EXHIBIT 4

HQ 964551

APRIL 23, 2001

CLA-2 RR:CR:GC 964551 JAS

CATEGORY Classification

TARIFF NO.: 7223.30.00(EN)

Port Director of Customs
Second & Chestnut Sts.
Philadelphia, PA 19106

RE: Protest 1101-00-100153; Stainless Steel Wire Rods, Shaved or Peeled

Dear Port Director:

This is our decision on Protest 1101-00-100153, filed against your classification, under the Harmonized Tariff Schedule of the United States (HTSUS), of shaved or peeled stainless steel wire rods. The entry under protest was liquidated on June 2, 2000, and this protest timely filed on

July 18, 2000. Counsel for the protestant presented additional facts and legal arguments in a letter to you, dated November 16, 1999. These were supplemented in a letter to us, dated April 2, 2001.

FACTS:

The merchandise at issue is produced from wire rod initially hot rolled from billets. This product, typically between .240 and .870 inch in outside diameter, is then annealed and pickled. The product is then either shaved or peeled, as described, to remove surface defects and improve its dimensional regularity. Shaving involves a two-step operation. The annealed and pickled wire rod is first cold-drawn through a carbide die into what protestant describes as wire, to reduce the outside diameter by .008 to .012 inch. This imparts a rounded profile to prepare the product for shaving using a reverse conical die as a cutting tool to effectively remove a layer of metal. Peeling is referred to as a machining operation in which rotating cutting tools remove a layer of metal, typically .012 inch from the annealed and pickled wire rod's outside diameter. An abrasive belt then grinds the rod to eliminate surface defects and an imperfect profile.

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The merchandise was entered under a provision of Heading 7223, HTSUS, for wire of stainless steel. Your office determined that the processing of the wire rod, as described, did not change its characteristics, but that the shaving or peeling were cold finished operations. The entry was liquidated under a provision o Heading 7222, HTSUS, for bars and rods, not further worked than cold-formed or cold-finished. On protest, counsel again asserts the heading 7223 classification, noting that the shaved product, at least, results from a cold-forming operation and meets a recognized American Society for Testing and Materials (ASTM) standard for wire. Counsel also asserts that the shaving and peeling of stainless steel wire rod both accomplish identical goals, i.e., the mechanical removal of metal to eliminate defects resulting from hot-rolling. The conclusion is that in use and application the peeled product is regarded commercially as a wire product and should be classified in the same provision as the shaved product. However, counsel agrees that if Heading 7223, HTSUS, is found not to apply, then subheading 7222.30.00(EN), HTSUS, represents the proper classification. Counsel argues, however, that in no event does either the shaved or peeled product qualify as hot-rolled bars and rod of stainless steel

The HTSUS provisions under consideration are as follows:

7221.00.00(EN) Bars and rods, hot-rolled, in irregularly wound coils, of stainless steel

* * * *

7222 Other bars and rods of stainless steel....

7222.30.00(EN) Bars and rods, not further worked than cold-formed or cold-finished

* * * *

7223 Wire of stainless steel

7223.00.10(EN) Round wire

ISSUE:

Whether shaving or peeling of stainless steel wire rod, as described, results in a product classifiable as wire.

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LAW AND ANALYSIS:

Under General Rule of Interpretation (GRI) 1, Harmonized Tariff Schedule of the United States (HTSUS), goods are to be classified according to the terms of the headings and any relative section or chapter notes, and provided the headings or notes do not require otherwise, according to GRIs 2 through 6.

The Harmonized Commodity Description and Coding System Explanatory Notes (ENs) constitute the official interpretation of the Harmonized System at the international level. Though not dispositive, the ENs provide a commentary on the scope of each heading of the HTSUS. Customs believes the ENs should always be consulted. See T.D. 89-80, 54 Fed. Reg. 35127, 35128 (Aug. 23, 1989).

Chapter 72, Note 1(m), HTSUS, in part, defines Other bars and rods as products that do not conform to the definition for hot-rolled bars and rods or to the definition for wire and which have a uniform solid cross section along their whole length in the shape of circles, segments of circles or ovals. Chapter 72, Note 1(o), HTSUS, in part defines Wire as cold-formed products in coils, of any uniform solid cross section along their whole length, which do not conform to the definition of flat rolled products (in Note 1(k).

The 72.17 ENs, wire of iron or non-alloy steel, apply by appropriate substitution of terms, to the products of heading 7223, wire of stainless steel. On p. 1090, these ENs state that wire is mostly produced from hotrolled bars and rods of heading 72.13 by drawing them through a die but may also be obtained by any other cold-forming process (e.g., cold-rolling).

It is clear that shaving and peeling are forms of cold-working that preclude the hot-rolled provisions of Heading 7221, HTSUS, from applying. The question is whether the products at issue are "cold-formed" for purposes of heading 7223. The 72.17 ENs cite (cold) drawing and cold-rolling as examples of cold-forming wire products. These involve realigning the cross sectional area of the metal or moving metal around, rather than removing metal. The shaving operation first involves a drawing of the product, but then a reverse conical die removes portions of metal to provide a uniform surface free of defects. The peeling operation involves the use of a rotating cutting tool followed by grinding, both of which involve removing metal. Shaving and peeling operations, as described, are akin to sizing, turning or centerless grinding, which are finishing operations designed to impart moderate reduction in cross section or improve out-of-roundness to a bar or rod product. Counsel cites ASTM designation A 555/A555M – 94a, General Requirements for Stainless Steel Wire and Wire Rods, which, in part, defines wire as any round or shaped cold-reduced product, in coils only, produced by cold-finishing coiled wire rod. To the extend this designation does not describe a

product produced by a cold-forming operation, it is inconclusive as authority for identifying the merchandise at issue as a wire product of heading 7223. The shaving and peeling, as described, are operations designed to remove metal. As they are not cold-forming operations as described in the cited ENs, the products produced by these operations cannot be classified as wire.

HOLDING:

Under the authority of GRI 1, the shaved or peeled stainless steel wire rod is provided for in heading 7222. It is classifiable in subheading 7222.20.00EN, HTSUS.

The protest should be DENIED. In accordance with Section 3A(11)(b) of Customs Directive 099 3550-065, dated August 4, 1993, Subject: Revised Protest Directive, you are to mail this decision, together with the Customs Form 19, to the protestant no later than 60 days from the date of this letter. Any reliquidation of the entry or entries in accordance with the decision must be accomplished prior to mailing the decision. Sixty days from the date of the decision the Office of Regulations and Rulings will make the decision available to Customs personnel, and to the public on the Customs Home Page on the World Wide Web at www.customs.gov, by means of the Freedom of Information Act, and other methods of public distribution.

Sincerely,

John Durant, Director

Commercial Rulings Division

PD G89955 04-23-01 CATEGORY: CLASSIFICATION

PD G89955

April 23, 2001

CLA-2-95 SE:CD D25 G89955

CATEGORY: Classification

TARIFF NO.: 9505.90.0020EN

Mr. Ken August
Fun World
80 Voice Road

EXHIBIT 5

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
TOOL STEEL PRODUCTS:			
European Union's Exclusion Requests Filed By O'MELVENY & MYERS LLP; (X-_____; Proprietary Submission)			
1. High Speed Steel in the Form of Peeled and Polished Bar	[		]
2. High Speed Steel in Form of Billets	[		]
3. High Speed Steel in the Form of Hot-Rolled Coil	[		]
4. High Speed Steel Sheet & Strip	[		]
5. Hand Hack Saw Blanks of High Speed Steel	[		]
6. High Speed Flat & Square Bars	[		]
7. Shaped Edgewire of High Speed Steel	[		]
8. Circular Disks of High Speed Steel	[		]
9. Flat Rolled Width of 600mm or more and Thickness of less than 4.75mm	[		]
10. Flat Rolled Width 600mm or more and Thickness of 4.75mm or more	[		]

* These products are company specific trade names. [

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**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
11. Flat Rolled Width 300mm - 600mm	[		]
12. Bohler Cross-Rolled High Speed Steel Sheets/Plates Annealed and Shot Peeled	[		]
13. Bohler W321 ISOBLOC (ESR remelted - hot work tool steel)	[		]
14. Chipper Knife Steel (Bohler K329)	[		]
15. Dievar (Premium hot work Tool Steel from Uddeholm)	[		]
16. 415C (V310), A-8 (K329)) Manufactured into special sections or profiles (shapes)	[		]
17. Bohler K-340 ISODUR (ESR Execution) - cold work	[		]
18. Bohler W-310 ISOBLOC (ESR Execution) - hot work	[		]
19. QRO 90/80 SUPREME Premium (patented, special hot work tool steel from Uddeholm)	[		]
20. AISI P-20 Tool Steel Plate over 150mm	[		]

* These products are company specific trade names.]

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PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
21. Uddelholm Orvar Supreme (ESR Execution)	[		]
22. Bohler W-302 ISOBLOC (ESR Execution)	[		]
23. Bohler W-402 VMR (VAR Execution) - hot work	[		]
24. DIN 2379 (AISI D-2) Forged Blocks; Thickness of 6" - 12"	[		]
25. DIN 2379 (AISI D-2) Round Bars, forged electric arc melted; nonESR/VAR; Size range from 16.5" through 30"	[		]
26. DIN.2324 (AISI S-7) Mold Quality for lense quality molds; Thickness of .5"-4.75" (plates)	[		]

* These products are company specific trade names.]

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PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
27. DIN.2324 (AISI S-7) Mold Quality for lense quality molds; Thickness of 5"-12." (blocks forged)	[		]
28. DIN.2363 (AISI A-2) Forged Blocks; Thickness of 6" - 12"	[		]
29. DIN.2767 (AISI 6F7) Flats & Blocks	[		]
30. DIN.2738 (AISI P-20 Mod.) Hardened and Tempered Flats and Blocks (High Hard); Thickness of 1" - 30"	[		]
31. DIN.2344 (AISI H-13) Hot rolled Anneal, Flats to GM's, Ford's Daimler Chrylor's Specifications; Thickness of .50" - 7.50"	[		]
32. DIN.2344 ESR (AISI H-13) Forged, Annealed, Blocks to GM's, Ford's, Daimler Chrysler's Specifications; Thickness of 7.75" - 24"	[		]
33. DIN.2344 ESR (AISI H-13) Hot Rolled Rounds to GM's and Daimler Chrysler's Specifications; Diameter of .50" - 7.25"	[		]
34. DIN.2344 ESR (AISI H-13) Forged Rounds to GM's, Ford's, Daimler Chrysler's Specifications; Diameter of 7.5" - 24"	[		]

* These products are company specific trade names. [

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PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
35. E-38K ESR -- Round Bars	[		]
36. E-38K ESR Remelted Flats & Blocks	[		]
37. DIN.2714 (AISI 6F3) Round Bars	[		]
38. DIN.2714 (AISI 6F3) Flats & Blocks	[		]
39. DIN.2999 ESR Flats	[		]
40. DIN.2381 (AISI S-5) Round Bars	[		]
41. DIN.2367 Round Bars	[		]
42. FOR 821 ESR Rounds	[		]
43. AISI P-20 Hot-Rolled Pre-Hard Plates; .Thickness of .50" - 7.50"	[		]
44. AISI P-20 Forged Pre-Hard Blocks; Thickness of 7.75" - 30"	[		]
45. CR7V-L Tool Steel Grade For Forging Dies	[		]

* These products are company specific trade names. [

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PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
46. Superplast P20 w/unit weight greater than 50 tons	[		]
47. Superplast P20 Tool Steel Plate with thickness greater than 159mm	[		]
48. Forged Tool Steel Bar, ASTM A681, grades D2, H13, A2, and S7	[		]
Eaton Corporation's Exclusion Request for Certain Engine Valve Steels Filed By HALE AND DORR; (X-027)			
49. Engine Valve Steel EMS 284 (SUH011; HTS No. 7228.50.1060 (CR Bars/Rods of Round/Rect; less or equal to 18mm; ground, milled, polished)	[		]
50. Engine Valve Steel EMS 1 (Silchrome 1); HTS No. 7228.50.1060 (CR Bars/Rods of Round/Rect; less or equal to 18mm; ground, milled, polished)	[		]

* These products are company specific trade names. [

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PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
ERAMET / Erasteel's Exclusion Requests Filed by LEBOEUF, LAMB, GREENE & MACRAE; (X-024a - X-024d)			
51. Circular Discs of High-Speed Steel made from high-speed sheet (AISI M2; M35; ASP 2023, ASP 2053), HTS No 7225.20.2000; Diameter of .787" - 39.37"	[		]
52. Flat and Square Bars of High-Speed Steel; (AISI M1; M2; 3:2; M4; M7; M35; M42; M50; E945); HTS No. 7228.10.0030; 7228.10.0060; 7228.10.0010; Thickness of 0.118" - 2.756" and width of 0.118" - 6.693"	[		]
53. Shaped Edgewire of High-Speed Steel; (AISI M2, 3.1, MATII; M42; WKE42); Thickness of 0.020 - 0.104" and width of 0.031 - .394"); HTS No. 7226.20.0000 and 7229.10.0000	[		]
54. Sheet and Strip of High-Speed Steel; (AISI M1; M2; M42; ABC 111; E945; M35; EV4; ASP2023); HTS Nos. 7225.20.0000; 7226.20.0000; Thickness of 0.028 - 0.787" and maximum width of 39.37"	[		]

[9] These products are company specific trade names. [ ]

**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
Acos Villares, S.A.'s Exclusion Request Filed By RIGGLE AND CRAVEN; (X-031)			
55. Tool Steel Classified Under HTSUS items 7228.30.40; 7228.30.60; 7228.50.10 (HR Bars/Rods including chipper knife; CR Bars/Rods of Round/Rect (AISI grades H-13 / A681; 6F3; 420; H12)	[		]
56. High Speed Steel Classified Under HTS No. 7228.10.00 (HR and CR Bars/Rods) (AISI M2)	HTS No. 7228.10.00 covers high-speed hot-rolled and cold-rolled bars and rods. [		]
57. Valve Steel (HTS No. 7228.50.00)	[		]

* These products are company specific trade names. [

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**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
Usinor's Exclusion Request Filed By SHEARMAN & STERLING: (X-090)			
58. Superplast P20 Tool Steel Plate with a unit wt greater than 50 tons; HTS No. 7228.50.1080 (plastic mold steel forged blocks and plates)	[		]
59. Superplast P20 Tool Steel Plates with a Thickness greater than 150 mm; HTS Nos. 7225.40.1090; 7228.60.1060; 7228.50.1080	[		]
60. Forged Tool Steel Bar (ASTM A 681; grade D2, H13, A2, S7); HTS No. 7228.40.0000; Diameter of 12 to 36" (forged or rough bar)	[		]
International Mold Steel's Exclusion Request Filed By ARENT FOX (X-134)			
61. NAK 55 (plastic mold steel) HTS No. 7226.91.5000 (plate, width less than 600mm)	[		]
62. DH2F (designed for molding of plastic parts); HTS No. 7225.40.1090 (plate, width 600 mm or more)	[		]

* These products are company specific trade names. [ ]

**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
63.DC53 (proprietary cold work die steel developed/patented by Daido Steel in Japan); HTS No. 7225.40.1090 (plate, width 600mm or more)	[		]
64. DH31-S (hot-working die cast steel); HTS No. 7225.40.1090 (plate, width 600mm or more)	[		]
Armco do Brasil S.A.'s Exclusion Request (X-008)			
65. High Speed Steel Strips Grade ABCIII & M2	[		]
JB&S Lees' Exclusion Request Filed By CAMERON & HORNBOSTEL; (X-010)			
66. Certain High Carbon Band Saw Steels	[		]
67. Alloy Band Saw Steel	[		

* These products are company specific trade names. [

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**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

PRODUCT	Allegheny's 2000 Production Volume (Short tons)	Latrobe's 2000 Production Volume (Short tons)	Other Domestic Producers That Currently Produce Product
Nachi America Inc.'s Exclusion Request			
68. Certain Hardened Tool Steel Bars and Blanks (of High-Speed Steel); (M2, M7, M33, M42, FAX40D); HTS No. 7228.10.0030 (CR High Speed Bars/Rods - diameters from .0078 - .5118" and lengths from 0.5906 - 78.7402; bright finish or unground finish) **(X-017a)**	[		]
69. Certain Flat Coiled Edge Wires for Bi-Metal Band Saw Blades (of High-Speed Steel); (M2, M42, M3-1, FAX18, FAXG2); HTS No. 7229.10.0000; width of 0.039 - 0.098" and thickness of 0.020 - 0.067")*	[		]
Hitachi Metal's Exclusion Request (X-177)			
70. High Speed Steel Flat Edgewire	[		]

* These products are company specific trade names. [

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**More information is needed about these products to determine whether there is current U.S. production of a directly competitive product.

EXHIBIT 6

Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures[1]

This standard is issued under the fixed designation A 774/A774M; 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 specification covers five grades of as-welded, wrought austenitic stainless steel fittings for low-pressure piping and intended for low and moderate temperatures and general corrosive service. Users should note that certain corrosive conditions may restrict the use of one or more grades. For applications requiring a product that requires heat treatment or full pressure rating refer to Specification A 403/A 403M. The term "fittings" applies to butt and socket welding parts such as 45° and 90° elbows, tees, reducers, wyes, laterals, crosses, and stub ends.

1.2 This specification covers as-welded fittings 3 through 48 in. [75 through 1225 mm] in outside diameter and in nominal wall thicknesses 0.062 through 0.500 in. [1.6 through 12.7 mm]. Table 1 and Table 2 list the common diameters and nominal thicknesses of fittings in this specification.

1.3 This specification does not apply to cast fittings. Cast austenitic steel fittings are covered by Specification A 351/A 351M.

1.4 Optional supplementary requirements are provided for fittings where a greater degree of examination is desired. These supplementary requirements call for additional tests. When desired, one or more of these may be specified in the order.

1.5 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

1.6 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.

2. Referenced Documents

2.1 *ASTM Standards:*

A 240 Specification for Heat Resisting Chromium and Chromium–Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels[2]

A 351/A351M Specification for Steel Castings, Austenitic, for High-Temperature Service[3]

A 403/A403M Specification for Wrought Austenitic Stainless Steel Piping Fittings[3]

A 751 Test Methods, Practices, and Definitions for Chemical Analysis of Steel Products[2]

E 165 Practice for Liquid Penetrant Inspection Method[4]

TABLE 1 Common Tubular Fittings Sizes, Outside Diameter[A]

in. [mm]	in. [mm]
3 [76]	12 ¾ [325]
3 ½ [90]	14 [355]
4 [100]	16 [405]
4 ½ [115]	18 [460]
6 [150]	20 [510]
6 ⅝ [170]	24 [610]
8 [205]	30 [760]
8 ⅝ [220]	36 [915]
10 [255]	40 [1015]
10 ¾ [275]	42 [1070]
12 [305]	48 [1220]

[A] Other sizes may be furnished provided they comply with all other requirements of this specification.

TABLE 2 Common Tubular Fittings Nominal Thicknesses[A]

in. or gage	in.	[mm]
16 gage	0.062	[1.6]
14 gage	0.078	[2.0]
12 gage	0.109	[2.8]
11 gage	0.125	[3.2]
10 gage	0.140	[3.6]
8 gage	0.172	[4.4]
⅛ in.	0.187	[4.8]
¼ in.	0.250	[6.4]
5/16 in.	0.312	[8.0]
⅜ in.	0.375	[9.5]
½ in.	0.500	[12.5]

[A] Other thicknesses may be furnished provided they comply with all other requirements of this specification.

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Valves, Fittings, Bolting, and Flanges for High and Subatmospheric Temperatures.

Current edition approved Nov. 10, 1995. Published January 1996. Originally published as A 774 – 80. Last previous edition A 774/A 774M – 95.

[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

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

E 527 Practice for Numbering Metals and Alloys (UNS)[3]

2.2 *ASME Standard:*

Section IX, Welding Qualifications, ASME Boiler and Pressure Vessel Code[5]

2.3 *MSS Standard:*

SP 43 Wrought Stainless Steel Butt Welding Fittings[6]

2.4 *AWS Standards:*

A5.4 Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes[7]

A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes[7]

2.5 *ASNT Standard:*

SNT-TC-1A(1984) Recommended Practice for Nondestructive Testing Personnel Qualification and Certification[8]

2.6 *SAE Standard:*

J1086 Unified Numbering System for Metals and Alloys[9]

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity (mass or number of pieces of each kind),

3.1.2 Description of fitting,

3.1.3 Dimensions (outside diameter and specified wall thickness, see Table 1 and Table 2),

3.1.4 Grade (Table 3),

3.1.5 End use, if known,

3.1.6 Specification number and date of issue,

3.1.7 Additional requirements, if any (see 15.3), and

3.1.8 Supplementary requirements, if any.

4. Manufacture

4.1 The fittings shall be made from flat-rolled steel, such as in Specification A 240. The flat rolled steel shall be in the solution annealed condition unless other heat treat conditions are agreed upon by the manufacturer and the purchaser. The fittings shall be formed by a hot or cold process, and welded by a shielded welding process with or without the addition of filler metal.

4.2 Fittings shall be furnished clean and free of scale.

4.3 *Welding:*

4.3.1 The joints shall be full penetration double-welded or single-welded butt joints employing fusion-welding processes with or without the addition of filler metal as defined under Definitions, ASME Boiler and Pressure Vessel Code, Section IX. This specification makes no provision for any difference in weld quality requirements regardless of the weld joint-type employed (single or double) in making the weld. Welding procedures and welding operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

4.3.2 For fittings employing multiple passes, the root-pass may be made without the addition of filler metal.

4.3.3 The alloy content (chromium, nickel, molybdenum, columbium, and tantalum) of the deposited weld metal shall conform to that required of the base metal or for equivalent weld metal as given in the AWS filler metal specification A5.4 or A5.9, except that, when welding on Types 304L base metal, the deposited weld metal shall correspond, respectively, to AWS Types E308L (ER308L) and, when welding on Type 321 base metal, the weld metal shall correspond to AWS Types E347 (ER347 or ER321).

5. Chemical Composition

5.1 The steel shall conform to requirements of chemical composition for the respective material prescribed in Table 3 and Table 4. Methods, Practices, and Definitions A 751 shall apply.

5.2 The steel shall not contain any unspecified elements for the ordered grade to the extent that it conforms to the requirements of another grade for which that element is a specified element having a required minimum content.

5.3 Mill certificates of analysis of each heat of steel shall be furnished on request.

6. Mechanical Properties

6.1 The material used in making these fittings shall conform

[3] Available from American Society of Mechanical Engineers, 345 E. 47th St. New York, NY 10017.

[6] Available from the Manufacturers' Standardization Society of the Valve and Fittings Industry, 1815 N. Fort Myer Drive, Arlington, VA 22209.

[7] Available from American Welding Society, 550 LeJeune Rd. P.O. Box 351040, Miami, FL 33135.

[8] Available from American Society for Nondestructive Testing, 4153 Arlingate Plaza, Columbus, OH 43228-0518.

[9] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

TABLE 3 Chemical Requirements

Note—Where an ellipsis (...) appears in this Table, there is no requirement.

Grade	UNS Designation[A]	Composition, %									
		Carbon, max[B]	Manganese, max	Phosphorus, max	Sulfur, max	Silicon, max	Chromium	Nickel	Molybdenum	Titanium	Columbium plus Tantalum	Nitrogen, max
TP 304L	S30403	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–13.0	...	...	...	0.10
TP 316L	S31603	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–15.0	2.00–3.00	...	...	0.10
TP 317L	S31703	0.030	2.00	0.045	0.030	1.00	18.0–20.0	11.0–15.0	3.0–4.0	...	...	0.10
TP 321	S32100	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	[C]	...	...
TP 347	S34700	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	[D]	...

[A] New designation established in accordance with ASTM Practice E 527 and SAE J1086.

[B] The carbon analysis shall be reported to the nearest 0.01 % except for the low carbon (0.030) types, that shall be reported to the nearest 0.001 %.

[C] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.

[D] The columbium plus tantalum content shall be not less than ten times the carbon content and not more than 1.10 %.

TABLE 4 Product Analysis Tolerances[A]

Element	Tolerance Over the Maximum Limit Or Under the Minimum Limit
Carbon	0.005
Manganese	0.040
Phosphorus	0.010
Sulfur	0.005
Silicon	0.050
Chromium	0.200
Nickel	0.100
Molybdenum	0.100
Nitrogen	0.006

[A] This table does not apply to heat analysis.

to the test requirements listed in Table 5 for the specified grade. Mechanical tests made on the sheet or plate by the manufacturer shall qualify the sheet or plate material.

6.2 Mechanical properties of fittings made to this specification are not verified unless specific tests and limits have been agreed upon between the purchaser and manufacturer.

7. Heat Treatment

7.1 Heat treatment is not required (see 15.1).

8. Permissible Variations in Nominal Dimensions

8.1 Refer to MSS SP 43 for tolerances for fittings covered by this specification. For fittings not covered in MSS SP 43 (wyes and laterals) acceptance limits must be agreed upon between the purchaser and manufacturer.

9. Hydrostatic Tests

9.1 Hydrostatic testing of the fittings is not required by this specification.

10. Surface Quality

10.1 Fittings supplied under this specification shall be examined visually. Selected typical surface discontinuities shall be explored for depth. The fittings shall be free of surface discontinuities that penetrate more than 5 % of the specified nominal wall thickness, except as defined in 10.3 and 10.4, and shall have a workmanlike finish.

10.2 Surface discontinuities deeper than 5 % of the specified nominal wall thickness, except as defined in 10.3 and 10.4, shall be removed by the manufacturer by machining or grinding to sound metal, and the repaired areas shall be well faired. The wall thickness at all points shall be at least 87½ % of the specified nominal wall thickness, and the diameters at all points shall be within the specified limits.

TABLE 5 Mechanical Test Requirements

Type	UNS Designation	Tensile Strength		Yield Strength		Elongation in 2 in. [50 mm], min, %	Hardness, max[A]	
		ksi	[MPa]	ksi	[MPa]		Brinell	Rockwell B
304L	S30403	70–95	485–655	25	170	40.0	183	88
316L	S31603	70–95	485–655	25	170	40.0	217	95
317L	S31703	75–100	515–690	30	205	35.0	217	95
321	S32100	75–100	515–690	30	205	40.0	217	95
347	S34700	75–100	515–690	30	205	40.0	202	92

[A] Either Brinell or Rockwell B Hardness is permissible.

10.3 Surface checks (fish scale) deeper than 1/64 in. [0.4 mm] shall be removed.

10.4 Mechanical marks deeper than in. [1.6 mm] shall be removed.

10.5 When the removal of a surface discontinuity reduces the wall thickness below 87½ % of the specified nominal wall thickness at any point, the fitting shall be subject to rejection or to repair as provided in Section 13.

11. Inspection

11.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with the specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

11.2 Other tests, when required by agreement, shall be made from material of the lots covered in the order.

NOTE 1—A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material and using one lot number of electrode or one heat of weld wire.

12. Repair of Defects

12.1 Injurious defects that are deeper than the minimum specified in Section 11 may be repaired with the approval of the purchaser. Such defects shall be entirely removed by either chipping, machining, or grinding before welding. Rewelding shall be in accordance with 4.3 of this specification.

13. Rejection and Rehearing

13.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for rehearing.

13.2 Fittings that develop defects in shop working or application operations may be rejected. Upon rejection the manufacturer shall be notified in writing.

14. Certification

14.1 A certification that the material conforms to the requirement of this specification shall be the basis of acceptance of the material. When requested by the purchaser, the manufacturer shall report to the purchaser, or his representative, the results of any supplementary test requirements.

14.2 Certification shall include the specification year of issue and revision letter, if any.

15. Product Marking

15.1 Each fitting shall be legibly marked with the manufacturer's name or brand, the schedule number or pressure class or thickness, the specified size, the specification number, the grade of material listed in Table 1, the heat number or manufacturer's heat identification, and the letters "HT-O" to indicate that there has been no heat treating after welding or forming.

NOTE 2—For purposes of identification marking, the manufacturer is considered the organization that certifies the piping component complies with the specification.

15.2 The specification year of issue and revision letter, if any, are not required for product marking.

15.3 *Bar Coding*—In addition to the requirements in15.1 and 15.2, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of the published industry standards for bar coding. If used on small fittings, the bar code may be applied to the box or a substantially applied tag.

16. Packaging

16.1 The manufacturer shall box, crate, or package in secure lifts or bundles to ensure safe delivery. If specified, the ends shall be protected with wooden or plastic plugs. Special packaging requiring extra operations other than those above must be specified by the purchaser.

17. Keywords

17.1 austenitic stainless steel; corrosive service applications; pipe fittings steel; piping applications; stainless steel fittings; temperature service applications-low

SUPPLEMENTARY REQUIREMENTS

These requirements shall not be considered unless specified in the order, in which event, any or all of the supplementary tests specified in Section S1 to S5 shall be made at the place of manufacture, unless otherwise agreed upon. The tests specified shall be witnessed by the purchaser's inspector before shipment of material if so specified in the order.

S1. Product Analysis (Note S1)

S1.1 A product analysis shall be made from each heat of base metal and from each lot number of welding filler material used in the fittings offered for delivery. The analysis shall conform to the requirements of chemical composition for the respective material prescribed in Table 3 and the tolerances shown in Table 4.

NOTE S1—If the results of any of the tests specified in Supplementary Requirements S1, S2, or S3 do not conform to requirements, retests may be made at the manufacturer's expense on additional fittings or representative test pieces of double the original number from the same heat or lot as defined in Supplementary Requirements S1, S2, or S3, each of which shall conform to the requirements specified.

S2. Tension Test (Note S2)

S2.1 One tension test shall be made on one fitting or representative test piece (Note S2) per lot (Note 1) of fittings. The tension specimen shall include the weld and be prepared so that the weld is at the midlength location of the specimen. Acceptance limits of the tensile properties of the specimen shall be based upon agreement between the purchaser and the manufacturer.

NOTE S2—Where the test specimen for the tension test cannot be taken from a fitting due to size limitations, a representative test piece shall be obtained. The test piece shall be from the same heat as the fittings it represents and shall have approximately the same amount of cold working. In addition, test pieces representing fittings shall have a cross section equal to the greatest cross section of the fitting, and test pieces representing fittings manufactured from pipe shall have an outside diameter and wall thickness equal to those of the fitting. The test piece for fittings shall be prepared to the same weld procedures and from the same heats of materials as the fittings it represents.

S3. Ultrasonic Examination

S3.1 The base material from which each fitting is made shall be ultrasonically examined to determine its soundness. Acceptance limits shall be as agreed upon between the purchaser and the manufacturer. Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

S4. Liquid Penetrant Examination

S4.1 All surfaces shall be liquid-penetrant examined. The method shall be in accordance with Practice E 165. Acceptance limits shall be as agreed upon between the purchaser and the manufacturer. Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

S5. Nondestructive Electromagnetic (Eddy-Current) Test

S5.1 For eddy-current testing, the calibration tube shall contain, at the option of the manufacturer, any one of the following discontinuities placed in the weld to establish a minimum sensitivity level for rejection.

S5.2 *Drilled Hole*—A hole not larger than 0.031 in. [0.79 mm] in diameter shall be drilled radially and completely through the tube wall, care being taken to avoid distortion of the tube while drilling.

S5.3 *Transverse Tangential Notch*—Using a round tool or file with a ¼-in. [6-mm] diameter, a notch shall be filed or milled tangential to the surface and transverse to the longitudinal axis of the tube. The notch shall have a depth not exceeding 12 ½ % of the specified wall thickness of the tube or 0.004 in. [0.102 mm], whichever is greater.

S5.4 *Longitudinal Notch*—A notch 0.031 in. [0.79 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 12 ½ % of the specified wall thickness of the tube or 0.004 in. [0.102 mm], whichever is greater. The length of the notch shall be compatible with the testing method.

S5.5 Fittings producing a signal equal to or greater than the calibration defect shall be subject to rejection. To be accepted, after rework, the fittings must pass the same test to which it was originally subjected.

S5.6 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

The American Society for Testing and Materials 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 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, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

An American National Standard

Designation: A 403/A 403M – 97a

Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings[1]

This standard is issued under the fixed designation A 403/A 403M; 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 specification covers wrought stainless steel fittings for pressure piping applications.[2]

1.2 Several grades of austenitic stainless steel alloys are included in this specification Grades are designated with a prefix, WP or CR, based on the applicable ANSI or MSS dimensional and rating standards, respectively.

1.3 For each of the WP stainless grades, several classes of fittings are covered, to indicate whether seamless or welded construction was utilized. Class designations are also utilized to indicate the nondestructive test method and extent of nondestructive examination (NDE). Table 1 is a general summary of the fitting classes applicable to all WP grades of stainless steel covered by this specification. There are no classes for the CR grades. Specific requirements are covered elsewhere.

1.4 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

1.5 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.

1.6 This specification does not apply to cast steel fittings. Austenitic stainless steel castings are covered in Specifications A 351/A 351M, A 743/A 743M, and A 744/A 744M.

2. Referenced Documents

2.1 *ASTM Standards:*

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels[3]

TABLE 1 Fitting Classes for WP Grades

Class	Construction	Nondestructive Examination
S	Seamless	None
W	Welded	Radiography or Ultrasonic
WX	Welded	Radiography
WU	Welded	Ultrasonic

A 351/A 351M Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure Containing Parts[4]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[3]

A 388/A 388M Practice for Ultrasonic Examination of Heavy Steel Forgings[5]

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip[5]

A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application[4]

A 744/A 744M Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant for Severe Service[4]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[3]

E 112 Test Methods for Determining the Average Grain Size[6]

E 165 Test Method for Liquid Penetrant Examination[7]

2.2 *ANSI Standards:*[8]

ANSI B16.9 Factory-Made Wrought Steel Butt-Welding Fittings

ANSI B16.11 Forged Steel Fittings, Socket-Welding and Threaded

ANSI B16.28 Wrought Steel Butt-Welding Short Radius Elbows and Returns

2.3 *MSS Standards:*[9]

MSS SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Steel Forgings and Wrought Findings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-403 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 01.03

[4] *Annual Book of ASTM Standards*, Vol 01.02

[5] *Annual Book of ASTM Standards*, Vol 01.05.

[6] *Annual Book of ASTM Standards*, Vol 03.01.

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

[8] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

[9] Available from Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park St., Northeast, Vienna, VA 22180.

MSS SP-43 Standard Practice for Light Weight Stainless Steel Butt-Welding Fittings
MSS SP-79 Socket-Welding Reducer Inserts
MSS SP-95 Swaged(d) Nipples and Bull Plugs
2.4 *ASME Boiler and Pressure Vessel Code:*
Section VIII Division I, Pressure Vessels[10]
Section IX Welding Qualifications[9]
2.5 *AWS Standards:*
A 5.4 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes[11]
A 5.9 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes[11]
2.6 *ASNT:*
SNT-TC-1A(1984) Recommended Practice for Nondestructive Testing Personnel Qualification and Certification[12]

3. Ordering Information

3.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. Examples of such information include but are not limited to the following:

3.1.1 Quantity, number of fittings of each kind,

3.1.2 Description of fitting and nominal dimension (standard or special),

3.1.3 Steel composition by grade and Class designation,

3.1.4 For all Grades of WP fittings, construction and NDE Class in accordance with Table 1 (unless a Class is specified by the purchaser, any Class may be furnished at the option of the supplier).

3.1.4.1 For all Grades of WP fittings, unless Class S, W, WX, or WU is specified by the purchaser, any Class may be furnished at the option of the supplier,

3.1.4.2 Grade CR fittings shall not be substituted for fittings ordered to Grade WP, but WP fittings may be substituted for Grade CR fittings.

3.1.5 Supplementary requirements if any, and

3.1.6 Additional requirements (see 4.1, 12.2, and 14.1).

4. Material

4.1 The material for fittings shall consist of forgings, bars, plates, or seamless or welded tubular products that conform to the chemical requirements in Table 2.

4.2 The steel shall be melted by one of the following processes:

4.2.1 Electric furnace (with separate degassing and refining optional),

4.2.2 Vacuum furnace, or

4.2.3 One of the former followed by vacuum or electroslag-consumable remelting.

4.3 If secondary melting is employed, the heat shall be defined as all ingots remelted from a primary heat.

5. Manufacture

5.1 *Forming*—Forging or shaping operations may be performed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining, or by a combination of two or more of these operations. The forming procedure shall be so applied that it will not produce injurious defects in the fittings.

5.2 All fittings shall be heat treated in accordance with Section 6.

5.3 Grade WP fittings ordered as Class S shall be of seamless construction and shall meet all requirements of ANSI B16.9, B16.28, or MSS SP-79.

5.4 Grade WP fittings ordered as Class W shall meet the requirements of ANSI B16.9 or B16.28 and:

5.4.1 Shall have all pipe welds made by mill or the fitting manufacturer with the addition of filler metal radiographically examined throughout the entire length in accordance with the Code requirements stated in 5.5, and,

5.4.2 Radiography is not required on single longitudinal seam welds made by the starting pipe manufacturer or the fitting manufacturer if made without the addition of filler metal.

5.4.3 In place of radiographic examination, welds made by the fitting manufacturer may be ultrasonically examined in accordance with the Code requirements stated in Eq 5.6.

5.4.4 After final heat treatment, the grain size of "H-Grade" steels shall be 7 or coarser in accordance with Test Methods E 112.

5.5 Grade WP fittings ordered as Class WX shall meet the requirements of ANSI B16.9 or B16.28 and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, radiographically examined throughout their entire length in accordance with Paragraph UW-51 of Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code.

5.6 Grade WP fittings ordered as Class WU shall meet the requirements of ANSI B16.9 or B16.28 and shall have all welds, whether made by the fitting manufacturer or the starting material manufacturer, ultrasonically examined throughout their entire length in accordance with Appendix 12 of Section VIII, Division I of ASME Boiler and Pressure Vessel Code.

5.7 The radiography or ultrasonic examination of welds for this class of fittings may be done at the option of the manufacturer, either prior to or after forming.

5.8 Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

5.9 Grade CR fittings shall meet the requirements of MSS SP-43 and do not require nondestructive examination.

5.10 All fittings shall have the welders, welding operators, and welding procedures qualified under the provisions of Section IX of the ASME Boiler and Pressure Vessel Code except that starting pipe welds made without the addition of filler metal do not require such qualification.

5.11 All joints welded with filler metal shall be finished in accordance with the requirements of Paragraph UW-35 (a) of Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code.

5.12 Fittings machined from bar shall be restricted to NPS 4

[10] Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

[11] Available from American Welding Society, 550 Lejeune Rd., P.O. Box 351040, Miami, FL 33135.

[12] Available from American Society for Nondestructive Testing, 4153 Arlington Plaza, Columbus, OH 43228-0518

TABLE 2 Chemical Requirements

Note 1—Where an ellipsis (...) appears in this Table, there is no requirement.

Grade[A]		Composition, %										
Grade WP	Grade CR	C[B]	Mn[B]	P[B]	S[B]	Si[B]	Ni	Cr	Mo	Ti	N_2[C]	Others
WP 304	CR 304	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...	...
WP 304H	CR 304H	0.04–0.10	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	...	...	...	...
WP 304L	CR 304L	0.035[D]	2.00	0.045	0.030	1.00	8.0–13.0	18.0–20.0	...	...	...	...
WP 304LN	CR 304LN	0.030	2.00	0.045	0.030	0.75	8.0–10.5	18.0–20.0	...	...	0.10–0.16	...
WP 304N	CR 304N	0.08	2.00	0.045	0.030	0.75	8.0–11.0	18.0–20.0	...	...	0.10–0.16	...
WP 309	CR 309	0.15	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	...	...	...	...
WP 310	CR 310	0.15	2.00	0.045	0.030	1.50	19.0–22.0	24.0–26.0	...	...	...	...
WP 316	CR 316	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...
WP 316H	CR 316H	0.04–0.10	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...
WP 316LN	CR 316LN	0.030	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	0.10–0.16	...
WP 316L	CR 316L	0.035[D]	2.00	0.045	0.030	1.00	10.0–16.0[E]	16.0–18.0	2.00–3.00	...	...	...
WP 316N	CR 316N	0.08	2.00	0.045	0.030	0.75	11.0–14.0	16.0–18.0	2.00–3.00	...	0.10–0.16	...
WP 317	CR 317	0.08	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...
WP 317L	CR 317L	0.030	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...
WP 321	CR 321	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	[F]	...	...
WP 321H	CR 321H	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	[G]	...	...
WP 347	CR 347	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	...	...	[H]
WP 347H	CR 347H	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	...	...	[I]
WP 348	CR 348	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0	...	...	...	Ta[H] + Cb 0.10 max
WP 348H	CR 348H	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0				Ta[I] + Cb 0.10 max
WP XM-19	CR XM-19	0.060	4.0–6.0	0.040	0.030	1.00	11.5–13.5	20.5–23.5	1.50–3.00	...	0.20–0.40	[J]
WP S31254	CR S31254	0.020	1.00	0.030	0.010	0.80	17.5–18.5	19.5–20.5	6.0–6.5		0.18–0.22	Cu 0.50–1.00
WP S31726	CR S31726	0.030	2.00	0.045	0.030	0.75	13.5–17.5	18.0–20.0	4.0–5.0	...	0.10 max	Cu 0.75 max
WP S31726	CR S31726	0.030	2.00	0.045	0.030	0.75	13.5–17.5	17.0–20.0	4.0–5.0	...	0.10–0.20	Cu 0.75 max
WP S34565	CR S34565	0.03	5.0–7.0	0.030	0.010	1.00	16.0–18.0	23.0–25.0	4.0–5.0	...	0.4–0.6	Cb + 0.1 max
WP S33228	CR S33228	0.04–0.08	1.0	0.020	0.015	0.30	31.0–33.0	26.0–28.0	...	...	...	Ce 0.05–0.10 Al 0.025 Cb 0.6–1.0

[A] See Section 15 for marking requirements.
[B] Maximum, unless otherwise indicated.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP 304L and TP 316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.24 mm] in average wall thickness.
[E] On pierced tubing, the nickel may be 11.0–16.00 %.
[F] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[G] The titanium content shall be not less than four times the carbon content and not more than 0.70 %.
[H] The columbium plus tantalum content shall be not less than ten times the carbon content and not more than 1.10 %.
[I] The columbium plus tantalum content shall be not less than eight times the carbon content and not more than 1.00 %.
[J] Columbium plus tantalum, 0.10–0.30 %; vanadium, 0.10–0.30 %.

or smaller. Elbows, return bends, tees, and header tees shall not be machined directly from bar stock.

5.12.1 All caps machined from bar shall be examined by liquid penetrant in accordance with Supplementary Requirement S7.

5.13 Weld buildup is permitted to dimensionally correct unfilled areas produced during cold forming of stub ends. Radiographic examination of the weld buildup shall not be required provided that all the following steps are adhered to:

5.13.1 The weld procedure and welders or welding operators meet the requirements of 5.10.

5.13.2 Annealing is performed after welding and prior to machining.

5.13.3 All weld surfaces are liquid penetrant examined in accordance with Appendix 8 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

5.13.4 Repair of areas in the weld is permitted, but 5.13.1, 5.13.2, and 5.13.3 must be repeated.

5.13.5 Fittings shall be marked with the symbol WBU following the alloy designation and classification marking (for example: WP 304/304 L-S/WBU, WP 316-W/WBU, etc.).

5.14 Stub ends may be produced with the entire lap added as weld metal to a straight pipe section provided the welding satisfies the requirements of 5.10 for qualifications and 6.4 post weld heat treatment.

5.14.1 *Grade WP Class W*—Radiographic inspection of the weld is required. See 5.4.

5.14.2 *Grade WP Class WX*—Radiographic inspection of all welds is required. See 5.5.

5.14.3 *Grade WP Class WU*—Ultrasonic inspection of all welds is required. See 5.6.

5.14.4 *Grade CR*—Nondestructive examination is not required. See 5.12.1.

6. Heat Treatment

6.1 All fittings shall be furnished in the heat-treated condition. The heat-treat procedure, except for those grades listed in 6.2, shall consist of solution annealing the fittings at a minimum temperature of 1900°F [1040°C] until the chromium carbides go into solution, and then cooling at a sufficient rate to prevent reprecipitation.

6.2 Grades 321H, 347H, and 348H shall be solution annealed at 1925°F [1050°C] minimum. S31254 shall be solution annealed at 2100°F (1150°C) minimum. S33228 shall be solution annealed at 2050°F [1120°C], minimum. S34565 shall be solution annealed in the range 2050°F [1120°C] to 2140°F [1170°C]. The maximum temperature for solution annealing grades 321, 321H, 347, and 347H under 6.1 and 6.2 shall be 2100°F [1150°C].

6.3 A solution annealing temperature above 1950°F [1065°C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in 321, 321H, 347, 347H, 348, and 348H. When specified by the purchaser, a lower temperature stabilization or resolution anneal shall be used subsequent to the initial high temperature solution anneal (see Supplemental Requirement S10).

6.4 All welding shall be done prior to heat treatment.

6.5 Fittings machined directly from solution-annealed forgings and bar stock need not be resolution annealed.

7. Chemical Composition

7.1 The chemical composition of each cast or heat used shall be determined and shall conform to the requirements of the chemical composition for the respective grades of materials listed in Table 2. The ranges as shown have been expanded to include variations of the chemical analysis requirements that are listed in the various specifications for starting materials (pipe, tube, plate, bar, and forgings) normally used in the manufacturing of fittings to this specification. Methods and practices relating to chemical analyses required by this specification shall be in accordance with Test Methods, Practices, and Terminology A 751. Product analysis tolerances in accordance with Specification A 480/A 480M are applicable.

7.2 The steel shall not contain any unspecified elements for the ordered grade to the extent that it conforms to the requirements of another grade for which that element is a specified element having a required minimum content.

7.3 In fittings of welded construction, the alloy content (carbon, chromium, nickel, molybdenum, columbium, and tantalum) of the deposited weld metal shall conform to that required of the base metal or for equivalent weld metal as given in the AWS filler metal specification A5.4 or A5.9 (Type 348 weld metal is listed in AWS A5.9 but not in AWS A5.4). Exceptions are when welding on Types 304L and 304 base metals, the deposited weld metal shall correspond, respectively, to AWS E308L(ER308L) and E308 (ER308), when welding on Type 321 base metal, the weld metal shall correspond to AWS Type E347 (ER347 or ER321); and, when welding on S31725, S31726, S31254 or S33228 osited weld metal shall correspond either to the alloy content of the base metal or to AWS A5.11 E NiCrMo-3 (UNS W86112) (AWS A5.14 Ni Cr Mo-3 (UNS N06625)).

7.3.1 Supplementary Requirement S8 may be specified where 16-8-2 filler metal is required for joining thick sections of Types 316, 321, or 347 and has adequate corrosion resistance for the intended service.

8. Tensile Properties

8.1 The tensile properties of the fitting material shall conform to the requirements of Table 3. The testing and reporting shall be performed in accordance with Methods and Definitions A 370.

TABLE 3 Tensile Requirements

All WP and CR Grades	Yield Strength, min, ksi [MPa]	Tensile Strength, min, ksi [MPa]
304, 304LN, 304H, 309, 310, 316, 316LN, 316H, 317, 317L, 321, 321H, 347, 347H, 348, 348H	30 [205]	75 [515]
S31725	25 [170]	70 [485]
304L, 316L	35 [240]	80 [550]
304N, 316N, S31726	55 [380]	100 [690]
316L10	44 [300]	94 [650] to 119 [820]
S31254	27 [185]	73 [500]
S33228	60 [415]	115 [795]

Elongation Requirements	Longitudinal	Transverse
Standard round specimen, or small proportional specimen, or strip-type specimen, minimum % in 4 D	28	20

8.2 Records of the tension test made on the starting material shall be certification that the material of the fitting meets the requirements of this specification provided that heat treatments are the same.

8.3 If the raw material was not tested, or if the heat treatment of the raw material was different than the heat treatment of the fitting, the fitting manufacturer shall perform at least one tension test per heat on material representative of the fitting, and in the same condition of heat treatment as the fitting it represents. Qualification of welding procedures shall be in accordance with 5.8.

8.4 If a tension test through the weld is desired, Supplementary Requirement S2 should be specified.

9. Hydrostatic Tests

9.1 Hydrostatic testing is not required by this specification.

9.2 All Grade WP fittings shall be capable of withstanding without failure, leakage, or impairment of serviceability, a test pressure equal to that prescribed for the specified matching pipe or equivalent material.

9.3 All Grade CR fittings, except tees covered in 9.3.1, shall be capable of withstanding without failure, leakage, or impairment of serviceability, a test pressure based on the ratings in MSS SP-43.

9.3.1 Grade CR tees fabricated using intersection welds shall be capable of passing a hydrostatic test based on 70 % of the ratings in MSS SP-43.

10. Surface Quality

10.1 Fittings supplied under this specification shall be examined visually. Selected typical surface discontinuities shall be explored for depth. The fittings shall be free from surface discontinuities that penetrate more than 5 % of the specified nominal wall thickness, except as defined in 10.3 and 10.4, and shall have a workmanlike finish.

10.2 Surface discontinuities deeper than 5 % of the specified nominal wall thickness, except as defined in 10.3 and 10.4,

shall be removed by the manufacturer by machining or grinding to sound metal, and the repaired areas shall be well faired. The wall thickness at all points shall be at least 87½ % of the specified nominal wall thickness, and the diameters at all points shall be within the specified limits.

10.3 Surface checks (fish scale) deeper than 1/64 in. [0.4 mm] shall be removed.

10.4 Mechanical marks deeper than 1/16 in. [1.6 mm] shall be removed.

10.5 When the removal of a surface discontinuity reduces the wall thickness below 87½ % of the specified nominal wall thickness at any point, the fitting shall be subject to rejection or to repair as provided in 10.6.

10.6 *Repair by Welding*:

10.6.1 Repair of unacceptable imperfections in the base metal is permissible for fittings made to the dimensional standards listed in 1.1 or for other standard fittings made for stock by the manufacturer. Prior approval of the purchaser is required to repair special fittings made to the purchaser's requirements. Welding of unacceptable imperfections in no case shall be permitted when the depth of defect exceeds 33⅓ % of the nominal wall thickness or the defect area exceeds 10 % of the surface area of the fitting.

10.6.2 The welding procedure and welders shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

10.6.3 The composition of the weld deposits shall be in accordance with 7.3 and in accordance with the procedure qualification for the applicable material.

10.6.4 Unacceptable imperfections shall be removed by mechanical means or by thermal cutting or gouging methods. Cavities prepared for welding shall be examined with liquid penetrant in accordance with Practice E 165. No cracks are permitted in the prepared cavities. Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

10.6.5 The weld repair shall be permanently identified with the welder's stamp or symbol in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.

10.6.6 Weld repair area(s) shall be blended uniformly to the base metal and shall be examined by liquid penetrant in accordance with Practice E 165. No cracks are permitted in the weld or surrounding ½ in. [12.7 mm] of base metal. Personnel performing NDE examinations shall be qualified in accordance with SNT-TC-1A.

10.6.7 After weld repair, material shall be heat treated in accordance with Section 6 .

10.7 The fittings shall be free of scale and shall be passivated.

11. Dimensions

11.1 For fittings covered by ANSI B16.9, ANSI B16.11, ANSI B16.28, MSS SP-43, or MSS SP-79, the sizes, shapes, and dimensions of the fittings shall be as specified in those standards.

11.1.1 Fittings of size or shape differing from these standards, but meeting all other requirements of this specification, may be furnished in accordance with Supplementary Requirement S9.

12. Inspection

12.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with this specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All examinations and inspections shall be made at the place of manufacture, unless otherwise agreed upon.

12.2 Other tests, when agreed upon, shall be made from material of the lots covered in the order.

13. Rejection and Rehearing

13.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the tests, the producer or supplier may make claim for rehearing.

13.2 Fittings that develop defects in shop working or application operations may be rejected. Upon rejection, the manufacturer shall be notified promptly in writing.

14. Certification

14.1 When requested by the purchaser, the manufacturer shall provide a certificate of conformance to this specification including year of issue and revision letter, if any. In addition, if requested to provide test reports, the manufacturer shall also provide the specification year of issue and revision letter, if any, and the following where applicable:

14.1.1 Chemical results, Section 7 (Table 2),

14.1.2 Tensile results, Section 8 (Table 3). Report yield strength and ultimate strength in ksi [MPa] and percent elongation,

14.1.3 Type of heat treatment, Section 6 or Supplementary Requirement S10,

14.1.4 Starting material, plate, bar, pipe (specify welded or seamless), forging,

14.1.5 Seamless or welded construction,

14.1.6 Any supplemental testing required by the purchase order, and

14.1.7 Heat identification.

14.2 Certification shall state whether welds have been examined radiographically or ultrasonically.

15. Product Marking

15.1 All fittings shall have the prescribed information stamped or otherwise suitably marked on each fitting in accordance with the latest edition of MSS SP-25. See Table 4 for marking examples of grades and classes.

15.2 Marking paint or ink shall not contain harmful amounts of chlorides, metals, or metallic salt, such as zinc or copper, that cause corrosive attack on heating. On wall thicknesses thinner than 0.083 in. [2.1 mm], no metal impression stamps shall be used. Vibrating pencil marking is acceptable.

15.3 The prescribed information for butt-welding fittings shall be: the manufacturer's name or trademark (Note 1), schedule number or nominal wall thickness designation, size, grade (Table 2), class, and the heat number or manufacturer's heat identification. The class S marking need not be added to the material grade for threaded or socket-welded fittings.

TABLE 4 Product Marking Examples for Grades and Classes

Grade and Class Marking	Description
CR304	Single grade: No classes in CR grades
CR304/304L	Multiple grades, meet chemical and mechanical properties of each
WP304-S	Single Grade: seamless
WP304-W	Single Grade: welded : RT or UT pipe welds with filler metal and all fitting manufacturer's welds
WP304-WX	Single grade: welded: RT all welds with or without filler metal
WP304-WU	Single grade: welded: UT all welds with or without filler metal
WP304-304L-S	Multiple grades: meet chemical and mechanical properties of each: seamless
WP304-S/WBU	Single grade: seamless: weld buildup for stub ends only

15.3.1 The prescribed information for cold-formed stub ends with weld buildup shall be: the manufacturer's name or trademark (Note 1), schedule number or nominal wall thickness designation, size, grade (listed in Table 2), class, WBU, and heat number or manufacturer's heat identification.

15.4 The prescribed information for threaded or socket-welding fittings shall be: the manufacturer's name or trademark (Note 1), pressure class or schedule number, grade (Table 2), and class.

NOTE 1—For purposes of identification marking, the manufacturer is considered the organization that certifies that the piping component complies with this specification.

15.5 Fittings meeting the chemical and mechanical property requirements of Table 2 and Table 3 for more than one grade designation may be marked with more than one class or grade designation, such as WP304/304H; WP304/304L; WP304/304L/304N, WP316/316L, etc.

15.6 *Bar Coding*—In addition to the requirements in 15.1, 15.2 15.3 15.4, and 15.5 bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of the published industry standards for bar coding. If used on small fittings, the bar code may be applied to the box or a substantially applied tag.

16. Keywords

16.1 austenitic stainless steel; corrosive service applications; pipe fittings; steel; piping applications; pressure containing parts; stainless steel fittings

SUPPLEMENTARY REQUIREMENTS

One or more of the supplementary requirements described below may be included in the purchaser's inquiry or in the order or contract. When so included, a supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirement details not fully described shall be agreed upon between the purchaser and the supplier.

S1. Product Analysis (Note S1.1)

S1.1 A product analysis shall be made for each heat of base metal and, if of welded construction, from each lot number of welding material of the fittings offered for delivery and shall conform to the requirements specified in Section 4.

S2. Tension Test (Note S1.1)

S2.1 One tension test shall be made on one fitting or representative test piece (Note S1.2) per lot (Note S1.3) of fittings. If the fittings are of welded construction, the tension specimen shall include the weld and be prepared so that the weld is at the midlength of the specimen.

NOTE S1.1—If the results of any of the tests specified in Supplementary Requirements S1, S3, or S2 do not conform to requirements, retests may be made at the manufacturer's expense on additional fittings or representative test pieces of double the original number from the same heat or lot as defined in Supplementary Requirements S1, S2, or S3, each of which shall conform to the requirements specified.

NOTE S1.2—Where the test specimen for the tension or intergranular corrosion bend test cannot be taken from a fitting due to size limitations, a representative test piece shall be obtained. The test piece shall be from the same lot it represents and shall have approximately the same amount of working. In addition, these pieces representing fittings manufactured from bars, plate, or forgings shall have a cross section equal to the greatest cross section of the fitting, and test pieces representing fittings manufactured from pipe shall have an outside diameter and wall thickness equal to those of the fitting. The test piece for fittings of welded construction shall be prepared to the same weld procedures and from the same heat of materials as the fittings it represents.

NOTE S1.3—A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material (and, if fabrication welding is performed using one lot number of electrode or one heat of weld wire), and heat treated using the same heat-treat cycle in either a continuous or batch-type furnace controlling within a range of 50°F [28°C] and equipped with recording pyrometers so that complete records of heat treatment are available.

S3. Intergranular Corrosion Bend Test (Note 1)

S3.1 One intergranular corrosion bend test shall be made on one fitting or representative test piece (Note S1.1) per lot (Note S1.2) of fittings. If the fittings are of welded construction, the bend specimen shall include the weld and be prepared so that the weld is at the midlength location of the specimen. Specimens containing a weld shall be bent so that the location of weld is at the point of maximum bend. The method of testing shall be in accordance with Practice E of Practices A 262.

S3.2 Types 304L, 316L, 317L, 321, 347, and 348 shall be tested after a heat treatment capable of producing sensitization. In the case of the other chromium-nickel steels (Series 300), the test shall be conducted on specimens representative of the material in the annealed condition.

S4. Ultrasonic Test

S4.1 Each fitting of the raw material from which each fitting is made shall be ultrasonically tested to determine its soundness. The method, where applicable, shall be in accordance with Practice A 388. Acceptance limits shall be specified by the purchaser. Personnel performing the examination shall be qualified in accordance with SNT-TC-1A.

S5. Photomicrographs

S5.1 Photomicrographs at 100 diameters shall be made, for information only, of the actual base metal structure from one fitting as furnished in each lot. The photomicrographs shall be identified as to fittings size, wall thickness, lot identification, and heat. The definition of "lot" shall be as specified by the purchaser.

S6. Surface Finish

S6.1 Machined surfaces shall have a maximum roughness of 250 µin. [6.4 µm] arithmetical average. All other surfaces shall be suitable for ultrasonic test.

S7. Liquid Penetrant Test

S7.1 All surfaces shall be liquid penetrant tested. The method shall be in accordance with Practice E 165. Personnel performing the examination shall be qualified in accordance with SNT-TC-1A.

S8. Special Filler Metal

S8.1 Filler metal shall be AWS Type E16-8-2 or ER 16-8-2 (AWS Specifications A5.4 and A5.9, respectively). Fittings welded with 16-8-2 weld metal shall be marked WP ___ HRW or CR ___ HRW, as appropriate.

S9. Special Fittings

S9.1 Partial compliance fittings of size and shape not conforming to the dimensional requirements of ANSI B16.9, B16.11B16.28 MSS SP-79, or MSS SP-95 shall meet all other requirements of this specification. In addition to the marking required in Section 15, the grade designation symbol shall be followed by the symbol "S9".

S10. Stabilization Treatment

S10.1 Subsequent to the solution anneal required by 6.2, Grades 321, 321H, 347, 347H, 348, and 348H shall be given a stabilization heat treatment at 1500 to 1600°F [815 to 870°C] for a minimum of 2h/in. [4.7 min/mm] of thickness and then cooling in the furnace or in air. In addition to the marking required in Section 15, the grade designation symbol shall be followed by the symbol" S10."

The American Society for Testing and Materials 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 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, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

EXHIBIT 7

MEMBER:
apfa
INCORPORATED
AMERICAN PIPE
FITTINGS ASSOC.
FLOWLINE®
STAINLESS STEEL
NICKEL, NICKEL ALLOY
ALUMINUM ALLOY
BUTT WELD FITTINGS
AND FLANGES
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Markovitz Enterprises, Inc.
World's Largest Manufacturer of Corrosion-Resistant Fittings
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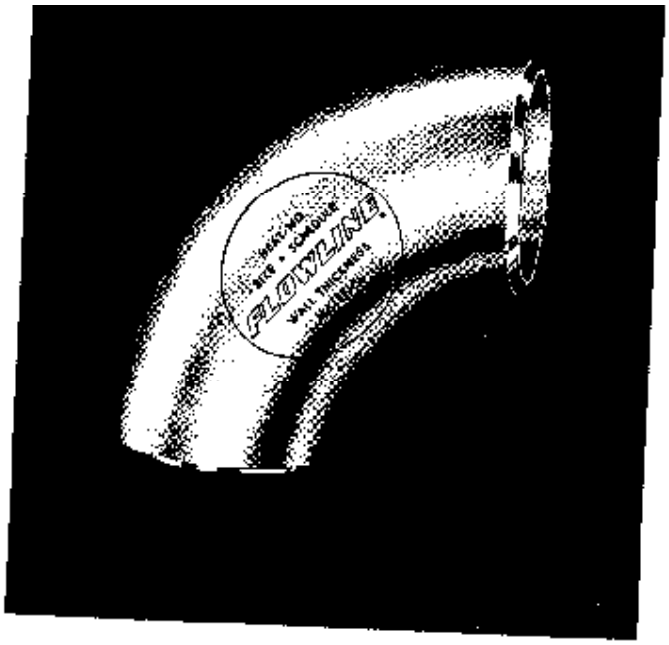


FLOWLINE®

90° ELBOWS

LONG RADIUS

STAINLESS STEELS

TYPES 304, 304L, 304H, 316, 316L, 316H

NICKEL ALLOYS

ALLOY 400, ALLOY 200

ALUMINUM ALLOYS

TYPES 3003-F, 6061-T6

REGULAR PRODUCTION ▶

			• STAINLESS STEELS			• STAINLESS STEELS • INCO ALLOYS			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS		
			PART L-5			PART L-1			PART L-4		
			SCHEDULE 5S Featherweight			SCHEDULE 10S Light I.P.S.			SCHEDULE 40S Standard I.P.S.		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	CENTER TO FACE (A)	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ‡	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ‡	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ‡
½	.840	1½	.710	.065	.12	.674	.083	.14	.622	.109	.18
¾	1.050	1½ (1)	.920	.065	.13	.884	.083	.15	.824	.113	.19
1	1.315	1½	1.185	.065	.19	1.097	.109	.30	1.049	.133	.35
1¼	1.660	1⅞	1.530	.065	.31	1.442	.109	.50	1.380	.140	.56
1½	1.900	2¼	1.770	.065	.38	1.682	.109	.69	1.610	.145	.68
2	2.375	3	2.245	.065	.64	2.157	.109	1.13	2.067	.154	1.56
2½	2.875	3¾	2.709	.083	1.50	2.635	.120	1.88	2.469	.203	3.00
3	3.500	4½	3.334	.083	2.00	3.260	.120	2.69	3.068	.216	4.81
3½	4.000	5¼	3.834	.083	2.62	3.760	.120	3.75	3.548	.226	6.25
4	4.500	6	4.334	.083	3.31	4.260	.120	4.75	4.026	.237	9.19
5	5.563	7½	5.345	.109	6.50	5.295	.134	8.00	5.047	.258	15.13
6	6.625	9	6.407	.109	10.00	6.357	.134	12.00	6.065	.280	24.00
8	8.625	12	8.407	.109	17.30	8.329	.148	23.50	7.981	.322	47.50
10	10.750	15	10.482	.134	32.00	10.420	.165	43.00	10.020	.365	85.00
12	12.750	18	12.438	.156	51.00	12.390	.180	60.00	12.000	.375	131.00
14	14.000	21	13.688	.156	68.00	13.624	.188	80.00	13.250	.375	155.00
16	16.000	24	15.670	.165	100.00	15.624	.188	105.00	15.250	.375	202.00
18	18.000	27	17.670	.165	125.00	17.624	.188	132.00	17.250	.375	269.00
20	20.000	30	19.624	.188	165.00	19.564	.218	220.00	19.250	.375	330.00
24	24.000	36	23.564	.218	280.00	23.500	.250	310.00	23.250	.375	464.00

Other analysis and metals can be furnished where quantity justifies production. See pages 62, 110 and 111.

The "L" grades are generally not available in Schedules 5S. The "L" grades are normally not available in Schedules 160 and XX Strong.

‡Weights shown are for Stainless Steel. Approximate Nickel and Nickel alloy weights are obtained by multiplying by 1.12. Approximate Aluminum weights are obtained by multiplying by .33.

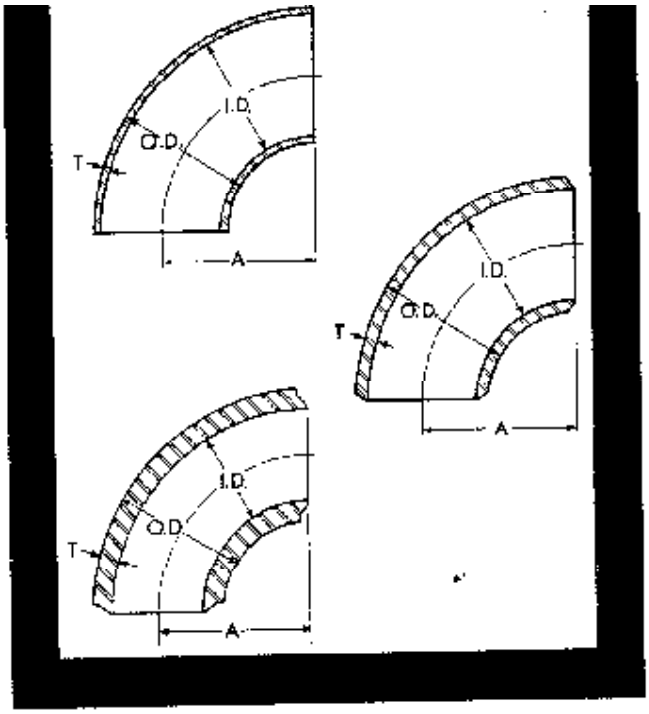
(continued on next page)

BUTT WELDING FITTINGS

SCHEDULES

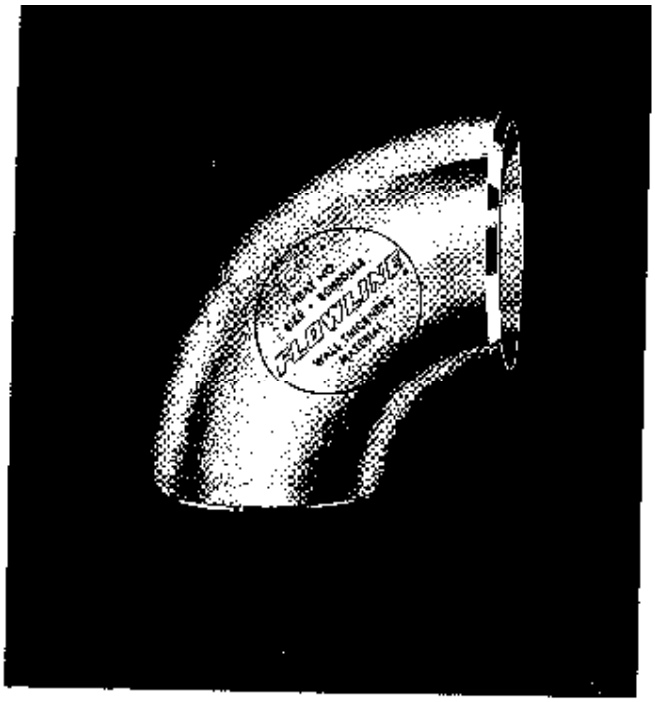
5S, 10S, 40S, 80S, 160, XX Strong Wall

MADE IN ACCORDANCE
WITH ASME & MSS STANDARDS



REGULAR PRODUCTION ▶			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS			• STAINLESS STEELS					
			PART L-8			PART L-16			PART L-XX		
			SCHEDULE 80S Extra Heavy L.P.S.			SCHEDULE 160			XX STRONG WALL		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	CENTER TO FACE (A)	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ±	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ±	Inside Diameter	Wall Thickness (T)	Approx. Wt. in Pounds ±
½	.840	1½	.546	.147	.23	.464	.188	.29	.252	.294	.46
¾	1.050	1½[1]	.742	.154	.25	.612	.219	.35	.434	.308	.50
1	1.315	1½	.957	.179	.48	.815	.250	.67	.599	.358	.96
1¼	1.660	1⅝	1.278	.191	.80	1.160	.250	1.15	.896	.382	1.76
1½	1.900	2¼	1.500	.200	1.13	1.338	.281	1.59	1.100	.400	2.26
2	2.375	3	1.939	.218	2.00	1.689	.343	3.14	1.503	.436	4.00
2½	2.875	3¾	2.323	.276	4.00	2.125	.375	5.44	1.771	.552	8.00
3	3.500	4½	2.900	.300	6.56	2.624	.438	9.58	2.300	.600	13.12
3½	4.000	5¼	3.364	.318	8.80	—	—	—	2.728	.636	17.60
4	4.500	6	3.826	.337	13.63	3.438	.531	21.53	3.152	.674	27.26
5	5.563	7½	4.813	.375	21.13	4.313	.625	35.29	4.063	.750	42.26
6	6.625	9	5.761	.432	36.00	5.187	.719	59.76	4.897	.864	72.00
8	8.625	12	7.625	.500	73.00	6.813	.906	132.00	6.875	.875	127.00
10	10.750	15	9.750	.500	114.00	8.500	1.125	256.00	—	—	—
12	12.750	18	11.750	.500	175.00	10.126	1.312	458.00	—	—	—
14	14.000	21	13.000	.500	206.00	11.188	1.406	—	—	—	—
16	16.000	24	15.000	.500	269.00	12.812	1.594	—	—	—	—
18	18.000	27	17.000	.500	350.00	14.438	1.781	—	—	—	—
20	20.000	30	19.000	.500	439.00	16.062	1.969	—	—	—	—
24	24.000	36	23.000	.500	617.00	19.312	2.344	—	—	—	—

All dimensions are in inches. See metric conversion charts on pages 312 through 321. (1) "A" dimension of 1½" may be furnished at manufacturer's option.
123, and dimensional tolerances on pages 60 and 61.
Ends are accurately machine tool cut and finished as shown on page 61.
Made in accordance with ASME B16.9 and MSS SP-43 where applicable.



FLOWLINE®
90° ELBOWS
SHORT RADIUS

STAINLESS STEELS
TYPES 304, 304L, 304H, 316, 316L, 316H

NICKEL ALLOYS
ALLOY 400, ALLOY 200

ALUMINUM ALLOYS
TYPES 3003-F, 6061-T6

REGULAR PRODUCTION ▶

			• STAINLESS STEELS			• STAINLESS STEELS • INCO ALLOYS			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS		
			PART H-5			PART H-1			PART H-4		
			SCHEDULE 5S Featherweight			SCHEDULE 10S Light I.P.S.			SCHEDULE 40S Standard I.P.S.		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O. D.)	CENTER TO FACE (H)	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡
1	1.315	1	1.185	.065	.17	1.097	.109	.23	1.049	.133	.26
1¼	1.660	1¼	1.530	.065	.31	1.442	.109	.38	1.380	.140	.45
1½	1.900	1½	1.770	.065	.43	1.682	.109	.49	1.610	.145	.63
2	2.375	2	2.245	.065	.63	2.157	.109	.81	2.067	.154	1.13
2½	2.875	2½	2.709	.083	1.25	2.635	.120	1.36	2.469	.203	2.25
3	3.500	3	3.334	.083	1.75	3.260	.120	2.17	3.068	.216	3.31
3½	4.000	3½	3.834	.083	2.35	3.760	.120	3.05	3.548	.226	4.54
4	4.500	4	4.334	.083	3.12	4.260	.120	3.79	4.026	.237	6.88
5	5.563	5	5.345	.109	4.94	5.295	.134	6.12	5.047	.258	11.63
6	6.625	6	6.407	.109	7.75	6.357	.134	9.15	6.065	.280	17.50
8	8.625	8	8.407	.109	15.44	8.329	.148	17.63	7.981	.322	37.60
10	10.750	10	10.482	.134	27.40	10.420	.165	35.00	10.020	.365	63.00
12	12.750	12	12.438	.156	35.00	12.390	.180	40.00	12.000	.375	80.00
14	14.000	14	13.688	.156	44.00	13.624	.188	52.00	13.250	.375	101.00
16	16.000	16	15.670	.165	65.00	15.624	.188	68.00	15.250	.375	131.00
18	18.000	18	17.670	.165	81.00	17.624	.188	86.00	17.250	.375	175.00
20	20.000	20	19.624	.188	107.00	19.564	.218	143.00	19.250	.375	215.00
24	24.000	24	23.564	.218	182.00	23.500	.250	202.00	23.250	.375	302.00

Other analysis and metals can be furnished where quantity justifies production. See pages 62, 110 and 111.

The "H" grades are generally not available in Schedules 5S. The "L" grades are normally not available in Schedules 160 and XX Strong.

‡Weights shown are for Stainless Steel. Approximate Nickel and Nickel alloy weights are obtained by multiplying by 1.12. Approximate Aluminum weights are obtained by multiplying by .33.

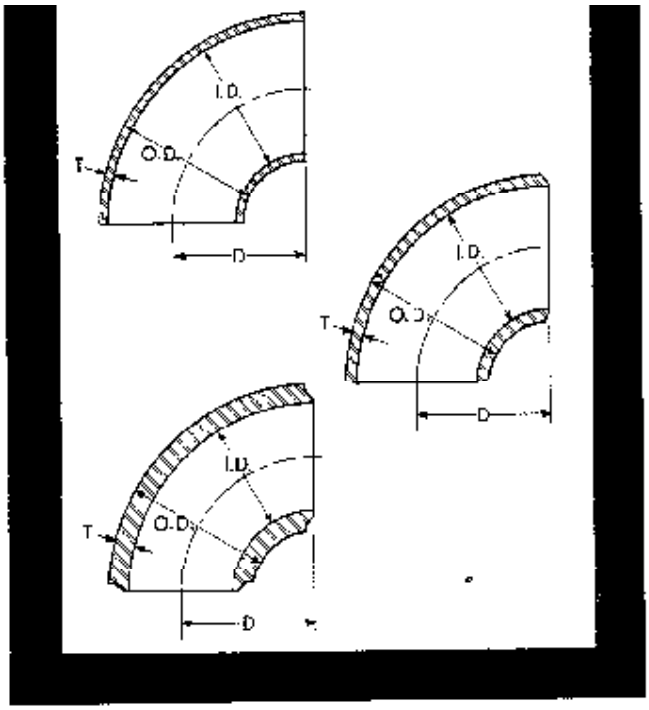
(continued on next page)

BUTT WELDING FITTINGS

SCHEDULES

5S, 10S, 40S, 80S, 160, XX Strong Wall

MADE IN ACCORDANCE
WITH ASME & MSS STANDARDS



REGULAR PRODUCTION ▶			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS			• STAINLESS STEELS					
			PART H-8			PART H-16			PART H-XX		
			SCHEDULE 80S Extra Heavy I.P.S.			SCHEDULE 160			XX STRONG WALL		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O. D.)	CENTER TO FACE (D)	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds.†	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds†	Inside Diameter (I. D.)	Wall Thickness (T)	Approx. Wt. in Pounds†
1	1.315	1	.957	.179	.38	.815	.250	.53	.599	.358	.76
1¼	1.660	1¼	1.278	.191	.63	1.160	.250	.82	.896	.382	1.26
1½	1.900	1½	1.500	.200	.88	1.338	.281	1.23	1.100	.400	1.76
2	2.375	2	1.939	.218	1.53	1.689	.343	2.43	1.503	.436	3.10
2½	2.875	2½	2.323	.276	2.88	2.125	.375	3.88	1.771	.552	5.76
3	3.500	3	2.900	.300	4.20	2.624	.438	6.09	2.300	.600	8.40
3½	4.000	3½	3.364	.318	5.35	— —	— —	— —	2.728	.636	10.70
4	4.500	4	3.826	.337	7.06	3.438	.531	14.22	3.152	.674	18.12
5	5.563	5	4.813	.375	16.10	4.313	.625	26.72	4.063	.750	32.20
6	6.625	6	5.761	.432	26.00	5.187	.719	43.16	4.897	.864	52.00
8	8.625	8	7.625	.500	54.80	6.813	.906	99.18	6.875	.875	109.00
10	10.750	10	9.750	.500	99.80	8.500	1.125	224.00	— —	— —	— —
12	12.750	12	11.750	.500	125.00	10.126	1.312	327.00	— —	— —	— —
14	14.000	14	13.000	.500	135.00	11.188	1.406	— —	— —	— —	— —
16	16.000	16	15.000	.500	175.00	12.812	1.594	— —	—	— —	— —
18	18.000	18	17.000	.500	229.00	14.438	1.781	— —	— —	— —	— —
20	20.000	20	19.000	.500	285.00	16.062	1.969	— —	— —	— —	— —
24	24.000	24	23.000	.500	401.00	19.312	2.344	— —	— —	— —	— —

Ends are accurately machine tool cut and finished as shown on page 61
Made in accordance with ASME B16.9 where applicable

All dimensions are in inches. See metric conversion charts on pages 112 through 123, and dimensional tolerances on pages 60 and 61.

FLOWLINE®
CAPS

STAINLESS STEELS
TYPES 304, 304L, 304H, 316, 316L, 316H

NICKEL ALLOYS
ALLOY 400, ALLOY 200

ALUMINUM ALLOYS
TYPES 3003-F, 6061-T6

REGULAR PRODUCTION ▶

			• STAINLESS STEELS			• STAINLESS STEELS • INCO ALLOYS			• STAINLESS STEELS • INCO ALLOYS - ALUMINUM ALLOYS		
			PART C-5			PART C-1			PART C-4		
		LENGTH (E)	SCHEDULE 5S Featherweight			SCHEDULE 10S Light I.P.S.			SCHEDULE 40S Standard I.P.S.		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	TANGENT LENGTH (S)	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds†	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds†	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds†
½	.840	E 1 S .74	.710	.065	.08	.674	.083	.09	.622	.109	.10
¾	1.050	E 1 S .88	.920	.065	.11	.884	.083	.12	.824	.113	.13
1	1.315	E 1⅛ S 1.10	1.185	.065	.18	1.097	.109	.19	1.049	.133	.28
1¼	1.660	E 1½ S 1.02	1.530	.065	.20	1.442	.109	.28	1.380	.140	.38
1½	1.900	E 1½ S .95	1.770	.065	.22	1.682	.109	.31	1.610	.145	.50
2	2.375	E 1½ S .85	2.245	.065	.30	2.157	.109	.38	2.067	.154	.60
2½	2.875	E 1¾ S .68	2.709	.083	.50	2.635	.120	.56	2.469	.203	1.00
3	3.500	E 2 S 1.02	3.334	.083	.86	3.260	.120	.88	3.068	.216	1.56
3½	4.000	E 2½ S 1.40	3.834	.083	1.20	3.760	.120	1.25	3.548	.226	2.25
4	4.500	E 2½ S 1.26	4.334	.083	1.25	4.260	.120	1.44	4.026	.237	2.69
5	5.563	E 3 S 1.48	5.345	.109	2.00	5.295	.134	2.25	5.047	.258	4.06
6	6.625	E 3½ S 1.70	6.407	.109	2.75	6.357	.134	3.00	6.065	.280	7.12
8	8.625	E 4 S 1.68	8.407	.109	4.50	8.329	.148	5.50	7.981	.322	12.50
10	10.750	E 5 S 2.13	10.482	.134	9.50	10.420	.165	10.80	10.020	.365	20.30
12	12.750	E 6 S 2.65	12.438	.156	14.00	12.390	.180	14.40	12.000	.375	28.80
14	14.000	E 6½ S 2.81	13.688	.156	17.00	13.624	.188	18.00	13.250	.375	35.70
16	16.000	E 7 S 2.81	15.670	.165	30.00	15.624	.188	32.00	15.250	.375	48.50
18	18.000	E 8 S 3.31	17.670	.165	38.00	17.624	.188	39.60	17.250	.375	59.40
20	20.000	E 9 S 3.81	19.624	.188	55.00	19.564	.218	60.00	19.250	.375	75.00
24	24.000	E 10½ S 4.31	23.564	.218	75.00	23.500	.250	76.00	23.250	.375	98.00

Other analysis and metals can be furnished where quantity justifies production. See pages 62, 110 and 111.

The "H" grades are generally not available in Schedules 5S. The "L" grades are normally not available in Schedules 160 and XX Strong.

Some small sizes may be fabricated from bar stock.

†Weights shown are for Stainless Steel. Approximate Nickel and Nickel alloy weights are obtained by multiplying by 1.12. Approximate Aluminum weights are obtained by multiplying by .33.

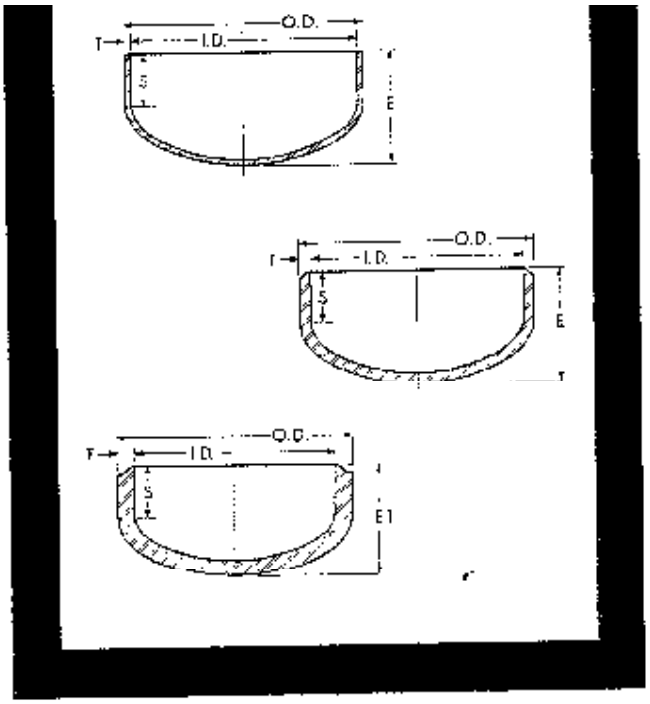
(continued on next page)

BUTT WELDING FITTINGS

SCHEDULES

5S, 10S, 40S, 80S, 160, XX Strong Wall

MADE IN ACCORDANCE WITH ASME & MSS STANDARDS



REGULAR PRODUCTION ▶

NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	LENGTH (E) TANGENT LENGTH (S)	LENGTH (E1) TANGENT LENGTH (S)	• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS — PART C-8 — SCHEDULE 80S Extra Heavy I.P.S. — Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	• STAINLESS STEELS — PART C-16 — SCHEDULE 160 — Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	PART C-XX — XX STRONG WALL — Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡
½	.840	E 1 S .72	E1 1 S .64	.546	.147	.11	.464	.188	.14	.252	.294	.22
¾	1.050	E 1 S .66	E1 1 S .58	.742	.154	.14	.612	.219	.20	.434	.308	.28
1	1.315	E 1½ S 1.08	E1 1½ S .99	.957	.179	.29	.815	.250	.40	.599	.358	.58
1¼	1.660	E 1½ S .92	E1 1½ S .87	1.278	.191	.39	1.160	.250	.50	.896	.382	.78
1½	1.900	E 1½ S .93	E1 1½ S .83	1.500	.200	.54	1.338	.281	.75	1.100	.400	1.08
2	2.375	E 1½ S .80	E1 1¾ S .95	1.939	.218	.75	1.689	.343	1.17	1.503	.436	1.50
2½	2.875	E 1½ S .64	E1 2 S 1.01	2.323	.276	1.12	2.125	.375	1.48	1.771	.552	2.24
3	3.500	E 2 S .78	E1 2½ S 1.32	2.900	.300	1.87	2.624	.438	2.71	2.300	.600	3.74
3½	4.000	E 2½ S 1.34	E1 3 S 1.70	3.364	.318	2.50	— —	— —	— —	2.728	.636	5.00
4	4.500	E 2½ S 1.21	E1 3 S 1.60	3.826	.337	3.54	3.438	.531	5.55	3.152	.674	7.08
5	5.563	E 3 S 1.42	E1 3½ S 1.73	4.813	.375	5.63	4.313	.625	9.34	4.063	.750	11.26
6	6.625	E 3½ S 1.63	E1 4 S 1.91	5.761	.432	10.00	5.187	.719	16.00	4.897	.864	20.00
8	8.625	E 4 S 1.59	E1 5 S 2.41	7.625	.500	16.38	6.813	.906	29.64	6.875	.875	22.76
10	10.750	E 5 S 2.06	E1 6 S 2.75	9.750	.500	27.30	8.500	1.125	61.42	— —	— —	— —
12	12.750	E 6 S 2.56	E1 7 S 3.16	11.750	.500	36.60	10.126	1.312	95.00	— —	— —	— —
14	14.000	E 6½ S 2.75	— —	13.000	.500	48.00	11.188	1.406	— —	— —	— —	— —
16	16.000	E 7 S 2.75	— —	15.000	.500	65.00	12.812	1.594	— —	— —	— —	— —
18	18.000	E 8 S 3.25	— —	17.000	.500	79.20	14.438	1.781	— —	— —	— —	— —
20	20.000	E 9 S 3.75	— —	19.000	.500	88.00	16.062	1.969	— —	— —	— —	— —
24	24.000	E 10½ S 4.25	— —	23.000	.500	135.00	19.312	2.344	— —	— —	— —	— —

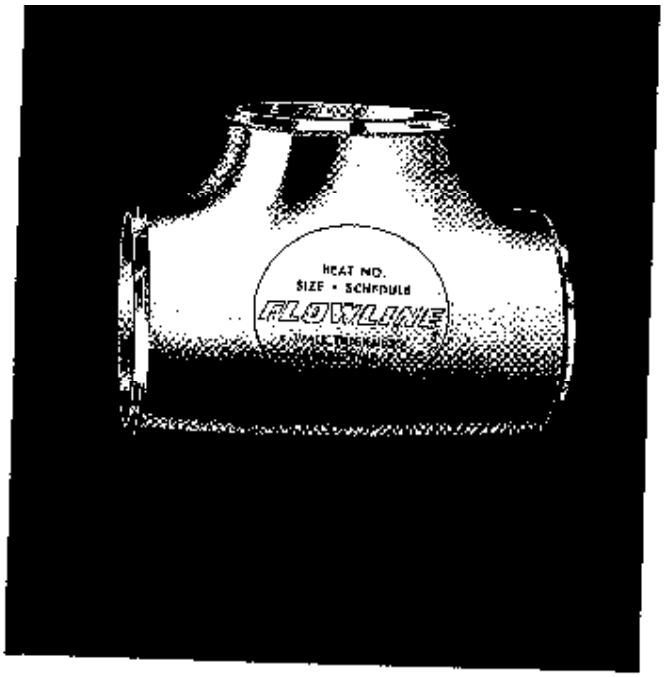
Ends are accurately machine tool cut and finished as shown on page 61.

All dimensions are in inches. See metric conversion charts on pages 112 through 123 and dimensional tolerances on pages 60 and 61.

Made in accordance with ASME B16.9 and MSS SP-43 where applicable

Caps are formed to an ellipsoidal shape in which the minor axis is equal to half the major axis. Tangent length "S" is approximate.

‡Length (E) applies to Schedules 5S, 10S, 40S, and 80S Caps. Length (E1) applies to wall thickness greater than Schedule 80S.



FLOWLINE®
STRAIGHT TEES

STAINLESS STEELS
TYPES 304, 304L, 304H, 316, 316L, 316H

NICKEL ALLOYS
ALLOY 400, ALLOY 200

ALUMINUM ALLOYS
TYPES 3003-F, 6061-T6

REGULAR PRODUCTION ▶

			• STAINLESS STEELS			• STAINLESS STEELS • INCO ALLOYS			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS		
			PART T-5			PART T-1			PART T-4		
			SCHEDULE 5S Featherweight			SCHEDULE 10S Light I.P.S.			SCHEDULE 40S Standard I.P.S.		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	CENTER TO END (C)	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡
½	.840	1	.710	.065	.19	.674	.083	.21	.622	.109	.23
¾	1.050	1⅛	.920	.065	.22	.884	.083	.28	.824	.113	.38
1	1.315	1½	1.185	.065	.40	1.097	.109	.63	1.049	.133	.65
1¼	1.660	1⅞	1.530	.065	.75	1.442	.109	1.10	1.380	.140	1.31
1½	1.900	2¼	1.770	.065	.93	1.682	.109	1.50	1.610	.145	1.90
2	2.375	2½	2.245	.065	1.20	2.157	.109	1.87	2.067	.154	2.83
2½	2.875	3	2.709	.083	2.15	2.635	.120	3.10	2.469	.203	4.85
3	3.500	3⅜	3.334	.083	3.40	3.260	.120	3.90	3.068	.216	7.30
3½	4.000	3¾	3.834	.083	5.50	3.760	.120	5.88	3.548	.226	9.00
4	4.500	4⅛	4.334	.083	7.20	4.260	.120	7.63	4.026	.237	11.63
5	5.563	4⅞	5.345	.109	13.00	5.295	.134	13.45	5.047	.258	20.75
6	6.625	5⅝	6.407	.109	17.20	6.357	.134	17.80	6.065	.280	24.25
8	8.625	7	8.407	.109	31.00	8.329	.148	34.50	7.981	.322	46.10
10	10.750	8¼	10.482	.134	55.00	10.420	.165	59.00	10.020	.365	78.00
12	12.750	10	12.438	.156	83.00	12.390	.180	87.00	12.000	.375	137.00
14	14.000	11	13.688	.156	89.00	13.624	.188	107.00	13.250	.375	175.00
16	16.000	12	15.670	.165	115.00	15.624	.188	130.00	15.250	.375	220.00
18	18.000	13½	17.670	.165	149.00	17.624	.188	169.00	17.250	.375	286.00
20	20.000	15	19.624	.188	171.00	19.564	.218	228.00	19.250	.375	358.00
24	24.000	17	23.564	.218	298.00	23.500	.250	343.00	23.250	.375	498.00

Other analysis and metals can be furnished where quantity justifies production. See pages 62, 104 and 111.

The "H" grades are generally not available in Schedules 5S. The "L" grades are normally not available in Schedules 160 and XX Strong.

‡Weights shown are for Stainless Steel. Approximate Nickel and Nickel alloy weights are obtained by multiplying by 1.12. Approximate Aluminum weights are obtained by multiplying .33.

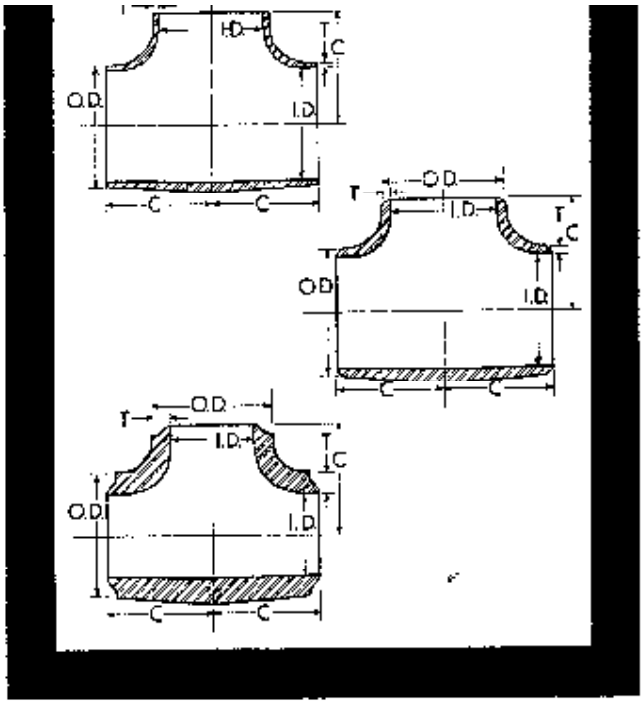
(continued on next page)

BUTT WELDING FITTINGS

SCHEDULES

5S, 10S, 40S, 80S, 160, XX Strong Wall

MADE IN ACCORDANCE WITH ASME & MSS STANDARDS



REGULAR PRODUCTION ▶			• STAINLESS STEELS • INCO ALLOYS • ALUMINUM ALLOYS			• STAINLESS STEELS					
			PART T-8			PART T-18			PART T-XX		
			SCHEDULE 80S Extra Heavy I.P.S.			SCHEDULE 160			XX STRONG WALL		
NOM. PIPE SIZE	OUTSIDE DIAMETER (O.D.)	CENTER TO END (C)	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡	Inside Diameter (I.D.)	Wall Thickness (T)	Approx. Wt. in Pounds‡
½	.840	1	.546	.147	.30	.464	.188	.38	.252	.294	.60
¾	1.050	1⅛	.742	.154	.45	.612	.219	.64	.434	.308	.90
1	1.315	1½	.957	.179	.85	.815	.250	1.19	.599	.358	1.70
1¼	1.660	1⅞	1.278	.191	1.50	1.160	.250	1.97	.896	.382	3.00
1½	1.900	2¼	1.500	.200	2.25	1.338	.281	3.15	1.100	.400	4.50
2	2.375	2½	1.939	.218	3.50	1.689	.343	5.50	1.503	.436	7.00
2½	2.875	3	2.323	.276	6.90	2.125	.375	9.38	1.771	.552	13.80
3	3.500	3⅜	2.900	.300	9.80	2.624	.438	14.31	2.300	.600	19.60
3½	4.000	3¾	3.364	.318	12.00	— —			2.728	.636	24.00
4	4.500	4⅛	3.826	.337	17.00	3.438	.531	26.86	3.152	.674	34.00
5	5.563	4⅞	4.813	.375	25.00	4.313	.625	41.75	4.063	.750	50.00
6	6.625	5⅝	5.761	.432	30.00	5.187	.719	49.80	4.897	.864	60.00
8	8.625	7	7.625	.500	62.00	6.813	.906	112.00	6.875	.875	108.00
10	10.750	8½	9.750	.500	110.00	8.500	1.125	247.00	— —	— —	— —
12	12.750	10	11.750	.500	185.00	10.126	1.312	484.00	— —	— —	— —
14	14.000	11	13.000	.500	210.00	11.188	1.406	590.00	— —	— —	— —
16	16.000	12	15.000	.500	265.00	12.812	1.594	812.00	— —	— —	— —
18	18.000	13½	17.000	.500	344.00	14.438	1.781	1097.00	— —	— —	— —
20	20.000	15	19.000	.500	430.00	16.062	1.969	1690.00	— —		— —
24	24.000	17	23.000	.500	600.00	19.312	2.344	2950.00	— —	— —	— —

Ends are accurately machine tool cut and finished as shown on page 61.
Made in accordance with ASME B16.9 and MSS SP-43 where applicable.

All dimensions are in inches. See metric conversion charts on pages 112 through 123, and dimensional tolerances on pages 60 and 61.

apfa
INCORPORATED
AMERICAN PIPE
FITTINGS ASSOC
FLOWLINE®
STAINLESS STEEL
NICKEL, NICKEL ALLOY
ALUMINUM ALLOY
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SPECIFICATIONS and MATERIALS APPLICABLE TO STAINLESS BUTT WELDING FITTINGS

ASTM (American Society for Testing Materials) SPECIFICATIONS

These are basically materials specifications. ASTM A-403 (Factory Made Wrought Austenitic Steel Welding Fittings) lists the permissible raw materials from which fittings can be made. In addition, it controls the method of manufacture, quality assurance and marking.

The corresponding ASME Spec is SA-403. This is found in Section II Part A of the ASME Boiler and Pressure Vessel Code. This is similar, but not identical to ASTM A-403.

ASME (American Society of Mechanical Engineers) BOILERS AND PRESSURE VESSEL CODE and MSS (Manufacturers Standardization Society) STANDARDS

Both ASME B 16.9 entitled "Wrought Steel Butt Welding Fittings" and MSS SP-43 entitled "Wrought Stainless Steel Butt Welding Fittings" cover ½" through 24" and govern dimension and tolerance. The difference is that ASME B 16.9 covers all wall thicknesses and requires fittings to be fully rated to the pressure temperature ratings of the matching pipe.

MSS SP-43 covers only light weight stainless steel fittings and allows lower pressure temperature ratings than B 16.9. See below for details.

Other supplementary ASME and MSS Standards

- ASME B 16.25 Butt Welding End Preparations
- ASME B 16.28 Butt Welding Short Radius Elbows and Returns 1" through 24"
- MSS SP 25 Marking of Each Fitting
- ASME Section II—Materials
  - Part A—Ferrous Part B—Non Ferrous Part C—Welding Materials Part D—Properties
- ASME Section III Nuclear Power Plant Components
  - For the manufacture of fittings where filler metal is added, a Certificate of Authorization (NPT Stamp) is required.
- ASME Section V—Non Destructive Examination
- ASME Section VIII—Pressure Vessels
- ASME Section IX—Welding Qualifications

MSS SP-43 vs ASME B16.9 for Schedules 5S and 10S Fittings

In response to the need of the process industries, SP-43 Specification was issued in 1950 by the Manufacturers Standardization Society. At that time, stainless steel piping was used for its resistance to corrosion and to eliminate product contamination. Pressure was seldom a factor.

Pressure ratings for 5S and 10S fittings are shown in MSS SP-43. They reflect the emphasis on corrosion resistance rather than pressure. These pressure ratings are less than the allowable pressure ratings that are applicable to the matching pipe.

Today there are many applications for schedules 5S and 10S piping at higher pressures than those permitted in SP-43. To cover this, SP-43 was revised to include a statement, "For fittings of same pressure rating of matching pipe, refer to ASME-B 16.9".

SP-43 and B 16.9 are similar dimensionally in that the fixed position for the welding ends with reference to the centerline of the fitting and the overall dimensions are identical.

ASME B 16.9 has the added provision that the pressure of the fitting shall at least equal the computed bursting pressure of seamless pipe of the same wall thickness and material.

In order to differentiate fittings made to these specifications, the prefix "CR" is shown before the alloy designated for SP-43 and the symbol "WP" is shown to indicate B 16.9 fittings.

A user who wants to obtain 5S and 10S to B 16.9 fittings must reference this Spec when ordering fittings to ASTM A-403. If B 16.9 is not specified, the manufacturer may supply either SP-43 or B 16.9 at his option.

Other suggestions to engineers and purchasing managers are on the following pages, and are offered as a guide to help you receive what you specify and order.

Shaw ALLOY PIPING PRODUCTS, INC.

PIPE FITTINGS FOR INDUSTRY

Butt Weld Fittings

STAINLESS PRICE LIST
BS-0899

Effective AUGUST 1999

304, 304L, 316, 316L

APP

INVENTORIED ITEMS

PRODUCT DESCRIPTION	SIZE RANGE
PIPE-WELDED - 304/304L - 316/316L - 317L SCHEDULE 5S, 10S, 40S, 80S **SEAMLESS**-304/304L/304H-316/316L-317L-321-2205 SCHEDULE 10S, 40S, 80S	½" - 36"* ½" - 12"
BUTT WELD FITTINGS - DOMESTIC WELDED AND SEAMLESS SCHEDULE 5S, 10S, 40S, 80S STAINLESS - STANDARD 300 SERIES ALLOY 20 - ALUMINUM	½" - 30"
BUTT WELD FITTINGS - IMPORT WELDED - SCHEDULE 10S, 40S ALLOYS 304/304L - 316/316L	½" - 12"
CARBON & CHROME FITTINGS SCHEDULE 80 THRU XXH WPB-WPC-WP11-WP22-WP5-WP9-WP91-High Yield	½" - 54"

PRODUCT DESCRIPTION	SIZE RANGE
FORGED FLANGES - DOMESTIC & IMPORT - 304/304L - 316/316L PRESSURE RATING 150# & 300#	½" - 24"
FORGED FITTINGS - IMPORT 304/304L - 316/316L SCREWED & SOCKET WELD PRESSURE RATING 3000#	⅛" - 4"
CAST FITTINGS - IMPORT 304 - 316 SCREWED PRESSURE RATING 150#	⅛" - 4"
NIPPLES - 304 AND 316 SCHEDULE 40 SCHEDULE 80	⅛" - 4" ⅛" - 2"

*The Tulsa Branch specializes in large O.D. pipe through 0.500 wall

STAINLESS & ALLOY PRODUCTION CAPABILITIES

STANDARD 300 SERIES STAINLESS AND DUPLEX 2205
NICKEL — ALUMINUM — MONEL — ALLOY 20 — HASTELOY AND OTHERS

PRODUCT DESCRIPTION	SIZE RANGE
MSS T-A & B STUB ENDS **MSS T-C STUB ENDS** **ASA T-A & B STUB ENDS**	½" - 48" 1" - 20" ½" - 48"
LR 90 ELBOWS **LR 45 ELBOWS** **SR 90 ELBOWS**	½" - 30" ½" - 30" ½" - 24"

PRODUCT DESCRIPTION	SIZE RANGE
STRAIGHT TEES **REDUCING TEES**	½" - 30" ¾" - 30"
CONCENTRIC REDUCERS **ECCENTRIC REDUCERS**	¾" - 36" ¾" - 36"
CAPS	1" - 24"
SPECIALS	**BY QUOTATION**

Most of the products above can be manufactured in welded or seamless construction through 12".
Large O.D. (14" and above is welded and x-rayed.)

We maintain an inventory of 304/304L and 316/316L fittings in sizes ½" thru 30".

CARBON & CHROME PRODUCTION CAPABILITIES

PRODUCT DESCRIPTION	SIZE RANGE
LR ELBOWS **LR 45 ELBOWS** **SR 90 ELBOWS**	½" - 54" ½" - 54" 2½" - 30"
TEES	2" - 54"
REDUCERS	2" - 60"
CAPS	2" - 48"

CARBON & CHROME A/SA 234 GRADES WPB/C, WP11, WP22, WP5, WP9, WP91
LOW TEMPERATURE A/SA 420 WPL6
HIGH YIELD MSS -SP75 TO 65,000 MYS
½" - 24" FITTINGS ARE PRODUCED IN THE FIRST SCHEDULE HEAVIER THAN EXTRA HEAVY

We maintain a carbon fitting inventory of 2" thru 48".

ADDITIONAL SERVICES AVAILABLE

Co or Coding, Additional Marking, 100% X Ray, Liquid Penetrant Testing, Ultrasonic Testing, Taper Boring, Special Facing and Lengths on Stub Ends, Special Beveling, Corrosion Testing, Physical and Chemical Testing.

EXHIBIT 8

REQUEST FOR ADDITIONAL INFORMATION INVOLVING EXCLUSIONS		
PRODUCT	**CURRENT PRODUCTION (Annualized YTD 2001 based on actual data through Oct. 31, 2001) (Volume and Value)**	**POTENTIAL PRODUCTION (description of what it will take to begin production and the time frame)**
NON-ORIENTED ELECTRICAL STEEL ("NOES")		
1 **Fully-Processed Silicon Electrical Steels** (Emerson Electric Co., X-077) (classified under HTS. Nos. 7225.19.0000, 7226.19.1000, and 7226.19.9000)	[ ]	[ ]
2. **Semi-Processed Silicon Electrical Steels** (Emerson Electric Co., X-077) (classified under HTS. No. 7225.50.8085)	[ ]	[ ]
3. **Cold-Rolled Motor Lamination Steels ("CRML")** (Emerson Electric Co, X-077) (classified under HTS. No. 7225.50.8085)	[ ]	[ ]
4. **High Frequency Low Core Loss NOES** (Nippon Steel Corporation, NKK Corporation, Kawasaki Steel Corporation, Sumitomo Metal Industries, Ltd., Kobe Steel, Ltd.,	[ ]	[ ]

Nisshin Steel Co., Ltd., Japan Iron & Steel Exporters' Association, and Suzuki Metal Industry, Ltd. X-142 Japanesecorr6) (classified under HTS. No. 7225.19.0000)		
5. **Non-Oriented Electrical Steel with Insulation Coatings** (Nippon Steel Corporation, X-061) (classified under HTS. No. 7225.50.8085)	[ ]	[ ]