Designation: E2699 – 20

Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Digital Radiographic (DR) Test Methods[1]

This standard is issued under the fixed designation E2699; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice facilitates the interoperability of digital X-ray imaging equipment using Digital Detector Arrays (DDA) as described in Practice E2698 by specifying image data transfer and archival methods in commonly accepted terms. A separate practice, Practice E2738, addresses this topic for digital X-ray imaging equipment using Computed Radiography (CR). This document is intended to be used in conjunction with Practice E2339 on Digital Imaging and Communication in Nondestructive Evaluation (DICONDE). Practice E2339 defines an industrial adaptation of the NEMA Standards Publication titled Digital Imaging and Communications in Medicine (DICOM, see http://medical.nema.org), an international standard for image data acquisition, review, storage, and archival storage. The goal of Practice E2339, commonly referred to as DICONDE, is to provide a standard that facilitates the display and analysis of NDE results on any system conforming to the DICONDE standard. Toward that end, Practice E2339 provides a data dictionary and a set of information modules that are applicable to all NDE modalities. This practice supplements Practice E2339 by providing information object definitions, information modules, and a data dictionary that are specific to digital X-ray test methods.

1.2 This practice has been developed to overcome the issues that arise when analyzing or archiving data from digital X-ray test equipment using proprietary data transfer and storage methods. As digital technologies evolve, data must remain decipherable through the use of open, industry-wide methods for data transfer and archival storage. This practice defines a method where all the digital X-ray technique parameters and test results are communicated and stored in a standard manner regardless of changes in digital technology.

1.3 This practice does not specify:

1.3.1 A testing or validation procedure to assess an implementation's conformance to the standard.

1.3.2 The implementation details of any features of the standard on a device claiming conformance.

1.3.3 The overall set of features and functions to be expected from a system implemented by integrating a group of devices each claiming DICONDE conformance.

1.4 *Units*—Although this practice contains no values that require units, it does describe methods to store and communicate data that do require units to be properly interpreted. The SI units required by this practice are to be regarded as standard. No other units of measurement are included in this standard.

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]

E1316 Terminology for Nondestructive Examinations

E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)

E2597 Practice for Manufacturing Characterization of Digital Detector Arrays

E2698 Practice for Radiographic Examination Using Digital Detector Arrays

E2738 Practice for Digital Imaging and Communication in

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.11 on Digital Imaging and Communication in Nondestructive Evaluation (DICONDE).

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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.

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

Nondestructive Evaluation (DICONDE) for Computed Radiography (CR) Test Methods

2.2 *Other Standard:*

DICOM NEMA PS3 / ISO 12052 Digital Imaging and Communications in Medicine (DICOM) Standard, National Electrical Manufacturers Association, Rosslyn, VA, USA (available free at http://www.dicomstandard.org/)

3. Terminology

3.1 *Definitions:*

3.1.1 Nondestructive evaluation terms used in this practice can be found in Terminology E1316.

3.1.2 DICONDE terms used in this practice are defined in Practice E2339.

3.1.3 Digital detector array terms used in this practice are defined in Practice E2597.

4. Summary of Practice

4.1 A fundamental principle of DICONDE is the use of standard definitions and attribute formats for data communication and storage. This means all systems that are DICONDE compliant use a common data dictionary and common communication protocols. To further standardization, the elements in the data dictionary are organized into common groups referred to as information modules. The data dictionary and information modules common to all NDE modalities are defined in Practice E2339.

4.2 The data dictionary and information modules specified in Practice E2339 do not cover the information storage requirements for each individual modality (CT, DDA, CR, UT, etc.). Additions to the data dictionary and information modules are required to support the individual modalities. This practice contains the additions to the DICONDE data dictionary and information modules necessary for digital X-ray inspection using Digital Detector Arrays.

4.3 The highest organizational level in the DICONDE information model is the information object definition (IOD). An information object definition is a collection of the information modules necessary to represent a set of test results from a specific modality. This practice contains information object definitions for digital X-ray inspection using Digital Detector Arrays.

5. Significance and Use

5.1 Personnel that are responsible for the creation, transfer, and storage of digital X-ray test results will use this standard. This practice defines a set of information modules that along with Practice E2339 and the DICOM standard provide a standard means to organize digital X-ray test parameters and results. The digital X-ray test results may be displayed and analyzed on any device that conforms to this standard. Personnel wishing to view any digital X-ray inspection data stored according to Practice E2339 may use this document to help them decode and display the data contained in the DICONDE-compliant inspection record.

6. Information Object Definitions

6.1 *Digital X-ray Image IOD Description:*

6.1.1 The digital X-ray (DX) Image Information Object Definition specifies an image that has been created by a direct digital X-ray imaging device for NDE purposes. To avoid duplication of relevant material from the DICOM standard, the IOD definition will follow that for DX Images found in Part 3, Section A.26 of the DICOM standard, except as noted in Table 1. Table 1 is not stand-alone and must be used in conjunction with Part 3, Section A.26 of the DICOM standard to have a complete definition of the NDE DX information object.

6.1.2 This IOD will use the Service-Object Pair (SOP) Classes for the DX IOD as defined in Part 4, Section B5 of the DICOM standard.

6.2 *Digital X-ray Multi-Frame Image IOD Description:*

6.2.1 The digital X-ray (DX) Multi-frame (MF) Image Information Object Definition specifies an image that has been created by a direct digital X-ray imaging device for NDE purposes. To avoid duplication of relevant material from the DICOM standard, the IOD definition will follow that for Enhanced X-ray Angiographic (Enhanced XA) Images found in Part 3, Section A.47 of the DICOM standard, except as noted

TABLE 1 DX Image Information Object Definition

DICOM Module	DICONDE Module	Reference	Usage[A]
Patient	Component	Practice E2339, Section 7	M
Specimen Identification	Not Applicable		
Clinical Trial Subject	Not Applicable		
General Study	Component Study	Practice E2339, Section 7	M
Patient Study	Not Applicable		
Clinical Trial Study	Not Applicable		
General Series	Component Series	Practice E2339, Section 7	M
Clinical Trial Series	Not Applicable		
General Equipment	NDE Equipment		M
Contrast/Bolus	Not Applicable		
DX Anatomy Imaged	Needed for DICOM compatibility		
DX Detector	NDE DX Detector	7.1	M
	NDE Indication	Practice E2339, Section 7	U
	NDE Geometry	Practice E2339, Section 7	U
	NDE DX Calibration Data	7.2	U
Acquisition Content	Needed for DICOM compatibility		
	NDE Source Radiography		U

[A] Definition of usage codes can be found in Part 3, Section A.1.3 of the DICOM standard.

in Table 2. Table 2 is not stand-alone and must be used in conjunction with Part 3, Section A.47 of the DICOM standard to have a complete definition of the NDE DX-MF information object.

6.2.2 This IOD will use the Service-Object Pair (SOP) Classes for the Enhanced XA IOD as defined in Part 4, Section B5 of the DICOM standard.

7. Information Modules

7.1 *NDE DX Detector Module:*

7.1.1 Table 3 specifies the Attributes that describe NDE Direct Digital X-ray (DX) Detectors.

7.1.1.1 For NDE DX Images, Detector Type (0018,7004) is specified to use the following defined terms.

DIRECT

SCINTILLATOR

7.1.1.2 For NDE DX Images, Detector Configuration (0018, 7005) is specified to use the following defined terms.

AREA

LINEAR

7.1.1.3 If Pixel Spacing (0028,0030) is present and the image has not been calibrated to correct for the effect of geometric magnification, the values of this attribute shall be the same as in Imager Pixel Spacing (0018,1164), if either of those attributes are present.

(1) If Pixel Spacing (0028,0030) is present and the values are different from those in Imager Pixel Spacing (0018,1164), then the image has been corrected for known or assumed geometric magnification or calibrated with respect to some object of known size at known depth within the component.

(2) If Pixel Spacing Calibration Type (0028,0A02) and Imager Pixel Spacing (0018,1164) and Nominal Scanned Pixel Spacing (0018,2010) are absent, then it cannot be determined whether or not correction or calibration have been performed.

7.1.1.4 For NDE DX Images, Pixel Spacing Calibration Type (0028,0A02) is specified to use the following defined terms.

GEOMETRY

The Pixel Spacing (0028,0030) values account for assumed or known geometric magnification effects and correspond to some unspecified depth within the component; the Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and at the same depth.

FIDUCIAL

The Pixel Spacing (0028,0030) values have been calibrated by the operator or image processing software by measurement of an object (fiducial) that is visible in the pixel data and is of known size and is located close to the central ray; the Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and located at the same depth within the component as the fiducial.

7.1.1.5 *Note for Pixel Spacing Calibration Description (0028,0A04)*—In the case of correction, the text might include description of the assumptions made about the component and geometry and depth within the component. In the case of calibration, the text might include a description of the fiducial and where it is located. Though it is not required, the Device Module (see Part 3, Section C.7.6.12 of the DICOM standard) may be used to describe the specific characteristics and size of the calibration device.

7.2 *NDE DX Calibration Data Module:*

7.2.1 Table 4 specifies the Attributes that describe NDE direct digital X-ray calibration data.

7.3 *NDE Source Radiography Module:*

7.3.1 Table 5 specifies the attributes that describe NDE Source Radiography Module.

8. Keywords

8.1 database; DICOM; DICONDE; digital data storage; digital data transmission; direct digital X-ray; DX; file format

TABLE 2 DX MF Image Information Object Definition

DICOM Module	DICONDE Module	Reference	Usage[A]
Patient	Component	Practice E2339, Section 7	M
Specimen Identification	Not Applicable		
Clinical Trial Subject	Not Applicable		
General Study	Component Study	Practice E2339, Section 7	M
Patient Study	Not Applicable		
Clinical Trial Study	Not Applicable		
General Series	Component Series	Practice E2339, Section 7	M
Clinical Trial Series	Not Applicable		
General Equipment	NDE Equipment	Practice E2339, Section 7	M
Enhanced Contrast/Bolus	Not Applicable		
Acquisition Context	Needed for DICOM compatibility		
Cardiac Synchronization	Not Applicable		
Respiratory Synchronization	Not Applicable		
X-Ray Detector	NDE DX Detector	7.1	M
	NDE Indication	Practice E2339, Section 7	U
	NDE Geometry	Practice E2339, Section 7	U
	NDE DX Calibration Data	7.2	U
	NDE Source Radiography		U

[A] Definition of usage codes can be found in Part 3, Section A.1.3 of the DICOM standard.