1. Scope

1.1 This practice describes the evaluation of DDA systems for industrial radiology. It is intended to ensure that the evaluation of image quality, as far as this is influenced by the DDA system, meets the needs of users, and their customers, and enables process control and long term stability of the DDA system.

1.2 This practice specifies the fundamental parameters of Digital Detector Array (DDA) systems to be measured to determine baseline performance, and to track the long term stability of the DDA system.

1.3 The DDA system performance tests specified in this practice shall be completed upon acceptance of the system from the manufacturer and at intervals specified in this practice to monitor long term stability of the system. The intent of these tests is to monitor the system performance for degradation and to identify when an action needs to be taken when the system degrades by a certain level.

1.4 The use of the gages provided in this standard is mandatory for each test. In the event these tests or gages are not sufficient, the user, in coordination with the cognizant engineering organization (CEO) may develop additional or modified tests, test objects, gages, or image quality indicators to evaluate the DDA system. Acceptance levels for these ALTERNATE tests shall be determined by agreement between the user, CEO and manufacturer.

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 and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

- E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiology
- E1316 Terminology for Nondestructive Examinations
- E1742 Practice for Radiographic Examination
- E2002 Practice for Determining Total Image Unsharpness in Radiology
- E2445 Practice for Qualification and Long-Term Stability of Computed Radiology Systems
- E2597 Practice for Manufacturing Characterization of Digital Detector Arrays
- E2698 Practice for Radiological Examination Using Digital Detector Arrays
- E2736 Guide for Digital Detector Array Radiology

3. Terminology

3.1 Definitions—the definition of terms relating to gamma and X-radiology, which appear in Terminology E1316, Practice E2597, Guide E2736, and Practice E2698 shall apply to the terms used in this practice.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 digital detector array (DDA) system—an electronic device that converts ionizing or penetrating radiation into a discrete array of analog signals which are subsequently digitized and transferred to a computer for display as a digital image corresponding to the radiologic energy pattern imparted upon the input region of the device. The conversion of the ionizing or penetrating radiation into an electronic signal may transpire by first converting the ionizing or penetrating radiation into visible light through the use of a scintillating material. These devices can range in speed from many seconds per image to many images per second, up to and in excess of real-time radioscopy rates (usually 30 frames per seconds).

3.2.2 active DDA area—the active pixelized region of the DDA, which is recommended by the manufacturer as usable.

3.2.3 signal-to-noise ratio (SNR)—quotient of mean value of the intensity (signal) and standard deviation of the intensity (noise). The SNR depends on the radiation dose and the DDA system properties.
3.2.4 contrast-to-noise ratio (CNR)—quotient of the difference of the signal levels between two material thicknesses, and standard deviation of the intensity (noise) of the base material. The CNR depends on the radiation dose and the DDA system properties.

3.2.5 contrast sensitivity—recognized contrast percentage of the material to examine. It depends on 1/CNR.

3.2.6 spatial resolution (SR)—the spatial resolution indicates the smallest geometrical detail, which can be resolved using the DDA with given geometrical magnification. It is the half of the value of the detector unsharpness divided by the magnification factor of the geometrical setup and is similar to the effective pixel size.

3.2.7 material thickness range (MTR)—the wall thickness range within one image of a DDA, whereby the thinner wall thickness does not saturate the DDA and at the thicker wall thickness, the signal is significantly higher than the noise.

3.2.8 frame rate—number of frames acquired per second.

3.2.9 lag—residual signal in the DDA that occurs shortly after detector read-out and erasure.

3.2.10 burn-in—change in gain of the scintillator that persists well beyond the exposure.

3.2.11 bad pixel—a pixel identified with a performance outside of the specification range for a pixel of a DDA as defined in Practice E2597.

3.2.12 five-groove wedge—a continuous wedge with five long grooves on one side (see Fig. 1).

3.2.13 phantom—a part or item being used to quantify DDA characterization metrics.

FIG. 1 5-Groove-Wedge (steel) – see Appendix
3.2.14 *duplex plate phantom*—two plates of the same material; Plate 2 has same size in x- and half the size in v-direction of Plate 1; the thickness of Plate 1 matches the minimum thickness of the material for inspection; the thickness of Plate 1 plus Plate 2 matches the maximum thickness of the material for inspection (see Fig. 2).

3.2.15 *DDA offset image*—image of the DDA in the absence of x-rays providing the background signal of all pixels.

3.2.16 *DDA gain image*—image obtained with no structured object in the x-ray beam to calibrate pixel response in a DDA.

3.2.17 *calibration*—correction applied for the offset signal and the non-uniformity of response of any or all of the X-ray beam, scintillator, and the read out structure.

3.2.18 *gray value*—the numeric value of a pixel in the DDA image. This is typically interchangeable with the term pixel value, detector response, Analog-to-Digital unit and detector signal.

3.2.19 *saturation gray value*—the maximum possible usable gray value of the DDA after offset correction.

Note 1—Saturation may occur because of a saturation of the pixel

![Fig. 2 Duplex Plate Phantom with IQIs positioned; one ASTM E1025 or E1742 Penetrameter on each plate and one ASTM E2002 Duplex Wire IQI on the thinner plate. The boxes ROI 1 to ROI 4 are for evaluation of signal level and SNR.](image-url)