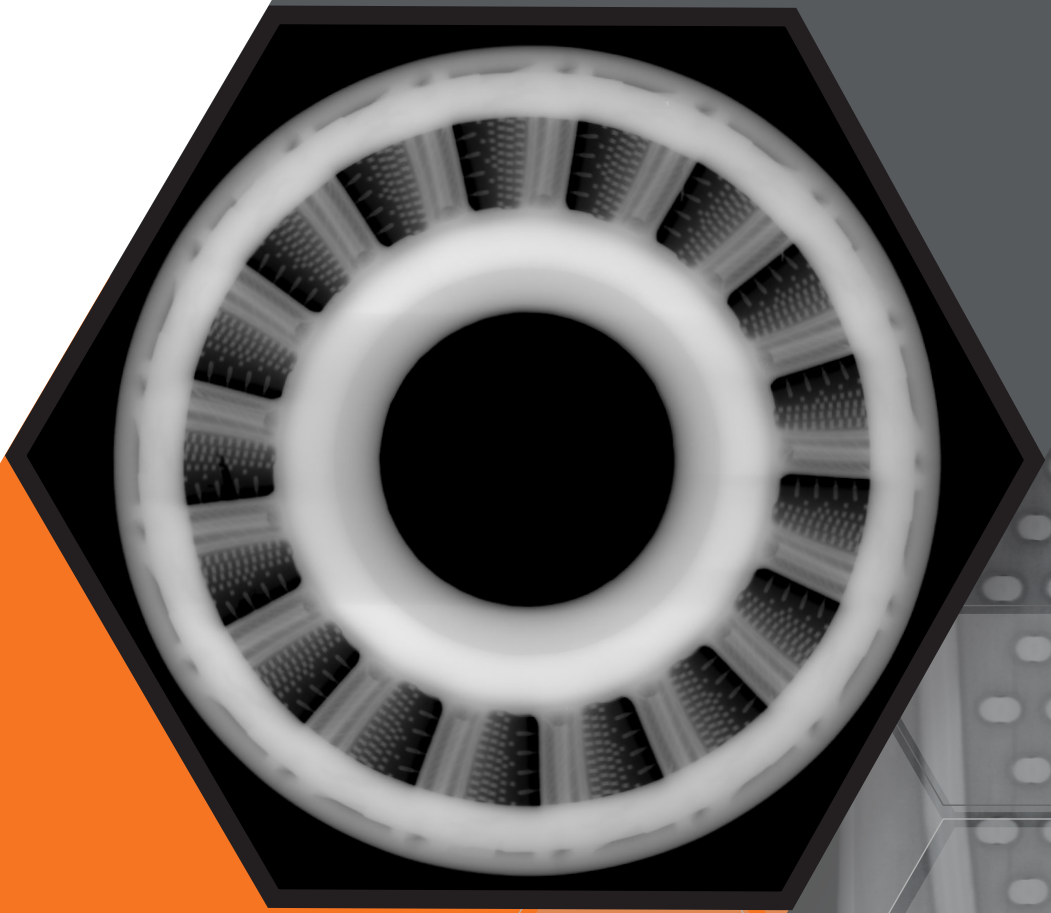
CarestreamNDT

WHITE PAPER

Digital transformation is not a destination but a journey.

Image Quality and Discontinuity Indication Terms



INTRODUCTION

At Carestream NDT we want to share not only our technological developments and product portfolio, but also the knowledge and practical experience that our staff obtains by working shoulder-to-shoulder with customers like you. We aim to share this knowledge and experience in a straightforward fashion so that our readers may find practical applications in their everyday activities.

This series is directed but not limited to NDE professionals in the following industries: Oil & Gas, Nuclear, Construction, Foundry and Castings, Energy Generation, Aerospace, Transportation, Automotive, Military and Defense, Agriculture, Art Restoration & Museum Artifacts, and NDE Services Companies.

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Often, while we are starting our exploration of a new field or professional activity, it is good to start with understanding the basic vocabulary in that discipline. This series of support articles should facilitate your understanding of the radiography process.

Regardless if you are already involved in radiography or just want to increase your understanding of the field, this portion of the series is for you.

- PART 1 — Common NDE Terms
- PART 2 — General Radiography Terms
- PART 3 — Film Radiography Terms
- PART 4 — Digital Radiography and Imaging Terms
- PART 5 — Image Quality and Discontinuity Indication Terms

This portion of the series will be beneficial, regardless if you are already involved in radiography or just interested in increasing your understanding of this field.

After reading this post and gaining new insights, we welcome you to explore other articles in this series.

Image Quality and Discontinuity Indication Terms

Table 1 was obtained from Section D of ASTM E1316 and proposes a series of Image Quality and Discontinuity Indication Terms, regardless if images are registered in film, imaging plates (IPs) for CR or digital detector arrays (DDAs) for DR and either Gamma- or X-radiologic testing is performed.

Terms are listed in alphabetical order:

TERM	DEFINITION
area of interest (AOI)	The portion of the radiograph or digital image that is to be evaluated and interpreted.
artifact	Spurious indication on a radiograph arising from, but not limited to, faulty manufacture, storage, handling, exposure, or processing.
bad pixel	A DDA pixel that does not conform to a specified performance. *DISCUSSION – Bad pixel criteria may include, but are not limited to, non-responding, over-responding, under-responding, noisy, non-uniform, non-persistent, or bad neighborhood; non-persistent bad pixels may have flickering or poor lag performance.*
bad pixel map	A binary image that represents the physical locations of bad pixels on a DDA.
blooming	In radiographic imaging, an undesirable artifact brought about by exceeding the allowable input brightness for the detector, causing signal to leak into adjacent areas, producing a degraded non-homogeneous image artifact near to the high exposure area.
blow back	The enlargement of a minified radiograph to its original size by use of an optical direct reader.
contrast-to-noise ratio (CNR)	Quotient of the difference of the mean linear pixel values between two image areas (Digital image contrast) and the standard deviation of the linear pixel values.
contrast sensitivity	A measure of the minimum percentage change in an object which produces a perceptible density/ brightness change in the radiological image.
contrast stretch	A function that operates on the greyscale values in an image to increase or decrease image contrast.
definition, image definition	The sharpness of delineation of image details in a radiograph. Generally used qualitatively.
densitometer	A device for measuring the optical density of radiograph film.
density (film)	See film density.
density comparison strip	Alternative term for step-wedge comparison film.
digital driving level (DDL)	A digital value that when given as input to a display system produces a luminance.
digital image enhancement	Any operation used for the purpose of enhancing some aspect of the original image.

TERM	DEFINITION
digital image processing system	A system which uses algorithms to process digital image data.
digital magnification (zoom)	Any change in the pixel mapping ratio between the captured image and the displayed image, effectively making objects in the image appear larger or smaller.
Dynamic range (for radiography)	The span of signal intensity that defines the system's range of performance.
Equivalent I.Q.I. sensitivity	That thickness of I.Q.I. expressed as a percentage of the section thickness radiologically examined in which a 2T hole or 2% wire size equivalent would be visible under the same radiological conditions.
Equivalent penetrameter sensitivity	That thickness of penetrameter, expressed as a percentage of the section thickness radiographed, in which a 2T hole would be visible under the same radiographic conditions.
Film density	The quantitative measure of diffuse optical light transmission (optical density, blackening) through a developed film. $D = \log(I_0/I)$ where: D = optical density, I_0 = light intensity incident on the film, and I = light intensity transmitted.
Fog	A general term used to denote any increase in optical density of a processed photographic emulsion caused by anything other than direct action of the image forming radiation and due to one or more of the following: **(a) aging** – deterioration, before or after exposure, or both, resulting from a recording medium that has been stored for too long a period of time, or other improper conditions. **(b) base** – the minimum uniform density inherent in a processed emulsion without prior exposure. **(c) chemical** – resulting from unwanted reactions during chemical processing. **(d) dichroic** – characterized by the production of colloidal silver within the developed sensitive layer. **(e) exposure** – arising from any unwanted exposure of an emulsion to ionizing radiation or light at any time between manufacture and final fixing. **(f) oxidation** – caused by exposure to air during developing. **(g) photographic** – arising solely from the properties of an emulsion and the processing conditions, for example, the total effect of inherent fog and chemical fog. **(h) threshold** – the minimum uniform density inherent in a processed emulsion without prior exposure.
fog density	A general term used to denote any increase in the optical density of a processed film caused by anything other than the direct action of the image-forming radiation.
graininess	The visual impression of irregularity of silver deposit in a processed film.
image definition	See **definition.**

TERM	DEFINITION
image processing	A method whereby digital image data is transformed through a mathematical function.
image quality indicator (IQI)	In industrial radiology, a device or combination of devices whose demonstrated image or images provide visual or quantitative data, or both, to determine radiologic quality and sensitivity. Also known as a penetrameter (disparaged). *DISCUSSION – It is not intended for use in judging size nor establishing acceptance limits of discontinuities.*
iSRb image	The interpolated basic spatial resolution of the imaging system, which corresponds to the dimension of the smallest feature that can be resolved at a modulation of twenty percent with geometric magnification. *NOTE – Typical units of resolution measurement are micrometers.*
iSRb detector	The interpolated basic spatial resolution of a detector, which corresponds to the dimension of the smallest feature that can be resolved at a modulation of twenty percent without geometric magnification. *NOTE – Typical units of resolution measurement are micrometers.*
IQI sensitivity	In radiography, the minimum discernible image and the designated hole in the plaque-type, or the designated wire image in the wire type image quality indicator.
latent image	A condition produced and persisting in the image receptor by exposure to radiation and able to be converted into a visible image by processing.
line pairs per millimetre	A measure of the spatial resolution of an image conversion device. A line pair test pattern consisting of one or more pairs of equal width, high contrast lines and spaces is utilized to determine the maximum density of lines and spaces that can be successfully imaged. The value is expressed in line pairs per millimetre.
line pair test pattern	A pattern of one or more pairs of objects with high contrast lines of equal width and equal spacing. The pattern is used with an imaging device to measure spatial resolution.
linear digital image contrast	Mean linear pixel value difference between any two regions of interest within a digital image. Linear digital image contrast = PV2 – PV1, where PV2 is the mean linear pixel value of region of interest "2" and PV1 is the mean linear pixel value of region of interest "1" on a digital image.
linear pixel value	The numeric value of a pixel in a digital image, which is directly proportional to the radiation dose of the corresponding detector element where a zero value represents the unexposed detector.
luminosity	A measure of emitted light intensity.
noise	The data present in a radiological measurement which is not directly correlated with the degree of radiation attenuation by the object being examined.

TERM	DEFINITION
optical density	The degree of opacity of a translucent medium (darkening of film) expressed as follows: $D = \log(I_0/I)$ where: OD = optical density, I_0 = light intensity incident on the film, and I = light intensity transmitted through the film.
penetrameter	Alternative term for **image quality indicator.**
penetrameter sensitivity	Alternative term for **IQI sensitivity.**
pixel	The smallest addressable element in an electronic image.
pixel, display size	The dimensions of the smallest picture element comprising the displayed image, given in terms of the imaged object's dimensions being represented by the element.
pixel size	The length and width of a pixel.
radiographic contrast	The difference in density from one area to another of a radiograph, resulting from the combination of film contrast and subject contrast.
radiographic quality	A qualitative term used to describe the capability of a radiograph to show flaws in the area under examination.
radiographic sensitivity	A general or qualitative term referring to the size of the smallest detail that can be seen on a radiograph, or the ease with which details can be seen.
region of interest	A defined group of pixels from which measurements or statistics, or both, can be derived.
relative digital image contrast	Digital image contrast normalized to the average linear pixel value of the two regions of interest in a digital image.
representative quality indicator (RQI)	An actual part or similar part of comparable geometry and attenuation characteristics to that of the test part(s), that has known or measurable features, or both, representing the facets of nonconformance for which the test part is to be examined.
saturation	The state at which the pixel value no longer increases as a function of dose.
sensitivity	See **contrast sensitivity,** equivalent IQI sensitivity, equivalent penetrameter sensitivity, IQI sensitivity, radiographic sensitivity.
shim	A material, typically placed under the IQI which is radiologically similar to the object being imaged.
signal	The data present in a radiological measurement which is directly correlated with the degree of radiation attenuation by the object being examined.
signal-to-noise ratio (SNR)	Quotient of mean value of the linear pixel values and standard deviation of the mean linear pixel value (noise) in a given region of interest in a digital image.

TERM	DEFINITION
SRb image	The basic spatial resolution of the imaging system, which corresponds to the dimension of the smallest feature that can be resolved at a specified modulation and geometric magnification. *NOTE – Typical units of resolution measurement are micrometers.*
SRb detector	The basic spatial resolution of a detector, which corresponds to the dimension of the smallest feature that can be resolved at a specified modulation without geometric magnification. *NOTE – Typical units of resolution measurement are micrometers.*
step wedge	A device with discrete step thickness increments used to obtain an image with discrete density step values.
step-wedge calibration film	A step-wedge comparison film the densities of which are traceable to a nationally recognized standardizing body.
step-wedge comparison film	A processed film with defined discrete optical density steps, used to characterize the optical density on a radiograph.
structure noise of DDAs	Noise originating from differing properties of the individual detector elements (pixels) in a DDA.
structure noise of IPs	Noise originating from physical variations in the sensitive layer and surface of an IP, which appears after scanning of the exposed imaging plate as overlaid fixed pattern noise in the digital image.
subject contrast	The logarithm of the ratio of the radiation intensities transmitted through selected portions of the specimen.
system induced artifacts	Anomalies that are created by a system during the acquisition, display processing, or storage of a digital image.
system noise	The noise present in a radiological measurement resulting from the individual elements of the radiological system.
total image unsharpness	The blurring of test object features, in a radiological image resulting from any cause(s).
translucent base media	Materials with properties that allow radiological interpretation by transmitted or reflected light.
transmission densitometer	An instrument that measures the intensity of the transmitted light through a radiographic film and provides a readout of the transmitted film density.
transmitted film density	The density of radiographic film determined by measuring the transmitted light.

Table 1 – Basic Image Quality and Discontinuity Indication Terms - Reprinted, with permission, from ASTM E1316-22, Standard Terminology for Nondestructive Examinations, copyright ASTM International.
A copy of the complete standard may be obtained from https://www.astm.org/e1316-22.html

How to make use of the information in this post

Here are some supplementary information resources from Carestream NDT's products and services portfolio:

Products:

- HPX-DR 3543 PE Non-Glass, Large Format Detector
- HPX-DR 2530 PH High-Resolution, Compact Detector
- HPX-DR 2530 PC High-Speed, Compact Detector
- HPX-DR 4336 GH High-Resolution, Large Format Detector
- HPX-DR 2329 GK, High-Resolution, Compact Detector

INDUSTREX Digital Radiography (DR)

- HPX-PRO Portable Digital System
- INDUSTREX HPX-1 Plus Digital System
- INDUSTREX Flex GP, HR and XL Blue Digital Imaging Plates
- HPX-1 Diagnostic Tool & HPX-1 Digital Plate Carrier

INDUSTREX Computed Radiography (CR)

- INDUSTREX Digital Viewing Software
- NDT Archive Solution

- INDUSTREX Films
- INDUSTREX Chemicals for Automatic Processing
- INDUSTREX Chemicals for Manual Processing
- INDUSTREX Eco-Friendly Chemicals
- INDUSTREX Processors

INDUSTREX Film

Training Services:

- **Advanced Industrial Radiographic Training Academy**
  Computed Radiography - 40 Hour Online Course
  Digital Imaging - 40 Hour Classroom Training

Other Carestream NDT Resources:

- Carestream NDT Virtual NDT Showcase
- Carestream NDT Resource Center

Resources from ASNT:

- Radiographic Interpretation, Revised Edition 2020:
https://www.asnt.org/Store/ProductDetail?productKey=826c3c22-42a3-4250-9040-913d40aa0946
- Nondestructive Testing Handbook, fourth edition: Volume 3, Radiographic Testing:
https://www.asnt.org/Store/ProductDetail?productKey=83ea27b3-d68f-483d-9354-e447ef2b3915

References:

1. ASTM (2021), ASTM E1316 – 21a, Standard Terminology for Nondestructive Examinations, West Conshohocken, PA, ASTM International, 2020.

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