

ASTM A450/A450M-03 《碳素钢、铁素体和奥氏体合金钢钢管的一般要求》									
12	复试	若有一组或一批试样力学性能结果不合各自标准要求，可从同一组或批另取2倍原样数量复试，每一根应符合规定的要求。							
13	重新热处理	若选为代表任一组或批的单根或多根钢管不能满足试验要求，则该组、该批、或单根钢管可以重新接受热处理并重新接受试验。重新热处理次数不能多于2次。							
14	压扁性能	试样长 $\geq 63\text{mm}$ 、压扁分二步 (1) 延性试验，压至小于H值，管样内外表面或端部表面不得有裂纹或破裂； (2) 完整性试验，压至试样破裂或两壁相触，整个过程无分层或缺陷。 压扁常数：低碳钢($C \leq 0.18\%$)和奥氏体钢为0.09；中碳钢($C \geq 0.19\%$)为0.07；铁素体钢为0.08。由试样表面缺陷造成的肤裂和对D/S < 10 钢管，压扁上下两顶点裂纹均不作拒收依据。							
15	扩口性能 (内径扩口率)%	试样长约100mm、顶心锥角 60°							
		d/D	0.9	0.8	0.7	0.6	0.5	0.4	0.3
		碳素钢、碳钼钢 奥氏体钢	≥ 21	≥ 22	≥ 25	≥ 30	≥ 39	≥ 51	≥ 68
		其它铁素体钢合金钢	≥ 15	≥ 17	≥ 19	≥ 23	≥ 28	≥ 38	≥ 50
16	卷边性能	卷边角 90°			卷边宽度				
		碳素钢、合金钢： $D \leq 63.5\text{mm}$ $D > 63.5 \sim 95.2\text{mm}$ $D > 95.2 \sim 203.2\text{mm}$			$15.0\%D$ $12.5\%D$ $10.0\%D$				
		奥氏体钢 各种尺寸			$15.0\%D$				
17	硬度试验	$S \geq 5.1\text{mm}$ 做布氏或洛氏硬度，硬度值按产品标准。 $S \geq 1.7 \sim 5.1\text{mm}$ 做洛氏硬度，硬度值按产品标准。 $S < 1.7\text{mm}$ 不做硬度。 若产品标准规定维氏硬度检验，则按ASTM E92进行。							
18	水压试验	逐支水压，试验压力为 $P=220.6S/D$ ， P：水压试验压力，Mpa，当 $P < 7\text{MPa}$ 时圆整到0.5MPa、 $P \geq 7\text{MPa}$ 时圆整到1MPa； S：规定的壁厚，mm； D：规定外径，mm； 水压时间 ≥ 5 秒，试验的最小压力不得超过下列值 $D < 25.4\text{mm}$ 7MPa $D \geq 38.1 \sim 50.8$ 14MPa $D \geq 76.2 \sim 127$ 24MPa $D \geq 25.4 \sim 38.1$ 10MPa $D \geq 50.8 \sim 76.2$ 17MPa $D \geq 127$ 31MPa							
19	气下水压试验	当采用此试验时，每一根内表面清洁、干燥了的管子应浸泡在清水中使用干净且不带水的压缩空气做最低内压为150psi (1000Kpa)的气压试验。管子的照明要良好，最好是在水下照明。在试验之前任何通风连接处的漏风应修好。在水表面已趋平静且通空气保压时间不少于5秒后，管子的整个外表面应经过检查。在水下气压试验过程中若管子有任何泄漏，则管子应被拒收。任何有泄漏的管段可以切去，管子需重新试验。							
20	无损检验	逐支进行超声 (E213)、涡流 (E309) 或漏磁 (E570) 检验。 涡流样管钻孔直径为 $\leq 0.8\text{mm}$ ；横切槽、纵向槽的深度 $\leq 12.5\%S$ (最小0.1mm)。 超声及漏磁样管内外刻槽深度均为 $\leq 12.5\%S$ (最小0.1mm)。超声样管槽宽 ≤ 2 倍槽深，漏磁样管槽长 $\leq 25\text{mm}$ 、宽度 \leq 深度。							
21	标志	标志内容：厂名或商标、标准号、牌号，需方要求时，可用条形码作为补充标志方法。 $D < 31.8\text{mm}$ 或 $L < 1\text{m}$ ，标志可印在标签上； $D \geq 31.8\text{mm}$ 且 $L \geq 1\text{m}$ ，标志应逐支印在钢管上。							
22	包装	当订单中规定时，按ASTM A700执行。							

ASTM A450/A450M-03 《碳素钢、铁素体和奥氏体合金钢钢管的一般要求》

23	<p>政府采购时的特殊规定</p>	<p>1、管子以外径和壁厚订货；</p> <p>2、压扁、扩口试验和外观、尺寸检验的最少取样数：</p> <table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">一批支数</td> <td style="text-align: center;">取样数</td> </tr> <tr> <td style="text-align: center;">2~8支</td> <td style="text-align: center;">整批</td> </tr> <tr> <td style="text-align: center;">9~90</td> <td style="text-align: center;">8支</td> </tr> <tr> <td style="text-align: center;">91~150</td> <td style="text-align: center;">12支</td> </tr> <tr> <td style="text-align: center;">151~280</td> <td style="text-align: center;">19支</td> </tr> <tr> <td style="text-align: center;">281~500</td> <td style="text-align: center;">21支</td> </tr> <tr> <td style="text-align: center;">501~1200</td> <td style="text-align: center;">27支</td> </tr> <tr> <td style="text-align: center;">1201~3200</td> <td style="text-align: center;">35支</td> </tr> <tr> <td style="text-align: center;">3201~10000</td> <td style="text-align: center;">38支</td> </tr> <tr> <td style="text-align: center;">10001~35000</td> <td style="text-align: center;">46支</td> </tr> </table> <p style="text-align: center;">其中全部合格即可接收，有一根不合格即可拒收。</p> <p>3、化学成分取样 从每批任意两根管子中各取一个样作化学成分试验。一批应为同一钢水浇注的所有材料。</p> <p>4、拉伸和弯曲试验取样 从每批钢管中取一个样。一批应由相同外径和壁厚、在8小时作业班内用同一炉钢制造、相同热处理、以及同时提交检查的管子组成。</p> <p>5、水压和超声探伤 逐根超声（当有规定时）和水压试验。当有规定时，超声波探伤按MIL-STD-271执行，刻槽深度为5%S或0.127mm，取其大值。</p> <p>6、标志 除按A530/A30M标准标志外，对于D≥13.7mm的管子，还应标志：a) 外径、壁厚和长度，b) 炉或批识别号。标志应按Fed. Std. No. 183和MIL-STD-792进行。</p> <p>7、直度</p> <table style="width: 100%; border: none;"> <thead> <tr> <th style="text-align: left;">规定外径 (mm)</th> <th style="text-align: left;">壁厚 (mm)</th> <th style="text-align: left;">每米最大弯曲度 (mm/m)</th> <th style="text-align: left;">全长最大弯曲度 (mm)</th> </tr> </thead> <tbody> <tr> <td>D≤127</td> <td>>3%D~12.7</td> <td style="text-align: center;">0.83</td> <td style="text-align: center;">0.83×L (m)</td> </tr> <tr> <td>D>127~203.2</td> <td>>4%D~19.05</td> <td style="text-align: center;">1.25</td> <td style="text-align: center;">1.25×L (m)</td> </tr> <tr> <td>D>203.2~323.85</td> <td>>4%D~25.4</td> <td style="text-align: center;">1.67</td> <td style="text-align: center;">1.67×L (m)</td> </tr> </tbody> </table> <p>8、表面</p> <p style="margin-left: 20px;">1) 不允许补焊</p> <p style="margin-left: 20px;">2) 允许壁厚偏差允许范围或0.127mm（取较大值）的划痕、矫痕、轻微的压痕、浅的凹坑和花纹氧化铁皮等缺陷存在。</p> <p>9、防锈 防锈应为A级或商品级，包装为A、B级或商品级，应按指定要求。</p>	一批支数	取样数	2~8支	整批	9~90	8支	91~150	12支	151~280	19支	281~500	21支	501~1200	27支	1201~3200	35支	3201~10000	38支	10001~35000	46支	规定外径 (mm)	壁厚 (mm)	每米最大弯曲度 (mm/m)	全长最大弯曲度 (mm)	D≤127	>3%D~12.7	0.83	0.83×L (m)	D>127~203.2	>4%D~19.05	1.25	1.25×L (m)	D>203.2~323.85	>4%D~25.4	1.67	1.67×L (m)
一批支数	取样数																																					
2~8支	整批																																					
9~90	8支																																					
91~150	12支																																					
151~280	19支																																					
281~500	21支																																					
501~1200	27支																																					
1201~3200	35支																																					
3201~10000	38支																																					
10001~35000	46支																																					
规定外径 (mm)	壁厚 (mm)	每米最大弯曲度 (mm/m)	全长最大弯曲度 (mm)																																			
D≤127	>3%D~12.7	0.83	0.83×L (m)																																			
D>127~203.2	>4%D~19.05	1.25	1.25×L (m)																																			
D>203.2~323.85	>4%D~25.4	1.67	1.67×L (m)																																			

常州仁成金属制品有限公司

官网: www.rcmetal.cn

电话: 0519-83611681

微信公众号: [steelbos](#)

官博: www.josen.net



Standard Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes¹

This standard is issued under the fixed designation A 450/A 450M; 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 Department of Defense.

1. Scope*

1.1 This specification² covers a group of requirements which, with the exceptions of 5.3 and Sections 6, 7, 18, 19, 20, 21, 22, 23, and 24, are mandatory requirements to the following ASTM tubular product specifications:³

Title of Specification	ASTM Designation ⁴
Electric-Resistance-Welded Carbon Steel and Carbon Manganese Steel Boiler Tubes	A 178/A 178M
Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes	A 179/A 179M
Seamless Carbon Steel Boiler Tubes for High-Pressure Service	A 192/A 192M
Seamless Medium-Carbon Steel Boiler and Superheater Tubes	A 210/A 210M
Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes	A 214/A 214M
Seamless and Electric-Welded Low-Alloy Steel Tubes	A 423/A 423M
Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines	A 539
Seamless Cold-Drawn Carbon Steel Feedwater Heater Tubes	A 556/A 556M
Seamless, Cold-Drawn Carbon Steel Tubing for Hydraulic System Service	A 822

⁴ These designations refer to the latest issue of the respective specifications.

1.2 One or more of Sections 5.3, 6, 7, 18, 19, 20, 21, 21.1, 23, and 24 apply when the product specification or purchase order has a requirement for the test or analysis described by these sections.

1.3 In case of conflict between a requirement of the product specification and a requirement of this general requirement specification only the requirement of the product specification need be satisfied.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must

be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation (SI) of the product specification is specified in the order.

2. Referenced Documents

2.1 ASTM Standards:⁴

- A 178/A 178M Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes
- A 179/A 179M Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
- A 192/A 192M Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service
- A 210/A 210M Specification for Seamless Medium-Carbon Steel Boiler and Superheater Tubes
- A 214/A 214M Specification for Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes
- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A 423/A 423M Specification for Seamless and Electric-Welded Low-Alloy Steel Tubes
- A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
- A 539 Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines⁵
- A 556/A 556M Specification for Seamless Cold-Drawn Carbon Steel Feedwater Heater Tubes
- A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A 822 Specification for Seamless Cold-Drawn Carbon Steel

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

Current edition approved March 1, 2004. Published April 2004. Originally approved in 1961. Last previous edition approved in 2003 as A 450/A 450M – 03.

² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-450 in Section II of that Code.

³ Annual Book of ASTM Standards, Vols 01.01 and 01.04.

⁴ 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.

⁵ Withdrawn.

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

- Tubing for Hydraulic System Service
- A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
- D 3951 Practice for Commercial Packaging
- E 92 Test Method for Vickers Hardness of Metallic Materials
- E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing
- E 273 Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing
- E 309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation
- E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel, and Similar Alloys
- E 570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products
- 2.2 *Federal Standard:*
Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products⁶
- 2.3 *Military Standards:*
MIL-STD-271 Nondestructive Testing Requirements for Metals⁶
MIL-STD-792 Identification Marking Requirements for Special Purpose Equipment⁶
- 2.4 *ASME Boiler and Pressure Vessel Code:*
Section IX Welding Qualifications⁷
- 2.5 *Steel Structures Painting Council:*
SSPC-SP 6 Surface Preparation Specification No. 6 Commercial Blast Cleaning⁸
- 2.6 *Other Document:*
SNT-TC-1A Recommended Practice for Nondestructive Personnel Qualification and Certification.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *remelted heat*—in secondary melting, all of the ingots remelted from a single primary heat.
- 3.1.2 *thin-wall tube*—a tube meeting the specified outside diameter and specified wall thickness set forth as follows:

Specified Outside Diameter	Specified Wall Thickness
-------------------------------	--------------------------

2 in. [50.8 mm] and less	2 % or less of specified outside diameter
Greater than 2 in. [50.8 mm]	3 % or less of specified outside diameter
All diameters	0.020 in. [0.5 mm] or less

3.2 *Other defined terms*—The definitions in Test Methods and Definitions A 370, Test Methods, Practices, and Terminology A 751, and Terminology A 941 are applicable to this specification and to those listed in 1.1.

4. Process

- 4.1 The steel may be made by any process.
- 4.2 If a specific type of melting is required by the purchaser, it shall be as stated on the purchase order.
- 4.3 The primary melting may incorporate separate degassing or refining and may be followed by secondary melting, such as electroslag remelting or vacuum-arc remelting.
- 4.4 Steel may be cast in ingots or may be strand cast. When steel of different grades is sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by an established procedure that positively separates the grades.

5. Chemical Composition

5.1 Samples for chemical analysis, and method of analysis shall be in accordance with Test Methods, Practices, and Terminology A 751.

5.2 *Heat Analysis*—If the heat analysis reported by the steel producer is not sufficiently complete for conformance with the heat analysis requirements of the applicable product specification to be fully assessed, the manufacturer may complete the assessment of conformance with such heat analysis requirements by using a product analysis for the specified elements that were not reported by the steel producer, provided that product analysis tolerances are not applied and the heat analysis is not altered.

5.3 *Product Analysis*—Product analysis requirements and options, if any, are contained in the product specification.

6. Tensile Properties

6.1 The material shall conform to the requirements as to tensile properties prescribed in the individual specification.

6.2 The yield strength corresponding to a permanent offset of 0.2 % of the gage length or to a total extension of 0.5 % of the gage length under load shall be determined.

6.3 If the percentage of elongation of any test specimen is less than that specified and any part of the fracture is more than 3/4 in. [19.0 mm] from the center of the gage length, as indicated by scribe marks on the specimen before testing, a retest shall be allowed.

⁶ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

⁷ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

⁸ Available from Steel Structures Painting Council (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656.

7. Standard Weights

7.1 The calculated weight per foot, based upon a specified minimum wall thickness, shall be determined by the following equation:

$$W = C(D - t)t \quad (1)$$

where:

$C = 10.69$ [0.0246615],

$W =$ weight, lb/ft [kg/m],

$D =$ specified outside diameter, in. [mm], and

$t =$ specified minimum wall thickness, in. [mm]

7.2 The permissible variations from the calculated weight per foot [kilogram per metre] shall be as prescribed in Table 1.

8. Permissible Variations in Wall Thickness

8.1 Variations from the specified minimum wall thickness shall not exceed the amounts prescribed in Table 2.

8.2 For tubes 2 in. [50.8 mm] and over in outside diameter and 0.220 in. [5.6 mm] and over in thickness, the variation in wall thickness in any one cross section of any one tube shall not exceed the following percentage of the actual mean wall at the section. The actual mean wall is defined as the average of the thickest and thinnest wall in that section.

Seamless tubes $\pm 10\%$

Welded tubes $\pm 5\%$

8.3 When cold-finished tubes as ordered require wall thicknesses $\frac{3}{4}$ in. [19.1 mm] or over, or an inside diameter 60 % or less of the outside diameter, the permissible variations in wall thickness for hot-finished tubes shall apply.

9. Permissible Variations in Outside Diameter

9.1 Except as provided in 9.2 and 9.3, variations from the specified outside diameter shall not exceed the amounts prescribed in Table 3.

9.2 Thin-wall tubes usually develop significant ovality (out of roundness) during final annealing, or straightening, or both. The diameter tolerances of Table 3 are not sufficient to provide for additional ovality expected in thin-wall tubes, and, for such tubes, are applicable only to the *mean* of the extreme (maximum and minimum) outside diameter readings in any one cross section. However, for thin wall tubes the *difference* in extreme outside diameter readings (ovality) in any one cross section shall not exceed the following ovality allowances:

Outside Diameter	Ovality Allowance
1 in. [25.4 mm] and under	0.020 in. [0.5 mm]
Over 1 in. [25.4 mm]	2.0 % of specified outside diameter

TABLE 1 Permissible Variations in Weight Per Foot^A

Method of Manufacture	Permissible Variation in Weight per Foot, %	
	Over	Under
Seamless, hot-finished	16	0
Seamless, cold-finished:		
1½ in. [38.1 mm] and under OD	12	0
Over 1½ in. [38.1 mm] OD	13	0
Welded	10	0

^A These permissible variations in weight apply to lots of 50 tubes or more in sizes 4 in. [101.6 mm] and under in outside diameter, and to lots of 20 tubes or more in sizes over 4 in. [101.6 mm] in outside diameter.

TABLE 2 Permissible Variations in Wall Thickness^A

Outside Diameter, in. [mm]	Wall Thickness, %							
	0.095 [2.4] and Under		Over 0.095 to 0.150 [2.4 to 3.8], incl		Over 0.150 to 0.180 [3.8 to 4.6], incl		Over 0.180, [4.6]	
	Over	Under	Over	Under	Over	Under	Over	Under
Seamless, Hot-Finished Tubes								
4 [101.6] and under	40	0	35	0	33	0	28	0
Over 4 [101.6]	35	0	33	0	28	0
Seamless, Cold-Finished Tubes								
	Over				Under			
1½ [38.1] and under	20				0			
Over 1½ [38.1]	22				0			
Welded Tubes								
All sizes	18				0			

^A These permissible variations in wall thickness apply only to tubes, except internal-upset tubes, as rolled or cold-finished, and before swaging, expanding, bending, polishing, or other fabricating operations.

TABLE 3 Permissible Variations in Outside Diameter^A

Outside Diameter, in. [mm]	Permissible Variations, in. [mm]	
	Over	Under
Hot-Finished Seamless Tubes		
4 [101.6] and under	¼ [0.4]	⅜ [0.8]
Over 4 to 7½ [101.6 to 190.5], incl	¼ [0.4]	¾ [1.2]
Over 7½ to 9 [190.5 to 228.6], incl	¼ [0.4]	⅛ [1.6]
Welded Tubes and Cold-Finished Seamless Tubes		
Under 1 [25.4]	0.004 [0.1]	0.004 [0.1]
1 to 1½ [25.4 to 38.1], incl	0.006 [0.15]	0.006 [0.15]
Over 1½ to 2 [38.1 to 50.8], excl	0.008 [0.2]	0.008 [0.2]
2 to 2½ [50.8 to 63.5], excl	0.010 [0.25]	0.010 [0.25]
2½ to 3 [63.5 to 76.2], excl	0.012 [0.3]	0.012 [0.3]
3 to 4 [76.2 to 101.6], incl	0.015 [0.38]	0.015 [0.38]
Over 4 to 7½ [101.6 to 190.5], incl	0.015 [0.38]	0.025 [0.64]
Over 7½ to 9 [190.5 to 228.6], incl	0.015 [0.38]	0.045 [1.14]

^A Except as provided in 9.2 and 9.3, these permissible variations include out-of-roundness. These permissible variations in outside diameter apply to hot-finished seamless, welded and cold-finished seamless tubes before other fabricating operations such as upsetting, swaging, expanding, bending, or polishing.

9.3 For cold-finished seamless austenitic and ferritic/austenitic tubes an ovality allowance is necessary for all sizes less than 2 in. [50.8 mm] outside diameter since they are likely to become out of round during their final heat treatment. In such tubes, the maximum and minimum diameters at any cross section shall deviate from the nominal diameter by no more than ± 0.010 in. [± 0.25 mm]; however, the mean diameter at that cross section must still be within the given permissible variation given in Table 3. In the event of conflict between the provisions of 9.3 and those of 9.2, the larger value of ovality tolerance shall apply.

10. Permissible Variations in Length

10.1 Variations from the specified length shall not exceed the amounts prescribed in Table 4.

TABLE 4 Permissible Variations in Length^A

Method of Manufacture	Outside Diameter, in. [mm]	Cut Length, in. [mm]	
		Over	Under
Seamless, hot-finished	All sizes	3/16 [5]	0 [0]
Seamless, cold-finished	Under 2 [50.8]	1/8 [3]	0 [0]
	2 [50.8] and over	3/16 [5]	0 [0]
Welded	Under 2 [50.8]	1/8 [3]	0 [0]
	2 [50.8] and over	3/16 [5]	0 [0]

^A These permissible variations in length apply to tubes before bending. They apply to cut lengths up to and including 24 ft [7.3 m]. For lengths greater than 24 ft [7.3 m], the above over-tolerances shall be increased by 1/8 in. [3 mm] for each 10 ft [3 m] or fraction thereof over 24 ft or 1/2 in. [13 mm], whichever is the lesser.

11. Permissible Variations in Height of Flash on Electric-Resistance-Welded Tubes

11.1 For tubes over 2 in. [50.8 mm] in outside diameter, or over 0.135 in. [3.44 mm] in wall thickness, the flash on the inside of the tubes shall be mechanically removed by cutting to a maximum height of 0.010 in. [0.25 mm] at any point on the tube.

11.2 For tubes 2 in. [50.8 mm] and under in outside diameter and 0.135 in. [3.4 mm] and under in wall thickness, the flash on the inside of the tube shall be mechanically removed by cutting to a maximum height of 0.006 in. [0.15 mm] at any point on the tube.

12. Straightness and Finish

12.1 Finished tubes shall be reasonably straight and have smooth ends free of burrs. They shall have a workmanlike finish. Surface imperfections (see Note 1) may be removed by grinding, provided that a smooth curved surface is maintained, and the wall thickness is not decreased to less than that permitted by this or the product specification. The outside diameter at the point of grinding may be reduced by the amount so removed.

NOTE 1—An imperfection is any discontinuity or irregularity found in the tube.

13. Repair by Welding

13.1 Repair welding of base metal defects in tubing is permissible only with the approval of the purchaser and with the further understanding that the tube shall be marked “WR” and the composition of the deposited filler metal shall be suitable for the composition being welded. Defects shall be thoroughly chipped or ground out before welding and each repaired length shall be reheat treated or stress relieved as required by the applicable specification. Each length of repaired tube shall be tested hydrostatically as required by the product specification.

13.2 Repair welding shall be performed using procedures and welders or welding operators that have been qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

14. Retests

14.1 If the results of the mechanical tests of any group or lot do not conform to the requirements specified in the individual specification, retests may be made on additional tubes of

double the original number from the same group or lot, each of which shall conform to the requirements specified.

15. Retreatment

15.1 If the individual tubes or the tubes selected to represent any group or lot fail to conform to the test requirements, the individual tubes or the group or lot represented may be retreated and resubmitted for test. Not more than two reheat treatments shall be permitted.

16. Test Specimens

16.1 Test specimens shall be taken from the ends of finished tubes prior to upsetting, swaging, expanding, or other forming operations, or being cut to length. They shall be smooth on the ends and free of burrs and flaws.

16.2 If any test specimen shows flaws or defective machining, it may be discarded and another specimen substituted.

17. Method of Mechanical Testing

17.1 The specimens and mechanical tests required shall be made in accordance with Annex A2 of Test Methods and Definitions A 370.

17.2 Specimens shall be tested at room temperature.

17.3 Small or subsize specimens as described in Test Methods and Definitions A 370 may be used only when there is insufficient material to prepare one of the standard specimens. When using small or subsize specimens, the largest one possible shall be used.

18. Flattening Test

18.1 A section of tube not less than 2 1/2 in. [63 mm] in length for seamless and not less than 4 in. [100 mm] in length for welded shall be flattened cold between parallel plates in two steps. For welded tubes, the weld shall be placed 90° from the direction of the applied force (at a point of maximum bending). During the first step, which is a test for ductility, no cracks or breaks, except as provided for in 18.4, on the inside, outside, or end surfaces shall occur in seamless tubes, or on the inside or outside surfaces of welded tubes, until the distance between the plates is less than the value of H calculated by the following equation:

$$H = \frac{(1 + e)t}{e + t/D} \quad (2)$$

where:

- H = distance between flattening plates, in. [mm],
- t = specified wall thickness of the tube, in. [mm],
- D = specified outside diameter of the tube, in. [mm], and
- e = deformation per unit length (constant for a given grade of steel: 0.07 for medium-carbon steel (maximum specified carbon 0.19 % or greater), 0.08 for ferritic alloy steel, 0.09 for austenitic steel, and 0.09 for low-carbon steel (maximum specified carbon 0.18 % or less)).

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the tube meet. Evidence of laminated or

unsound material, or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

18.2 Surface imperfections in the test specimens before flattening, but revealed during the first step of the flattening test, shall be judged in accordance with the finish requirements.

18.3 Superficial ruptures resulting from surface imperfections shall not be cause for rejection.

18.4 When low *D*-to- *t* ratio tubular products are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the six and twelve o'clock locations, cracks at these locations shall not be cause for rejection if the *D* to *t* ratio is less than 10.

19. Reverse Flattening Test

19.1 A 5 in. [100 mm] in length of finished welded tubing in sizes down to and including ½ in. [12.7 mm] in outside diameter shall be split longitudinally 90° on each side of the weld and the sample opened and flattened with the weld at the point of maximum bend. There shall be no evidence of cracks or lack of penetration or overlaps resulting from flash removal in the weld.

20. Flaring Test

20.1 A section of tube approximately 4 in. [100 mm] in length shall stand being flared with a tool having a 60° included angle until the tube at the mouth of the flare has been expanded to the percentages specified in Table 5 without cracking or showing imperfections rejectable under the provisions of the product specification.

21. Flange Test

21.1 A section of tube shall be capable of having a flange turned over at a right angle to the body of the tube without cracking or showing imperfections rejectable under the provisions of the product specification. The width of the flange for carbon and alloy steels shall be not less than the percentages specified in Table 6. For the austenitic grades, the width of the flange for all sizes listed in Table 6 shall be not less than 15 %.

22. Hardness Test

22.1 For tubes 0.200 in. [5.1 mm] and over in wall thickness, either the Brinell or Rockwell hardness test shall be used.

TABLE 6 Flange Requirements

Outside Diameter of Tube, in. [mm]	Width of Flange
To 2½ [63.5], incl	15 % of OD
Over 2½ to 3¾ [63.5 to 95.2], incl	12½ % of OD
Over 3¾ to 8 [95.2 to 203.2], incl	10 % of OD

When Brinell hardness testing is used, a 10-mm ball with 3000, 1500, or 500-kg load, or a 5-mm ball with 750-kg load may be used, at the option of the manufacturer.

22.2 For tubes less than 0.200 in. [5.1 mm] to and including 0.065 in. [1.7 mm] in wall thickness, the Rockwell hardness test shall be used.

22.3 For tubes less than 0.065 in. [1.7 mm] in wall thickness, the hardness test shall not be required.

22.4 The Brinell hardness test may be made on the outside of the tube near the end, on the outside of a specimen cut from the tube, or on the wall cross section of a specimen cut from the tube at the option of the manufacturer. This test shall be made so that the distance from the center of the impression to the edge of the specimen is at least 2.5 times the diameter of the impression.

22.5 The Rockwell hardness test may be made on the inside surface, on the wall cross section, or on a flat on the outside surface at the option of the manufacturer.

22.6 For tubes furnished with upset, swaged, or otherwise formed ends, the hardness test shall be made as prescribed in 22.1 and 22.2 on the outside of the tube near the end after the forming operation and heat treatment.

22.7 For welded or brazed tubes, the hardness test shall be made away from the joints.

22.8 When the product specification provides for Vickers hardness, such testing shall be in accordance with Test Method E 92.

23. Hydrostatic Test

23.1 Except as provided in 23.2 and 23.3, each tube shall be tested by the manufacturer to a minimum hydrostatic test pressure determined by the following equation:

$$\begin{aligned} \text{Inch-Pound Units: } P &= 32000 t/D \\ \text{SI Units: } P &= 220.6t/D \end{aligned} \tag{3}$$

where:

- P* = hydrostatic test pressure, psi or MPa,
- t* = specified wall thickness, in. or mm, and
- D* = specified outside diameter, in. or mm.

23.1.1 The hydrostatic test pressure determined by Eq 3 shall be rounded to the nearest 50 psi [0.5 MPa] for pressure below 1000 psi [7 MPa], and to the nearest 100 psi [1 MPa] for pressures 1000 psi [7 MPa] and above. The hydrostatic test may be performed prior to cutting to final length, or prior to upsetting, swaging, expanding, bending or other forming operations, or both.

23.2 Regardless of the determination made by Eq 3, the minimum hydrostatic test pressure required to satisfy these requirements need not exceed the values given in Table 7. This does not prohibit testing at higher pressures at manufacturer's option or as provided in 23.3.

TABLE 5 Flaring Test Requirements

Ratio of Inside Diameter to Outside Diameter ^A	Minimum Expansion of Inside Diameter, %	
	Carbon, Carbon-Molybdenum, and Austenitic Steels	Other Ferritic Alloy Steels
0.9	21	15
0.8	22	17
0.7	25	19
0.6	30	23
0.5	39	28
0.4	51	38
0.3	68	50

^A In determining the ratio of inside diameter to specified outside diameter, the inside diameter shall be defined as the actual mean inside diameter of the material tested.

TABLE 7 Hydrostatic Test Pressures

Outside Diameter of Tube, in. [mm]	Hydrostatic Test Pressure, psi [MPa]
Under 1 [25.4]	1000 [7]
1 to 1½ [25.4 to 38.1], excl	1500 [10]
1½ to 2 [38.1 to 50.8], excl	2000 [14]
2 to 3 [50.8 to 76.2], excl	2500 [17]
3 to 5 [76.2 to 127], excl	3500 [24]
5 [127] and over	4500 [31]

23.3 With concurrence of the manufacturer, a minimum hydrostatic test pressure in excess of the requirements of 23.2 or 23.1, or both, may be stated on the order. The tube wall stress shall be determined by the following equation:

$$S = PD/2t \quad (4)$$

where:

S = tube wall stress, psi or MPa, and all other symbols as defined in 23.1.1.

23.4 The test pressure shall be held for a minimum of 5 s.

23.5 If any tube shows leaks during the hydrostatic test, it shall be rejected.

23.6 The hydrostatic test may not be capable of testing the end portion of the pipe. The lengths of pipe that cannot be tested shall be determined by the manufacturer and, when specified in the purchase order, reported to the purchaser.

24. Air Underwater Pressure Test

24.1 When this test is employed, each tube, with internal surface clean and dry, shall be internally pressurized to 150 psi [1000 kPa] minimum with clean and dry compressed air while being submerged in clear water. The tube shall be well-lighted, preferably by underwater illumination. Any evidence of air leakage of the pneumatic couplings shall be corrected prior to testing. Inspection shall be made of the entire external surface of the tube after holding the pressure for not less than 5 s after the surface of the water has become calm. If any tube shows leakage during the air underwater test, it shall be rejected. Any leaking areas may be cut out and the tube retested.

25. Nondestructive Examination

25.1 When nondestructive examination is specified by the purchaser or the product specification, each tube shall be examined by a nondestructive examination method in accordance with Practice E 213, Practice E 309 (for ferromagnetic materials), Practice E 426 (for non-magnetic materials), or Practice E 570. Upon agreement, Practice E 273 shall be employed in addition to one of the full periphery tests. The range of tube sizes that may be examined by each method shall be subject to the limitations in the scope of that practice. In case of conflict between these methods and practices and this specification, the requirements of this specification shall prevail.

25.2 The following information is for the benefit of the user of this specification.

25.2.1 Calibration standards for the nondestructive electric test are convenient standards for calibration of nondestructive testing equipment only. For several reasons, including shape, orientation, width, etc., the correlation between the signal produced in the electric test from an imperfection and from

calibration standards is only approximate. A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular product.

25.2.2 The ultrasonic examination referred to in this specification is intended to detect longitudinal discontinuities having a reflective area similar to or larger than the calibration reference notches specified in 25.4. The examination may not detect circumferentially oriented imperfections or short, deep defects.

25.2.3 The eddy current examination referenced in this specification has the capability of detecting significant discontinuities, especially of the short abrupt type. Practices E 309 and E 426 contain additional information regarding the capabilities and limitations of eddy-current examination.

25.2.4 The flux leakage examination referred to in this specification is capable of detecting the presence and location of significant longitudinally or transversely oriented discontinuities. The provisions of this specification only provide for longitudinal calibration for flux leakage. It should be recognized that different techniques should be employed to detect differently oriented imperfections.

25.2.5 The hydrostatic test referred to in Section 22 is a test method provided for in many product specifications. This test has the capability of finding defects of a size permitting the test fluid to leak through the tube wall and may be either visually seen or detected by a loss of pressure. This test may not detect very tight, through-the-wall defects or defects that extend an appreciable distance into the wall without complete penetration.

25.2.6 A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular products.

25.3 *Time of Examination*—Nondestructive examination for specification acceptance shall be performed after all deformation processing, heat treating, welding, and straightening operations. This requirement does not preclude additional testing at earlier stages in the processing.

25.4 *Surface Condition:*

25.4.1 All surfaces shall be free of scale, dirt, grease, paint, or other foreign material that could interfere with interpretation of test results. The methods used for cleaning and preparing the surfaces for examination shall not be detrimental to the base metal or the surface finish.

25.4.2 Excessive surface roughness or deep scratches can produce signals that interfere with the test.

25.5 *Extent of Examination:*

25.5.1 The relative motion of the tube and the transducer(s), coil(s), or sensor(s) shall be such that the entire tube surface is scanned, except for end effects as noted in 25.5.2.

25.5.2 The existence of end effects is recognized, and the extent of such effects shall be determined by the manufacturer, and, if requested, shall be reported to the purchaser. Other nondestructive tests may be applied to the end areas, subject to agreement between the purchaser and the manufacturer.

25.6 Operator Qualifications:

25.6.1 The test unit operator shall be certified in accordance with SNT TC-1-A, or an equivalent documented standard agreeable to both purchaser and manufacturer.

25.7 Test Conditions:

25.7.1 For examination by the ultrasonic method, the minimum nominal transducer frequency shall be 2.0 MHz, and the maximum transducer size shall be 1.5 in. (38 mm).

25.7.2 For eddy current testing, the excitation coil frequency shall be chosen to ensure adequate penetration, yet provide good signal-to-noise ratio.

25.7.2.1 The maximum coil frequency shall be:

Specified Wall Thickness	Maximum Frequency
<0.050 in.	100 KHz
0.050 to 0.150	50
>0.150	10

25.8 Reference Standards:

25.8.1 Reference standards of convenient length shall be prepared from a length of tube of the same grade, specified size (outside diameter and wall thickness), surface finish and heat treatment condition as the tubing to be examined.

25.8.2 For eddy current testing, the reference standard shall contain, at the option of the manufacturer, any one of the following discontinuities:

25.8.2.1 *Drilled Hole*—The reference standard shall contain three or more holes, equally spaced circumferentially around the tube and longitudinally separated by a sufficient distance to allow distinct identification of the signal from each hole. The holes shall be drilled radially and completely through the tube wall, with care being taken to avoid distortion of the tube while drilling. The holes shall not be larger than 0.031 in. (0.8 mm) in diameter. As an alternative, the producer may choose to drill one hole and run the calibration standard through the test coil three times, rotating the tube approximately 120° each time. More passes with smaller angular increments may be used, provided testing of the full 360° of the coil is obtained. For welded tubing, if the weld is visible, one of the multiple holes or the single hole shall be drilled in the weld.

25.8.2.2 *Transverse Tangential Notch*—Using a round tool or file with a ¼ in. (6.4 mm) diameter, a notch shall be milled or filed tangential to the surface and transverse to the longitudinal axis of the tube. Said notch shall have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. (0.1 mm), whichever is greater.

25.8.2.3 *Longitudinal Notch*—A notch 0.031 in. (0.8 mm) or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the tube, to have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. (0.1 mm), whichever is greater. The length of the notch shall be compatible with the testing method.

25.8.3 For ultrasonic testing, the reference ID and OD notches shall be any one of the three common notch shapes shown in Practice E 213, at the option of the manufacturer. The depth of the notches shall not exceed 12½ % of the specified wall thickness of the tube or 0.004 in. (0.1 mm), whichever is greater. The width of the notch shall not exceed two times the depth. For welded tubing, the notches shall be placed in the weld, if the weld is visible.

25.8.4 For flux leakage testing, the longitudinal reference notches shall be straight-sided notches machined in a radial plane parallel to the tube axis on the inside and outside surfaces of the tube. Notch depth shall not exceed 12½ % of the specified wall thickness or 0.004 in. (0.1 mm), whichever is greater. Notch length shall not exceed 1 in. (25.4 mm), and the width shall not exceed the depth. Outside and inside notches shall have sufficient separation to allow distinct identification of the signal from each notch.

25.8.5 More or smaller reference discontinuities, or both, may be used by agreement between the purchaser and the manufacturer.

25.9 Standardization Procedure:

25.9.1 The test apparatus shall be standardized at the beginning and end of each series of tubes of the same specified size (diameter and wall thickness), grade and heat treatment condition, and at intervals not exceeding 4 h during the examination of such tubing. More frequent standardizations may be performed at the manufacturer's option or may be required upon agreement between the purchaser and the manufacturer.

25.9.2 The test apparatus shall also be standardized after any change in test system settings, change of operator, equipment repair, or interruption due to power loss or shutdown.

25.9.3 The reference standard shall be passed through the test apparatus at the same speed and test system settings as the tube to be tested, except that, at the manufacturer's discretion, the tubes may be tested at a higher sensitivity.

25.9.4 The signal-to-noise ratio for the reference standard shall be 2.5:1 or greater, and the reference signal amplitude for each discontinuity shall be at least 50 % of full scale of the display. In establishing the noise level, extraneous signals from identifiable surface imperfections on the reference standard may be ignored. When reject filtering is used during UT testing, linearity must be demonstrated.

25.9.5 If, upon any standardization, the reference signal amplitude has decreased by 29 % (3.0 dB), the test apparatus shall be considered out of standardization. The test system settings may be changed, or the transducer(s), coil(s), or sensor(s) adjusted, and the unit restandardized, but all tubes tested since the last acceptable standardization must be retested.

25.10 Evaluation of Imperfections:

25.10.1 Tubing producing a test signal to or greater than the lowest signal produced by the reference standard shall be designated suspect, shall be clearly marked or identified, and shall be separated from the acceptable tubing.

25.10.2 Such suspect tubing shall be subject to one of the following three dispositions:

25.10.2.1 The tubes may be rejected without further examination, at the discretion of the manufacturer.

25.10.2.2 If the test signal was produced by imperfections such as scratches, surface roughness, dings, straightener marks, loose ID bead and cutting chips, steel die stamps, stop marks, tube reducer ripple, or chattered flash trim, the tubing may be accepted or rejected depending on visual observation of the severity of the imperfection, the type of signal it produces on the testing equipment used, or both.

25.10.2.3 If the test signal was produced by imperfections which cannot be identified, or was produced by cracks or crack-like imperfections, the tubing shall be rejected.

25.10.3 Any tubes with imperfections of the types in 25.10.2.2 and 25.10.2.3, exceeding 0.004 in. (0.1 mm) or 12½ % of the specified minimum wall thickness (whichever is greater) in depth shall be rejected.

25.10.4 Rejected tubes may be reconditioned and retested providing the wall thickness is not decreased to less than that required by this or the product specification. If grinding is performed, the outside diameter in the area of grinding may be reduced by the amount so removed. To be accepted, reconditioned tubes must pass the nondestructive examination by which they were originally rejected.

26. Certified Test Report

26.1 When specified in the purchase order or contract, the producer or supplier shall furnish a Certified Test Report certifying that the material was manufactured, sampled, tested and inspected in accordance with the Specification, including year date, the Supplementary Requirements, and any other requirements designated in the purchase order or contract, and that the results met the requirements of that Specification, the Supplementary Requirements and the other requirements. A signature or notarization is not required on the Certified Test Report, but the document shall be dated and shall clearly identify the organization submitting the Report.

NOTE 2—Notwithstanding the absence of a signature or notarization, the organization submitting the Report is responsible for the contents of the Report.

26.2 In addition, the Certified Test Report shall include the following information and test results, when applicable:

- 26.2.1 Heat Number,
- 26.2.2 Heat Analysis,
- 26.2.3 Product Analysis, when specified,
- 26.2.4 Tensile Properties,
- 26.2.5 Width of the gage length, when longitudinal strip tension test specimens are used,
- 26.2.6 Flattening Test acceptable,
- 26.2.7 Reverse Flattening Test acceptable,
- 26.2.8 Flaring Test acceptable,
- 26.2.9 Flange Test acceptable,
- 26.2.10 Hardness Test values,
- 26.2.11 Hydrostatic Test pressure,
- 26.2.12 Non-destructive Electric Test method,
- 26.2.13 Impact Test results, and
- 26.2.14 Other test results or information required to be reported by the product specification.

26.3 Test results or information required to be reported by supplementary requirements, or other requirements designated in the purchase order or contract shall be reported, but may be reported in a separate document.

26.4 The Certified Test Report shall include a statement of explanation for the letter added to the specification number marked on the tubes (see 29.3), when all of the requirements of the specification have not been completed. The purchaser must certify that all requirements of the specification have been completed before removal of the letter (that is, X, Y, or Z).

27. Inspection

27.1 The inspector representing the purchaser shall have entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All required tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted so as not to interfere unnecessarily with the operation of the works.

28. Rejection

28.1 Each length of tubing received from the manufacturer may be inspected by the purchaser and, if it does not meet the requirements of the specification based on the inspection and test method as outlined in the specification, the length may be rejected and the manufacturer shall be notified. Disposition of rejected tubing shall be a matter of agreement between the manufacturer and the purchaser.

28.2 Material that fails in any of the forming operations or in the process of installation and is found to be defective shall be set aside and the manufacturer shall be notified for mutual evaluation of the material's suitability. Disposition of such material shall be a matter for agreement.

29. Product Marking

29.1 Each length of tube shall be legibly stenciled with the manufacturer's name or brand, the specification number, and grade. The marking need not include the year date of the specification. For tubes less than 1¼ in. [31.8 mm] in diameter and tubes under 3 ft. [1 m] in length, the required information may be marked on a tag securely attached to the bundle or box in which the tubes are shipped.

29.2 For austenitic tubes, the marking paint or ink shall not contain any harmful metal, or metal salts, such as zinc, lead, or copper, which cause corrosive attack on heating.

29.3 When it is specified that certain requirements of a specification adopted by the ASME Boiler and Pressure Vessel Committee are to be completed by the purchaser upon receipt of the material, the manufacturer shall indicate that all requirements of the specification have not been completed by a letter such as X, Y, or Z, immediately following the specification number. This letter may be removed after completion of all requirements in accordance with the specification. An explanation of specification requirements to be completed is provided in Section 26.

29.4 *Bar Coding*—In addition to the requirements in 29.1-29.3, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.

30. Packaging, Marking, and Loading

30.1 When specified on the purchase order, packaging, marking, and loading for shipment shall be in accordance with the procedures of Practices A 700.

31. Government Procurement

31.1 *Scale Free Pipe*:

31.1.1 When specified in the contract or order, the following requirements shall be considered in the inquiry contract or order, for agencies of the U.S. Government where scale free tube is required. These requirements shall take precedence if there is a conflict between these requirements and the product specification.

31.1.2 Tube shall be ordered to outside diameter (OD) and wall thickness.

31.1.3 *Responsibility for Inspection*— Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility for ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept the material. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections and tests set forth when such inspections and tests are deemed necessary to ensure that the material conforms to the prescribed requirements.

31.1.4 *Sampling for Flattening and Flaring Test and for Visual and Dimensional Examination*—Minimum sampling for flattening and flaring tests and visual and dimensional examination shall be as follows:

Lot Size (pieces per lot)	Sample Size
2 to 8	Entire lot
9 to 90	8
91 to 150	12
151 to 280	19
281 to 500	21
501 to 1200	27
1201 to 3200	35
3201 to 10 000	38
10 001 to 35 000	46

In all cases, the acceptance number is zero and the rejection number is one. Rejected lots may be screened and resubmitted for visual and dimensional examination. All defective items shall be replaced with acceptable items prior to lot acceptance.

31.1.5 *Sampling for Chemical Analysis*— One sample for chemical analysis shall be selected from each of two tubes chosen from each lot. A lot shall be all material poured from one heat.

31.1.6 *Sampling for Tension and Bend Test*— One sample shall be taken from each lot. A lot shall consist of all tube of the same outside diameter and wall thickness manufactured during an 8-h shift from the same heat of steel, and heat treated under the same conditions of temperature and time in a single charge in a batch type furnace, or heat treated under the same condition in a continuous furnace, and presented for inspection at the same time.

31.1.7 *Hydrostatic and Ultrasonic Tests*— Each tube shall be tested by the ultrasonic (when specified) and hydrostatic tests.

31.1.8 Tube shall be free from heavy oxide or scale. The internal surface of hot finished ferritic steel tube shall be pickled or blast cleaned to a free of scale condition equivalent to the CSA2 visual standard listed in SSPC-SP6. Cleaning shall be performed in accordance with a written procedure that has been shown to be effective. This procedure shall be available for audit.

31.1.9 In addition to the marking in Specification A 530/A 530M, each length of tube ¼ in. outside diameter and larger shall be marked with the following listed information. Marking shall be in accordance with FED-STD-183 and MIL-STD-792. (a) Outside diameter, wall thickness, and length (b) Heat or lot identification number.

31.1.10 Tube shall be straight to within the tolerances specified in Table 8:

31.1.11 When specified, each tube shall be ultrasonically examined in accordance with MIL-STD-271, except that the notch depth in the calibration standard shall be 5 % of the wall thickness or 0.005 in., whichever is greater. Any tube which produces an indication equal to or greater than 100 % of the indication from the calibration standard shall be rejected.

31.1.12 The tube shall be free from repair welds, welded joints, laps, laminations, seams, visible cracks, tears, grooves, slivers, pits, and other imperfections detrimental to the tube as determined by visual and ultrasonic examination, or alternate tests, as specified.

31.1.13 Tube shall be uniform in quality and condition and have a finish conforming to the best practice for standard quality tubing. Surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits, and scale pattern will not be considered injurious if the imperfections are removable within the tolerances specified for wall thickness or 0.005 in., whichever is greater. The bottom of imperfections shall be visible and the profile shall be rounded and faired-in.

31.1.14 No weld repair by the manufacturer is permitted.

31.1.15 Preservation shall be level A or commercial, and packing shall be level A, B, or commercial, as specified. Level A preservation and level A or B packing shall be in accordance with MIL-STD-163 and commercial preservation and packing shall be in accordance with Practices A 700 or Practice D 3951.

32. Keywords

32.1 alloy steel tube; austenitic stainless steel; carbon steel tube; general delivery; stainless steel tube; steel tube

TABLE 8 Straightness Tolerances

Specified OD (in.)	Specified Wall Thickness (in.)	Maximum Curvature in Any 3 ft (in.)	Maximum Curvature in Total Length (in.)
Up to 5.0, incl	Over 3 % OD to 0.5, incl	0.030	0.010 × length, ft
Over 5.0 to 8.0, incl	Over 4 % OD to 0.75, incl	0.045	0.015 × length, ft
Over 8.0 to 12.75, incl.	Over 4 % OD to 1.0, incl	0.060	0.020 × length, ft

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 450/A 450M – 03, which may impact the use of this standard. (Approved March 1, 2004)

(1) Revised 5.2.

(2) Deleted 5.2.1.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 450/A 450M – 02, which may impact the use of this standard. (Approved September 10, 2003)

(1) Added Terminology A 941 to Sections 3 and 8 as well as Referenced Documents.

(2) Added Section 3, Terminology. Renumbered subsequent sections accordingly.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 450/A 450M – 96a (2001), which may impact the use of this standard. (Approved September 10, 2002)

(1) Paragraph 1.1 was revised to delete standards that were either discontinued or now have their general requirements

addressed by Specification A 1016/A 1016M.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).



常州仁成金属制品有限公司	微信公众号: steelbos
官网: www.rcmetal.cn	官博: www.josen.net
电话: 0519-83611681	

ASTM 美国标准译文

ASTM A450/A450M-96a

铁素体、铁素体和奥氏体合金钢
钢管一般要求



冶金工业信息标准研究院

标准化研究所 标准信息部

碳钢、铁素体和奥氏体合金钢管一般要求

1. 范围

1.1 本标准除节4.3、5、6、17、18、19、20、21、22、23以外,包括一组对下列ASTM 管状产品标准的强制性要求。

标准名称	ASTM号
炼油用无缝低碳钢和碳铝合金钢蒸馏釜钢管	A161
电阻焊碳素钢和碳锰钢锅炉钢管	A178/A178M
无缝冷拔低碳钢热交换器和冷凝器钢管	A179/A179M
高压用无缝碳钢管锅炉钢管	A192/A192M
冷拔无缝中合金钢热交换器和冷凝器钢管	A199/A199M
炼油用无缝中合金钢蒸馏釜钢管	A200
无缝碳铝合金钢锅炉和过热器钢管	A209/A209M
无缝中碳钢管锅炉和过热器钢管	A210/A210M
无缝铁素体和奥氏体合金钢锅炉、过热器和热交换器钢管	A213/A213M
电阻焊碳钢管热交换器和冷凝器钢管	A214/A214M
高压用电阻焊碳钢管锅炉和过热器钢管	A226/A226M
焊接奥氏体钢锅炉、过热器、热交换器和冷凝器钢管	A249/A249M
电阻焊铁素体合金钢锅炉和过热器钢管	A250/A250M
普通无缝和焊接铁素体和马氏体不锈钢管	A268/A268M
普通无缝和焊接奥氏体不锈钢管	A269
无缝和焊接奥氏体不锈钢卫生钢管	A270
炼油用无缝奥氏体铬镍钢蒸馏釜钢管	A271
低温用无缝和焊接碳钢和合金钢管	A334/A334M
无缝和电阻焊低合金钢管	A423/A423M
煤气和燃料油用电阻焊成盘钢管	A539
冷拔无缝碳钢给水加热器管	A556/A556M
电阻焊碳钢给水加热器管	A557/A557M
焊接奥氏体不锈钢给水加热器管	A688/A688M
无缝中等强度碳铝合金钢锅炉和过热器钢管	A692
增殖反应堆核心部件用奥氏体不锈钢管	A771
普通无缝和焊接铁素体/奥氏体不锈钢管	A789/A789M
焊接未退火铁素体不锈钢管	A791/A791M
焊接铁素体不锈钢给水加热器钢管	A803/A803M
液压系统用无缝冷拔碳钢管	A822
增殖反应堆核心部件奥氏体和铁素体不锈钢导管	A826
高频感应焊接未退火奥氏体钢冷凝器管	A851

上述这些标准均为各自标准的最近版本。

1.2 只有在产品标准或订货单中规定节4.3、5、6、17、18、19、20、21、22和23对试验或分析有要求时,才使用上述各节的1条或几条。

1.3 本产品标准的要求与本一般要求标准的要求相互矛盾时,只需满足产品标准之要求。

1.4 以英寸-磅或Si二者之一为单位表示的数值,应按标准区别对待。在标准正文中,把Si单位列在圆括号中。以每种体系表示的数值不是完全相等的,因此,每种体系必须独立于其他体系单独应用。兼顾两种体系的数值,可能与本标准不一致。除在定单中规定产品标准采用“M”符号(Si)外,均应采用英寸-磅单位。

2. 适用文件

2.1 ASTM标准:

A370 钢产品力学检验的方法和定义

A530/A530M 专用碳钢和合金钢管一般要求

A700 国内装运钢产品包装、标志和装载方法

A751 钢产品化学分析方法、操作及术语

D3951 商业包装操作

E92 金属材料维氏硬度试验法

E237 直缝焊接钢管超声波检验法

E213 金属管的超声波检验法

E309 应用磁饱和原理做管状产品涡流检验法

E426 奥氏体不锈钢和类似合金钢无缝和焊接管状产品的电磁(涡流)检验法

E570 铁磁性钢制管状产品漏磁检验法

2.2 民用标准:

Fed. Std. No. 183 铁和钢产品的连续标志

2.3 军用标准:

MIL-STD-271 金属非破坏性检验要求

MIL-STD-792 特殊用途装备的标志要求

2.4 钢结构涂漆委员会

SSPC-SP6 表面制备规范No.6商业喷吹清洗

2.5 其他文件

SNT-TC-1A 非破坏性技术人员技能和证书

3. 制造方法

3.1 钢以任何方法制造。

3.2 如需方要求特殊种类的冶炼方法,应在需方订单中说明。

3.3 第一次冶炼是结合脱气或精炼进行的,有可能接着第二次冶炼,例如电渣重熔或真空电弧重熔。这种冶炼属于对第一次冶炼的全部钢锭的再次冶炼。

3.4 钢可以浇注成钢锭或连铸坯,当不同牌号的钢依次浇注成连铸坯时,要求对材料变换的结果作出标示。供方应采用已制定的强制分离钢牌号的工序。

4. 化学分析

4.1 化学成分取样以及分析方法,应符合A751钢产品化学分析方法、操作及术语的规定。

4.2 熔炼分析

钢的制造厂对每炉钢进行分析,以便测定所规定的各元素百分含量。如果进行第二次冶炼,则熔炼分析应从一根重熔钢锭上获得。或从第一次冶炼的一根重熔钢锭的产品上获得。这样测定出的,或由管状产品进行成分分析测得的化学成分,应符合产品规范中所规定的要求。

4.2.1 对于参照标准一般要求的产品标准所订货的不锈钢来说,这种钢不得含有某一未规定的元素,但氮元素除外。对于订货牌号达到这样的程度以至钢符合另外的牌号要求,这个另外牌号中的该元素是具有要求最小含量的规定元素。对于这样的要求来说,牌号以UNS牌号表示方法分别称为合金,以化学成分表的方式,把在本标准所包括的范围内容列入到任何标准中。

5. 拉伸性能

5.1 钢管应符合各个标准中所规定的拉伸性能要求。

5.2 测定屈服强度是在负荷作用下进行的,按照试样标距的0.2%的永久变形或标距的0.5%总伸长来确定。

5.3 如果任何试样的伸长率小于规定数值,而且断裂的任何部分距检验前试样上标记所示的标距的中心大于3/4英寸(19.0mm)以外,应允许进行复验。

6. 标准重量

6.1 每英尺计算得出的重量,是以规定的最小壁厚为基础,采用下述公式得到的:

$$W=C(D-t)t$$

其中: $C=10.69(0.0246615)$

W =重量,磅/英尺(Kg/m)

D =规定的外径,英寸(mm)

t =规定的最小壁厚,英寸(mm)

6.2 每英尺计算得出的重量允许偏差,应符合表1规定。

7. 壁厚允许偏差

7.1 规定的最小壁厚允许偏差应不超过表2所规定的数值。

7.2 对于外径不小于2英寸(50.8mm)和壁厚不小于0.220英寸(5.6mm)的钢管,任一钢管上任一横切面壁厚的偏差,应不超过该断面实际平均壁厚的下列百分数。实际平均壁厚是该断面最厚和最薄管壁的平均值。

无缝钢管 $\pm 10\%$

焊接钢管 $\pm 5\%$

7.3 在定单中要求冷加工钢管时,如果壁厚不小于3/4英寸(19.1mm),或内径不大于外径的60%时,则可采用热加工钢管的壁厚允许偏差。

8. 外径允许偏差

8.1 除了8.2.1和8.3中规定的以外,规定的外径允许偏差应不超过表3规范。

8.2 通常,薄壁管在最终退火或矫直中,或这两道工序的过程中会产生严重的椭圆度(不圆度)。薄壁管,是指下列规定外径和规定壁厚的钢管。

规定的外径	规定的壁厚
< 2英寸 (50.8mm)	< 规定外径的2%
> 2英寸 (50.8mm)	< 规定外径的3%
各种直径	< 0.020英寸 (0.5mm)

8.2.1 表3中的直径允许偏差对于薄壁管会出现的额外椭圆度是不够的,而且,对于这样的钢管,只适用于钢管任一横断面上两个极端(最大和最小)外径读数的平均值。不管怎样,对于薄壁管,任一横断面两个极端外径读数的差不得超过下列椭圆度允许量:

外径	椭圆度允许量
< 1英寸 (25.4mm)	0.020英寸 (0.5mm)
> 1英寸 (25.4mm)	规定外径的2.0%

8.3 对于冷加工无缝奥氏体和铁素体/奥氏体钢管来说,全部外径小于两英寸的钢管,在最终热处理时,很可能变得不那么圆,因此规定一个椭圆度允许量是必要的。对于这样的钢管,在任一横截面处的最大和最小直径将会偏离公称直径,但不能大于 ± 0.010 英寸(± 0.25 mm)。不管怎样,该横截面的平均直径必须在表3允许偏差之内。万一发生8.3和8.2.1出现矛盾,则采用较大椭圆度允许偏差。

9. 长度允许偏差

9.1 规定长度的允许偏差应不超过表4的规定。

10 电阻焊钢管焊瘤高度允许偏差

10.1 对于外径大于两英寸(50.8mm),或壁厚大于0.135英寸(3.44mm)的钢管,管侧的焊瘤应用机械切除,在钢管任何一点最高不超过0.010英寸(0.25mm)。

10.2 对于外径不大于2英寸和壁厚不大于0.135英寸的钢管,管内的焊瘤应用机械切除,在钢管任何一点最高不超过0.006英寸(0.15mm)。

11. 平直度与加工

11.1 已加工的钢管应有较好的平直,完整的端部,无毛刺。钢管应经精细加工。表面缺陷(注1)应采用砂轮清除,保持光滑的曲面,壁厚不得减薄到本标准或产品标准的规定。在打磨面的外径,由于清除而减少。

注1——在钢管上可以发现缺陷的不连续性或不规则性。

12. 焊接修补

12.1 焊接修补钢管底面上金属缺陷是允许的,但应征需求方同意,另外还要在钢管上打上能够辨认的标志字母“WR”,堆焊填充金属的焊药要与焊接用焊药相匹配,在焊接前应将缺陷彻底修磨掉或铲掉,每根修磨的钢管应重新加热处理或依据使用的标准要求消除应力。每根经修磨的钢管,都要按照标准要求进行液压检验。

12.2 焊接修补应执行所使用的工艺规程,焊接工或焊接操作者的资格,应符合ASTM锅炉和压力容器规范,节1X要求。

13. 重验

13.1 如任何一组或一批力学试验结果不符合各自标准的规定要求,应从同一组或同一批追加双倍原数量的钢管进行重验,每根钢管必须符合规定的要求。

14. 重新处理

14.1 如每根钢管或挑出的钢管,任何一组或一批不符合检验要求,则对此出现的每根钢管,或一组或一批钢管都要进行重新处理并提交检验。热处理不允许超过两次。

15. 试样

15.1 在钢管顶锻、挤压、扩管,或其他变形操作,或切成长定尺等加工前,应从钢管端部制取试样。钢管端部应完整,没有毛刺和裂缝。

15.2 如任何试样有裂缝或有机加工缺陷,则另取试样代替。

16. 力学试验方法

16.1 所需要的试样和力学试验,应按附录A2的试验方法和术语A370制取和进行。

16.2 试样应在室温下进行试验。

16.3 当现有材料不足以制备成一个标准规定试样时,才使用试验方法和术语A370所规定的细小或更小的试样。在使用细小或更小试样检验时,应尽可能使用最大的那个试样进行试验。

17. 压扁检验

17.1 对于长度不小于 $2\frac{1}{2}$ 英寸(63mm)无缝钢管和不少于4英寸(100mm)焊接钢管的一般钢管,应分两步在平行压板间进行冷压扁。对于焊接管来说,焊缝应置于与施力方向成 90° 角(在最大弯曲点处)。第一步是韧性检验,在进行韧性检验过程中,除17.4规定之外,在无缝管的内、外面或端面或焊接管的内、外表面均不得出现裂缝或断裂,其压扁直到两板间距离小于或计算得出的H值:

$$H = \frac{(1+e)t}{e+t/D}$$

其中:

H=压板间距离,mm;

t=规定的壁厚,mm;

D=规定的外径,mm;

e=每单位长度的变形,钢牌号常数:0.07,中碳钢(最大规定含碳量 $>0.19\%$):0.08,铁素体合金钢;0.09,奥氏体钢;0.09,低碳钢(规定的最大含碳量 $<0.18\%$)

第二步检验,是完整性检验,将试样继续压扁,直到试样断裂,或相对管壁相碰。在整个压扁试验过程中,材料呈现出明显的分层,或不完整性,或焊缝不完整,应把它作为判废依据。

17.2 压扁试验前试样表面缺陷,是在第一步压扁试验中显现的,则应依据加工要求加以判断。

17.3 由于表面缺陷造成的表层开裂,将不作为判废依据。

17.4 如管状产品的直径与壁厚之比率比较低,由于几何形状的原因,在内表面6和12点位置上造成了过高的应变,则直径与壁厚之比的比率小于10时,在该位置上出现的裂缝不作为判废依据。

18. 反向压扁检验

18.1 将外径大于或等于1/2英寸(12.7mm),长4英寸(102mm)的一段焊好的钢管,使焊缝两侧各成90度纵向剖开,并且展开,使焊缝置于最大弯曲点压扁。不得有裂纹,或未焊透或由于焊缝处飞溅造成的叠层。

19. 扩口检验

19.1 将一段约4英寸(102mm)长的钢管用一个60度夹角的工具进行扩口检验,直到钢管在扩口的口上扩展到表5中所规定的百分数,不得有断裂或出现产品标准相关条款规定的导致报废的缺陷。

20. 卷边检验

20.1 一段钢管应能做一个翻成与管体成直角的法兰,而不出现断裂或产品标准相关条款规定的导致报废的缺陷。对于碳钢和合金钢,卷边的宽度应不小于表6中所规定的百分数。对于奥氏体钢,表6中所列各种尺寸的钢管的卷边宽度都不得小于15%。

21. 硬度检验

21.1 对于壁厚不小于0.200英寸(5.1mm)的钢管,应进行布氏硬度检验或洛氏硬度检验。如果采用布氏硬度检验,供方可任选10mm的球,用3000、1500或500公斤负荷进行检验,也可以用5mm的球,用750公斤负荷进行检验。

21.2 对于壁厚0.065英寸(1.7mm)到小于0.200英寸(5.1mm)的钢管应采用洛氏硬度检验。

21.3 对于壁厚小于0.065英寸(1.7mm)的钢管,不要求作硬度检验。

21.4 布氏硬度检验可以管壁在钢管外面接近端头的位置,在从钢管上切下的试样的外面,或在从钢管上切下的试样的管壁横断面上进行,由供方任意选择。进行该项检验时,应使压痕中心至试样边缘的距离至少为压痕直径的2.5倍。

21.5 洛氏硬度表面可在内表面、管壁横断面或外表面的一块平面上进行,由供方任意选择。

21.6 对于有顶锻、挤压或其它成型端头供货的钢管,硬度检验应如21.1和21.2所述,在成型操作和热处理过后,在钢管靠近外表面端部位置进行。

21.7 对于焊接和钎焊的钢管,硬度检验应在离开接缝的位置进行。

21.8 如产品标准规定维氏硬度检验,则试验应按试验方法E92规定进行。

22. 液压检验

22.1 除22.2和22.3所规定的以外,供方应对每根钢管进行液压检验,最小液压检验压力根据下列公式计算:

$$\text{英寸—磅单位: } P=32000t/D$$

$$\text{SI单位(公制): } P=220.6t/D$$

其中:

P=液压检验压力,磅/平方英寸或Mpa,

t=规定的壁厚,英寸或mm;

D=规定的外径,英寸或mm。

22.1.1 根据22.1中公式所确定的液压检验压力,低于1000磅/平方英寸(7Mpa)时应修约到50磅/平方英寸(0.5Mpa);大于和等于1000磅/平方英寸(7Mpa)时,则应修约到100磅/平方英寸(1Mpa)。液压检验可以在切成最终定尺之前,或在顶锻、挤压、扩管、弯曲或其它成型操作之前,或上述两种工序之前进行。

22.2 不管根据22.1中公式推算出的结果如何,满足这些要求需要的最小液压检验压力不需超过表7中给定的值。这并不禁止供方选用较高压力或如22.3中提出的规定进行检验。

22.3 经供方同意,超过22.2或22.1或都超的最小液压检验压力,可以在定货单中提出。管壁应力可根据下列公式计算:

$$S=PD/2t$$

式中:S=管壁应力,磅/平方英寸或Mpa,其它所有符号如22.1.1中所规定的。

22.4 检验压力应至少持续5秒钟。

22.5 任何在检验过程中有渗漏的管子均应报废。

22.6 液压试验有可能出现不能在管端进行试验,未进行的那段钢管应由供方进行测定,如需方订单有规定时,供方要通告需方。

23. 液下压力检验

23.1 如进行该试验,则每根钢管的内表面都应清洁并干燥,把它浸入清洁的水中,在整个浸液过程中,把清洁、干燥的压缩空气通入钢管中,使其最小内压达到150英磅/平方英寸(1000Kpa)。用水下照明设备,很好地使钢管照亮。在试验之前,对冲气管接头渗漏空气的任何迹象均应排除掉。在稳压不小于5秒钟以及在水表面变得平静后,对钢管整个外表面进行检查。如在水中通空气试验期间,任何钢管出现渗漏现象,则应予拒收处理。任何渗漏面积应被切掉,并对钢管进行复验。

24. 非破坏性检验

24.1 如需方或产品标准规定进行非破坏性检验,则每根钢管均采用E213、E309(铁磁性材料)、E426(非磁性材料)或E570规定的非破坏性检验方法进行该项检验。按照协议,进行E273试验,但整个周边试验中的一项除外。用每种方法检验钢管尺寸范围,都要受到该方法操作范围的限制。在这种方法与操作和本标准之间存在矛盾时,以本标准要求为准。

24.2 下述资料为本标准使用者的利益

24.2.1 非破坏性检验用的校准管,是非破坏性试验设备的检验用的较为便宜的校准管。由于某些原因,包括形状、排列方向、宽度等,试验时来自缺陷产生的信号与校准管产生的信号之间的相互关系是近似的。对缺陷本质(类型、大小、排列方向、位置)有兴趣的需方,可同管状产品制造者讨论这一问题。采用特殊检验操作,能够测到这些缺陷。

24.2.2 本标准涉及到的超声波检验,是用来测定反射面积等于或大于24.4规定的检验反射槽口的不连续性缺陷的。该检验测不到环形排列的缺陷或短的、深的缺陷。

24.2.3 本标准提及到的涡流检验具有这种可能性,即能够探测出严重的间断不连续缺陷,特别是突发类型缺陷。E309和E42操作规定,含有涡流检验能力和界限的附加资料。

24.2.4 涉及到本标准的漏磁检验能够测定严重的纵向或横向排列的不连续性的存在和位置。本标准有关条款,仅规定了纵向漏磁检验。采用不同的技术工艺,达到识别不同排列的不连续性缺陷。

24.2.5 节22提及到的液压试验有能力发现某种大小的缺陷,它是通过试验液体穿透管壁渗漏,采用肉眼观察或测定压力损失进行的。这种试验不能测定很致密的钢管,缺陷穿透管壁的钢管,或者缺陷深入到很深距离而没有完全贯穿的钢管。

24.2.6 对于弄清专门采用这种检测方法能够测出不连续性缺陷本质(类型、大小、位置、排列情况)有兴趣的需方,可与管状产品制造厂讨论这个问题。

24.3 检验时间

用于验收的非破坏性检验,应在形变工序、热处理、焊接和矫直操作之前完成。这种要求不能阻碍在本工序前追加试验。

24.4 表面状态

24.4.1 全部表面不得有氧化铁皮、污物、润滑油、涂染料或其他外来物,这些东西会干扰试验结果数据分析。为检验而采用的清理表面的方法不得有害于基体金属或表面加工。

24.4.2 表面过分粗糙或有较深的擦伤,都会产生干扰试验的信号。

24.5 检验范围

24.5.1 钢管和传感器、线圈或探头的相互移动,能使整个钢管表面接受扫描,但节24.5.2所述的管端效应除外。

24.5.2 辩认管端效应的存在,应由供方测定。如有要求,应通告需方。在管端进行其非破坏性检验时,应由供需双方协商确定。

24.6 操作员资格

24.6.1 某项试验的操作者,应按SNT TC-1-A或按供需双方都同意与该规定等同的书面文件,保证其资格。

24.7 检验状态

24.7.1 对于超声波方法检验来说,传感器最小公称频率为2.0MHZ,传感器最大探测宽度为1.5英寸(38mm)。

24.7.2 对于涡流检验来说,所选择的激发线圈频率应能满足穿透要求,并提供良好的信噪比。

规定的壁厚	最大频率
<0.050英寸	100KHZ
0.050~0.150英寸	50KHZ
>0.150英寸	10KHZ

24.8 校准管

24.8.1 为检验制管情况,应制备适宜长度的校准管,它是从同一牌号、规定尺寸(外径和壁厚)、表面加工和热处理状态的钢管中取一根钢管制备而成。

24.8.2 对于涡流检验,校准管应包括下列不连续性缺陷中的任何一种,以便供方选择。

24.8.2.1 钻孔—校准管应包括三个或三个以上的钻孔,各孔等距环绕钢管,并且在纵向上分隔开,保持足够距离,使各孔能够发出清晰的信号。应在径向上钻孔,并且完全穿透壁厚,注意在钻孔时避免钢管变形。这些钻孔直径不大于0.031英寸(0.8mm)。作为备选方案,供方可以在钢管上钻一个孔,将检验管在线圈中转动3次,每次大约转动120°。采用转动角度稍有过量的方式则所提供的转满线圈360°的试验是可行的。对于焊接钢管来说,如果焊缝是可见的,那么多个钻孔的一个孔或单个孔,应在焊缝上钻孔。

24.8.2.2 横向切线槽口—用一个直径 $1/16$ 英寸(6.4mm)的圆形工具或锉刀,采用铣或锉的方法开槽,该槽口切向于表面,横向于纵向轴线。槽口深度不大于规定壁厚的12.5%或0.004英寸(0.1mm)中较大的那个。

24.8.2.3 纵向槽—在钢管外表面与钢管轴线平行的一个径向平面上机加工宽度不大于0.031英寸(0.8mm)的槽口,该槽口深度不大于规定壁厚的12.5%或0.004英寸(0.1mm)中较大的那个。槽口长度应符合试验方法要求。

24.8.3 关于超声波检验,内径和外径槽口由供方任选E213所示通常三种槽口形状中的任何一种。槽口深度不大于规定壁厚的12.5%或0.004英寸(0.1mm)中较大的那个。槽口宽度不大于深度的2倍。对于焊接钢管来说,槽口应在焊缝位置,如果焊缝明显可见的话。

24.8.4 关于漏磁检验,在钢管内外表面平行于轴线的径向位置上,机加工出带有直边的纵向槽口。槽口深度不大于规定壁厚的12.5%或0.004英寸(0.1mm)中较大的那个。槽口长度不大于1英寸(25.4mm),槽口宽度不大于深度。外和内槽口应保持足够间距,以便获得每个槽口有清晰可辨别的信号。

24.8.5 经供需双方协商,可采用具有较多的或较小的不连续性缺陷的校准管或两者都采用。

24.9 标准化程序

24.9.1 应对试验设备进行标准化处理,即在生产同一规定尺寸(直径和壁厚)、同一牌号和同一热处理的每种系列钢管的开始和结束时进行,以及在制管期间不超过4小时进行一次处理。更多次数的标准化处理,由供方选择决定,或由供需双方协议规定。

24.9.2 在出现下列情况以后,也要对试验设备进行标准化处理:更换某些试验设备,更换操作人员、设备维修、电源不足或线路引起的中断等。

24.9.3 对于检验的钢管来说,要以同一速度和同一试验系统设备通过标准管的检验。除此之外,可按供方的意愿,采用更高的敏感性系统检验钢管。

24.9.4 校准管的信噪比应为25:1或更大,每处不连续性产生信号的波幅,至少为整个显像刻度的50%。在确定噪声水平等级时,在校准管上出现可辨认的表面不连续性的额外信号可以不考虑。如UT试验(超声波检验)期间,滤除拒收钢管时,必须论证其线性关系。

24.9.5 在进行标准化处理时,如果参考信号波幅减少29%(3.0dB)的话,则试验设备视为不符合标准要求。试验系统设备应进行更换,或者要对传感器、线圈、或探测器进行校正,直到达到标准化要求为止,并对上次验收标准化处理以来已检验的全部钢管必须进行检验。

24.10 不连续性评价

24.10.1 制管产生的试验信号等于或大于校准管产生的最低信号,应作出怀疑的标示,应该清晰地做标志或识别标记,并从验收的制管中把它分离出来。

24.10.2 这种有怀疑的制管应经受下述3种处置中的一种处理:

24.10.2.1 这种钢管应拒收,由供方自由处理,除非作更进一步检验。

24.10.2.2 如果由下述不连续性产生的试验信号,例如划伤、表面粗糙度、勾缝、矫直压痕、松散的内径波纹和切割屑、钢冲压痕迹、终加工印迹、钢管减径波纹,或颤动飞边等,应接收钢管,或依据肉眼检查不连续性的严重程度而拒收钢管,或两者都有。

24.10.2.3 如果不连续性产生的试验信号,但该不连续性未作出标示,或信号由裂纹或类似裂纹的不连续性产生的,则这种钢管将拒收。

24.10.3 具有24.10.2.2和24.10.2.3中所列各种类型的不连续性的任何钢管,其不连续性深度超过0.004英寸(0.1mm)或规定最小壁厚的12.5%中较大的那个,均被拒收。

24.10.4 已拒收的钢管应收回修整并复验,如果壁厚没有减薄到比本标准或产品标准规定的更小的话。如实施打磨,则打磨面积处的外径由于修磨的原因而减小。为了取得验收,已收回修整的钢管必须通过非破坏性检验,因为这些钢管已在当初被拒收。

25. 检验合格报告

25.1 如需方订单或合同有规定,则生产厂或供货方应提交一份检验合格报告,证明钢管的制造、取样、试验和检查符合本标准要求,包括年份日期、补充要求,以及订单或合同中规定的任何其他要求,还有其结果符合那个标准规范、补充要求和其他要求。不需要在检验合格证书上签名或有公

证人的证实,但文件必须注明日期和清晰的标出提交报告的组织机构。

注2:虽然缺少签名或公证人证实,但提交报告的组织机构要对报告的内容承担责任。

25.2 试验合格报告应包括下述资料和试验结果,当对使用有利时:

25.2.1 炉号;

25.2.2 熔炼分析;

25.2.3 成品分析,如有规定时;

25.2.4 拉伸性能;

25.2.5 标距宽度,采用纵向钢带拉伸试样时;

25.2.6 压扁试验,可接受的;

25.2.7 反向压扁试验,可接受的;

25.2.8 扩口试验,可接受的;

25.2.9 卷边试验,可接受的;

25.2.10 硬度试验值;

25.2.11 液压试验压力;

25.2.12 非破坏性试验方法;

25.2.13 冲击试验结果;

25.2.14 产品标准报告所要求的其他试验结果或资料。

25.3 补充要求报告所要求的试验结果或资料,或订单或合同中规定的其他要求,也将被通告,是以单独分开的文件方式加以通告的。

25.4 试验合格报告包括一份说明性的报告书。当本标准的全部要求还未完成,应在钢管上做标志的追加到标准号上的那个字母(见28.3)作出说明。需方必须用合格证书证明,在去掉字母(即X、Y、或Z)之前,标准的全部要求都已完成。

26. 检查

26.1 代表需方的检查员,按需方合同进行工作的全部时间内,应能进入制造厂中与制造所购材料有关的所有工作场所,制造厂应向检查员提供全部合理的便利条件,使其确信材料是按本标准生产供应的。除另有规定外,全部检验和检查应在发运前在生产场所进行,并且不得去干扰车间的操作。

27. 拒收

27.1 需方应对从供方接收的每根钢管进行检查,如果以本标准大纲规定的检查和方法为依据,不符合本标准的各项要求,则这根钢管将被拒收,并通告供方。对拒收钢管的处理,由供需双方商定。

27.2 对成型操作中不合格的钢管,或在安装过程中不合格的钢管,以及发现有缺陷的钢管,均把它放置一边,并把钢管适用性的评价通告供方。对这种钢管的处理,由供需双方协议处理。

28. 产品标志

28.1 应对每根钢管清晰地做标志,其上注有制造厂名称或商标、标准号和牌号。做标志不必包括标准的年份日期。对于直径小于1 $\frac{1}{4}$ 英寸、每根长度小于3英尺(1m)的钢管,应在装运时,把所要的资料标志在安全可靠地挂到每捆的标签上或每个装箱上。

28.2 对于奥氏体钢管而言,做标志的漆或印剂不得含有任何有害金属,或金属盐类,例如锌、铝或铜,他们会在加热时产生腐蚀。

28.3 如规定采纳ASTM锅炉和压力容器委员会标准的某些要求的材料,在验收材料时,需方打算完成这些要求,供方应立即在下列标准号的位置给一个字母,例如X、Y或Z,以表示还没有完成验收该标准的全部要求。当按该标准规定完成全部要求后,方可去掉该字母。完成标准要求的说明,已在节2 B中作了规定。

28.4 条形码—除28.1~28.3的要求外,条形码是验收用的一种补充的标示方法,需方可在订单中规定一种专门使用的条形码体系。

29. 包装、标志和装运

29.1 如在需方订单上有规定,则产品包装、标志和装运应符合A700操作规程的规定。

30. 政府采购

30.1 不定尺钢管

30.1.1 如在订单或合同中有规定,在美国政府经销部门要求不定尺供货的情况下,则在咨询、合同或订货时应考虑以下要求,如果这些要求与产品标准之间存在矛盾的话,应把这些要求放在首位。

30.1.2 钢管应按外径和壁厚订购

30.1.3 检查的责任—除非合同或需方订单另有规定外,供方有责任完成所规定的全部检查和试验要求。标准中任何检查要求的缺少,不应减轻承包者的责任,保证产品或供货按合同规定的全部要求提交政府用于验收。作为制造操作的一部分,取样检查是为弄清与要求一致性的可接受的操作方式。无论怎样,都不得对已知有缺陷的材料给予认可,或作出说明或视为有效,不能把它提交给政府用作验收。除合同或订单另有规定外,供方应使用自身或任何其他适合的实施检查和试验所要求的设备,除非安排订单一时需方不同意这样做。需方有权进行任何检查和试验,如果他们认为,为保证材料符合规定要求而进行的检查和试验是必要的话。

30.1.4 压扁和扩口试验取样以及视觉和尺寸检查取样—压扁和扩口试验以及视觉和尺寸检查的最小取样数量如下:

批大小(每批根数)	取样数量
20~8	整批
9~90	8
91~150	12
151~280	19
281~500	21
501~1200	27
1201~3200	35
3201~10000	38
10001~35000	46

在各种情况下,应把那些拒收的批挑出并提交进行肉眼视觉检查和进行尺寸检查。在该批验收前,用验收的材料代替全部有缺陷的材料。

30.1.5 化学分析取样—每批取出2根钢管中的每根钢管,各作一个化学分析用试样。该批应为一炉钢浇注成的全部材料的一部分。

30.1.6 拉伸和弯曲试验取样—从每批钢管取一个试样。该批全部钢管由下述组成,即由同一外径、同一壁厚、同一炉钢在8小时内制造的,在一次装料类型的炉子中,以一次装料的方式,在

同一温度和时间状态下热处理,或在连续炉中同一状态下热处理,在同一时间检查的钢管组成。

30.1.7 液压和超声波检验—每根钢管均应进行超声波检验(有规定时)和液压检验。

30.1.8 钢管不得有较厚的氧化铁皮或氧化物。热加工铁素体钢管内表面应进行酸洗或喷砂处理,以便清除氧化铁皮,达到与SSPC-SP6所列外观标准CSa2相等的水平。表面清理工作应按书面程序进行。该程序对于检查是有利的。

30.1.9 除按A530/A530M规定标志外,每根外径不小于1/4英寸的钢管,应采用下述资料做标志,即按FED-STD-183和MIL-STD-792(a)外径、壁厚和长度,(b)炉号或批号的规定。

30.1.10 钢管应平直,限制在表8规定的偏差之内。

30.1.11 如有规定,每根钢管按MIL-STD-271进行超声波检查,但校准管槽口深度为壁厚的5%或0.005英寸中较大的那个除外。任何钢管所产生的标示比标准校准管产生的标示的100%相等或更大,则钢管予以拒收。

30.1.12 钢管不得有修补的焊缝、焊瘤、折叠、分层、可见裂缝、撕裂、沟槽、开裂、凹坑及其他损害视觉和超声波检验的缺陷,或依据规定不能再更替检验。

30.1.13 钢管应保持质量与状态的一致性,其加工至少与标准质量制管的最佳操作相一致。表面缺陷,例如修磨痕迹、矫直印、轻微的芯棒拉痕、拉制划痕、浅坑和氧化铁皮花纹等,均不得视为有害的缺陷,如果这些缺陷是可清除的,清除后限定在壁厚规定的偏差之内或0.005英寸中较大的那个的话,缺陷底部应是可见的,其轮廓应呈圆形并平整。

30.1.14 制造厂未经焊补操作是允许的。

30.1.15 钢管应按A级水平或商业惯例进行保管,按A、B级液平或商业惯例进行包装,按其规定,A级保管和A或B级包装应符合MIL-STD-163的规定,商业保管和包装应符合A700或D35951的规定。

31. 关键词

31.1 合金钢管,奥氏体不锈钢,碳钢钢管,一般供货要求,不锈钢管,钢管。

表1 每英尺重量允许偏差^A

生产方法	每英尺重量允许偏差, %	
	大于	小于
无缝,热加工	16	0
无缝,冷加工:		
外径 < 1 1/2英寸 (38.1mm)	12	0
外径 > 1 1/2英寸 (38.1mm)	13	0
焊接	10	0

A 这些重量偏差适用于外径不大于4英寸,50根或更多根一批的钢管,也适用于外径大于4英寸,20根或更多根一批的钢管。

表2 壁厚允许偏差

外径, mm	壁 厚, %							
	< 0.095 (2.4)		> 0.095 ~ 0.150 (2.4~ 3.8)		> 0.150 ~ 0.180 (3.8~ 4.6)		> 0.180 (4.6)	
	+	-	+	-	+	-	+	-
无缝热加工管								
< 4(101.6)	40	0	35		33	0	28	0
> 4(101.6)	35		33	0	28	0
无缝冷加工管								
< 1 ¹ / ₂ (38.1)			20				0	
> 1 ¹ / ₂ (38.1)			22				0	
焊接管								
全部尺寸			18				0	

A 这些壁厚允许偏差,除顶锻外,仅适用于挤压、扩管、弯曲、抛光,或其他加工操作之前的轧制或冷加工钢管。

表3 外径允许偏差[^]

外径,英寸(mm)	允许偏差,英寸(mm)	
	大于	小于
热 加 工 无 缝 钢 管		
< 4(101.6)	1/64(0.4)	1/32(0.8)
> 4 ~ < 7 ¹ / ₂ (101.6 ~ 190.5)	1/64(0.4)	3/64(1.2)
> 7 ¹ / ₂ ~ < 9(190.5 ~ 228.6)	1/64(0.4)	1/16(1.6)
焊 接 钢 管 和 冷 加 工 无 缝 钢 管		
< 1(25.4)	0.004(0.1)	0.004(0.1)
1 ~ < 1 ¹ / ₂ (25.4 ~ 38.1)	0.006(0.15)	0.006(0.15)
> 1 ¹ / ₂ ~ < 2(38.1 ~ 50.8)	0.008(0.2)	0.008(0.2)
2 ~ < 2 ¹ / ₂ (50.8 ~ 63.5)	0.010(0.25)	0.010(0.25)
2 ¹ / ₂ ~ < 3(63.5 ~ 76.2)	0.012(0.3)	0.012(0.3)
3 ~ < 4(76.2 ~ 101.6)	0.015(0.38)	0.015(0.38)
> 4 ~ < 7 ¹ / ₂ (101.6 ~ 190.5)	0.015(0.38)	0.025(0.64)
> 7 ¹ / ₂ ~ < 9(190.5 ~ 228.6)	0.015(0.38)	0.045(1.14)

A 除8.2和8.3规定以外,这些偏差不包括椭圆度。这些外径允许偏差,适用于其他加工操作之前,例如顶锻、挤压、扩径、弯曲或抛光等的热加工无缝、焊接和冷加工无缝钢管。

表4 长度允许偏差^A

生产方法	外径,英寸(mm)	定尺长度,英寸(mm)	
		大于	小于
无缝,热加工	各种尺寸	3/16(5)	0(0)
	<2(50.8)	1/8(3)	0(0)
无缝,冷加工	>2(50.8)	3/16(5)	0(0)
	<2(50.8)	1/8(3)	0(0)
接焊	>2(50.8)	3/16(5)	0(0)
	<2(50.8)	3/16(5)	0(0)

A 这些长度允许偏差适用于弯曲加工以前的钢管。适用于小于和等于24英尺(7.3m)的长度。对于超过24英尺(7.3m)的长度,每增加10英尺或其一部分,允许加1/8英寸的正偏差,或1/2英寸(13mm)中两者较小的那个。

表5 扩口检验要求

内径和外径之比 ^A	内径的最小扩张,%	
	碳钢,碳-钼钢和奥氏体钢	其它铁素体合金钢
0.9	21	15
0.8	22	17
0.7	25	19
0.6	30	23
0.5	39	28
0.4	51	38
0.3	68	50

A 在确定内径和外径之比时,内径应规定为检验材料的实际平均内径。

表6 卷边要求

钢管 外径,英寸(mm)	卷边 宽度
<2 ¹ / ₂ (63.5)	外径的15%
>2 ¹ / ₂ ~<3 ³ / ₄ (63.5~95.2)	外径的12.5%
>3 ³ / ₄ ~<8(95.2~203.2)	外径的10%

表7 液压检验压力

钢管外径,英寸(mm)	液压检验压力,磅/平方英寸(Mpa)	钢管外径,英寸(mm)	液压检验压力,磅/平方英寸(Mpa)
<1(25.4)	1000(7)	2~<3(50.8~76.2)	2500(17)
1~<1 ¹ / ₂ (25.4~38.1)	1500(10)	3~<5(76.2~127)	3500(24)
1 ¹ / ₂ ~<2(38.1~50.8)	2000(14)	>5(127)	4500(31)

表8 平直度偏差

规定外径,英寸	规定壁厚,英寸	最大弯曲,英寸 任何3英尺长度	最大弯曲,英寸 全长
>5.0	>3%外径至0.5	0.030	0.010×长度,英尺
>5.0~8.0	>4%外径至0.75	0.045	0.015×长度,英尺
>8.0~12.75	>4%外径至1.0	0.060	0.020×长度,英尺

常州仁成金属制品有限公司

官网: www.rcmetal.cn

电话: 0519-83611681

微信公众号: steelbos

官博: www.josen.net