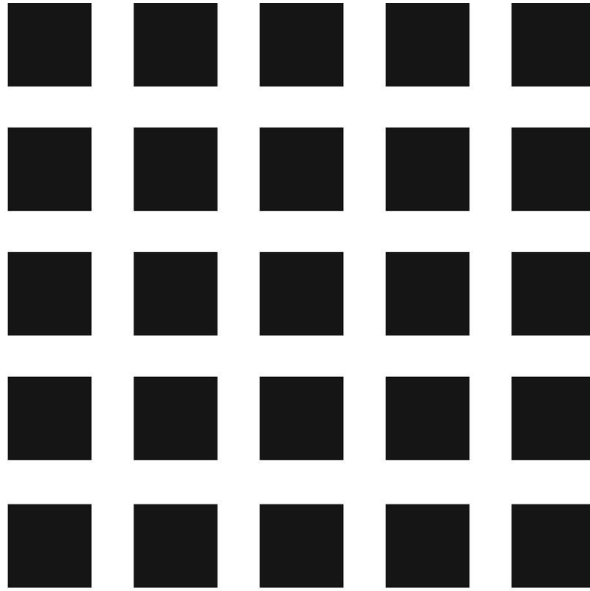
1.5 Use of this standard requires procurement of the adjunct test plates.

1.6 *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.*

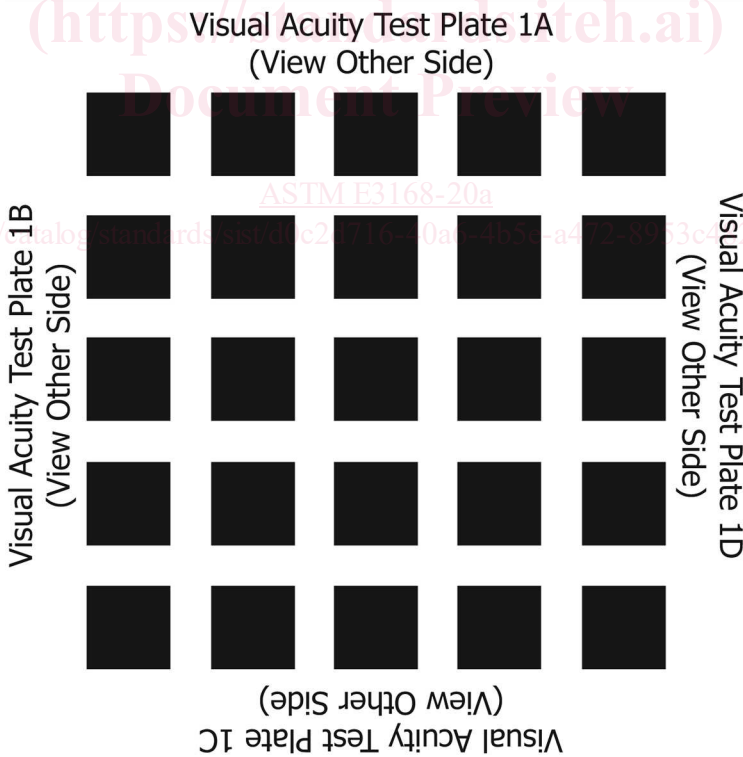
¹ This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.02 on Reference Radiological Images.

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



a) Front of Visual Acuity Test Plate



b) Back of Visual Acuity Test Plate

FIG. 1 Layout of Visual Acuity Test Plate

1.7 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](#)
[E1390 Specification for Illuminators Used for Viewing Industrial Radiographs](#)

2.2 ASTM Adjuncts:³

5 Visual Acuity Test Plates and Answer Key

2.3 NIST Document:⁴

[NBS Technical Note 1143 Visual Acuity Testing of Radiographic Inspectors in Nondestructive Inspection](#)

2.4 AIA Document:⁵

[NAS 410 Certification & Qualification of Nondestructive Test Personnel](#)

2.5 ASNT Documents:⁶

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

2.6 ANSI/ISO Standard:⁷

[ISO 9712 NDT—Qualification and Certification of NDT Personnel](#)

3. Terminology

3.1 *Definitions*—Definitions relating to radiographic examinations which appear in Terminology [E1316](#) shall apply to terms used in this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *answer master, n*—a representation of the answer sheet, provided with the adjunct set showing the correct answers for each of the 25 reading locations in the corresponding test plate.

3.2.2 *low-contrast visual acuity, n*—the ability of an individual to resolve faint, blurred linear indications in a low-light-level environment typical of the radiographic interpretation environment.

3.2.3 *slit image, n*—a linear indication produced by radiographic techniques of a 0.5 in. (12.7 mm) slit in a shim.

3.2.3.1 *Discussion*—

As printed, the image appears as a slightly darker line, approximately 0.6 in. (15 mm) long in a slightly lighter background. In some images, the line may appear discontinuous, but will be straight and of the appropriate length.

3.2.4 *test administrator, n*—(1) a certified Radiographic Testing Level III 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 agency, as applicable; or (2) a licensed optometrist or ophthalmologist.

4. Significance and Use

4.1 This practice is used to evaluate the ability of a radiographic interpreter to discriminate low contrast slit images in a radiographic interpretation environment. A radiographic viewer, as described in Specification [E1390](#), and a viewing environment, as described in Guide [E94](#), are strongly recommended. The minimum acceptable test score in any given application depends on

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 ASTM International Headquarters. Order Reference Radiograph RRE3168.

⁴ Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://www.nist.gov>.

⁵ Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, <http://www.aia-aerospace.org>.

⁶ Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

⁷ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

the requirements of the application. Using parties should develop and maintain records of their test results to guide the establishment of acceptable test scores for their applications. (See [Note 1](#).)

NOTE 1—During round robin testing with experienced radiographic interpreters, 76 % of the interpreters achieved a score of 85 % or higher, and 95 % achieved a score of 80 % or higher. The average score was 90.7 %, and the standard deviation was 6.7 %. In a second study from 2017, with both certified radiographers and uncertified personnel, the average and standard deviation among certified radiographers was 90.4 ± 4.0 % and among uncertified personnel was 88.4 ± 4.9 %. It was found that on each test page there are 3 or 4 images where the average score for each was less than 80 % correct and the remainder of the images all individually scored greater than 80 % on average. A limited number of the general public was examined, and the average score among these was 75.0 ± 3.3 %.

4.2 Administration of the Test

4.2.1 The test procedure described in this practice is intended to determine the ability of a radiographic interpreter to detect low contrast images in a low light level environment. Appropriate dark adaptation time should be permitted. A minimum of 1 min is recommended; however, longer dark adaptation times may be required by some users.

4.2.2 The test ~~should~~shall be administered by or under the direction of a test administrator. ~~administrator~~ (see [3.2.4](#)). The individual being tested shall not know the identification of the plate or orientation prior to the test.

4.2.3 The interpretation of each of the 25 image areas on a plate is recorded on an answer sheet, [Fig. 2](#), by drawing a line corresponding to the location and orientation of the slit image in that image area. Where no line image is detected, a circle should be drawn on the answer sheet in the area corresponding to the image area in which no slit image was detected. An example score sheet is given in [Fig. 3](#), illustrating typical line locations and orientations and illustrating the method for marking answers. The markings shown in the sample score sheet are not taken from any of the actual test plates; however, they illustrate typical distributions of slit images. [Fig. 2](#) of this ~~standard~~practice may be photocopied to provide answer sheets, or the using organization may generate their own suitable answer sheet. In any case, the answer sheet must have provisions for recording both the location and orientation of the indication in each of the 25 image locations.

4.2.4 The order in which the indications are marked is not important. The reader may mark the indications in order, or may mark the easier images and return to the more difficult images.

4.2.5 Once the score sheet is completed, the test administrator shall determine the identity and orientation of the plate that was read and score the answers using the appropriate answer key.

5. Basis of Application

5.1 Effective use of this document requires agreement between the using parties as to the conditions of application. In particular, the following issues should be addressed in the specifying documentation.

5.1.1 *Acceptance Criteria*—Required acceptance criteria for the low-contrast visual acuity test for a particular application shall be identified.

5.1.2 *Frequency of Examination*—The timing and frequency of visual acuity testing must be specified.

5.1.3 *Corrective Actions*—Allowable or required corrective actions shall be identified. See [6.9](#).

5.1.4 Viewing environment for the test.

5.1.5 Qualifications of the test administrator.

6. Procedure

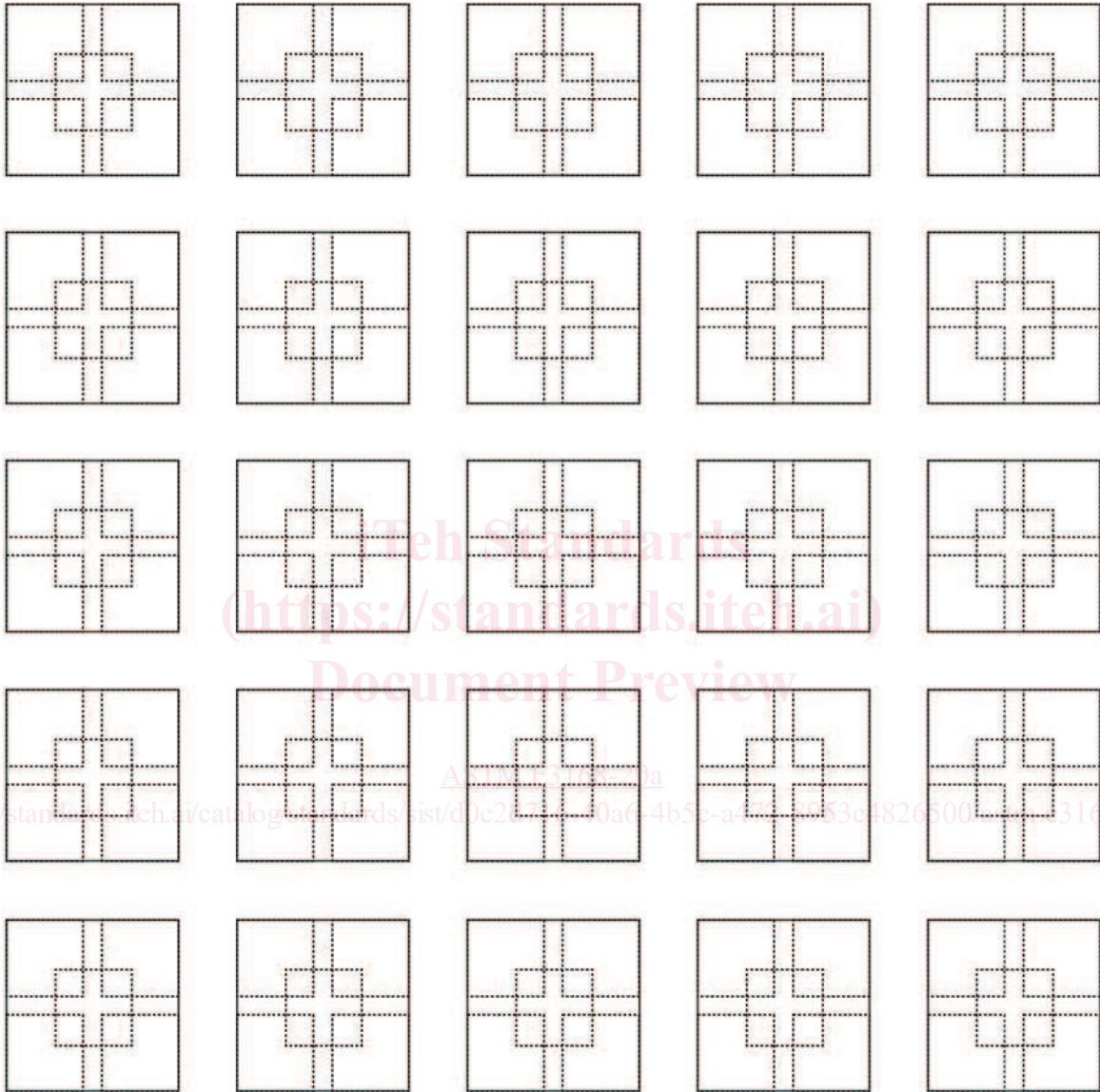
6.1 The tests should be conducted in the same radiographic interpretation environment that would be used in production interpretations. The test plate shall be mounted on the viewer such that the individual being tested does not see any of the identification on the back side of the plate. Identification of the test plate and orientation shall be completed after the plate is viewed. When using illuminators with small viewing ports, the test plate may be held by the interpreter and precautions must be taken to ensure that the plate is not rotated from the upright position during viewing and that the interpreter cannot see the printed information on the back of the plate.

Name _____

Date _____

Dark Adaptation Time _____

Test Plate Number/Orientation _____



Time to complete Test Plate _____

Other Comments or Conditions: _____

FIG. 2 Visual Acuity Test Score Sheet

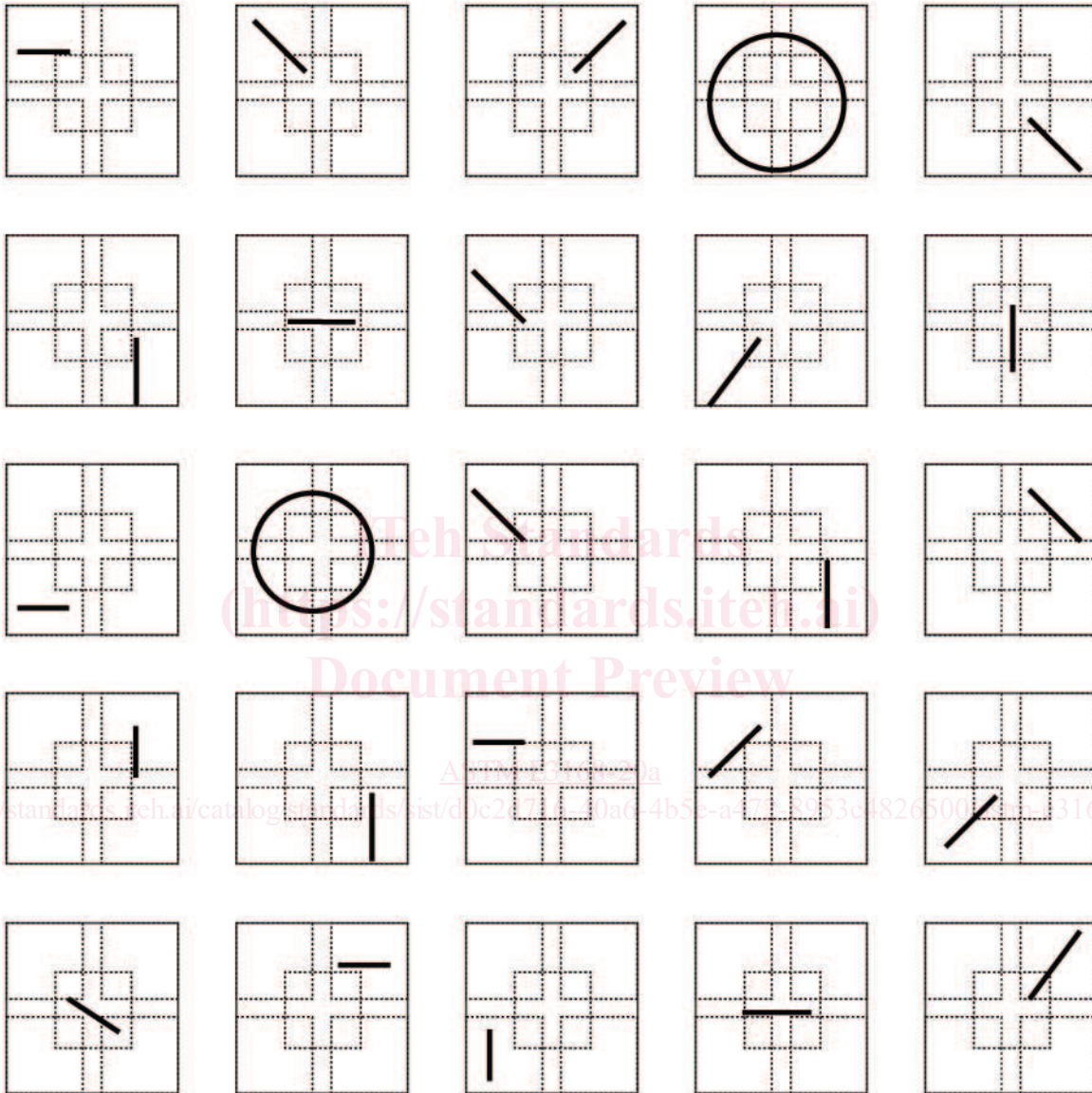
6.2 The distance from the interpreter's eyes to the test plate shall be maintained within the range of 14 to 20 in. (35 to 50 cm). Corrective eye wear shall be used during the test if it is normally used by this individual during radiographic film interpretation. No other optical aids are permitted. In particular, optical magnification devices such as magnifying glasses, loupes, optical comparators, or magnifying hoods may not be used during the test, even if such aids are routinely used in the interpretation of radiographic films.

Name Joe Smith

Date March 23 2003

Dark Adaptation Time 2:30

Test Plate Number/Orientation 4C



Time to complete Test Plate 3 minutes 20 seconds

Other Comments or Conditions: _____

FIG. 3 Example of Completed Visual Acuity Test Score Sheet

6.3 A variable intensity illuminator in compliance with Specification E1390 should be used which emits uniform illumination over the viewing area. Any stray illumination which might influence the test results should be masked off. The luminance through the pattern background should be maintained at a level normally used for interpretation of radiographs of about the same optical density.

6.4 A typical score sheet, as shown in Fig. 2, shall be furnished for the interpreter to record the location and orientation of the slit image or the absence of an indication for each image area.

6.5 Prior to beginning the test, the interpreter should record the date, his or her name, the dark adaptation time, and any other conditions considered relevant. Examples of relevant conditions would include: use of corrective lenses, interpretation environment, type of viewing equipment, etc.

6.6 For each image area, the interpreter shall record the location and orientation of the slit image by drawing a line on the score sheet. If no slit image is detected, a circle shall be drawn in that area of the score sheet. It is permissible to re-evaluate an image area.

6.7 After all test results have been recorded on the answer sheet, the test administrator shall carefully rotate the test plate about the vertical axis, and read the designation of the test plate as printed on the back, at the “top” edge of the plate. That is, the edge of the plate that corresponds to the top of the answer sheet. The test plate/orientation identification will appear as a number and a letter, for example, Plate 4B. The test plate identification number and orientation letter shall then be recorded on the examinee’s answer sheet.

6.8 Answer masters are provided for each test plate. The test administrator shall check the answer sheet against the master and determine the score as the total number of correct “calls” relative to the total number of patterns used in the test (number correct/25 for a single plate test), expressed as a percentage. A more accurate assessment of the reader’s visual acuity can be assessed by reading multiple plates.

NOTE 2—See the Appendix, which documents a “difficulty score” for each individual image determined by analysis of the round robin data.

6.9 If an interpreter has not achieved an acceptable test score, a second test may be taken using a different plate or orientation from the set, or both. Evaluate conditions associated with 6.9.1 – 6.9.5 before administering the second test, and take corrective action if warranted. If an acceptable result is not achieved on the second test, corrective measures shall be taken. Appropriate and allowable corrective actions shall be agreed upon by the using parties. Possible corrective actions might include:

6.9.1 Modify background lighting condition.

6.9.2 Modify illuminator brightness and uniformity.

6.9.3 Correct light leakage conditions.

6.9.4 Evaluate for eye fatigue.

6.9.5 Allow a longer dark adaptation time.

6.9.6 Obtain professional visual examination.

6.9.7 Provide additional training and instruction.

7. Keywords

7.1 dark adaptation; nondestructive testing; radiographic interpreter; radiography; radiology; slit image; visual acuity