Designation: E3147 – 18

Standard Practice for Evaluating DICONDE Interoperability of Nondestructive Testing and Inspection Systems[1]

This standard is issued under the fixed designation E3147; 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.

1. Scope

1.1 This practice describes procedures for evaluating DICONDE compliance of radiographic, ultrasonic and eddy current examination instruments and systems.

1.2 This practice establishes no performance limits for examination systems; if such acceptance criteria are required, these must be specified by the using parties. Where acceptance criteria are implied herein they are for example only and are subject to more or less restrictive limits imposed by customer's and end user's controlling documents.

1.3 The specific parameters to be evaluated, conditions and frequency of test, and report data required, must also be determined by the user.

1.4 This practice may be used for the evaluation of a complete examination system, including search unit, instrument, interconnections, scanner fixtures and connected alarm and auxiliary devices, primarily in cases where such a system is used repetitively without change or substitution. This practice is not intended to be used as a substitute for calibration or standardization of an instrument or system to inspect any given material.

1.5 Alternate procedures, such as examples described in this practice, or others, may only be used with customer approval.

1.6 It is expected that the customer sets the requirements for the level to which this practice be conformed, including the requirements for which functionality and DICONDE interoperability be incorporated for testing.

1.7 Two customer types are targeted for usage: a high-level purchaser wishing to quickly assess results and a low-level systems developer wishing to understand the details about the extent of the results, as discussed in Section 5.

1.8 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.9 *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.*

1.10 *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:*

E1316 Terminology for Nondestructive Examinations

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

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 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

2.2 *DICOM Standards*

NEMA Standards Publication PS3, Version 3 Digital Imaging and Communications in Medicine (DICOM)

ACR-NEMA 300-1998 Digital Imaging and Communications in Medicine

3. Terminology

3.1 Refer to Terminology E1316 for definitions of terms in this practice.

3.2 *Definitions:*

[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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3.2.1 *application entity (AE)*—a local or remote DICOM (DICONDE) service.

3.2.2 *AE title*—the name of the application entity, for example, the name of the computer running the local or remote service, or other user-defined name of the application entity.

3.2.3 *connectivity*—the ability to establish a connection between two or more systems and exchange messages.

3.2.4 *DICONDE interconnectivity*—the level to which two application entities can exchange messages using the DICONDE protocol.

3.2.5 *DICONDE interoperability*—ability for two application entities to exchange composite information objects or information about normalized information objects and for each entity to interpret, view, and present that info in the same way.

3.2.6 *DICONDE validation*—the assurance that the NDE system meets the needs of the purchaser and other identified stakeholders. It often involves acceptance with external entities.

3.2.7 *DICONDE verification*—the evaluation of whether the NDE system conforms to the DICONDE standard. It is often an internal process.

3.2.8 *PS3*—NEMA DICOM standard publication.

3.2.9 *SCP*—a Service Class Provider (SCP) is a device that acts as a server and "provides" a DICONDE service. SCP types most commonly include the storage type (C-STORE or C-MOVE) to accept data that is transmitted from another device and the find type (C-FIND) to respond to searches (queries) for data and fulfill transmission requests. A device may serve as both SCP and SCU. Refer to PS3.4 for more information. See Section 5 for diagram.

3.2.10 *SCU*—a Service Class User (SCU) is a device that initiates DICONDE requests from an SCP. SCU types most commonly include the storage type (C-STORE or C-MOVE) to allow sending of data to another device for storage and the find type (C-FIND) to enable searching and retrieval of stored data. A device may serve as both SCU and SCP. Refer to PS3.4 for more information. See Section 5 for diagram.

3.2.11 *validation system*—the real-world application entity that interconnectivity and interoperability is tested against.

3.2.12 *verification system*—the system that a vendor uses internally to verify conformance to the DICONDE standard. An example is DVTk: See Appendix X1 and Appendix X2.

4. Summary of Practice

4.1 This practice is intended for use by NDE system manufacturers and NDE system purchasers, who need to assess the technical extent of a system's compliance and conformance to the DICONDE standard. The procedure is organized in such a way that the level to which the DICONDE standard is supported is evident by the last step of the procedure that passes. The intent is for a vendor to be able to verify DICONDE compliance internally and validate DICONDE compliance with an external system without participating in a connect-a-thon. It provides concrete examples for how to achieve this without mandating a specific means for verification and validation. It achieves this by keeping the procedure abstracted from an implementation, and placing an example implementation suggestion in Appendix X1.

4.2 The practice is intended to verify and validate all the Application Entities of interest to the user for the system under evaluation when performing the DICONDE networking evaluation. For example, a system under evaluation for DICONDE networking interoperability may have more than one Application Entity: One may be dedicated to responding to search requests, and another may be dedicated to receiving image data.

5. Significance and Use

5.1 This practice describes the recommended procedure for NDE system manufacturers and NDE system purchasers to assess the system's level of compliance and conformance to the DICONDE standard.

5.2 The use cases for interconnectivity and interoperability are illustrated in Fig. 1.

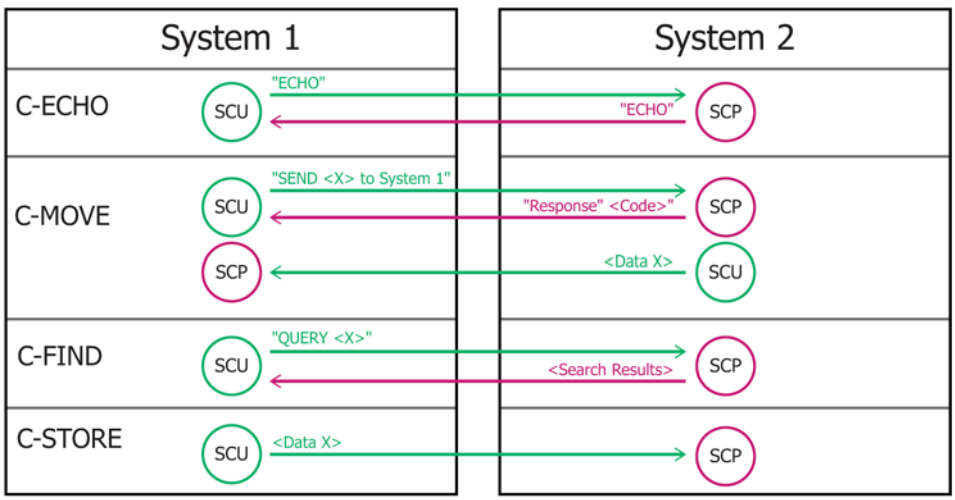

FIG. 1 Illustration of Common SCP and SCU Functions on Two Interoperating DICONDE Systems

6. Procedure

6.1 *Requirements for DICONDE Conformance*—The vendor being evaluated under this practice shall submit their DICOM Conformance Statement (conforming to DICOM PS3.2 - Conformance) to the user evaluating the system. The vendor shall list the following information from the vendor's DICOM conformance statement.

6.1.1 *Relevant Network Transfer Services*—List the relevant Network Transfer services, that is, NDE modalities, that the user is interested in evaluating in A1.1.1 of Annex A1 (Relevant Network Transfer Services) of this practice. DICOM Conformance Statement reference: DICOM Conformance Statement Overview.

6.1.2 *Relevant Query / Retrieve Network Services*—List the relevant Query / Retrieve Network Transfer services that the user is interested in evaluating in A1.1 of Annex A1, Relevant Query / Retrieve Network Services. DICOM Conformance Statement reference: DICOM Conformance Statement Overview.

6.1.3 *Relevant Media Services (Import/Export)*—List the relevant Media services that the user is interested in evaluating in A1.1.1 (Relevant Media Services) of Annex A1 of this practice. DICOM Conformance Statement reference: DICOM Conformance Statement Overview.

6.1.4 *Relevant Implementation Identifying Information*—List every relevant Application Entity that the user is interested in evaluating in A1.1.4 (Relevant Implementation identifying information) of Annex A1 of this practice. DICOM Conformance Statement reference: Heading 4.2 (AE Specification), section 4.2.x (Application entity x), sub-section 4.2.x.2 (Association policies), point 4.2.x.2.4 (Implementation identifying information); where "x" refers to the Application Entity identifier listed in the DICOM Conformance Statement.

6.1.5 *Relevant Configuration*—List relevant configuration parameters for the system being evaluated in A1.2 of Annex A1 of this practice. DICOM Conformance Statement reference: Heading 4.4 (Configuration) and section 4.4.2 (Parameters)

6.2 *DICONDE Verification*—DICONDE media files shall also conform to DICOM media file requirements. In accordance with Part 10 of the DICOM standard, DICONDE file verification shall ensure the following conformances:

6.2.1 The software shall have a conformance statement based on Part 11 of the DICOM standard in accordance with 6.1 of this practice.

6.2.2 The software shall support the file service as specified in PS3.10, Section 8. Verify that this is listed in the conformance statement.

6.2.3 The software shall meet the requirements of the DICOM file formats specified in PS3.10, Section 7. Verify that these requirements are met. Specifically, the file shall:

6.2.3.1 Start with a 128-byte preamble followed by a 4-byte DICOM prefix containing the character string "DICM".

6.2.3.2 Contain the Group 2 required meta information tags as defined in PS3.10, Section 7.

6.2.3.3 Contain all other attribute requirements outlined in the DICONDE Service Object Pair (SOP) Class, or imaging modality, for the file.

(1) Type 1 attributes must be present with a value defined.

(2) Type 1C attributes must be present with a value defined, given that the specified condition is met.

(3) Type 2 attributes must be present with at least a 0-length value defined.

(4) Type 2C attributes must be present with at least a 0-length value defined, given that the specified condition is met.

6.2.4 The software shall perform the media operations defined in PS3.10, Section 8. Verify that these requirements are met. Specifically, as defined in the conformance statement, the AE may take one or more of the following roles:

6.2.4.1 *File Set Creator*—Implements the M-WRITE operations to create the DICOMDIR file and DICONDE files.

6.2.4.2 *File Set Reader*—Implements the M-READ operations to access files from a DICONDE file set.

6.2.4.3 *File Set Updater*—Implements the M-READ, M-WRITE, and M-DELETE operations. Note that if an AE needs to change values in a DICONDE file, this is considered a M-DELETE operation followed by a M-WRITE operation.

6.2.5 The software shall support the DICOMDIR file with content specified in the Media Storage Directory SOP Class in PS3.3, Section 4. The DICOMDIR is a reserved file ID and the software must generate it for all DICONDE file sets residing on storage media. PS3.10, Annex 1 contains an example DICOMDIR construction.

6.2.6 To ensure these conformances are met, the system shall be evaluated against its ability to store all the attributes and attribute values and be compared to the required and optional values for all supported SOP classes by the product. This functionality shall be tested using a validation tool that can evaluate the completeness of DICONDE metadata based on the information object definitions presented in the Standard Practices specified for the required NDT inspection modalities.

6.2.7 The system shall be evaluated against its ability to read and store all metadata and imagery associated with an instance of an SOP Class on storage media per PS3.10. This functionality shall be tested by generating specific media and examining its contents using a DICONDE verification tool chosen by the individual or individuals tasked with verifying that the system under evaluation and has the following capabilities:

6.2.7.1 Lists all the attributes and attribute values in a DICOM Part 10 file ordered by ascending tag number.

6.2.7.2 Compares those values to the required and optional values for the SOP Class.

6.2.7.3 Reports missing or incorrect attributes based on DICONDE elements for the SOP Class.

6.2.7.4 Displays a formatted report of all attributes ordered by information module.

6.3 *DICONDE Import*—To test an imaging system's compliance with Part 10 of the DICOM standard, DICONDE files may be acquired from the ASTM web site. DICONDE file verification shall ensure the following conformances: