



Designation: ~~E2339 – 15~~ E2339 – 21

Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)¹

This standard is issued under the fixed designation E2339; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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 NDE imaging and data acquisition equipment by specifying the image data in commonly accepted terms. This practice represents a harmonization of NDE imaging systems, or modalities, with 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. In addition, this practice will provide a standard set of industrial NDE specific information object definitions, which travel beyond the scope of standard DICOM modalities. The goal of this practice is to provide a standard by which NDE image/signal data may be displayed on by any system conforming to the ASTM DICONDE format, regardless of which NDE modality was used to acquire the data.

1.2 This practice has been developed to overcome the issues that arise when archiving or analyzing the data from a variety of NDE techniques, each using proprietary data acquisition systems. As data acquisition modalities evolve, data acquired in the past must remain decipherable. This practice proposes an image data file format in such a way that all the technique parameters, along with the image file, are preserved, regardless of changes in NDE technology. This practice will also permit the viewing of a variety of image types (CT, CR, Ultrasonic, Infrared, and Eddy Current) on a single workstation, maintaining all of the pertinent technique parameters along with the image file. This practice addresses the exchange of digital information between NDE imaging equipment.

1.3 This practice does not specify:

1.3.1 A complete description of all the information necessary to implement the DICONDE standard for an imaging modality. This document must be used in conjunction with one of the method-specific DICONDE Standard Practice documents and the DICOM Standard to completely describe all the requirements necessary to implement the DICONDE standard for an imaging modality. See Section 2.1 of this document for a current list of the method-specific standard practice documents.

1.3.2 A testing or validation procedure to assess an implementation's conformance to the standard. Best practices for demonstrating conformance can be found in Practice E3147.

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

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

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).

Current edition approved Dec. 1, 2015/Dec. 1, 2021. Published December 2015/May 2022. Originally approved in 2004. Last previous edition approved in 2014/2015 as E2339 – 14/E2339 – 15. DOI: 10.1520/E2339-15-10.1520/E2339-21.

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

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

E2663 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods

E2699 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Digital Radiographic (DR) Test Methods

E2738 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Computed Radiography (CR) Test Methods

E2767 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for X-ray Computed Tomography (CT) Test Methods

E2934 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Eddy Current (EC) Test Methods

E3147 Practice for Evaluating DICONDE Interoperability of Nondestructive Testing and Inspection Systems

E3169 Guide for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)

2.2 Other Documentation:³

NEMA Standards Publication PS3.1, Version 3: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/>)

ACR-NEMA 300–1998 Digital Imaging and Communication in Medicine

3. Terminology

3.1 Definitions:

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

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *AE*—*AE*, *n*—application entity

3.2.2 *attribute*—*attribute*, *n*—a property of an information object. An attribute has a name and a value, which are independent of any encoding scheme.

3.2.3 *attribute tag*, *n*—a unique identifier for an *attribute* of an *information object* composed of an ordered pair (~~gggg~~, ~~eeee~~)(~~gggg~~,~~eeee~~), where ~~gggg~~ represents the group number and ~~eeee~~ represents the data element.

3.2.4 *conformance statement*—*statement*, *n*—a formal statement associated with a specific implementation of the standard, specifying the service class, information objects, and communications protocols supported by the implementations.

3.2.5 *data dictionary*—*dictionary*, *n*—a registry of data elements, which assigns a unique tag, a name, value characteristics, and semantics to each data element.

3.2.6 *data element*—*element*, *n*—a unit of information as defined by a single entry in the *data dictionary*. An encoded IOD attribute that is composed of, at a minimum, three fields: a *data element tag*, a *value length*, and a *value field*.

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 National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, <http://www.nema.org>.

3.2.7 *data element tag*—~~tag~~, *n*—a unique identifier for a *data element* composed of an ordered pair of numbers (a *group number* followed by an *element number*).

3.2.8 *data element type (type)*—~~(type)~~, *n*—used to specify whether an *attribute* of an IOD is required and must have a non-zero value (Type 1), required but may have a zero value (Type 2), required only under certain conditions (Type 1C and 2C), or optional (Type 3). See Part 5, Section 7.4 of the DICOM standard for additional details.

~~3.2.9 *DICONDE version identifier*, *n*—unique string placed in the DICONDE object to identify the version of DICONDE used to create the object.~~

3.2.10 *element number*—~~number~~, *n*—the second number in the ordered pair of numbers that make up a *data element tag*.

3.2.11 *group number*—~~number~~, *n*—the first number in the ordered pair of numbers that makes up a *data element tag*.

3.2.12 *information object definition (IOD)*—~~(IOD)~~, *n*—a data abstraction of a class of similar *real-world objects* which defines the nature and *attributes* relevant to the class of *real-world object* represented.

3.2.13 *module*—~~module~~, *n*—a set of *attributes* with an *Information Object Definition*.

3.2.14 *private data element*—~~element~~, *n*—additional *data element*, defined by an implementer, to communicate information that is not contained in standard *data elements*. Private *data elements* have odd *group numbers*.

3.2.15 *service-object pair class (SOP class)*—~~class~~, *n*—the union of a service class and an information object definition. SOP Classes are the building blocks that support the interaction between two DICOM application entities.

3.2.16 *unique identifier (UID)*—~~(UID)~~, *n*—a numeric identifier that is guaranteed to be unique among all DICOM numeric identifiers.

3.2.17 *usage*—~~usage~~, *n*—used to specify whether an information module is Mandatory (M), Conditional (C), or User OptionOptional (U). See Part 3, Section A.1.3 of the DICOM standard for additional details.

3.2.18 *value*—~~value~~, *n*—a component of a *value field*. A *value field* may consist of one or more of these components.

3.2.19 *value field*—~~field~~, *n*—the field within a *data element* that contains the *value(s)* of that *data element*.

3.2.20 *value length*—~~length~~, *n*—the field within a *data element* that contains the length of the *value field* of the *data element*.

3.2.21 *value multiplicity (VM)*—~~(VM)~~, *n*—specifies the number of *values* contained in the *value field* of a *data element*.

3.2.22 *value representation (VR)*—~~(VR)~~, *n*—specifies the data type and format of the *value(s)* contained in the *value field* of a *data element*. A complete list of all the VR's can be found in Part 5, subsection 6.2 of the DICOM standard.

~~3.2.22 *DICONDE version identifier*—unique string placed in the DICONDE object to identify the version of DICONDE used to create the object.~~

4. Summary of Practice

4.1 Guide [E3169](#) provides an overview of the ASTM International standard practices that address DICONDE and assistance in identifying the correct standard practices needed to implement specific use cases. That document should be the first document utilized for any DICONDE application.

4.2 The basic concept of DICOM and DICONDE is the use of standardized data identifiers. This means all participants are using the standardized data identifiers to represent the same information and have a common understanding of communication protocols for mutual use.

4.2.1 DICOM was developed in liaison with ACR (the American College of Radiology) and NEMA (the National Electrical Manufacturers Association) and other ~~Standard Organizations~~ standard organizations, including CEN TC251 in Europe and JIRA in Japan, with review also by other organizations, including IEEE, HL7, and ANSI in the USA. The DICOM Standard is structured as a multi-part document.

4.3 This practice will contain terms and definitions that apply to all NDT methods. DICONDE terms and definitions that apply to a specific NDT method will be contained in a separate standard practice for that method as illustrated in Fig. 1. This practice must be used in conjunction with the method-specific standard practices. For a list of method-specific standard practices, refer to subsection 2.1 of this document. If no method-specific practice exists, the user should default back to the DICOM terms and definitions for the modality associated with that test method.

4.4 The DICONDE practices will consist of descriptions of the attribute and object definitions that are specific to NDE (that is, no equivalent counterpart in medicine) and provide standard database tag identifiers for use with the DICOM database already in existence. The use of this practice is based upon and to be used in conjunction with the medical DICOM standard. This practice, in conjunction with the DICOM standard, will set forth the requirements for the transfer and display of NDE image data from any NDE image modalities equipment.

4.4.1 DICONDE, utilizing the existing DICOM database of object definitions, provides both replacement and additional module definitions that represent a conversion between the medical community language present in DICOM, to the terminology appropriate for NDE. For the DICONDE practices, only the attributes and object definitions that differ from the medical implementation will be discussed. In the case where no replacement attribute or object exists, the DICOM standard should be followed.

4.4.2 One of the inherited features of DICONDE is an internal structured grouping of images separate from the name or location of the file, or both. The mandatory tags of Study Instance UID (0020,000D), Series Instance UID (0020,000E), and SOP Instance UID (0008,0018) stored within each DICONDE object, uniquely identify each image and allow for the grouping of images into series and study groups. This is a major advantage for datasets with large numbers of individual files, bringing them together into a logical group for simplified access and management. A common example is with CT methods where many hundreds of individual images are captured and logically grouped together for volumetric reconstruction.

4.5 As a superset of DICOM, DICONDE provides a standard for the file-level storage, network communication, and management of evaluation data. While these three elements are contained within DICONDE, compliance does not require the support of all three. For example, a system can produce DICONDE compliant files without needing to support network communications. The capabilities are outlined in the conformance statement.

4.6 The key to interoperability using the DICOM standard is the conformance statement. This formal statement is associated with a specific implementation of the DICOM standard. It specifies the service classes, information objects, communication protocols,

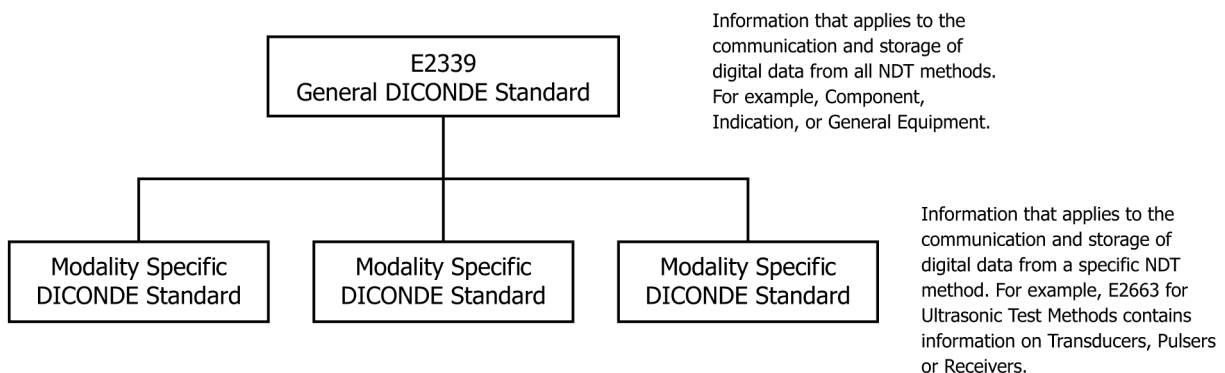


FIG. 1 DICONDE Document Relationships

and media storage application profiles supported by the implementation. Complete information on DICOM conformance statements, including several examples, can be found in Part 2 of the DICOM standard.

4.6.1 Specific implementations of the DICONDE standard should also provide conformance statements. The majority of the conformance statement for DICONDE will be similar to DICOM. The exception being that the information objects listed in the conformance statement should be the DICONDE specific information objects that the implementation supports.

4.6.2 As the DICONDE standard continues to evolve, data elements, modules, and information object definitions are added to the family of DICONDE standard practices. As this occurs, it is likely that these additions may result in DICONDE files or objects created using previous versions of the standard practices becoming non-conforming to the most recent standard practice. The conformance of a DICONDE file or object needs to be determined relative to the versions of the standard practices used to create the file or object.

4.6.3 To track the version of the DICONDE standard practice used to create a DICONDE file or object, the Software Versions (0018, 1020) attribute is used to store a unique identifier. This unique identifier corresponds to the version of the DICONDE standard practice used to create the file or object. For more information, see subsection 7.2.5 of this document.

4.7 Practice [E3147](#) provides methods for determining if the practices defined in this and other DICONDE practices are implemented correctly. It also provides methods for assuring that multiple DICONDE implementations can successfully interoperate together.

5. Significance and Use

5.1 Personnel that are responsible for the transfer of NDE data between systems will use this standard. This practice will define a set of NDE information object definitions that along with the DICOM standard will provide a standard means to organize image data. Once conformance statements have been generated, the NDE image data may be displayed on any imaging/analysis device that conforms to the standard. This process of developing conformance statements with both the NDE specific object definitions and the DICOM accepted definitions, will provide a means to automatically and transparently communicate between compliant equipment without loss of information.

NOTE 1—Knowledge and understanding of the existing DICOM standard will be required to generate conformance statements and thereby facilitate the data transfer.

6. Information Object and Service-Object Pair Class Definitions

6.1 Information Object Definitions

6.1.1 Details of the DICOM Information Object Definitions can be found in the DICOM Standard Part 3, Annexes A and B.

6.1.2 DICONDE Information Object Definitions are found in the method-specific standard practices—practices (Practices [E2663](#), [E2699](#), [E2738](#), [E2767](#), and [E2934](#)). For a list of current method-specific standard practices, refer to subsection 2.1 of this document.

6.1.3 The Information Object Definition is composed of a table of Information Modules included in the IOD. This table includes a usage for each module. Usage is used to specify whether an information module is Mandatory (M), Conditional (C), or User Optional (U). The usage of the information module takes precedence over the type of the data element. For example, a data element of type 1 in an information module whose usage is U need only be present with a value if the user chooses to include that information module in the DICONDE file or object. If that information module is not included in the file or object that data element is not required to be included with a value.

6.2 DICOM to DICONDE Information Object Definition

6.2.1 The DICOM standard specifies mandatory, conditional, and user optional information modules for each DICOM IOD. The relationship between the IODs and modules is found in the DICOM Standard Part 3. The DICONDE standard will follow that relationship except as noted.

6.2.2 The terminology associated with certain modules of the DICOM information objects must be changed for use in an industrial

context. For instance, industry deals with components not patients. In the industrial objects, the equivalent medical information modules will be reused when possible. For example, a Component information module will be assigned to the Patient information module.

6.2.3 In some cases, there will exist no equivalent medical information module for a required set of industrial data. When no equivalent DICOM information module exists, an industrial specific data module will be created as part of that object.

6.3 *Service-Object Pair (SOP) Class Definitions:*

6.3.1 Details of the DICOM SOP Class Definitions can be found in the DICOM Standard, Part 4, Section 6.

6.4 *DICOM to DICONDE SOP Class Definitions:*

6.4.1 The DICOM standard defines Standard, Standard Extended, Specialized Extended and Private SOP Classes in Part 2, Section 3.11.

6.4.2 To maintain compatibility with standard DICOM devices, the DICONDE standard will be based on Standard Extended DICOM SOP Classes as described in Part 2, Section 3.11.3 of the DICOM Standard except as noted below.

6.4.3 Some nondestructive testing methods do not have an equivalent medical imaging modality. An example of such a test method is Eddy Current testing. For these test methods, the DICONDE standard will define DICONDE Standard SOP Classes instead of using DICOM Standard Extended SOP Classes.

6.5 *Conformance:*

6.5.1 Since the DICONDE standard is based on Standard Extended DICOM SOP Classes, only DICOM devices with Level 2 (Full) conformance should be used in DICONDE applications. Level 2 (Full) conformance ensures that all Type 1, 2 and 3 as well as Private attributes will be stored and may be accessed by the device. See DICOM Part 4, Section B.4 for more information.

6.5.2 Note that test data that use DICONDE Standard SOP Classes may not be accepted or displayed by many standard DICOM image display and storage tools since these SOP classes are not used in medical applications.

6.6 For network communication, DICOM Standard PS 3, part 4, section C.6 defines both a Patient Root Query/Retrieve Information Model and a Study Root Query/Retrieve Information Model. With specific regard to DICONDE, the Component ID is not a central reference point as it is in the medical field, and due to the varied industries and NDE procedures, reconciling evaluation data to a single field can be problematic. For example, Component Name variations could be overwritten because of reconciliation against Component ID. As the Patient Root is specifically aimed at a reconciled master index around the Patient ID (Component ID), it is therefore not included in the DICONDE standard. Non-inclusion of this model in the DICONDE standard in no way breaks or prevents the implementation and use of that model.

7. DICONDE Information Modules

7.1 *Information Module Definitions*

7.1.1 Details of the DICOM Information Module Definitions can be found in the DICOM Standard Part 3, Annex C.

7.1.2 All data elements in the information modules must be described by an *attribute* name, a *data element tag*, a *value representation (VR)*, a *value multiplicity (VM)*, and a *data element type*.

7.2 *DICOM to DICONDE Information Module Definition*

7.2.1 The terminology associated with certain elements of the DICOM information modules must be changed for use in an industrial context. For instance, industry deals with parts/components, not patients. The DICONDE standard defines industrial information modules that are equivalent to those found in the DICOM standard. In the industrial modules, the equivalent medical data elements will be reused when possible. For example, a component ID number or serial number will be assigned to the Patient ID attribute.

7.2.2 In some cases, there will exist no equivalent medical data element for a required industrial data element. There is no equivalent of Component Manufacturer in the current DICOM data model. When no equivalent DICOM data element exists, an industrial specific data element will be created as part of that module.

7.2.3 When a logical correspondence exists, an existing DICOM data element, element with an associated NDE meaning associated with them, will be used for industrial data. For example, the Patient Name data element (0010, 0010) is used to store Component Name for NDE applications.

7.2.4 Some industrial data element tags are unique and do not duplicate any existing medical tags. These NDE data elements are stored as DICOM Private Data Element Tags. Private *data elements tags* are defined in Part 5, Section 7.8 of the DICOM standard.

7.2.5 The version identifier of the DICONDE file will be stored in the Software Versions data element (0018, 1020) in the NDE Equipment Module. The Software Versions data element is multi-valued. If additional software versions are stored in this data element, the DICONDE version must be the first value stored in the data element. The current DICONDE version identifier is “~~DICONDE15~~”:“DICONDE21”. No changes in capitalization or spacing is allowed in the DICONDE version identifier.

7.3 *DICONDE Information Modules*

7.3.1 The DICONDE practice contains the common modules that are needed for every technique. Any technique specific modules for NDE will have information modules, attributes, and data elements identified in a technique specific practice.

7.3.2 **Table 1** summarizes the current list of industrial modules and, if appropriate, the medical modules that they supersede.

7.4 *Component Module*

7.4.1 **Table 2** specifies the attributes that describe components.

7.4.1.1 For information objects using the component module, Component Shape (~~0014, 0050~~) (0014,0050) is specified to use the values in **Table 3**.

7.4.1.2 For information objects using the component module, Curvature Type (~~0014, 0052~~) (0014,0052) is specified to use the following values:

ASTM E2339-21
<https://standards.iteh.ai/catalog/standards/sist/7cf389d5-91cc-4690-ad39-4f919cc64ba/astm-e2339-21>

CONCAVE	CONVEX	COMPOUND
---------	--------	----------

7.5 *Component Summary Module*

7.5.1 **Table 4** summarizes the attributes that describe components. This module has been retired from DICONDE but is left for reference.

7.6 *Component Study Module*

TABLE 1 DICONDE Modules with Medical Equivalents

DICOM Module	DICONDE Module
Patient	Component
Patient Summary (Retired)	Component Summary (Retired)
General Study	Component Study
General Study	Component Study
General Series	Component Series
General Equipment	NDE Equipment
<u>VL Photographic Geolocation Module</u>	<u>NDE Geolocation Module</u>
	NDE Indication
	NDE Geometry
	NDE Approval
	NDE Approval
	<u>NDE Tag Label Dictionary</u>