



Designation: E747 – 18

Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology¹

This standard is issued under the fixed designation E747; 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 practice² covers the design, material grouping classification, and manufacture of wire image quality indicators (IQI) used to indicate the quality of radiographic images.

1.2 This practice is applicable to X-ray and gamma-ray radiography.

1.3 This practice covers the use of wire penetrameters as the controlling image quality indicator for the material thickness range from 6.4 to 152 mm (0.25 to 6.0 in.).

1.4 The values stated in inch-pound units are to be regarded as 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:³

B139/B139M Specification for Phosphor Bronze Rod, Bar, and Shapes

B150M Specification for Aluminum Bronze, Rod, Bar, and

Shapes [Metric] (Withdrawn 2002)⁴

B161 Specification for Nickel Seamless Pipe and Tube

B164 Specification for Nickel-Copper Alloy Rod, Bar, and Wire

B166 Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), and Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674) Rod, Bar, and Wire

E1025 Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiography

E1316 Terminology for Nondestructive Examinations

2.2 ISO Standards:⁵

ISO 19232-1 Non-Destructive Testing—Image Quality of Radiographs-Part 1: Image Quality Indicators (Wire-Type)-Determination of Image Quality Value

ISO 19232-2 Non-Destructive Testing—Image Quality of Radiographs-Part 2: Determination of the Image Quality Value using Step/hole Type Image Quality Indicators

ISO 19232-3 Non-Destructive Testing—Image Quality of Radiographs-Part 3: Image Quality Classes

3. Terminology

3.1 *Definitions*—The definitions of terms in Terminology **E1316**, Section D, relating to gamma and X-radiography, shall apply to the terms used in this practice.

4. Wire IQI Requirements

4.1 The quality of all levels of examination shall be determined by a set of wires conforming to the following requirements:

4.1.1 Wires shall be fabricated from materials or alloys identified or listed in accordance with **7.2**. Other materials may be used in accordance with **7.3**.

4.1.2 The IQI consists of sets of wires arranged in order of increasing diameter. The diameter sizes specified in **Table 1** are

¹ This practice is under the jurisdiction of ASTM Committee **E07** on Nondestructive Testing and is the direct responsibility of Subcommittee **E07.01** on Radiology (X and Gamma) Method.

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² For ASME Boiler and Pressure Vessel Code applications see related Practice SE-747 in Section II of that Code.

³ 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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

TABLE 1 Wire IQI Sizes and Wire Identity Numbers

SET A		SET B	
Wire Diameter in. (mm)	Wire Identity	Wire Diameter in. (mm)	Wire Identity
0.0032 (0.08) ^A	1	0.010 (0.25)	6
0.004 (0.1)	2	0.013 (0.33)	7
0.005 (0.13)	3	0.016 (0.4)	8
0.0063 (0.16)	4	0.020 (0.51)	9
0.008 (0.2)	5	0.025 (0.64)	10
0.010 (0.25)	6	0.032 (0.81)	11
SET C		SET D	
Wire Diameter in. (mm)	Wire Identity	Wire Diameter in. (mm)	Wire Identity
0.032 (0.81)	11	0.10 (2.5)	16
0.040 (1.02)	12	0.126 (3.2)	17
0.050 (1.27)	13	0.160 (4.06)	18
0.063 (1.6)	14	0.20 (5.1)	19
0.080 (2.03)	15	0.25 (6.4)	20
0.100 (2.5)	16	0.32 (8)	21

^A The 0.0032 wire may be used to establish a special quality level as agreed upon between the purchaser and the supplier.

TABLE 2 Wire Diameter Tolerances, mm

Wire Diameter (<i>d</i>), mm	Tolerance, mm
0.000 < <i>d</i> ≤ 0.125	±0.0025
0.125 < <i>d</i> ≤ 0.25	±0.005
0.25 < <i>d</i> ≤ 0.5	±0.01
0.50 < <i>d</i> ≤ 1.6	±0.02
1.6 < <i>d</i> ≤ 4	±0.03
4.0 < <i>d</i> ≤ 8	±0.05

TABLE 3 Wire Diameter Tolerances, in.

Wire Diameter (<i>d</i>), in.	Tolerance, in.
0.000 < <i>d</i> ≤ 0.005	±0.0001
0.005 < <i>d</i> ≤ 0.010	±0.0002
0.010 < <i>d</i> ≤ 0.020	±0.0004
0.020 < <i>d</i> ≤ 0.063	±0.0008
0.063 < <i>d</i> ≤ 0.160	±0.0012
0.160 < <i>d</i> ≤ 0.320	±0.0020

established from a consecutive series of numbers taken in general from the ISO/R 10 series. The IQI shall be fabricated in accordance with the requirements specified in Figs. 1-8 and Tables 1-3. IQIs previously manufactured to the requirements of Appendix X1 may be used as an alternate provided all other requirements of this practice are met.

4.1.3 Image quality indicator (IQI) designs other than those shown in Figs. 1-8 and Annex A1 are permitted by contractual agreement. If an IQI set as listed in Table 1 or Annex A1 is modified in size, it must contain the grade number, set identity, and essential wire. It must also contain two additional wires that are the next size larger and the next size smaller as specified in the applicable set listed in Table 1.

4.1.4 Each set must be identified using letters and numbers made of industrial grade lead or of a material of similar radiographic density. Identification shall be as shown on Figs. 1-8 or Annex A1, unless otherwise specified by contractual agreement.

4.1.5 ISO standard ISO 19232-1 contains similar provisions (with nominal differences-see Table A1.1) for wire image quality indicators as this standard (E747). International users of these type IQI standards who prefer the use of ISO 19232-1 for their particular applications should specify such alternate provisions within separate contractual arrangements from this standard.

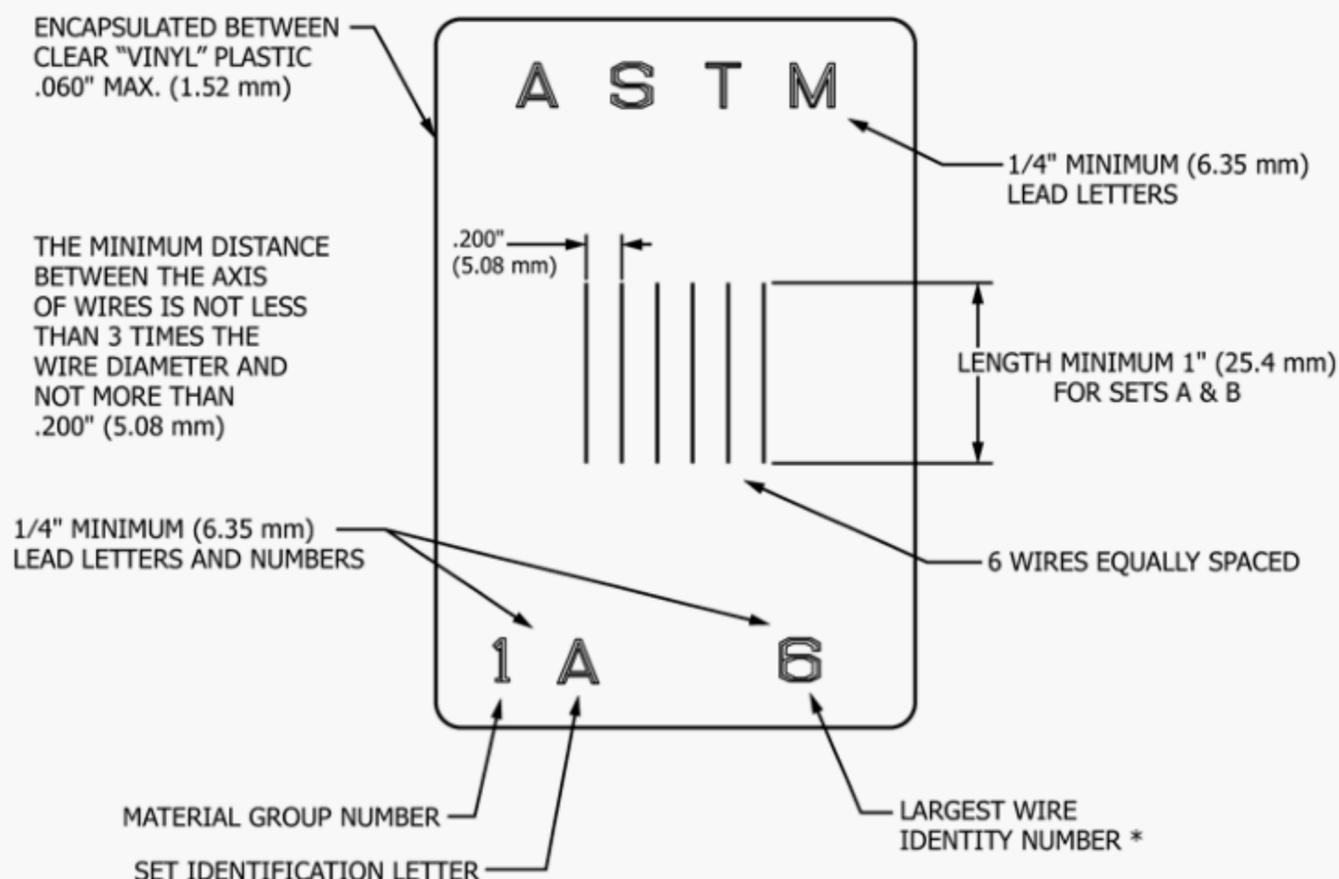
5. Image Quality Indicator (IQI) Procurement

5.1 When selecting IQI's for procurement, the following factors should be considered:

5.1.1 Determine the alloy group(s) of the material to be examined.

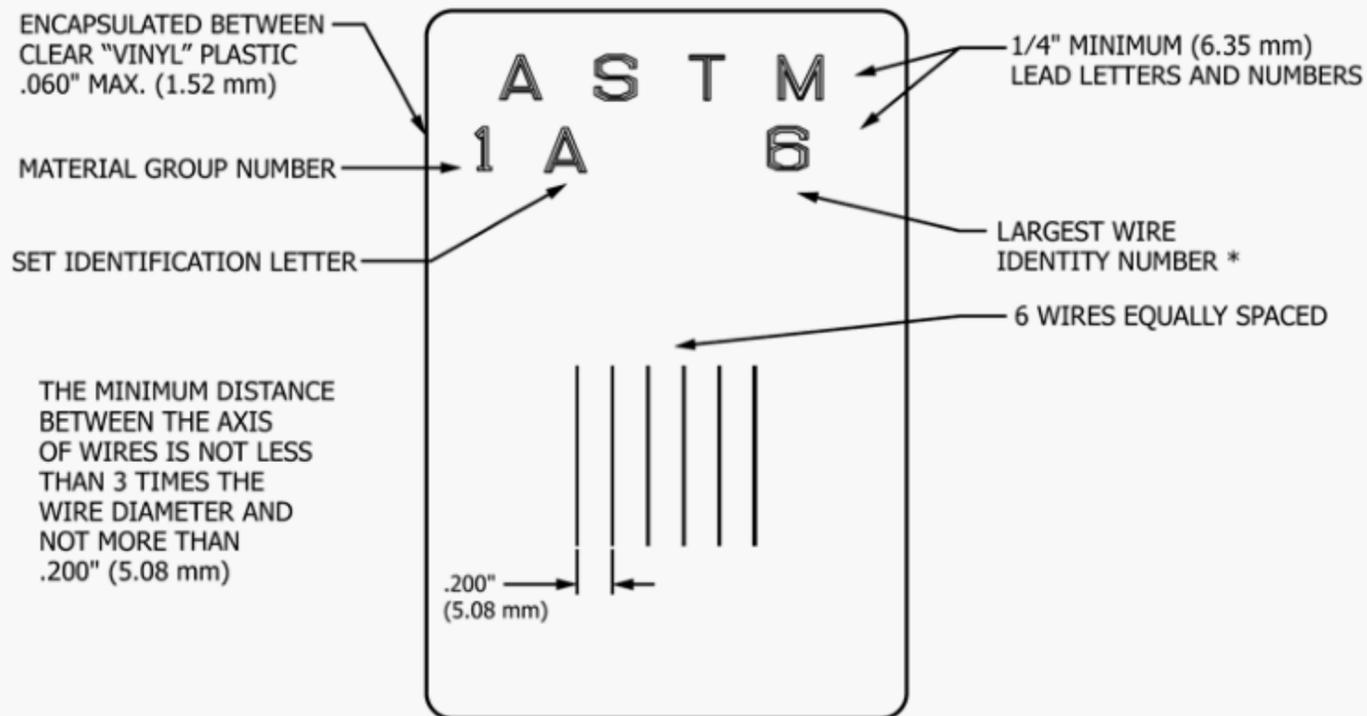
5.1.2 Determine the thickness or thickness range of the material(s) to be examined.

5.1.3 Select the applicable IQI's that represent the required IQI thickness(s) and alloy(s).



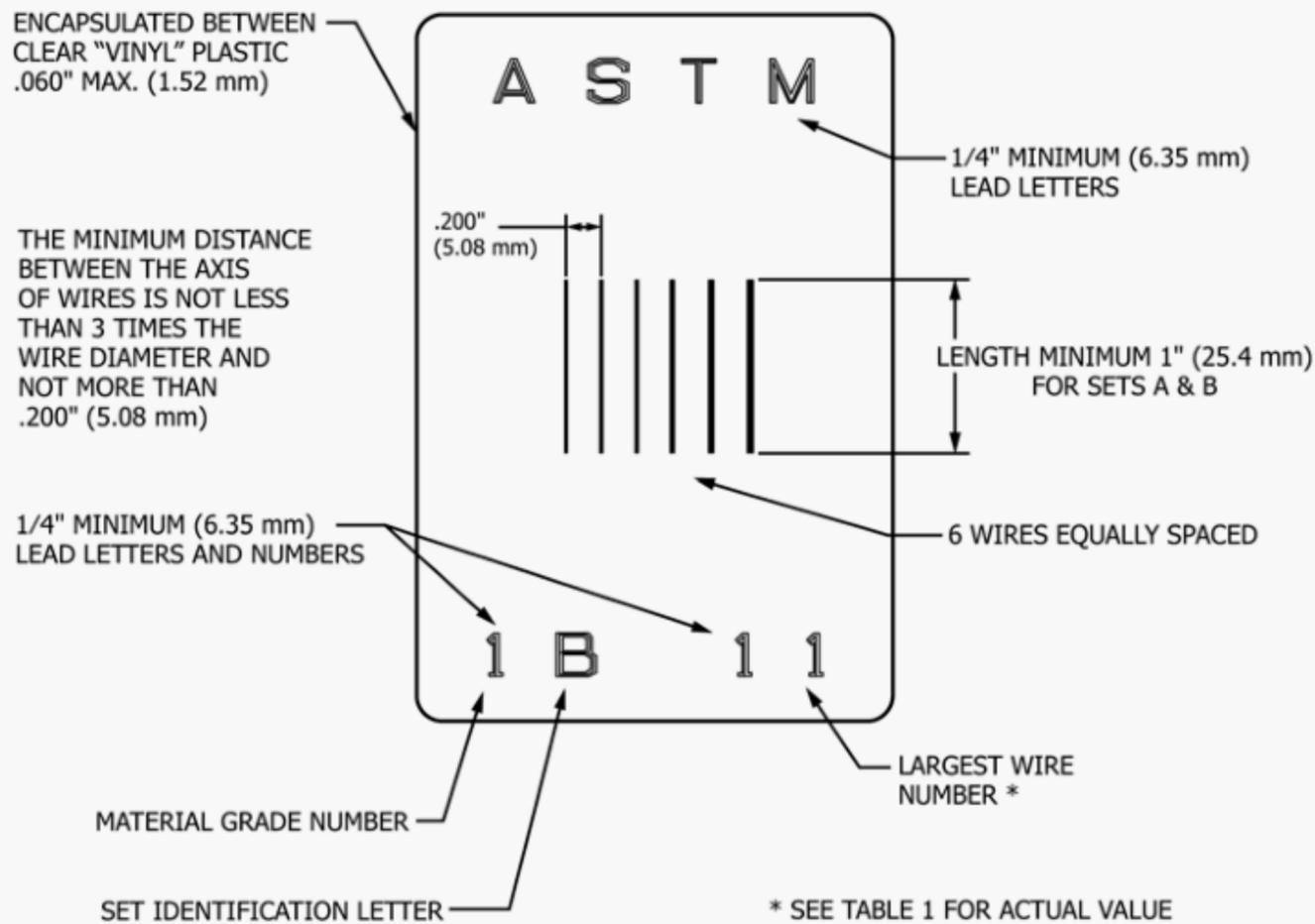
* SEE TABLE 1

FIG. 1 Set A/Alternate 1



* SEE TABLE 1

FIG. 2 Set A/Alternate 2



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. 3 Set B/Alternate 1

6. Image Quality Levels

6.1 The quality level required using wire penetrameters shall be equivalent to the 2-2T level of Practice E1025 for hole-type IQI's unless a higher or lower quality level is agreed upon between purchaser and supplier. The conversion of plaque identification number to the equivalent wire diameter and identity as defined in this standard is provided in Annex A1.

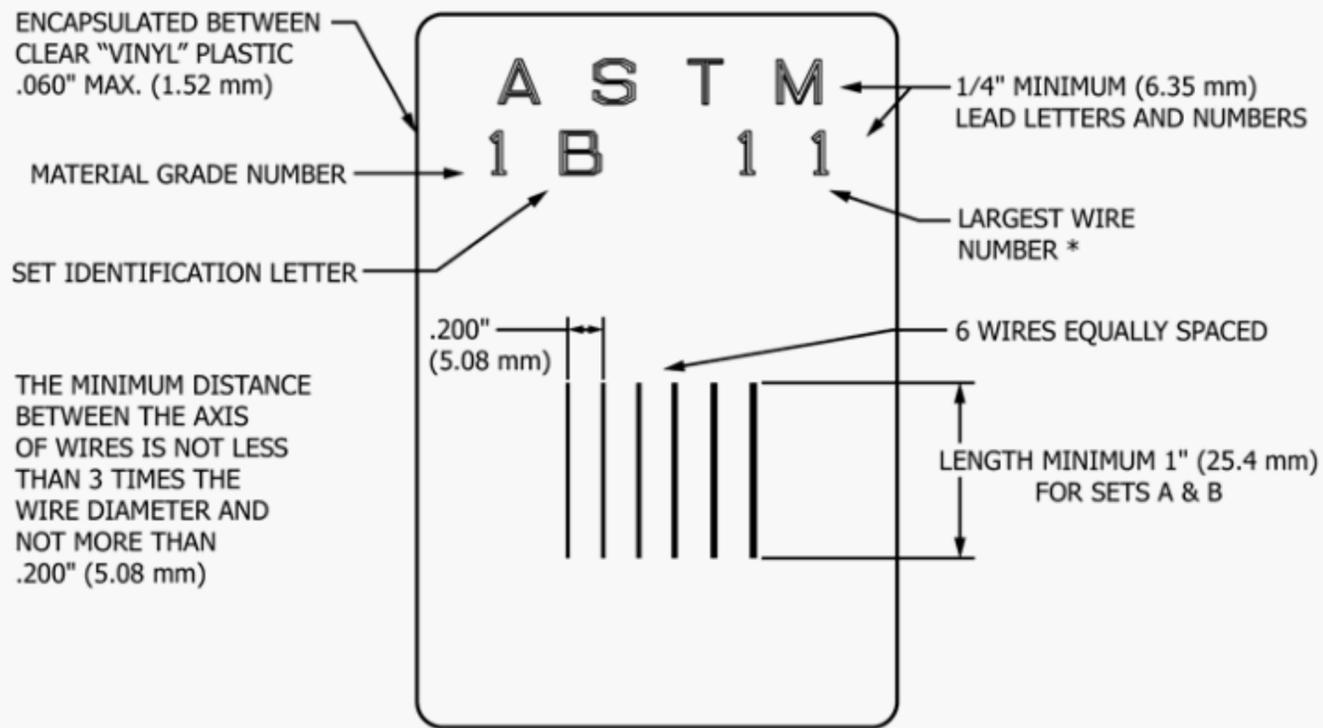
6.2 In specifying quality levels, the contract, purchase order, product specification, or drawing should clearly indicate the

thickness of material to which the quality level applies. Careful consideration of required quality levels is particularly important.

7. Material Groups

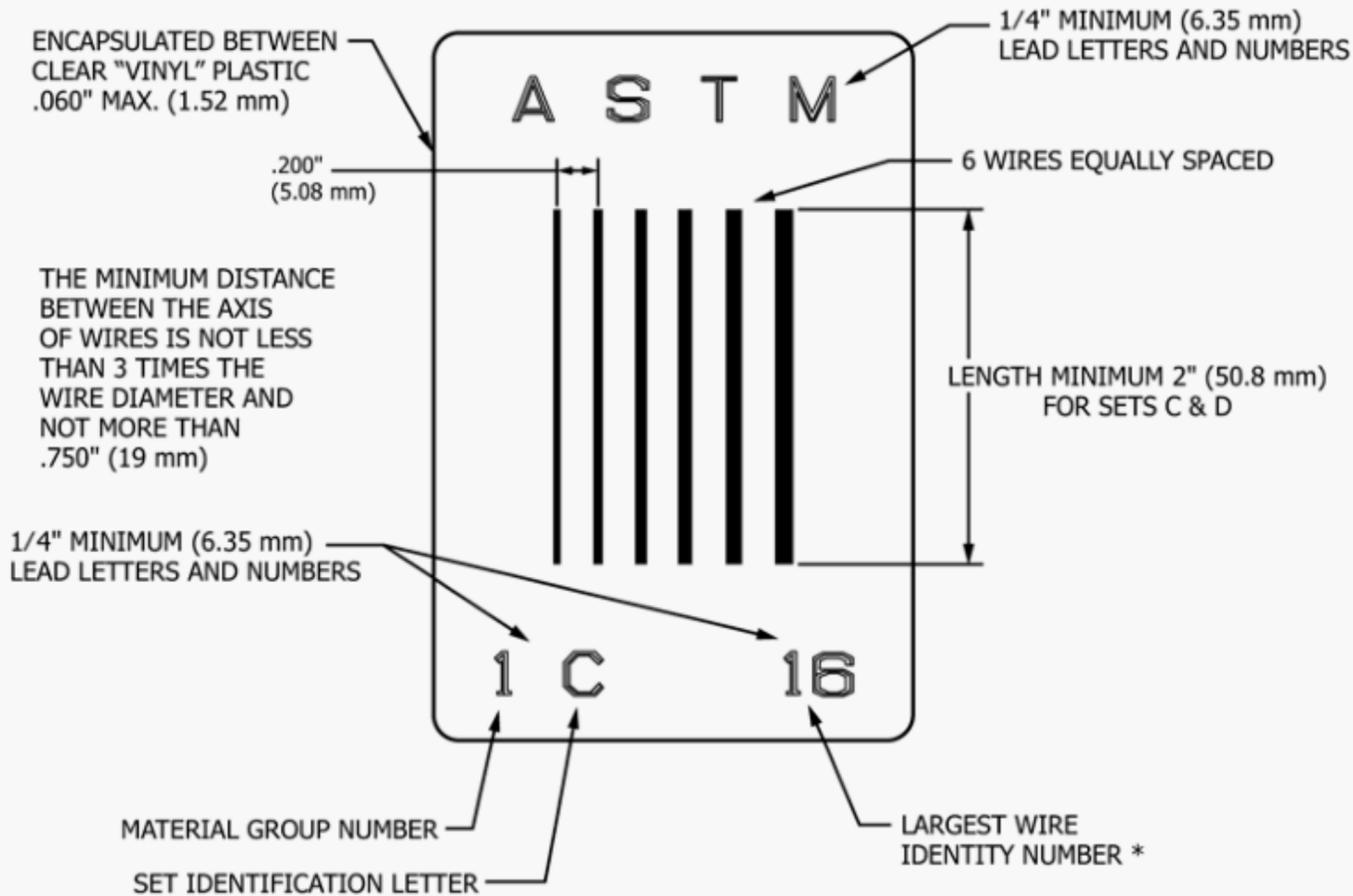
7.1 General:

7.1.1 Materials have been designated in eight groups based on their radiographic absorption characteristics: groups 03, 02, and 01 for light metals and groups 1 through 5 for heavy metals.



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. 4 Set B/Alternate 2



* SEE TABLE 1

FIG. 5 Set C/Alternate 1

7.1.2 The light metal groups, magnesium (Mg), aluminum (Al), and titanium (Ti) are identified 03, 02, and 01 respectively, for their predominant alloying constituent. The materials are listed in order of increasing radiation absorption.

7.1.3 The heavy metal groups, steel, copper-base, nickel-base, and kindred alloys are identified 1 through 5. The materials increase in radiation absorption with increasing numerical designation.

7.1.4 Common trade names or alloy designations have been used for clarification of the pertinent materials.

7.1.5 The materials from which the IQI for the group are to be made are designated in each case and these IQI's are applicable for all materials listed in that group. In addition, any group IQI may be used for any material with a higher group number, provided the applicable quality level is maintained.

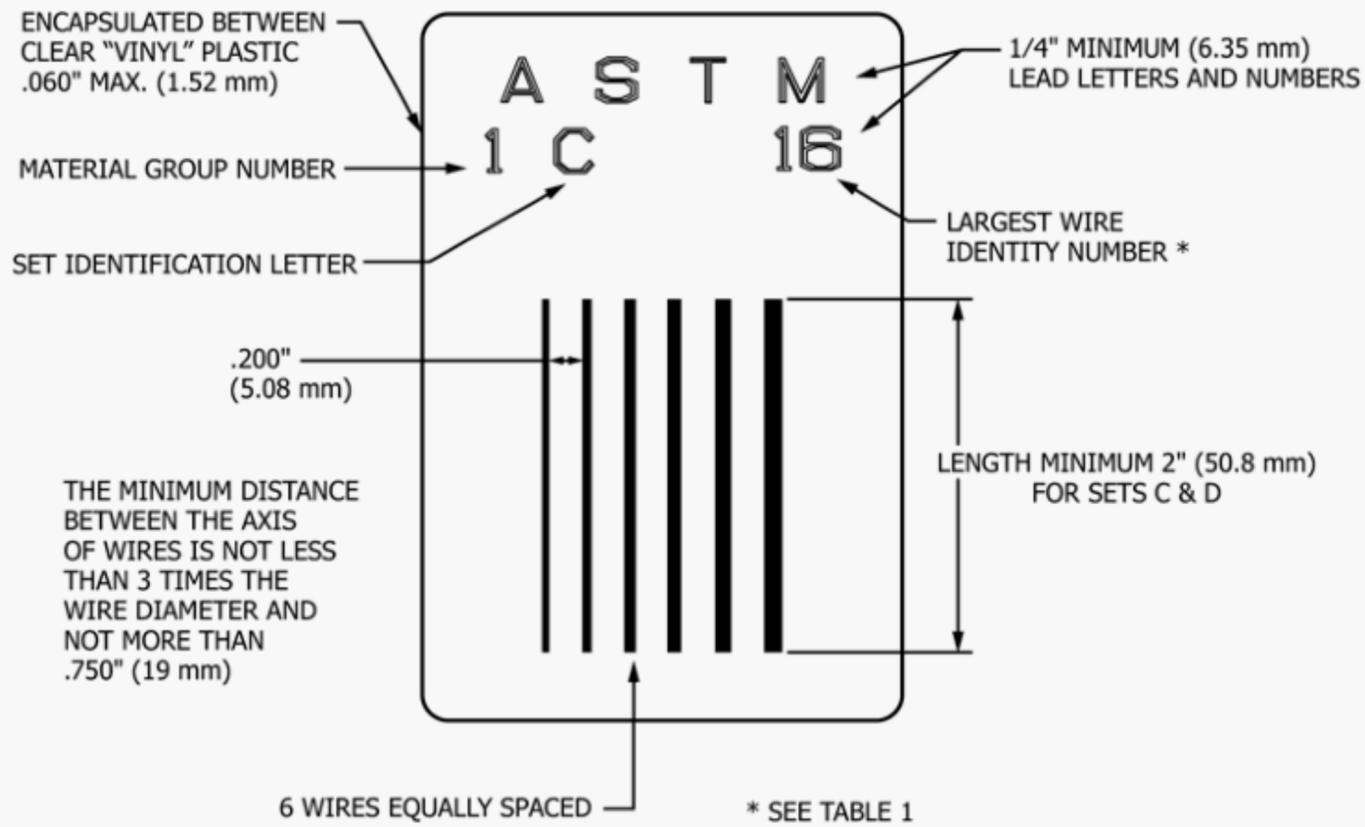


FIG. 6 Set C/Alternate 2

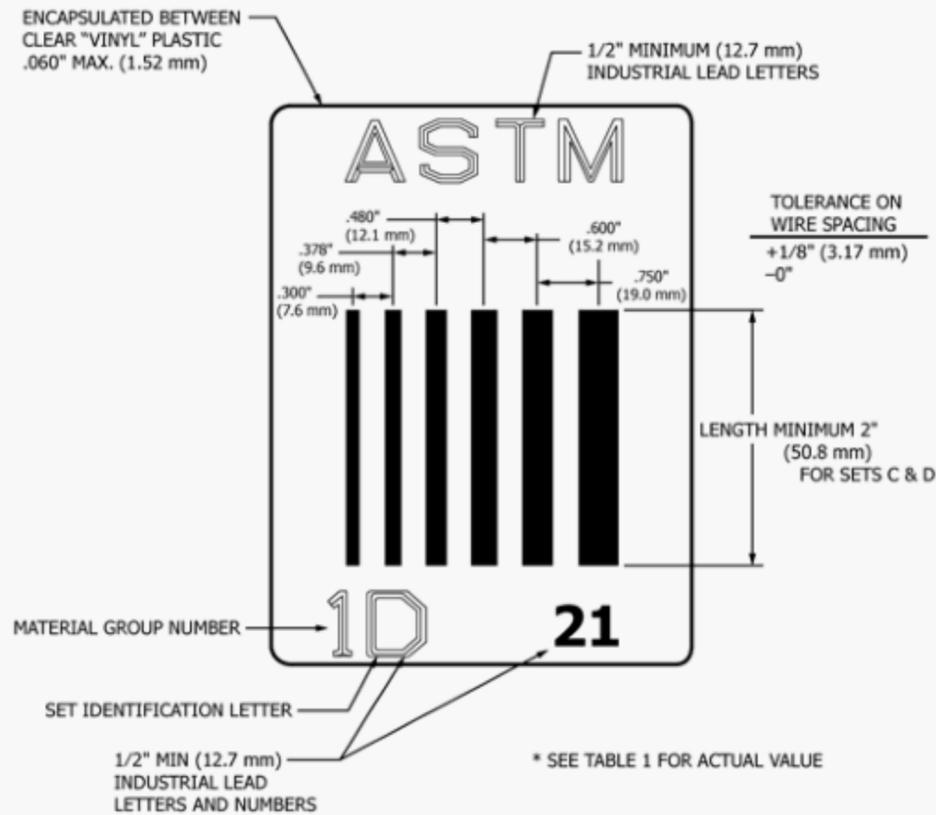


FIG. 7 Set D/Alternate 1

7.2 Materials Groups:

7.2.1 Materials Group 01:

7.2.1.1 Image quality indicators (IQI's) shall be made of titanium or titanium shall be the predominant alloying constituent.

7.2.1.2 Use on all alloys of which titanium is the predominant alloying constituent.

7.2.2 Materials Group 02:

7.2.2.1 Image quality indicators (IQI's) shall be made of aluminum or aluminum shall be the predominant alloying constituent.

7.2.2.2 Use on all alloys of which aluminum is the predominant alloying constituent.

7.2.3 Materials Group 03:

7.2.3.1 Image quality indicators (IQI's) shall be made of magnesium or magnesium shall be the predominant alloying constituent.

7.2.3.2 Use on all alloys of which magnesium is the predominant alloying constituent.

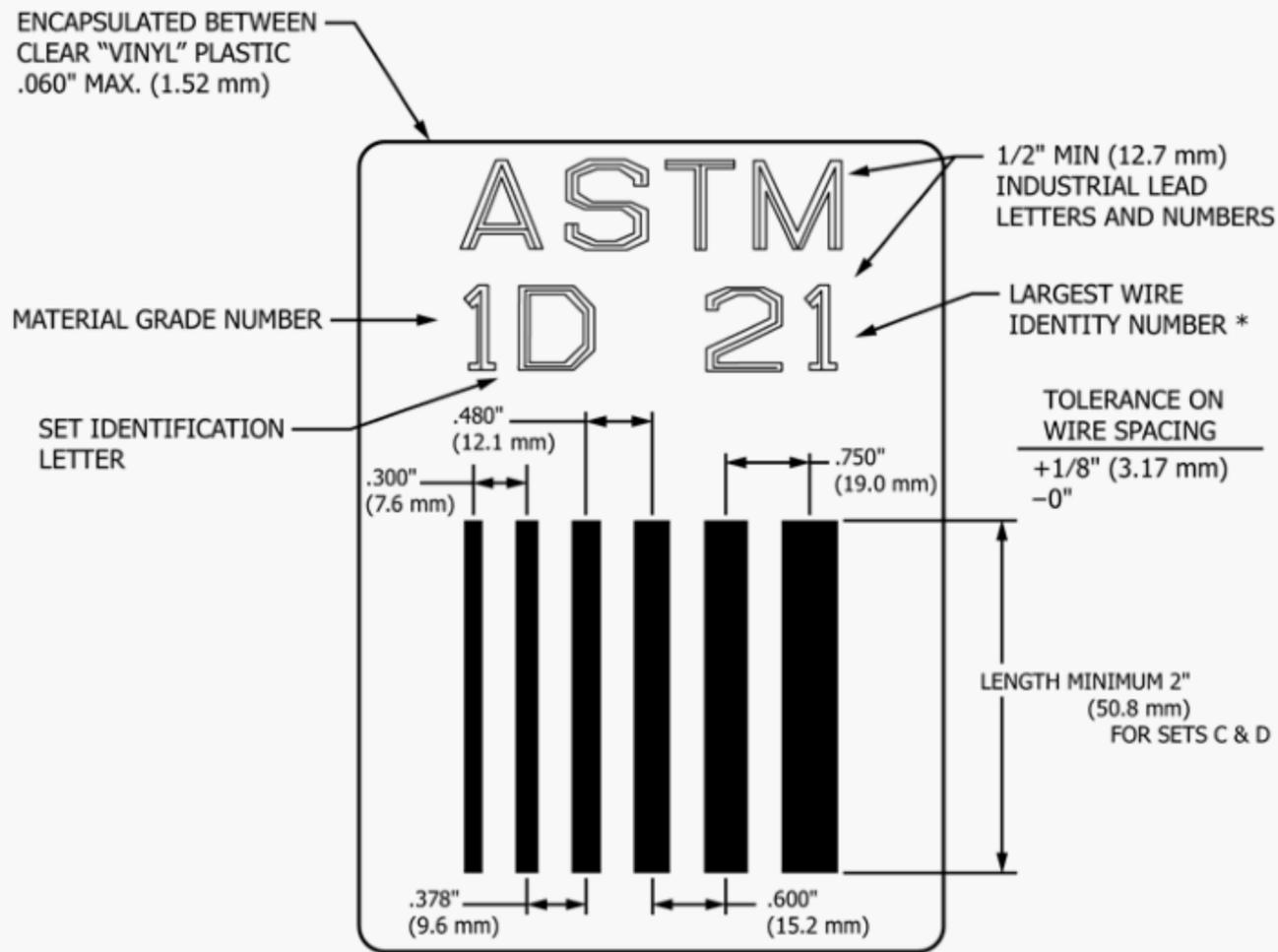
7.2.4 Materials Group 1:

7.2.4.1 Image quality indicators (IQI's) shall be made of carbon steel or Type 300 series stainless steel.

7.2.4.2 Use on all carbon steel, low-alloy steels, stainless steels, and manganese-nickel-aluminum bronze (Superston).⁶

7.2.5 Materials Group 2:

⁶ Superston is a registered trademark of Superston Corp., Jersey City, NJ.



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. 8 Set D/Alternate 2

7.2.5.1 Image quality indicators (IQI's) shall be made of aluminum bronze (Alloy No. 623 of Specification **B150M**) or equivalent, or nickel-aluminum bronze (Alloy No. 630 of Specification **B150M**) or equivalent.

7.2.5.2 Use on all aluminum bronzes and all nickel-aluminum bronzes.

7.2.6 *Materials Group 3:*

7.2.6.1 Image quality indicators (IQI's) shall be made of nickel-chromium-iron alloy (UNS No. N06600) (Inconel).⁷ (See Specification **B166**).

7.2.6.2 Use on nickel-chromium-iron alloy and 18 % nickel-maraging steel.

7.2.7 *Materials Group 4:*

7.2.7.1 Image quality indicators (IQI's) shall be made of 70 to 30 nickel-copper alloy (Monel)⁸ (Class A or B of Specification **B164**) or equivalent, or 70 to 30 copper-nickel alloy (Alloy G of Specification **B161**) or equivalent.

7.2.7.2 Use on nickel, copper, all nickel-copper series, or copper-nickel series of alloys, and all brasses (copper-zinc alloys). Group 4 IQI's may include the leaded brasses since leaded brass increases in attenuation with increase in lead content. This would be equivalent to using a lower group IQI.

7.2.8 *Materials Group 5:*

7.2.8.1 Image quality indicators (IQI's) shall be made of tin bronze (Alloy D of Specification **B139/B139M**).

7.2.8.2 Use on tin bronzes including gun-metal and valve bronze, or leaded-tin bronze of higher lead content than valve bronze. Group 5 IQI's may include bronze of higher lead content since leaded bronze increases in attenuation with increase in lead content. This would be equivalent to using a lower group IQI.

NOTE 1—In developing the eight listed materials groups, a number of other trade names or other nominal alloy designations were evaluated. For the purpose of making this practice as useful as possible, these materials are listed and categorized, by group, as follows:

(1) *Group 2*—Haynes Alloy IN-100.⁹

(2) *Group 3*—Haynes Alloy No. 713C, Hastelloy D¹⁰, G.E. Alloy SEL, Haynes Stellite Alloy No. 21, GMR-235 Alloy, Haynes Alloy No. 93, Inconel X⁷, Inconel 718, and Haynes Stellite Alloy No. S-816.

(3) *Group 4*—Hastelloy Alloy F, Hastelloy Alloy X, and Multimeter Alloy Rene 41.

(4) *Group 5*—Alloys in order of increasing attenuation: Hastelloy Alloy B, Hastelloy Alloy C, Haynes Stellite Alloy No. 31, Thetaloy, Haynes Stellite No. 3, Haynes Alloy No. 25. Image quality indicators (IQI's) of any of these materials are considered applicable for the materials that follow it.

NOTE 2—The committee formulating these recommendations recommend other materials may be added to the materials groups listed as the need arises or as more information is gained, or that additional materials groups may be added.

7.3 *Method for Other Materials:*

7.3.1 For materials not herein covered, IQI's of the same materials, or any other material, may be used if the following

⁷ Inconel is a registered trademark of The International Nickel Co., Inc., Huntington, WV 25720.

⁸ Monel is a registered trademark of The International Nickel Co., Inc., Huntington, WV 25720.

⁹ All Haynes alloys are registered trademarks of Union Carbide Corp., New York, NY.

¹⁰ All Hastelloys and Haynes Stellite alloys are registered trademarks of the Cabot Corp., Boston, MA.

requirements are met. Two blocks of equal thickness, one of the material to be examined (production material) and one of the IQI material, shall be radiographed on one film by one exposure at the lowest energy level to be used for production. Transmission densitometer measurements of the radiographic image of each material shall be made. The density of each image shall be between 2.0 and 4.0. If the image density of the IQI material is within 1.00 to 1.15 times (–0 % to + 15 %) the image density of the production material, IQI's made of that IQI material may be used in radiography of that production material. The percentage figure is based on the radiographic density of the IQI material.

7.3.2 It shall always be permissible to use IQI's of similar composition as the material being examined.

8. Image Quality Indicator (IQI) Certification

8.1 Documents shall be provided by the IQI manufacturer attesting to the following:

- 8.1.1 IQI identification alternate, if used.
- 8.1.2 Material type.
- 8.1.3 Conformance to specified tolerances for dimensional values.
- 8.1.4 ASTM standard designation, for example, ASTM E747—(year designation) used for manufacturing.

9. Precision and Bias

9.1 *Precision and Bias*—No statement is made about the precision or bias for indicating the quality of images since the results merely state whether there is conformance to the criteria for success specified in this practice.

10. Keywords

10.1 density; image quality level; IQI; radiographic; radiography; X-ray and gamma radiation

ANNEX

(Mandatory Information)

A1. ALTERNATE IQI IDENTIFICATION

A1.1 The use of IQI's with identifications as shown on Figs. A1.1-A1.9 and as listed in Table A1.1 is permitted as an acceptable alternate provided all other requirements of Practice E747 are satisfied.

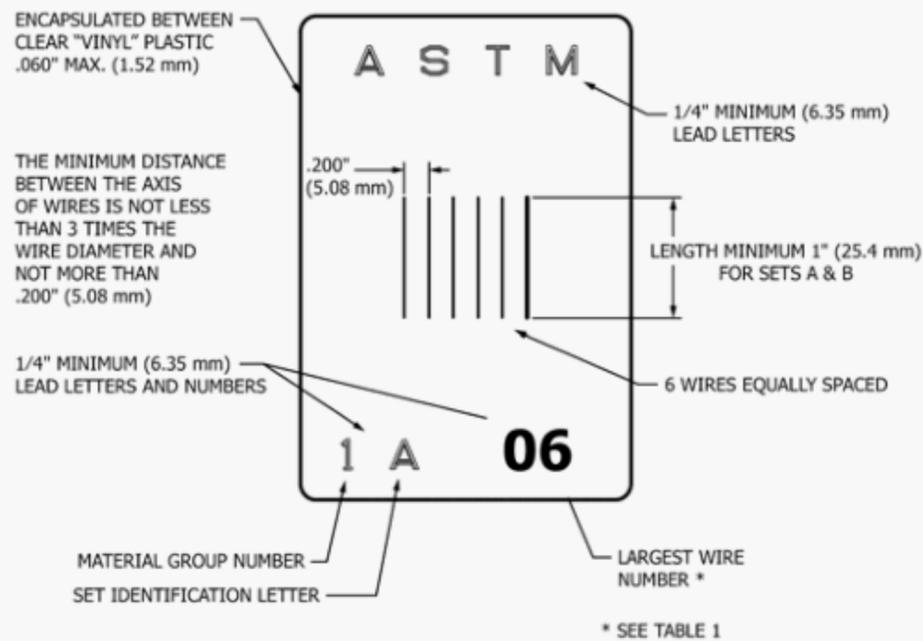
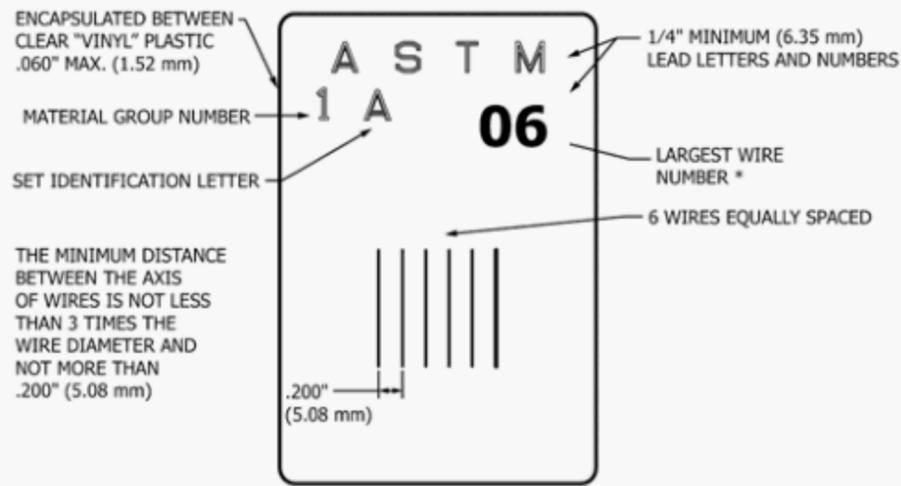
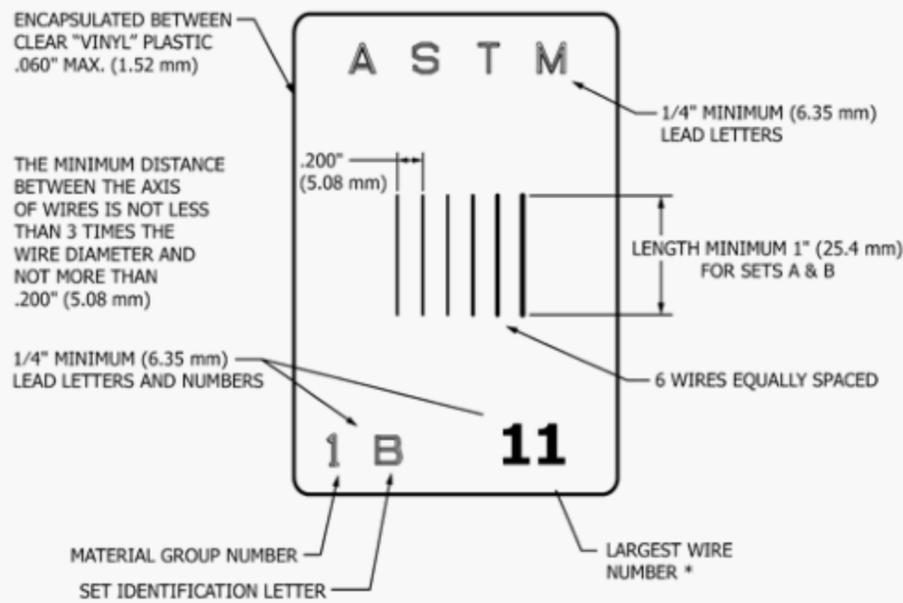


FIG. A1.1 Set A/Alternate 1



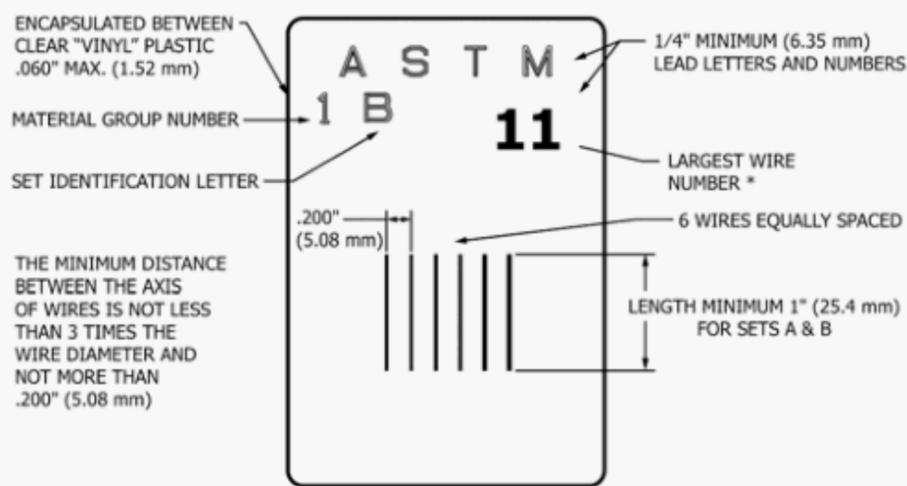
* SEE TABLE 1

FIG. A1.2 Set A/Alternate 2



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. A1.3 Set B/Alternate 1



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. A1.4 Set B/Alternate 2

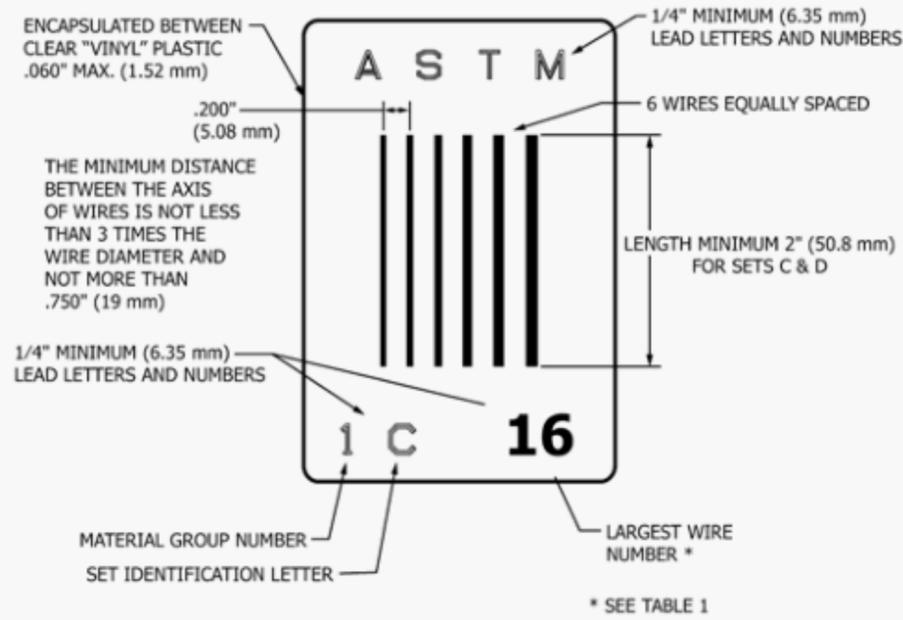


FIG. A1.5 Set C/Alternate 1

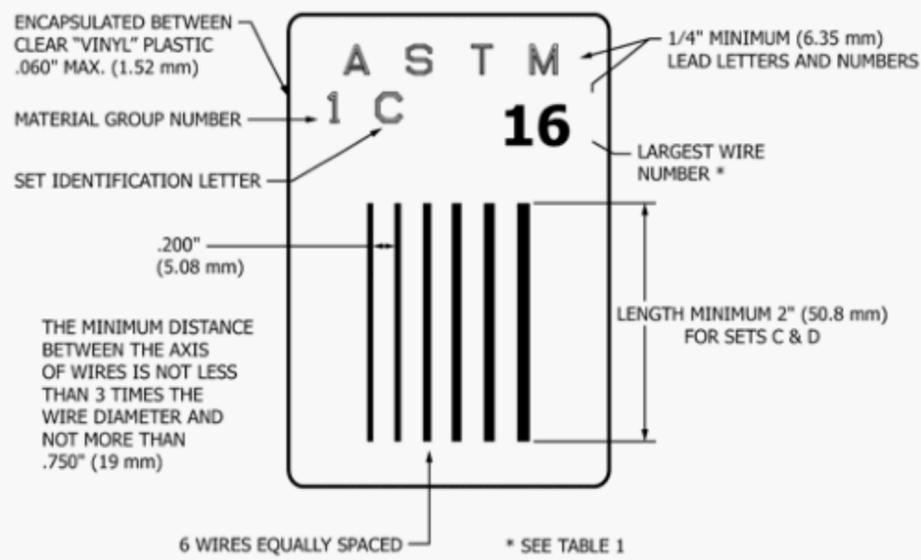


FIG. A1.6 Set C/Alternate 2

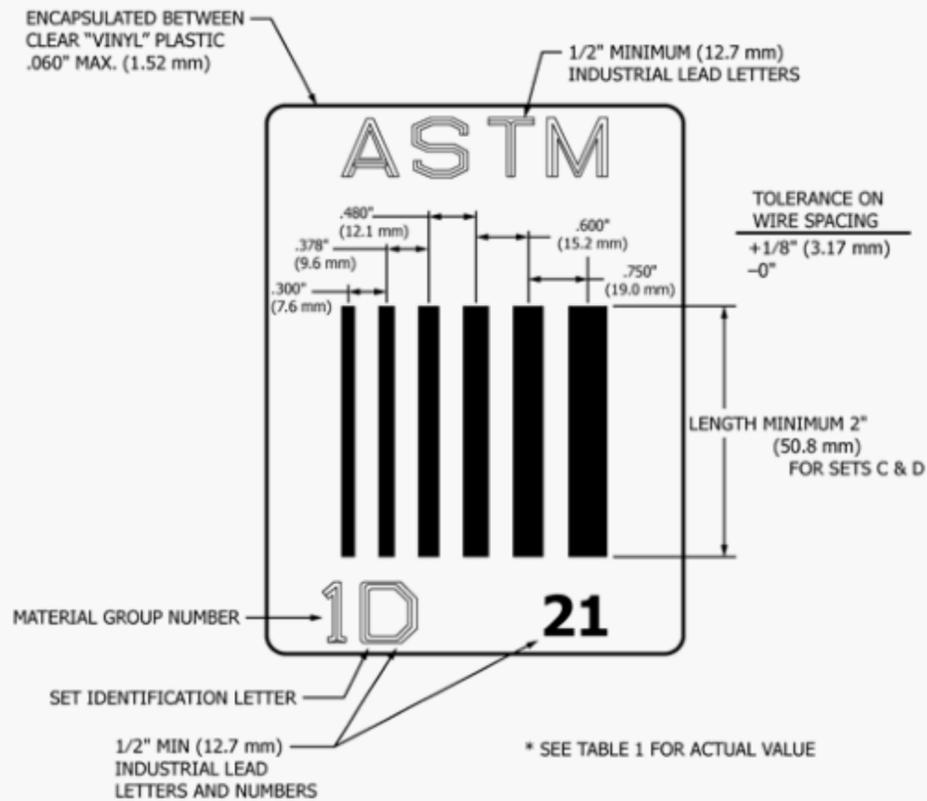
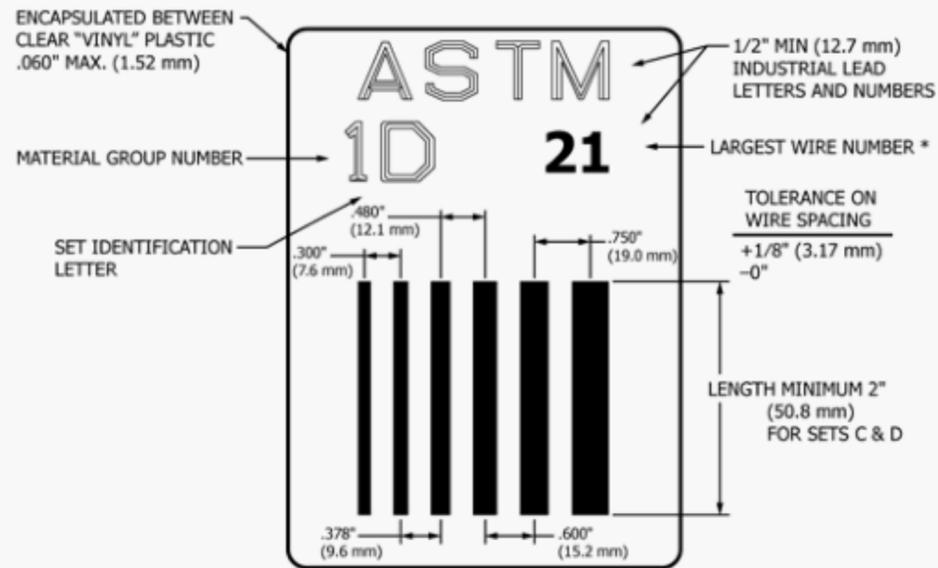
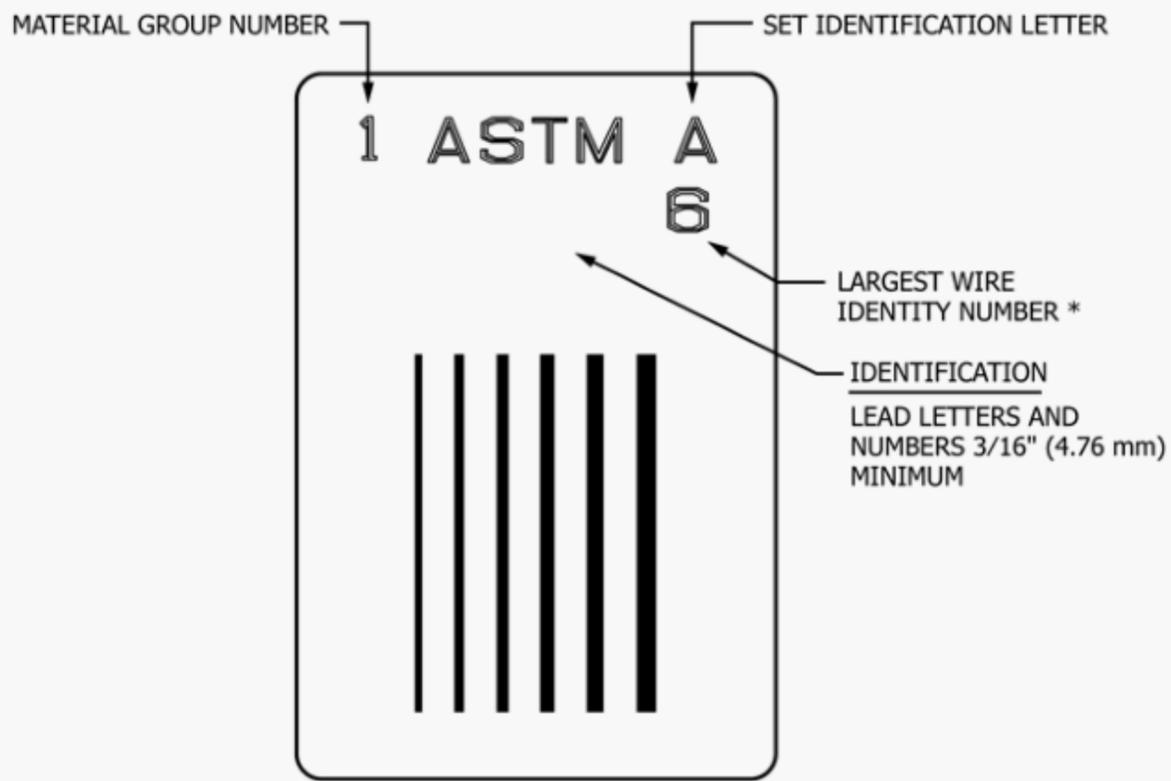


FIG. A1.7 Set D/Alternate 1



* SEE TABLE 1 FOR ACTUAL VALUE

FIG. A1.8 Set D/Alternate 2



* SEE TABLE 1

NOTE 1—All other IQI requirements as shown on Figs. 1-8 or Figs. A1.1-A1.8 apply.

FIG. A1.9 Alternate Identification Locations and Letter, Number Size-Typical All Sets (A, B, C, D)

TABLE A1.1 IQI Wire Diameters in. (mm) and Wire Identities
TABLE A1.1 Conversion of ASTM to ISO Wire Identities

SET A	ASTM Wire Identity	ISO Alternate Wire No. ISO 19232-1 ^A	SET B	ASTM Wire Identity	ISO Alternate Wire No. ISO 19232-1 ^A
0.0032(0.08)	1	W 17	0.010(0.25)	6	W 12
0.0040(0.1)	2	W 16	0.013(0.33)	7	W 11
0.0050(0.13)	3	W 15	0.016(0.41)	8	W 10
0.0063(0.16)	4	W 14	0.020(0.51)	9	W 9
0.0080(0.2)	5	W 13	0.025(0.64)	10	W 8
0.010(0.25)	6	W 12	0.032(0.81)	11	W 7

SET C	ASTM Wire Identity	ISO Alternate Wire No. ISO 19232-1 ^A	SET D	ASTM Wire Identity	ISO Alternate Wire No. ISO 19232-1 ^A
0.032(0.81)	11	W 7	0.100(2.5)	16	W 2
0.040(1.02)	12	W 6	0.126(3.2)	17	W 1
0.050(1.27)	13	W 5	0.160(4.06)	18	...
0.063(1.6)	14	W 4	0.20(5.1)	19	...
0.080(2.03)	15	W 3	0.25(6.4)	20	...
0.100(2.50)	16	W 2	0.32(8.1)	21	...

^AAs governed under provisions of paragraph 4.1.5 of this practice.

APPENDIX

(Nonmandatory Information)

X1. CALCULATION OF EQUIVALENT WIRE IDENTITIES FOR PLAQUE HOLE IDENTITIES

X1.1 International Procedures for Conversion of Plaque Hole Identities to Equivalent Wire Identities

X1.1.1 Two different conversion models are used in different international standards. These are:

X1.1.1.1 ISO 19232-3 and ISO 17636-2 (both have identical conversion tables; see Fig. X1.2).

X1.1.1.2 ASTM E747 (version of 2010 and Table X1.3) and ASME BPVC, API, etc.

X1.1.2 Both conversion models are not equivalent (see Fig. X1.1) at higher material thicknesses (>1 in. (25.4 mm)) and higher radiation energies (> 400 kV for steel). The user may select the conversion model depending on the standard practice to apply and its requirements for IQI reading. Different requirements on positioning and discernibility of the wire IQIs and hole type IQIs are defined in the standard systems mentioned above. The specific data are given in X1.2 and X1.3.

TABLE X1.3 Wire Sizes Equivalent to Corresponding 1T, 2T, and 4T Holes in Various Hole Type Plaques^A

Plaque Thickness,	Plaque IQI Identification Number	Diameter of wire with EPS of hole in plaque					
		1T		2T		4T	
inch (mm)		inch	mm	inch	mm	inch	mm
0.005 (0.13)	5			0.0038	(0.09)	0.006	(0.15)
0.006 (0.16)	6			0.004	(0.10)	0.0067	(0.18)
0.008 (0.20)	8	0.0032	(0.08)	0.005	(0.13)	0.008	(0.20)
0.009 (0.23)	9	0.0035	(0.09)	0.0056	(0.14)	0.009	(0.23)
0.010 (0.25)	10	0.004	(0.10)	0.006	(0.15)	0.010	(0.25)
0.012 (0.30)	12	0.005	(0.13)	0.008	(0.20)	0.012	(0.28)
0.015 (0.38)	15	0.0065	(0.16)	0.010	(0.25)	0.016	(0.41)
0.017 (0.43)	17	0.0076	(0.19)	0.012	(0.28)	0.020	(0.51)
0.020 (0.51)	20	0.010	(0.25)	0.015	(0.38)	0.025	(0.63)
0.025 (0.64)	25	0.013	(0.33)	0.020	(0.51)	0.032	(0.81)
0.030 (0.76)	30	0.016	(0.41)	0.025	(0.63)	0.040	(1.02)
0.035 (0.89)	35	0.020	(0.51)	0.032	(0.81)	0.050	(1.27)
0.040 (1.02)	40	0.025	(0.63)	0.040	(0.02)	0.063	(1.57)
0.050 (1.27)	50	0.032	(0.81)	0.050	(1.27)	0.080	(2.03)
0.060 (1.52)	60	0.040	(1.02)	0.063	(1.57)	0.100	(2.54)
0.070 (1.78)	70	0.050	(1.27)	0.080	(2.03)	0.126	(3.20)
0.080 (2.03)	80	0.063	(1.57)	0.100	(2.54)	0.160	(4.06)
0.100 (2.50)	100	0.080	(2.03)	0.126	(3.20)	0.200	(5.08)
0.120 (3.05)	120	0.100	(2.54)	0.160	(4.06)	0.250	(6.35)
0.140 (3.56)	140	0.126	(3.20)	0.200	(5.08)	0.320	(8.13)
0.160 (4.06)	160	0.160	(4.06)	0.250	(6.35)		
0.200 (5.08)	200	0.200	(5.08)	0.320	(8.13)		
0.240 (6.10)	240	0.250	(6.35)				
0.280 (7.11)	280	0.320	(8.13)				

^AMinimum plaque hole sizes were used as defined within Practice E1025.

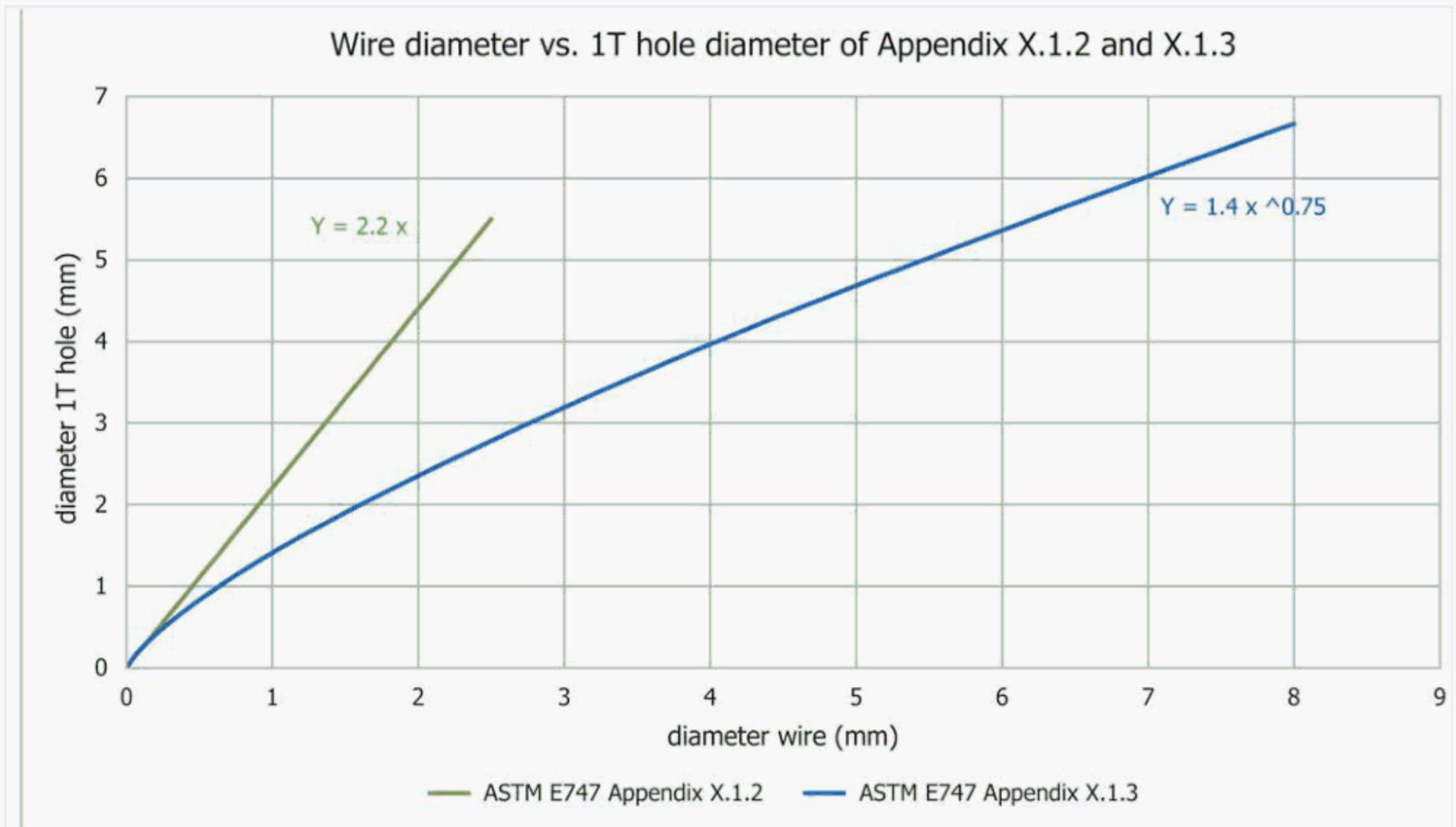


FIG. X1.1 Conversion Graph of 1T Hole Diameters to Wire Diameters for Different Applications

X1.2 Conversion of Plaque Hole Identities to Wire Identities to be Placed on Uniform Surface Profiles

X1.2 The visibility of wires in film radiography and in digital radiography can be determined by the following equation in reference to ISO 19232-3 and ISO 17636-1, 17636-2:

$$d_{wire} = \frac{\sqrt{d_{hole} \cdot T_{plaque}}}{2.2} \quad (X1.1)$$

The factor of 2.2 is an empirically approximated factor. It is used in ISO 19232-3, and ISO 17636-1 and 17636-2 for conversion of IQI wire diameters to IQI step hole diameters with 1T holes for equivalent visibility requirements. It is used for film and digital radiography applications. ISO 17636-1 and 17636-2 recommend to read the wire number in the area of the base material near the weld and not across the weld indication. It is required to see the wire over a length of at least 0.4 in. (~10 mm) without interruption. The required wire number is selected depending on the nominal base material thickness. ISO 19232-3 and ISO 17636-1 and 17636-2 define the image quality requirements by wire numbers for wires in a diameter range of 0.002 in. (0.05 mm) and 0.08 in. (2.05 mm). The exact conversion values be can be found in Table X1.2. The table contains different conversion values for true T hole IQIs and regular T hole IQIs with limitation of lower hole diameter as defined in E 1025. If the holes are larger than the minimum values as defined in E 1025 (1T ≥ 0.01 in. (0.254 mm), 2T ≥ 0.02 in. (0.508 mm) and 4T ≥ 0.04 in.(1.016 mm)) the regular hole IQIs are identical with true T hole IQIs. This explains also the free fields in Table X1.2, since all holes ≥ 0.01 in. (0.254 mm) are regular and true T hole IQIs. The wire IQIs, as defined

TABLE X1.1 Determination of Equivalent Wire Diameter in Dependence on Radiographic Sensitivity (EPS) and Plaque Thickness

Sensitivity	Sensitivity and Hole-to-Wire Conversion		
	EPS (%)	Plaque Thickness	Equivalent Wire Diameter
1-1T	0.7	0.01 x T	0.0045 x T
1-2T	1	0.01 x T	0.0064 x T
1-4T	1.4	0.01 x T	0.0091 x T
2-1T	1.4	0.02 x T	0.0091 x T
2-2T	2	0.02 x T	0.013 x T
2-4T	2.8	0.02 x T	0.018 x T

in this standard, start with identity "1" at 0.0032 in. (0.08 mm) wire diameter. ISO 19232-1 IQIs have also smaller wire diameters, which are W 18 and W 19. These wires are included in the list for completeness.

X1.3 Conversion of Plaque Hole Identities to Wire Identities to be placed on Non-Uniform Profiles.

X1.3 ASME BPVC, API-1104, ASTM E 1742 and E 1032 require to read the wire number in the area of the weld indication with the wires across the weld. It is required to see the wire over the full length without interruption. The required wire number is selected depending on the weld thickness. The related reading of the hole type IQIs requires positioning the IQI on an equivalent block or on shims near the weld or on the weld. The block or shim thickness is chosen to achieve the IQI reading at the average thickness of the weld. The equation to determine the equivalencies between wire and (hole type) IQI's based on E747-10 is as follows:

$$F^3 d^3 l = T^2 H^2 (\pi/4)$$

TABLE X1.2 Wire Diameters and Identity Equivalent to Corresponding 1T, 2T, and 4T Holes in Various Hole Type Plaques

Wire IQI identification by ASTM E747	Wire IQI Diameter as Defined in ASTM E747		Equivalent Plaque IQI Identification Number Corresponding to E1025		
	inch	mm	1T	2T	4T
	1T True T Holes		1T	2T True T Holes	4T
W 19	0.0020	0.51	4	3	2
W 18	0.0025	0.064	6	4	3
1	0.0032	0.081	7	5	4
2	0.004	0.102	9	6	4
3	0.005	0.127		8	6
4	0.0063	0.160			7
5	0.008	0.203			9
	Regular Holes with Limited Hole Size as Defined in E1025				
1	0.0032	0.081	2	1	1
2	0.004	0.102	4	2	1
3	0.005	0.127	6	3	1
4	0.0063	0.160	9	4	2
5	0.008	0.203		7	4
	Regular Holes and True T Holes				
3	0.005	0.127	11		
4	0.0063	0.160	14	10	
5	0.008	0.203	18	12	
6	0.010	0.254	22	16	11
7	0.013	0.330	29	20	14
8	0.016	0.406	35	25	18
9	0.020	0.508	44	31	22
10	0.025	0.635	55	39	28
11	0.032	0.813	70	50	35
5					
12	0.04	1.016	88	62	44
13	0.050	1.270	110	78	55
14	0.063	1.600	139	98	69
15	0.080	2.032	176	124	88
16	0.100	2.540	220	156	110
17	0.126	3.200	277	196	139

where:

- F = form factor for wire, 0.79,
- d = wire diameter, in. (mm),
- l = effective length of wire, 0.3 in. (7.6 mm),
- T = plaque thickness, in. (mm), and
- H = diameter of hole, in. (mm).

NOTE X1.1—The wire and plaque (hole type) IQI sensitivities is not converted by a fixed constant here. The exact conversion values be can found in **Table X1.3**. The table contains conversion values for regular T hole IQIs with limitation of lower hole diameter as defined in E 1025 (1T \geq 0.01 in. (0.254 mm), 2T \geq 0.02 in. (0.508 mm) and 4T \geq 0.04 in. (1.016 mm)).

NOTE X1.2— T is the specimen thickness of the sample to penetrate. The table is correct, if T is used in inch or mm.

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