Designation: 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 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 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 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.

1.4 *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

[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

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 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, n*—application entity

3.2.2 *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), where gggg represents the group number and eeee represents the data element.

3.2.4 *conformance 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, 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, 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*.

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

3.2.11 *group 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), 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, n*—a set of *attributes* with an *Information Object Definition*.

3.2.14 *private data 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), 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), n*—a numeric identifier that is guaranteed to be unique among all DICOM numeric identifiers.

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

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

3.2.20 *value 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), n*—specifies the number of *values* contained in the *value field* of a *data element*.

3.2.22 *value representation (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.

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

[3] Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, http://www.nema.org.

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, 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, 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

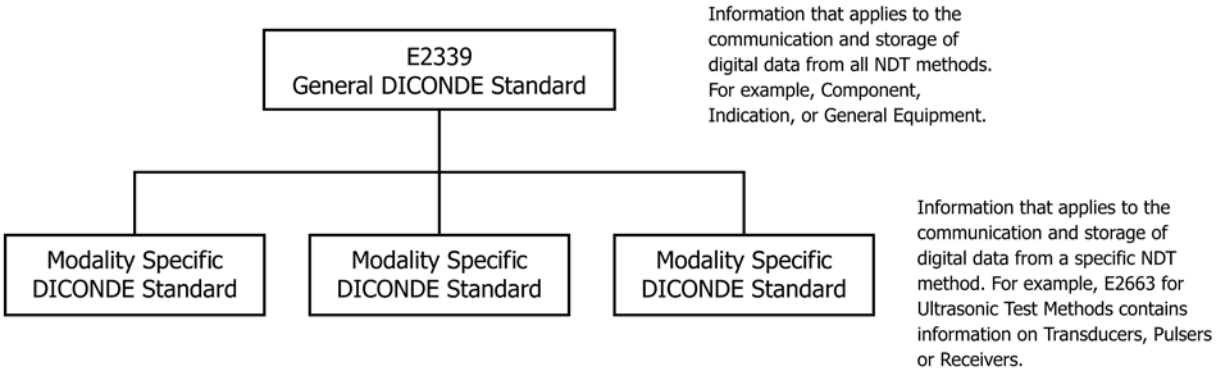

FIG. 1 DICONDE Document Relationships

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 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 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 with an associated NDE meaning 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 "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.

TABLE 1 DICONDE Modules with Medical Equivalents

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

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) is specified to use the values in Table 3.

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

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*

7.6.1 Table 5 summarizes the attributes that describe a study or set of inspections on a given component.

7.7 *Component Series Module*

7.7.1 Table 6 summarizes the attributes that identify and describe information within a component series.

7.7.1.1 For information objects using the component series module, Modality (0008, 0060) is specified to use the following values:

CR = Computed Radiography
CT = Computed Tomography
CT_MF = Multiframe CT
US-MF = Multiframe Ultrasound (Retired)
US = Ultrasound
US_MF = Multiframe Ultrasound
DX = Digital Radiography
TG = Thermography
ES = Borescope
PR = Presentation State
SC = Secondary Capture
XA = Real Time Digital Radiography

7.8 *NDE Equipment Module*

7.8.1 Table 7 summarizes the attributes that describe information regarding the NDE equipment used to acquire the image.

7.8.1.1 Date of Last Calibration (0018,1200) and Time of Last Calibration (0018,1201) are used to convey the date and time of calibration. The Attribute Date of Last Calibration may be supported alone, however, Time of Last Calibration Attribute has no meaning unless Attribute Date of Last Calibration is also supported. The order of each attribute shall be from the oldest date/time to the most recent date/time. When the attributes are both supported, they shall be provided as pairs.

7.8.1.2 Pixel Padding Value (0028,0120) is used to pad images to rectangular format. The native format of some images is not rectangular. It is common for devices with this format to pad the images to the rectangular format required by the DICOM standard with a specific pixel value that is not contained in the native image. Further, when resampling, such as after spatial registration, padding may be needed to fill previously non-existent pixels.

7.9 *NDE Indication Module*

7.9.1 Table 8 summarizes the attributes that identify and describe information regarding the indications found by a reviewer of the acquired image.

TABLE 2 Component Module

Attribute Name	Tag	VR	VM	Type	Description
Component Name	(0010,0010)	PN	1	2	Component Name or Part name
Component ID Number	(0010,0020)	LO	1	2	Component ID or Part ID
Other Component IDs	(0010,1000)	LO	1-N	3	Retired
Other Component IDs Sequence	(0010,1002)	SQ	1	3	Additional Component IDs when multiple parts in one image.
> Other Component Names	(0010,1001)	PN	1-N	3	Additional Component names when multiple parts in one image
> Component Manufacturing Date	(0010,0030)	DA	1	2	
> Patient Sex	(0010,0040)	CS	1	2	Required for DICOM compliance. Should either contain zero value or the enumerated value of "O" for OTHER.
> Component Notes	(0010,4000)	LT	1	3	
> Component Manufacturing Procedure	(0014,0025)	ST	1	3	
> Component Manufacturer	(0014,0028)	ST	1	3	
> Component Welder IDs	(0014,0100)	LO	1-N	3	A text string identifying the individual or machine performing welding operations on the component.
Material					
Material Name	(0010,2160)	SH	1	2	Steel, copper, etc. (16 char. max.)
Material Grade	(0014,0042)	ST	1	3	
Material Properties Description	(0014,0044)	ST	1	3	
Material Notes	(0014,0046)	LT	1	3	
Geometry					
Material Thickness	(0014,0030)	DS	1-N	3	Wall/material thickness in mm
Material Pipe Diameter	(0014,0032)	DS	1-N	3	(Retired)
Material Isolation Diameter	(0014,0034)	DS	1-N	3	(Retired)
Component Shape	(0014,0050)	CS	1	3	General description of the shape of the test piece. See 7.4.1.1for additional information.
Curvature Type	(0014,0052)	CS	1	3	Type of curvature present in the test piece. See 7.4.1.2 for additional information.
Outer Diameter	(0014,0054)	DS	1	3	Outer diameter of curved test specimen in mm
Inner Diameter	(0014,0056)	DS	1	3	Inner diameter of curved test specimen in mm

TABLE 3 Values for the Component Shape (0014,0050) Attribute

Shape Description	Shape Value
Flat	FLAT
Hollow Cylinder	CYLH
Solid Cylinder	CYLS
Hollow Sphere	SPHEREH
Solid Sphere	SPHERES
Compound Curvature	COMPOUND

7.9.1.1 For information objects using the NDE Indication module, Indication Type (0014,201A) is specified to use the values in Table 9.

Additional NDE Indication Types may be specified in the DICONDE standard practices for individual inspection modalities.

7.9.1.2 For information objects using the NDE Indication module, Indication Disposition (0014,201C) is specified to the following values:

ACCEPT REJECT HOLD

Additional NDE Indication Dispositions may be specified in the DICONDE standard practices for individual inspection modalities.

7.9.1.3 The Property Units Code Sequence (0040,08EA) will use the DICOM Code Sequence Macro. The Code Scheme to be used is the Unified Codes for Units of Measure found at www.unitsofmeasure.org. The Code Scheme Designator (0008, 0103) shall be the string UCUM.

Additional Property Units may be specified in the DICONDE Standard Practices for individual inspection modalities.

7.10 *NDE Geometry Module*

7.10.1 Table 10 summarizes the attributes that identify and describe information regarding a specific coordinate system related to the data set and relationships between coordinate systems. These coordinate systems include scanner coordinates, part coordinates, or other defined coordinate systems.

7.10.1.1 For information objects using the NDE Geometry module, Coordinate System Data Set Mapping (0014,2208) is specified to use the following values:

ROW COLUMN FRAME

7.10.1.2 For information objects using the NDE Geometry module, Coordinate System Axis Type (0014,220C) is specified to use the following values:

SCAN INDEX GIMBLE
SWIVEL ROTATION FIXED

7.10.1.3 For information objects using the NDE Geometry module, Coordinate System Axis Units (0014,220E) and Transformed Axis Units (0014,2228) are specified to use the following values:

COUNTS MM DEGREES

7.10.1.4 For information objects using the NDE Geometry module, Coordinate System Rotation and Scale Matrix (0014, 222A) is specified as follows. For a system with N axes, the axes positions for a given point in the coordinate system can be specified as Nx1 matrix

$$\begin{bmatrix} x_1 \\ x_N \end{bmatrix}$$

TABLE 4 Component Summary Module (Retired)

Attribute Name	Tag	VR	VM	Type	Description
Component Name	(0010,0010)	PN	1	2	Component Name or Part name
Component ID Number	(0010,0020)	LO	1	2	Component ID or Part ID

TABLE 5 Component Study Module

Attribute Name	Tag	VR	VM	Type	Description
Study Instance UID	(0020,000D)	UI	1	1	Unique identifier of the study
Study Date	(0008,0020)	DA	1	1	Date the study started
Study Time	(0008,0030)	TM	1	1	Time the study started
Study ID	(0020,0010)	SH	1	2	User or equipment generated study identifier
Accession Number	(0008,0050)	SH	1	2	Inspection order number
Component Owner Name	(0008,0090)	PN	1	2	Company that owns the component being tested
Inspecting Company Name	(0008,1048)	PN	1-N	2	Company responsible for the inspection
Certifying Inspector Name	(0008,1060)	PN	1-N	2	Name of inspector certifying
Study Description	(0008,1030)	LO	1	2	User generated description or classification of the study
Referenced Study Sequence	(0008,1110)	SQ	1	3	Identification of a study that is significantly related to this study. May have zero or more items. NOTES: 1. For example, series may be related if for data acquisition or storage efficiency, the NDE Geometry data for this series is stored in a related series.
> Study Instance UID	(0020,000D)	UI	1	1	Instance UID of the study to which the related series belongs
> Series Instance UID	(0020,000E)	UI	1	1	Instance UID of the related series
Examination Notes	(0032,4000)	LT	1	2	User defined notes on the examination
Expiry Date	(0014,1020)	DA	1	2	Date on which the validation expires.

TABLE 6 Component Series Module

Attribute Name	Tag	VR	VM	Type	Description
Modality	(0008,0060)	CS	1	1	Type of equipment that originally acquired the data used to create the images in this series. See 7.7.1.1 for defined terms.
Series Instance UID	(0020,000E)	UI	1	1	Unique identifier of the series
Series Number	(0020,0011)	IS	1	2	A number that identifies this series
Series Date	(0008,0021)	DA	1	3	Date the series started
Series Time	(0008,0031)	TM	1	3	Time the series started
Series Description	(0008,103E)	LO	1	3	User provided description of the series
Inspector Name	(0008,1050)	PN	1-N	3	Person responsible for the inspection
Operator Name	(0008,1070)	PN	1-N	3	Names of operators assisting the inspector (if any)
Related Series Sequence	(0008,1250)	SQ	1	3	Identification of series significantly related to this series. Zero or more items may be present.
> Study Instance UID	(0020,000D)	UI	1	1	Instance UID of the study to which the related series belongs.
> Series Instance UID	(0020,000E)	UI	1	1	Instance UID of related series.
Environmental Conditions	(0014,1040)	ST	1	3	User defined text regarding the nominal environmental conditions of the test.
Actual Environmental Conditions	(0014,1010)	ST	1	3	User defined text regarding the actual environmental conditions of the test.

Then the mapping between these coordinates and a new coordinate system can be specified as an NxN matrix

$$\left[\begin{array}{ccc} a_{11} & \cdots & a_{1N} \\ a_{N1} & \cdots & a_{NN} \end{array}\right]$$

where the new coordinates are the linear product of these two matrices.

$$\left[\begin{array}{c} x_1' \\ x_N' \end{array}\right] = \left[\begin{array}{ccc} a_{11} & \cdots & a_{1N} \\ a_{N1} & \cdots & a_{NN} \end{array}\right] \left[\begin{array}{c} x_1 \\ x_N \end{array}\right]$$

The values of the transformation matrix, a_{11} to a_{NN} are stored in row major format (that is, a_{11}, a_{12}, ..., a_{1N}, a_{21}, ...) in the multi-valued field. Note that the Coordinate System Transform Rotation and Scale Matrix can be combined with the Coordinate System Transform Translation Matrix in 7.10.1.5 when needed to express the relationship between two coordinate systems.

7.10.1.5 For information objects using the NDE Geometry module, Coordinate System Transform Translation Matrix (0014,222C) is specified as follows. For a system with N axes, the axes positions for a given point in the coordinate system can be specified as a Nx1 matrix.

$$\left[\begin{array}{c} x_1 \\ x_N \end{array}\right]$$

Then the mapping between these coordinates and a new translated coordinate system can be specified as an Nx1 matrix