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Standard Guide for Data Fields for Computerized Transfer of Digital Ultrasonic Examination Data[1]

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1. Scope

1.1 This guide provides a listing and description of the fields that are recommended for inclusion in a digital ultrasonic examination data base to facilitate the transfer of such data. This guide is prepared for use particularly with digital image data obtained from ultrasonic scanning systems. The field listing includes those fields regarded as necessary for inclusion in the data base (as indicated by Footnote C in Table 1); these fields, so marked, are regarded as the minimum information necessary for a transfer recipient to understand the data. In addition, other optional fields are listed as a remainder of the types of information that may be useful for additional understanding of the data, or applicable to a limited number of applications.

1.2 It is recognized that organizations may have in place an internal format for the storage and retrieval of ultrasonic examination data. This guide should not impede the use of such formats since it is probable that the necessary fields are already included in such internal data bases, or that the few additions can be made. The numerical Field Number listing indicated in this guide is only for convenience; the specific numbers carry no inherent significance and are not a part of the data file.

1.3 The types of ultrasonic examination systems that appear useful in relation to this guide include those described in Practices E 114, E 214 and E 1001. Many of the terms used are defined in Terminology E 1316. The search unit parameters used in this guide follow from those used in Guide E 1065.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 114 Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method[2]

E 214 Practice for Immersed Ultrasonic Examination by the Reflection Method Using Pulsed Longitudinal Waves[2]

E 1001 Practice for Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves[2]

E 1065 Guide for Evaluating Characteristics of Ultrasonic Search Units[2]

E 1316 Terminology for Nondestructive Examinations[2]

3. Significance and Use

3.1 The primary use of this guide is to provide a standardized approach for the data file to be used for the transfer of digital ultrasonic data from one user to another where the two users are working with dissimilar ultrasonic systems. This guide describes the contents, both required and optional, for an intermediate data file that can be created from the native format of the ultrasonic system on which the data was collected and that can be converted into the native format of the receiving ultrasonic or data analysis system. The development of translator software to accomplish these data format conversions is being addressed under a separate effort; this will include specific items needed for the data transfer, for example, language used, memory requirements and intermediate specification, including detailed data formats and structures. This guide will also be useful in the archival storage and retrieval of ultrasonic data as either a data format specifier or as a guide to the data elements that should be included in the archival file.

3.2 Although the recommended field listing includes more than 120 items, only about one third of those are regarded as essential and marked with Footnote C in Table 1. Fields so marked must be addressed in the data base. The other recommended fields provide additional information that a user will find helpful in understanding the ultrasonic examination result. These header field items will, in most cases, make up only a very small part of an ultrasonic examination file. The actual stream of ultrasonic data that make up the image will take up the largest part of the data base. Since an ultrasonic image file will normally be large, the concept of data compression will be considered in many cases. Compressed data should be noted,

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[2] *Annual Book of ASTM Standards,* Vol 03.03.

along with a description of the compression method, as indicated in Field No. 122.

3.3 This guide describes the structure of a data file for all of the ultrasonic information collected in a single scan. Some systems record multiple examination results during a single scan. For example, through transmission attenuation data as well as pulse echo thickness data may be recorded at the same time. These data may be stored in separate image planes; see Field No. 102. In other systems, complete digitized waveforms may be recorded at each examination point. It is recognized that the complete examination record may contain several files, for example, for the same examination method in different object areas, with or without image processing, for different examination methods (through-transmission, pulse-echo, radiologic, infrared, etc.) collected during the same or during different scan sessions, and for variations within a single method (frequency change, etc.). Information about the existence of other images/examination records for the examined object should be noted in the appropriate fields. A single image plane may be one created by overlaying or processing results for multiple examination approaches, for example data fusion. For such images, the notes sections must clearly state how the image for this file was created.

TABLE 1 Field Listing

Field Number[A]	Field Name and Description	Data Type/Units[B]
Header Information:		
1[C]	Intermediate file name	Alphanumeric string[D]
2[C]	Format revision code	Alphanumeric string
3[C]	Format revision date	yyyy/mm/dd[D]
4[C]	Source file name	Alphanumeric string
5	Examination file description notes	Alphanumeric string
6[C]	Examining company and location	Alphanumeric string[D]
7[C]	Examination date	yyyy/mm/dd
8[C]	Examination time	hh:mm:ss
9[C]	Type of examination	Alphanumeric string[D]
10[C]	Other examinations performed	Alphanumeric string[D]
11	Operator Name	Alphanumeric string
12[C]	Operator identification code	Alphanumeric string
13[C]	ASTM, ISO, or other applicable standard specification	Alphanumeric string
14	Date of applicable standard	yyyy/mm/dd
15[C]	Acceptance criteria	Alphanumeric string
16[C]	System of units	Alphanumeric string[D]
17	Notes	Alphanumeric string
Examination System Description:		
18	Examination system manufacturer(s)	Alphanumeric string[D]
19[C]	Examination system model	Alphanumeric string
20	Examination system serial number	Alphanumeric string
Pulser Description:		
21	Pulser electronics manufacturer	Alphanumeric string
22	Pulser electronics model number	Alphanumeric string
23	Pulser type	Alphanumeric string[D]
24	Pulse repetition frequency	Real number, kiloHertz
25	Pulse height	Alphanumeric string[D]
26	Pulse width	Real number, nsec
27	Last calibration date	yyyy/mm/dd
28	Notes on pulser section	Alphanumeric string
Receiver Description:		
29	Receiver electronics manufacturer	Alphanumeric string
30	Receiver electronics model	Alphanumeric string
31	Receiver electronics response center frequency	Real number, MHz[D]
32	Receiver bandwidth	Real number, MHz[D]
33	Fixed receiver gain	Real number, dB
34	User selected receiver gain	Real number, dB
35	Last calibration date	yyyy/mm/dd
	Notes on receiver section	Alphanumeric string
Gate Description:		
37	Number of gates	Integer
38	Gate type	Alphanumeric string[D]
39	Gate synchronization	Alphanumeric string
40	Gate start delay	Alphanumeric string
41	Gate width	Alphanumeric string
42	Gate threshold level	Alphanumeric string
43	Notes on gate section	Alphanumeric string
Search Unit Description:		
44	Transmit search unit manufacturer	Alphanumeric string
45	Transmit search unit model	Alphanumeric string
46	Transmit search unit serial number	Alphanumeric string
47	Transmit search unit element diameter	Real number
48	Measured beam diameter of the Transmit search unit at the examination surface	Real number
49	Location of measurement of beam diameter of the transmit search unit	Alphanumeric string[D]
50	Transmit search unit focal length	Real number[D]

Field Number[A]	Field Name and Description	Data Type/Units[B]
51	Transmit search unit nominal frequency	Real number, MHz
52	Transmit search unit response center frequency	Real number, MHz
53	Transmit search unit response bandwidth	Real number, MHz
54	Transmit search unit cable type	Alphanumeric string
55	Transmit search unit cable length	Real number
56	Number of values for Transmit search unit digitized waveform	Integer[D]
57	Transmit search unit waveform values	Real number
58	Notes on Transmit search unit waveform	Alphanumeric string
59	Transmit search unit coupling technique and medium	Alphanumeric string
60	Receive search unit manufacturer	Alphanumeric string
61	Receive search unit model number	Alphanumeric string
62	Receive search unit serial number	Alphanumeric string
63	Receive search unit element diameter	Real number
64	Measured beam diameter of the “receive” search unit at the examination surface	Real number
65	Location of measurement of beam diameter of the receive search unit	Alphanumeric string[D]
66	Receive search unit focal length	Real number[D]
67	Receive search unit nominal frequency	Real number, MHz
68	Receive search unit response center frequency	Real number, MHz
69	Receive search unit response bandwidth	Real number, MHz
70	Receive search unit cable type	Alphanumeric string
71	Receive search unit cable length	Real number
72	Number of values for “receive” search unit digitized waveform	Integer[D]
73	Receive search unit waveform values	Real number
74	Notes on Receive search unit waveform	Alphanumeric string
75	Receive search unit coupling technique and medium	Alphanumeric string
Examined Sample Description:		
76[C]	Examined sample identification	Alphanumeric string
77[C]	Examined sample name	Alphanumeric string
78	Examined sample description	Alphanumeric string
79[C]	Examined sample material	Alphanumeric string
80	Examined sample notes (history, use, etc.)	Alphanumeric string[D]
81[C]	Number of scan segments for this part	Integer
82	Reference sample identification	Alphanumeric string
83	Reference sample description	Alphanumeric string
84	Reference sample file name/location	Alphanumeric string
85	Reference sample notes (use, etc.)	Alphanumeric string[D]
Coordinate System and Scan Description Machine Coordinate System:		
86	Machine scan axis	Alphanumeric string[D]
87	Machine index axis	Alphanumeric string
88	Machine third axis	Alphanumeric string
89	Reference for machine coordinate system	Alphanumeric string
Part Coordinate System:		
90	First part axis	Alphanumeric string[D]
91	Second part axis	Alphanumeric string
92	Third part axis	Alphanumeric string
93	Reference for part coordinate system	Alphanumeric string
Object Target Points:		
94[C]	Number of target points	Integer
95[C]	Description of target point	Alphanumeric string
96[C]	Coordinate of target point in first part axis	Real number
97[C]	Coordinate of target point in second part axis	Real number
98	Coordinate of target point in third part axis	Real number
Data Plane:		
99	Description of the plane onto which data will be projected	Alphanumeric string
100	Coordinate system notes	Alphanumeric string
Examination Parameters:		
101[C]	Coordinate location number	Integer
102[C]	Number of data values per coordinate location	Integer[D]
103[C]	Minimum value of examination data range or resolution	Integer[D]
104[C]	Maximum value of examination data range or resolution	Integer[D]
105[C]	Engineering units for minimum legal data value	Alphanumeric string[D]
106[C]	Engineering units for maximum legal data value	Alphanumeric string[D]
107[C]	Number of bits to which the original data was digitized	Integer
108[C]	Type of data scale	Alphanumeric string[D]
109[C]	Size of data step	Real number[D]
110[C]	Format of data recording	Alphanumeric string[D]
111[C]	Number of colors or gray levels used	Integer
112[C]	Distribution of colors or gray levels	Alphanumeric string
Examination Results:		
113[C]	Scan segment number	Integer[D]
114[C]	Scan segment description	Alphanumeric string
115	Scan segment location on part	Alphanumeric string
116	Scan segment orientation	Alphanumeric string
117[C]	Scan pattern description	Alphanumeric string
118	Annotation	Alphanumeric string[D]

Field Number[A]	Field Name and Description	Data Type/Units[B]
119[C]	Distance between data sample points	Real number
120[C]	Interval between data locations in index direction	Real number
121	Notes on data intervals	Alphanumeric string
122	Notes on data format including notes on any compression techniques used	Alphanumeric string
123[C]	Total number of data points	Integer[D]
124[C]	Actual stream of ultrasonic data	Real numbers[D]

[A] Field numbers are for reference only. They do not imply a necessity to include all those fields in any specific database nor do they imply a requirement that fields be used in this particular order.
[B] Units listed first are SI; secondary units are inch-pound (English); see Field No. 16.
[C] Denotes essential field for computerization of examination results.
[D] See Section 5 for further explanation.

4. Description of the Field Listings

4.1 Table 1 is a recommended field format for the computerized transfer of ultrasonic examination data. There are three columns of information, as indicated in 4.1.1-4.1.3:

4.1.1 *Field Number*—A reference number for ease of use in dealing with the individual fields within this guide. This number has no permanent value and does not become part of the data base itself.

4.1.2 *Field Name and Description*—The complete name of the field, descriptive of the element of information that would be included in this field of the data base.

4.1.3 *Data Type/Units*—A listing of the types of information which would be included in the field or the units in which the values are expressed, or both.

4.2 The information for reporting ultrasonic examination results is divided into ten segments, as follows:

4.2.1 Header information,

4.2.2 Examination system description,

4.2.3 Pulser description,

4.2.4 Receiver description,

4.2.5 Gate description,

4.2.6 Search unit description,

4.2.7 Examined sample description,

4.2.8 Coordinate system and scan description,

4.2.9 Examination parameters, and

4.2.10 Examination results.

4.3 Additional explanations and allowable entries for some fields are given in Section 5.

5. Explanation of Fields

5.1 *Field Number, Name, and Description*:

5.1.1 *Field No. 1: Intermediate File Name*—The name of the data base file containing all of the information to follow. This is the transfer or archive file itself.

5.1.2 *Field No. 3: Format Revision Date*—The date of the file format code used for the data base file being created. Enter in the form of four digits for the year, two digits for the month, and two digits for the day of the month.

5.1.3 *Field No. 6: Examining Company and Location*—The legal name and location of the company that performed the ultrasonic examination.

5.1.4 *Field No. 9: Type of Examination*—For example, one of the following may be used: through-transmission; pulse-echo amplitude; pulse-echo time-of-flight; reflector plate; full digitized waveform, and multivalued data, etc.

5.1.5 *Field No. 10: Other Examinations Performed*—Identify other nondestructive examinations performed on this part, such as: x-radiography (film based); x-radioscopy (video tape record), and infrared thermal examination, etc.

5.1.6 *Field No. 16: System of Units*—Specify whether SI (metric) or inch-pound (English) units are used for specifying dimensional quantities.

5.1.7 *Field No. 18: Examination System Manufacturer(s)*—Give the name of the ultrasonic system manufacturer. Where multiple vendors are involved, give the name of the manufacturer for each subsystem. Also give the model name and number and serial number of each subsystem for the following fields.

5.1.8 *Field No. 23: Pulser Type*—For example: spike pulse, square wave, tone burst, etc.

5.1.9 *Field No. 25: Pulse Height*—Indicate the amplitude of the electrical pulse in volts and identify whether the measurement is peak-to-peak, rectified, etc.

5.1.10 *Field Nos. 31 and 32: Receiver Frequency and Bandwidth*—Give the manufacturers specified nominal values.

5.1.11 *Field No. 38: Gate Type*—For Example: flaw gate, back echo gate, transmission amplitude gate, etc.

5.1.12 *Field No. 49: Location of Beam Diameter Measurement*—For immersion examinations measure in accordance with Guide E 1065. For squirter examinations measure through the water stream at the working distance. For contact examinations use the active element diameter.

5.1.13 *Field No. 50: Search Unit Focal Length*—Enter the focal length of the search unit. For flat search units, enter a value of 0.0.

5.1.14 *Field Nos. 56 Through 58: Transmit Search Unit Waveform*—Provides a digitized waveform of the search unit recorded from the reflection from a flat plate. Waveform should be representative of the manner in which the search unit is used in the system. Include a description of the manner in which the waveform was digitized.

5.1.15 *Field No. 65: Location of Beam Diameter Measurement*—See notes for Field No. 49.

5.1.16 *Field No. 66: Search Unit Focal Length*—See notes for Field No. 50.

5.1.17 *Field Nos. 72 Through 74: Receive Search Unit Waveform*—See notes for Field Nos. 56 through 58.

5.1.18 *Field No. 80: Examined Sample Notes (History, Use, etc.)*—Give any service data available for the article including service use hours, aircraft or system assignments, and special incidents, such as collisions, impacts, hail storms, fires, etc.

5.1.19 *Field No. 85: Reference Sample Notes*—Describe how the sample was used in the setup of the ultrasonic system response; reject response level, etc.

5.1.20 *Field Nos. 86 Through 89: Machine Coordinate System*—Describe the coordinate system used by the original examination equipment. Reference to the receive search unit. For example, scan axis = *X* axis, positive right; index axis = *Y* axis, positive down; *Z* axis, positive away.

5.1.21 *Field Nos. 90 through 93 Part Coordinate System*—Describe the coordinate system of the part in the scan frame. Give the origin and unit vectors as referenced to the machine coordinate system.

5.1.22 *Field No. 102: Number of Data Values Per Coordinate*—Where multivalued scans or digitized waveforms are included, indicate the number of values recorded at each point and the significance of each. The definitions of Field Nos. 103 through 112 may need to be repeated for each of the multivalued parameters.

5.1.23 *Field No. 103: Minimum Value of the Examination Data Range*—The lower bound of the pixel value for the data type. For example, 00.

5.1.24 *Field No. 104: Maximum Value of the Examination Data Range*—The upper bound of the pixel value for the data type. For example, 127 or 255.

5.1.25 *Field No. 105: Engineering Units for Minimum*—Give the significance of the value in item 100. For legal value example, 00 represents saturation of the A/D that occurs at 5.0 V at the input to the preamp. It is important that the units for Field Nos. 105 and 106 be the same (decibel, volts, etc.)

5.1.26 *Field No. 106: Engineering Units for Maximum Legal Value*—Give the significance of the value in Field No. 101. For example, 127 represents a signal strength 127 dB below the saturation level, or 2.2 μv at the input to the preamp. (In practice the noise floor typically occurs at approximately 50 μv that would give a pixel value of 100.)

5.1.27 *Field No. 108: Type of Data Scale*—For example, linear, logarithmic, etc.

5.1.28 *Field No. 109: Size of Data Step*—For example, 1.0 dB, or 0.004 in. (0.1 mm) thickness.

5.1.29 *Field No. 110: Format of Data Recording*—For example, ASCII, numeric values, ASCII, characters, binary, two 8-bit words, etc.

5.1.30 *Field No. 113: Scan Segment Number*—Enter the sequence number for this segment of the scan data. If the entire part is scanned in one pattern and all of this data is saved in a single file, there will be only one scan segment for the part (and perhaps one for the reference standard).

5.1.31 *Field No. 118: Annotation*—Report any annotation included with the file. Annotations should be referenced to part coordinates.

5.1.32 *Field No. 123: Total Number of Data Points*—Number of pixels in image. May be given in terms of rows and columns, for example 256 by 256.

5.1.33 *Field No. 124: Actual Stream of Ultrasonic Data*—The actual stream of data conforming to the limits, significance, and given format.

6. Keywords

6.1 database; data retrieval; data storage; guide; nondestructive testing; ultrasonic examination; ultrasonic image