

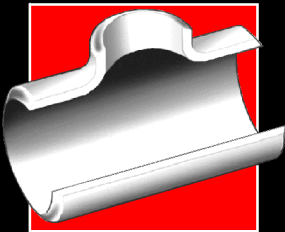
## Section 4

# ASTM Flanges and Fittings Specifications



This Section summarises the requirements of selected ASTM standards for stainless steel flanges, fittings, and other parts used in piping systems.

ASTM Standards covered in this Section		Page
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# ASTM Flanges & Fittings - General Requirements

This general requirements subsection covers summary information and common requirements data extracted from relevant ASTM standards. These standards are used to define flanges and fittings in conjunction with the dimensional standards summarised in other sections of this manual (see Dimensions and Tolerances below for references).

The ASTM standard applicable to flanges, and other forged fittings, valves and parts, is ASTM A 182. This is expanded on pages 4-6 to 4-11.

The ASTM standards for wrought fittings, A 403, A 774 and A 815, are expanded in pages 4-12 to 4-22.

## Specifications

Refer to page 4-1 for a list of the ASTM flanges and fittings standards available and covered in this Section.

## Applications and General Coverage

Summary of applications and features identified in ASTM flanges and fittings standards

Application or feature	Forgings	Wrought Fittings		
	A 182	A 403	A 774	A 815
Low temperature use	✓	✓	✓	✓
Moderate temperature use	✓	✓	✓	✓
High temperature use	✓	✓		✓
Flanges	✓			
Valves	✓			
Fittings (general)		✓	✓	✓
Butt welding fittings		✓	✓	✓
Socket welding and threaded fittings	✓	✓	✓	✓
Light weight butt-welding fittings		✓		✓
Swaged nipples and bull plugs		✓		
Non standard fittings		✓		✓

Notes

- ✓ A tick in the table indicates that the standard *specifically* identifies (but is not necessarily restricted to) the application or feature listed. Other features are covered in further summary tables on the following pages.
- ASTM Standards for cast fittings are not covered in this manual.

## Dimensions and Tolerances

- **Dimensions and Tolerances.** The ASTM standards for flanges and fittings do not specify dimensions and tolerances since they are defined in applicable ASME/ANSI, MSS and API specifications. None standard pipe fittings are allowable in the ASTM standards, provided they conform to defined requirements.
  - **Flange Dimensions and Tolerances** are covered in Section 8 (see page 8-1).
  - **Buttweld Fittings Dimensions and Tolerances** are covered in Section 6 (see page 6-1).
  - **Socket Weld and Threaded Fittings Dimensions and Tolerances** are covered in Section 7 (see page 7-1)
- **Units of Measure.** American standards for flanges and fittings use both imperial and metric (SI) units of measurement. It is important not to combine the use of these units since rounding of dimensions has resulted in an incompatibility between some values.

# ASTM Flanges & Fittings - General Requirements

## Manufacture

Summary of manufacturing processes covered by ASTM flanges and fittings standards

	A 182	A 403	A 774	A 815
Starting materials (made from)	F	F, Br, P, ST, WT	FRS	F, Br, P, ST, WT
Forming: Forging & shaping	Not applicable	H, Pr, Pi, Ex, U, R, B, FW, M		H, Pr, Pi, Ex, U, R, B, FW, M
Hot/Cold Formed			Either	
Welded		✓	✓	✓
Filler metal <sup>1</sup> used		✓ <sup>3</sup>	With or without	✓ <sup>3</sup>
Classes of fittings <sup>2</sup>		WP-S, -W, -WX, -WU; CR		WP-S, -W, -WX; CR
Final Heat Treatment	As Spec'd	As Spec'd		

Notes

- |  |  |   |
|--|--|---|
| <p>1 Filler metal specifications are not covered in this manual.</p> <p>2 See individual specifications for a description of the classes of fittings.</p> <p>3 Requires 100% radiographic testing of weld.</p> | <p>- Starting materials:<br/>F = Forgings<br/>Br = Bars<br/>P = Plates<br/>ST = Seamless Tube<br/>WT = Welded Tube<br/>FRS = Flat Rolled Steel</p> | <p>- Forming alternatives:<br/>H = Hammering<br/>Pr = Pressing<br/>Pi = Piercing<br/>Ex = Extruding<br/>U = Upsetting<br/>R = Rolling<br/>B = Bending<br/>FW = Fusion Welding<br/>M = Machining</p> |
|--|--|---|

Summary of materials covered by ASTM flanges and fitting standards

	A 182	A 403	A 774	A 815
Austenitic	✓	✓	✓	
Ferritic	✓			✓
Martensitic	✓			✓
Duplex	✓			✓

- **Materials.** Materials used for the manufacture of stainless steel fittings are specified in the individual ASTM Standards. These are summarised in the table above (refer to page 1-10 for a detailed breakdown of grades applicable to each ASTM standard).
- **Manufacturing processes.** A summary of ASTM fitting manufacturing process is provided in the table above.
- **Heat Treatments.** Heat treatments are specified in each ASTM fitting standard. There are no general requirements; treatment is dependent on the individual stainless steel grade, on the method of forming used and on the final use of the fitting. Retreatment to obtain properties required by the standard (up to two times without purchaser agreement) is permissible.
- **Test Reports.** Typically, the application of the product marking is certification that a fitting conforms to specification. The purchaser may additionally request a certified test report containing the following items as applicable:
  - Manufacturer and date.
  - Specification and year date.
  - Heat number and chemical analysis.
  - Product analysis results.
  - Specified test results (e.g. tensile, hardness, and grain size tests).
  - Examination results (e.g. visual inspection, radiographic, ultrasonic).
  - Starting material and type of manufacture (e.g. plate, bar, pipe, seamless or welded).
  - Heat treatment.
  - Purchaser requirements (optional and supplementary requirements).
- **Product Marking.** Each fitting is marked in paint, ink, vibrating pencil or stamped if thickness permits. Bar coding is acceptable. Minimum marking requirements are for manufacturer's name or brand, specification number (not year), and grade.

# ASTM Flanges & Fittings - General Requirements

## Finish and Repair

- **Finish.** A workmanlike finish is required for all fittings.
- **Defects.** Defects may be removed, as permitted in individual ASTM fitting standards, by the following methods:
  - **Grinding, machining, or chipping** provided that the wall thickness is not reduced below the specified minimum (87.5% of nominal, or as specified).
  - **Welding**, as agreed by the purchaser. Discontinuities must be completely removed before welding. Discontinuities >33.3% of nominal wall thickness, or >25% of nominal diameter (or >10% of surface area) of the fitting, are not permitted.
- **Scale and contaminating particles.** These are removed, but methods are not usually specified.
- **Passivation.** Performed when specified.

### Summary of finish and repair requirements covered by ASTM fitting standards

	A 182	A 403	A 774	A 815
Defect removal	W, M, G, C	W(spa for special fittings), M, G	W(spa), M, G, C, Other	W(spa), M, G, Other
Scale removal	Cleaned free of scale	Cleaned free of scale	NS	Cleaned free of scale
Passivation	NS	Yes	NS	NS

#### Notes

- NS=Not Specified, spa/spr=subject to purchaser approval/request.
- Defect removal:  
G=Grinding  
M=Machining  
C=Chipping  
W=Welding

## Mandatory Testing

### Summary of mandatory tests as specified by ASTM fitting standards

	A 182	A 403	A 774	A 815
Heat Analysis <sup>1</sup>	✓	✓	✓	✓
Tension Test <sup>2</sup>	✓	✓	✓	✓
Hardness	✓			
Grain Size (austenitic steels only)	✓			
Surface Quality Inspection	✓	✓	✓	✓

#### Notes

- 1 To be performed on the starting material used to make the fitting, in accordance with ASTM A 751.
- 2 To be performed on material used to make the fitting, in accordance with test methods and definitions in ASTM A 370.

- **Introduction.** Each ASTM fitting standard specifies the mandatory and optional/supplementary test requirements. The table above shows the mandatory tests. Other tests may be specified by the purchaser. (Refer to page 10-5 for a general description of the test methods used for stainless steel products.)
- **Heat Analysis.** Heat analysis is the chemical analysis of the cast or heat used to produce the starting material from which a flange or fitting is made. It is usually performed by the steel manufacturer and results accompany the steel and products made from it.
- **Product Analysis.** Product analysis of a test specimen shows the chemical composition of the finished flange or fitting. This may vary from that obtained from the heat analysis made by the steel manufacturer. ASTM flanges and fittings standards chemical composition tables (reproduced in this manual) show the amount of each element as a range or as a maximum value. ASTM flanges and fittings standards also define tolerances within which the product analysis results may be considered as in conformance with the standard. Methods of chemical analysis are listed in ASTM A 751 (not reproduced in this manual).

# ASTM Flanges & Fittings - General Requirements

- **Test Specimens.** A test specimen, suitable for the test to be performed, is taken from a representative fitting, or a representative test piece may be prepared from the same base and weld materials, having approximately the same amount of working and cross sectional dimensions as the finished fitting it represents. Such specimens or test pieces are required for destructive testing.
- **Mechanical Testing Methods.** Mechanical testing methods of testing are defined in ASTM A 370 and A 450. Refer to pages 3-6, 10-5 and 10-14 for further information.
- **Nondestructive Tests and Examinations.** These include radiographic and ultrasonic examinations.
- **Retesting and Retreatment.** Retreatment is permitted if results of mechanical tests do not conform to requirements. Retreated fittings must have mechanical tests repeated also.

## Optional and Supplementary Requirements

- Each ASTM standard identifies optional and supplementary requirements. These usually provide for additional testing and are identified on test certificates.
- The following table summarises the supplementary requirements listed in the ASTM flanges and fittings standards.

**Summary of supplementary requirements as specified by ASTM fitting standards**

	A 182	A 403	A 774	A 815
Product analysis	S2	S1	S1	S1
Tension test	S3	S2	S2	S2
Hardness test	S12			
Intergranular corrosion bend test		S3		S3
Hydrostatic test	S6			
Ultrasonic examination (test)		S4	S3	S4
Nondestructive electromagnetic (eddy current) test			S5	
Microetch test	S1			
Photomicrographs		S5		S5
Liquid penetrant examination (test)	S5	S7	S4	S7
Magnetic particle examination	S4			
Corrosion tests	S10			
Grain size (for austenitic grades)	S15			
Special fittings		S9		S8
Material for optimum resistance to stress corrosion cracking	S9			
Special filler metal	S11	S8		
Repair welding	S7			
Stabilising heat treatment		S10		
Special heat treatment (for austenitic forgings)	S14			
Heat treatment details (test report)	S8			
Alternative heat treatment (grade F 91 only)	S13			
Surface finish		S6		S6

## ASTM A 182/A 182M - 96

### Forged or Rolled Alloy - Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service

This specification covers forged low alloy and stainless steel piping components for use in pressure systems. These include flanges, fittings, valves and similar parts manufactured to dimensional standards such as ASME/ANSI. Products made to this specification are limited to a maximum weight of 10,000 lb (4,540 kg).

**Note**

- Although low alloy steels are covered by this standard, only stainless steels (martensitic, ferritic, austenitic and duplex) are included in this summary.

### Dimensions and Tolerances

- **Dimensions and Tolerances.** ASME/ANSI specifications B16.5 and B16.11 are referenced.
- **Flange Dimensions and Tolerances** are covered in Section 8 (see page 8-1).

### Manufacture

- **Materials.** Refer to chemical composition table. (stainless steel grades only shown). Elements not specified in the table are not permitted, specifically selenium or other elements added for free-machining properties.
- **The steel** may be melted by electric-furnace, or vacuum-furnace, or by either of these followed by vacuum or electroslag-consumable remelting. Vacuum melting or remelting is not suitable for grades containing or modified by nitrogen. Grade F XM-27Cb may be electron-beam melted.
- **Manufacture.** The steel is forged or rolled as near as possible to size and shape of the product. Small cylindrical parts (excluding flanges) may be machined directly from forged or rolled bar without additional hot working (limits defined in ASTM A 234 apply for martensitic steels, in A 403 for austenitic steels and A 815 for duplex steels). Elbows, returns and tees are not machined directly from bar.
- **Heat treatment.** Refer to heat treatment table. Heat treatment of forgings may be performed before machining. For martensitic and ferritic grades, liquid quench followed by tempering is permitted, subject to purchaser agreement. Small cylindrical parts (excluding flanges) machined directly from forged or rolled austenitic steel may be furnished annealed to this specification with subsequent light cold drawing or straightening permitted. (See also S9).
- **Marking.** Each forging is marked with manufacturers name, heat number (or heat identification), designation of service rating, specification number, grade (e.g. F 304) and size. Additionally:  
 QT = Liquid quenched and tempered  
 W = Welded  
 WNS = Not post repair weld heat treated.

### Finish and Repair

- **Appearance.** Forgings have a workmanlike finish and shall be free of scale, machining burns and injurious, imperfections (i.e. those that encroach on minimum wall thickness).
- **Defect repair by grinding or machining.** The following may be removed:
  - Surface discontinuity as above.
  - Mechanical marks, abrasions or pits deeper than 1/16 in (1.6 mm).
- **Defect repair by welding:**
  - Permitted unless purchaser prohibits (S7).
  - Defect removal by chipping or grinding is verified by magnetic particle inspection.
  - Repair is limited to 10% of surface area and 33 1/3% of nominal wall thickness.
  - Repair welding electrodes and post weld repair heat treatments are defined in A 182 but are not detailed in this summary.

## Flanges, Forged Fittings, Valves, Parts for High Temp. A 182

### Ordering Information

Item	Notes
Specification number	ASTM A 182/A 182M - 96
Quantity	Number of fittings
Size and pressure class or dimensions	Manufacturing standard (e.g. ASME/ANSI B16.5, B16.11)
Grade	Refer to chemical composition table
Additional Requirements	See optional and supplementary requirements S1 to S15

### Mandatory Testing

- **Heat analysis.** Each heat or furnace ladle of steel to be analysed. Results to conform to chemical composition table.
- **Tension Test.** One specimen tested from each heat. Specimen to be heat treated with the product.
- **Hardness Test.** Applicable to martensitic, ferritic and duplex stainless steels only. Two pieces tested per batch, minimum.
- **Grain Size.** Applicable to the following grades.
  - Grades F304H, F309H, F310H and F316H shall be No 6 or coarser.
  - Grade F321H, F347H and F348H shall be No 7 or coarser.

### Optional and Supplementary Requirements

- **Approval of Drawings.** Manufacturer may be required to submit drawings showing rough forging before machining and exact location of test specimen.
- **Inspection by Purchaser.** The purchaser may inspect the manufacture and testing of products, provided inspection does not interfere unnecessarily with the manufacturer's operations.
- S1 **Micro-etch.** A sample forging shall be sectioned and etched to show flow lines and internal imperfections. Test details to be agreed with purchaser.
- S1 **Product Analysis.** A product analysis made from one representative forging of each size and shape. Each forging checked following failure. Test results reported to purchaser.
- S1 **Tension Tests.** One tension specimen obtained from specified location on one representative forging from each heat as agreed with purchaser.
- S1 **Magnetic Particle Examination.** All accessible surfaces of the finished forging to be examined in accordance with Test Method A 275/A 275M, as agreed with purchaser.
- S1 **Liquid Penetrant Examination.** All accessible surfaces to be examined in accordance with Practice E 165, as agreed with the purchaser.
- S1 **Hydrostatic Testing.** Pressure agreed with purchaser.
- S1 **Repair Welding.** No repair welding to be permitted without approval of the purchaser.
- S1 **Heat Treatment Details.** Test report details of heat treating cycle required.
- S1 **Material for Optimum Resistance to Stress-Corrosion Cracking.** Austenitic stainless steel to be furnished in solution-annealed condition with no subsequent cold working. Straightening of bars from which parts are machined is permitted unless prohibited by purchaser.
- S1 **Corrosion Tests.** Austenitic and ferritic stainless steels shall pass intergranular corrosion tests in accordance with Practice E of Practice A 262. The number of specimens and their source and location are to be agreed with purchaser.
- S1 **Special Filler Metal.** In repair welded F316, F316L, F316H, and F316N forgings, the deposited weld metal shall conform to E308 composition wire. Forgings repair welded with E308 weld metal shall be marked F\_\_W308.
- S1 **Hardness Test.** Each forging to be tested to meet requirements of hardness table.
- S1 **Alternate Heat Treatment (Grade F91).** Non-stainless grade F91 is not covered in this summary.
- S1 **Heat Treatment of Austenitic Forgings.** Treatment specified by purchaser. Test report to be supplied by manufacturer.
- S1 **Grain Size for Austenitic Grades.** Forgings made from austenitic grades other than H grades to be tested in accordance with Test Method E 112 for average grain size as agreed with purchaser.

## A 182 Flanges, Forged Fittings, Valves, Parts for High Temp.

### Tensile and Hardness Requirements

Grade	UNS	Tensile Strength min		Yield Strength <sup>1</sup> min		Elongation in 2 in (50 mm) or 4D, min	Reduction of area, min	Brinell Hardness HB
		ksi	MPa	ksi	MPa			
<b>Martensitic Stainless Steels:</b>								
F6a Class 1	S41000	70	485	40	275	18	35.0	143-187
F6a Class 2	S41000	85	585	55	380	18	35.0	167-229
F6a Class 3	S41000	110	760	85	585	15	35.0	235-302
F6a Class 4	S41000	130	895	110	760	12	35.0	263-321
F6b	S41026	110-135	760-930	90	620	16	45.0	235-285
F6NM	S41500	115	790	90	620	15	45.0	295 max
<b>Ferritic Stainless Steels:</b>								
FXM-27Cb	S44627	60	415	35	240	20.0	45.0	190 max
F429	S42900	60	415	35	240	20.0	45.0	190 max
F430	S43000	60	415	35	240	20.0	45.0	190 max
<b>Austenitic Stainless Steels:</b>								
All	All	75 <sup>2</sup>	515 <sup>2</sup>	30	205	30	50	-
F304L	S30403	70 <sup>3</sup>	485 <sup>3</sup>	25	170	30	50	-
F304N	S30451	80	550	35	240	30 <sup>4</sup>	50 <sup>5</sup>	-
F316L	S31603	70	485	25	170	30	50	-
F316N	S31651	80	550	35	240	30 <sup>4</sup>	50 <sup>5</sup>	-
F317L	S31703	70	485	25	170	30	50	-
FXM-11	S21904	90	620	50	345	45	60	-
FXM-19	S20910	100	690	55	380	35	55	-
F10	S33100	80	550	30	205	30	50	-
F44	S31254	94	650	44	300	35	50	-
F45	S30815	87	600	45	310	40	50	-
F46	S30600	78	540	35	240	40.0	50.0	-
F47	S31725	75	525	30	205	40.0	50.0	-
F48	S31726	80	550	35	240	40.0	50.0	-
F49	S34565	115	795	60	415	35	40	-
F56	S33228	73	500	27	185	30	35	-
<b>Duplex Stainless Steels</b>								
F50	S31200	100-130	690-900	65	450	25	50	-
F51	S31803	90	620	65	450	25	45	-
F52	S32950	100	690	70	485	15	-	-
F53	S32750	116 <sup>6</sup>	800 <sup>6</sup>	80 <sup>6</sup>	550 <sup>6</sup>	15	-	310 max
F54	S32740	116	800	80	550	15	30	310 max
F55	S32760	109-130	750-895	80	550	25.0	45	-
F57	S39277	118	820	85	585	25	50	-

**Notes**

- 1 Determined by the 0.2% offset method. For ferritic steels only, the 0.5% extension-under-load method may also be used.
- 2 For sections over 5 in. [130 mm] in thickness, the minimum tensile strength shall be 70 ksi [485 MPa].
- 3 For sections over 5 in. [130 mm] in thickness, the minimum tensile strength shall be 65 ksi [450 MPa].
- 4 Longitudinal. The transverse elongation shall be 25% in 2 in. or 50 mm, min.
- 5 Longitudinal. The transverse reduction of area shall be 45% min.
- 6 For sections over 2 in. [50 mm] in thickness, the minimum tensile strength shall be 109 ksi [750 MPa]; the minimum yield strength shall be 75 ksi [515 MPa].
- All = All austenitic grades as listed in the chemical composition table except as identified in this table.

## Flanges, Forged Fittings, Valves, Parts for High Temp. A 182

### Heat Treatment

Grade	UNS	Heat Treatment	Temperature		Cooling Media	Quench Cool below		Tempering Temp	
			°F min	°C min		°F	°C	°F min	°C min
Martensitic Stainless Steels:									
F6a Class 1	S41000	Anneal Normalise & temper Temper	NS NS NS	NS NS NS	Furnace Cool Air Cool NA	NA 400 NA	NA 205 NA	NA 1325 1325	NA 725 725
F6a Class 2	S41000	Anneal Normalise & temper Temper	NS NS NS	NS NS NS	Furnace Cool Air Cool NA	NA 400 NA	NA 205 NA	NA 1250 1250	NA 675 675
F6a Class 3	S41000	Anneal Normalise & temper	NS NS	NS NS	Furnace Cool Air Cool	NA 400	NA 205	NA 1100	NA 595
F6a Class 4	S41000	Anneal Normalise & temper	NS NS	NS NS	Furnace Cool Air Cool	NA 400	NA 205	NA 1000	NA 540
F6b	S41026	Anneal Normalise & temper	1750 1750	955 955	Furnace Cool Air Cool	NA 400	NA 205	NA 1150	NA 620
F6NM	S41500	Normalise & temper	1850	1010	Air Cool	200	95	1040- 1120	560- 600
Ferritic Stainless Steels:									
FXM-27Cb	S44627	Anneal	1850	1010	Furnace Cool	NA	NA	NA	NA
F429	S42900	Anneal	1850	1010	Furnace Cool	NA	NA	NA	NA
F430	S43000	Anneal	NS	NS	Furnace Cool	NA	NA	NA	NA
Austenitic Stainless Steels <sup>1</sup> :									
All	All	Solution treat & quench	1900	1040	Liquid	500	260	NA	NA
F321H	S32109	Solution treat & quench	1925	1050	Liquid	500	260	NA	NA
F347H	S34709	Solution treat & quench	1925	1050	Liquid	500	260	NA	NA
F348H	S34809	Solution treat & quench	2000	1100	Liquid	500	260	NA	NA
F44	S31254	Solution treat & quench	2100	1150	Liquid	500	260	NA	NA
F46	S30600	Solution treat & quench	2010- 2140	1100- 1140	Liquid	500	260	NA	NA
F49	S34565	Solution treat & quench	2050	1120	Liquid	500	260	NA	NA
F56	S33228	Solution treat & quench	2050- 2160	1120- 1180	Liquid	500	260	NA	NA
Duplex Stainless Steels:									
F50	S31200	Solution treat & quench	1925	1050	Liquid	500	260	NA	NA
F51	S31803	Solution treat & quench	1870	1020	Liquid	500	260	NA	NA
F52	S32950	Solution treat <sup>2</sup> & quench	1825- 1875	995- 1025	Water	NS	NS	NA	NA
F53	S32750	Solution treat & quench	1880	1025	Liquid	500	260	NA	NA
F54	S32740	Solution treat & quench	1920- 2060	1050- 1125	Liquid	500	260	NA	NA
F55	S32760	Solution treat & quench	2010- 2085	1100- 1140	Liquid	500	260	NA	NA
F57	S39277	Solution treat & quench	1940	1060	Liquid	175	80	NA	NA

**Notes**

- 1 Austenitic grades (except grades F304H, F316H, F321, F321H, F347, F347H, F348, F348H) may be individually quenched following hot working of a forging while its temperature is not less than the minimum solution treating temperature.
  - 2 Solution treated for 30 min/in of thickness, at temperature within range as stated in table.
- NA = Not Applicable.
  - NS = Not Specified.
  - All = All austenitic grades as listed in the chemical composition table except as identified.
  - Post weld repair heat treatment is not covered in this summary. Refer to the full specification for these details.
  - Duplex grades do not require post weld repair heat treatment.

## A 182 Flanges, Forged Fittings, Valves, Parts for High Temp.

### Chemical Composition

Grade	UNS	Composition Percentage, max or range								Note
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	
<b>Martensitic Stainless Steels:</b>										
F6a	S41000	0.15	1.00	0.040	0.030	1.00	0.50	11.5-13.5	-	
F6b	S41026	0.15	1.00	0.02	0.02	1.0	1.0-2.0	11.5-13.5	0.40-0.60	1
F6NM	S41500	0.05	0.50-1.00	0.030	0.030	0.60	3.5-5.5	11.5-14.0	0.5-1.0	
<b>Ferritic Stainless Steels:</b>										
FXM-27Cb	S44627	0.01	0.40	0.020	0.020	0.40	0.50	25.0-27.5	0.75-1.50	2
F429	S42900	0.12	1.00	0.040	0.030	0.75	0.50	14.0-16.0	-	
F430	S43000	0.12	1.00	0.040	0.030	0.75	0.50	16.0-18.0	-	
<b>Austenitic Stainless Steels:</b>										
F304	S30400	0.08	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	-	19
F304H	S30409	0.04-0.10	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	-	
F304L	S30403	0.035	2.00	0.045	0.030	1.00	8.0-13.0	18.0-20.0	-	19
F304N	S30451	0.08	2.00	0.045	0.030	0.75	8.0-10.5	18.0-20.0	-	20
F304LN	S30453	0.030	2.00	0.045	0.030	0.75	8.0-10.5	18.0-20.0	-	20
F310	S31000	0.15	2.00	0.045	0.030	1.00	19.0-22.0	24.0-26.0	-	
F316	S31600	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	19
F316H	S31609	0.04-0.10	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	
F316L	S31603	0.035	2.00	0.045	0.030	1.00	10.0-15.0	16.0-18.0	2.00-3.00	19
F316N	S31651	0.08	2.00	0.045	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	20
F316LN	S31653	0.030	2.00	0.045	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	20
F317	S31700	0.08	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0	
F317L	S31703	0.03	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0	
F321	S32100	0.080	2.00	0.045	0.030	1.00	9.0-12.0	17.0	-	21
F321H	S32109	0.04-0.10	2.00	0.045	0.030	1.00	9.0-12.0	17.0	-	22
F347	S34700	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	23
F347H	S34709	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	24
F348	S34800	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	3,23
F348H	S34809	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	3,24
FXM-11	S21904	0.040	8.0-10.0	0.060	0.030	1.00	5.5-7.5	19.0-21.5	-	4
FXM-19	S20910	0.06	4.0-6.0	0.040	0.030	1.00	11.5-13.5	20.5-23.5	1.50-3.00	5
F10	S33100	0.10-0.20	0.50-0.80	0.040	0.030	1.00-1.40	19.0-22.0	7.0-9.0		
F44	S31254	0.020	1.00	0.030	0.010	0.80	17.5-18.5	19.5-20.5	6.0-6.5	6
F45	S30815	0.05-0.10	0.80	0.040	0.030	1.40-2.00	10.0-12.0	20.0-22.0		7
F46	S30600	0.018	2.00	0.020	0.020	3.7-4.3	14.0-15.5	17.0-18.5	0.20	
F47	S31725	0.030	2.00	0.045	0.030	0.75	13.0-17.5	18.0-20.0	4.0-5.0	8
F48	S31726	0.030	2.00	0.045	0.030	0.75	13.5-17.5	17.0-20.0	4.0-5.0	9
F49	S34565	0.030	5.0-7.0	0.030	0.010	1.00	16.0-18.0	23.0-25.0	4.0-5.0	10
F56	S33228	0.04-0.08	1.00	0.020	0.015	0.30	31.0-33.0	26.0-28.0	-	11
<b>Duplex Stainless Steels</b>										
F50	S31200	0.030	2.00	0.045	0.030	1.00	5.5-6.5	24.0-26.0	1.2-2.0	12
F51	S31803	0.030	2.00	0.030	0.020	1.00	4.5-6.5	21.0-23.0	2.5-3.5	13
F52	S32950	0.03	2.00	0.035	0.010	0.60	3.5-5.2	26.0-29.0	1.00-2.50	14
F53	S32750	0.030	1.2	0.035	0.020	0.8	6.0-8.0	24.0-26.0	3.0-5.0	15
F54	S39274	0.030	1.0	0.030	0.020	0.80	6.0-8.0	24.0-26.0	2.50-3.50	16
F55	S32760	0.030	1.00	0.030	0.010	1.00	6.00-8.00	24.00-26.00	3.00-4.00	17
F57	S39277	0.025	0.80	0.025	0.002	0.80	6.5-8.0	24.0-26.0	3.0-4.0	18

Flanges, Forged Fittings, Valves, Parts for High Temp. A 182

Chemical Composition (Continued)

Grade	UNS	Composition Percentage, max or range								Note
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	
Product Analysis Tolerances <sup>A</sup> (% over max or under min)		0.005 if ≤0.030, 0.01 if ≤0.20	0.03 if ≤1.00, 0.04 if ≤3.00, 0.05 if ≤6.00, 0.06 if ≤10.00	0.005	0.005	0.05 if ≤1.00, 0.10 if ≤5.00	0.03 if ≤1.00, 0.07 if ≤5.00, 0.10 if ≤10.00, 0.15 if ≤20.00, 0.20 if ≤22.00	0.10 if ≤10.00, 0.15 if ≤15.00, 0.20 if ≤20.00, 0.25 if ≤27.50	0.03 if ≤0.60, 0.05 if ≤2.00, 0.10 if ≤7.00	25

Note

A The product analysis tolerances are not applicable to heat analysis.

Composition Notes

- 1 Copper 0.50% max
- 2 Nitrogen 0.015% max, Copper 0.20% max, Niobium 0.05-0.20%
- 3 Tantalum 0.10% max
- 4 Nitrogen 0.15-0.40%
- 5 Niobium+Tantalum: 0.10-0.30%, Nitrogen 0.20-0.40%, Vanadium 0.10-0.30%
- 6 Nitrogen 0.18-0.22%, Copper 0.50-1.00%
- 7 Nitrogen 0.14-0.20%, Cerium 0.03-0.08%
- 8 Nitrogen 0.10% max
- 9 Nitrogen 0.10-0.20%
- 10 Niobium+Tantalum: 0.10% max, Nitrogen 0.4-0.6%
- 11 Niobium+Tantalum: 0.6-1.0%, Cerium 0.05-0.10%, Aluminium 0.025% max
- 12 Nitrogen 0.14-0.20%
- 13 Nitrogen 0.08-0.20%
- 14 Nitrogen 0.15-0.35%
- 15 Nitrogen 0.24-0.32%, Copper 0.5% max
- 16 Nitrogen 0.24-0.32%, Copper 0.20-0.80%, Tungsten 1.50-2.50%
- 17 Nitrogen 0.20-0.30%, Copper 0.50-1.00%, Tungsten 0.50-1.00%
- 18 Nitrogen 0.23-0.33%, Copper 1.20-2.00%, Tungsten 0.80-1.20%
- 19 Nitrogen 0.10% max
- 20 Nitrogen 0.10-0.16%
- 21 Titanium ≥5 x Carbon and Ti ≤0.70%
- 22 Titanium ≥4 x Carbon and Ti ≤0.70%
- 23 Niobium + Tantalum ≥10 times Carbon and 1.10% max
- 24 Niobium + Tantalum ≥8 times Carbon and 1.10% max
- 25 Tolerances (% over max or under min) for other elements are as follows:
  - 0.05 for Titanium
  - 0.03 for Copper if ≤1.00%
  - 0.01 for Nitrogen if ≤0.19%
  - 0.02 for Nitrogen if ≤0.25%
  - 0.03 for Nitrogen if ≤0.35%
  - 0.04 for Nitrogen if ≤0.45%
  - 0.05 for Nitrogen if ≤0.60%
  - 0.01 for Niobium if in range 0.05-0.20%
  - 0.05 for Niobium+Tantalum in all ranges
  - 0.02 for Tantalum if ≤0.10%
  - 0.04 for Tungsten if ≤1.00%

Note

- Niobium is sometimes referred to as Columbium.

# ASTM A 403/A 403M - 96

## Wrought Austenitic Stainless Steel Pipe Fittings

This specification covers two general classes, known as WP (Wrought Pipe) and CR (Corrosion Resistant) stainless steel fittings of both seamless and welded construction.

### Dimensions and Tolerances

- **Dimensions and Tolerances.** ASME/ANSI B16.9, B16.11 and B16.28, and MSS SP-43, SP-79 and SP-95 are referenced. Supplementary requirement S9 applies for non-standard fittings.
  - **Buttweld Fittings Dimensions and Tolerances** are covered in **Section 6** (see page 6-1).
  - **Socket Weld and Threaded Fittings Dimensions and Tolerances** are covered in Section 7 (see page 7-1)
- **Wall Thicknesses** are as defined in appropriate pipe specifications (see Section 5). Minimum thickness must not be encroached.

### Manufacture

- **Materials.** Refer to chemical composition table. Fittings may be made from forgings, bars, plates, or seamless or welded tubular products, provided the materials conform to the chemical composition table.
- **The steel** may be melted by electric-furnace, or vacuum-furnace, or by either of these followed by vacuum or electroslag-consumable remelting.
- **Forming.** Fittings may be formed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining or any combination of these processes.
- **Heat Treatment.** All fittings are heat treated in accordance with the heat treatment table. All welding must be done prior to heat treatment.
- **Class WP-S Fittings.** Fittings marked WP-S are of seamless construction and meet all the requirements of ANSI B16.9, B16.11, B16.28 or MSS SP-79.
- **Class WP-W Fittings.** Fittings marked WP-W contain welds with or without filler metal. All welds made with filler metal are radiographically examined throughout the entire length. The fittings conform with ANSI B16.9 or B16.28.
- **Class WP-WX Fittings.** Fittings marked WP-WX are of welded construction and have *all* welds radiographically examined throughout their entire length. The fittings conform to the requirements of ANSI B16.9 or B16.28.
- **Class WP-WU Fittings.** Fittings marked WP-WU are of welded construction and have *all* welds are ultrasonically examined throughout their entire length. The fittings conform to the requirements of AMSI B16.9 or B16.28.
- **Class CR fittings.** These fittings are manufactured to the requirements of MSS SP-43. They need not be radiographically or ultrasonically examined.
- **Small Fittings** machined from bar shall be restricted to NPS 4 or smaller. No elbows, return bends or tees shall be machined from bar. Supplementary requirement S7 applies to caps machined from bar.
- **Stub ends.** Weld build up is permitted to dimensionally correct unfilled areas produced during cold forming of stub ends. Weld repair is also permitted. Radiographic examination is not necessary if prescribed procedures are followed. Stub ends may also be produced with the entire lap added as weld metal to a straight pipe section. (Refer to the full specification for details).
- **Weld Materials:** Any deposited weld metal should conform in its alloy content to that of the fitting base metal, or as given in the AWS filler metal specification A5.4 or A5.9. Exceptions are when welding on 304, 304L or 321 base metal, in which cases the weld metal should correspond to AWS Types E308 (ER308L), or E347 (ER347 or ER321) respectively. Also, when welding on S31725, S31726, S31254, or S33228 the weld metal should correspond to the base metal or to UNS W86112/N06625.
- **Marking.** MSS SP-25 applies. For butt-welded fittings marking includes: manufacturers name or trademark, schedule number or nominal wall thickness, size, class, grade, heat number or heat identification, supplementary requirement 'S' suffix unless threaded or socket-welded. For cold-format stub ends with weld build up: add 'WBU' to grade. For threaded or socket welding fittings: pressure rating may be used in place of schedule number. Bar coding may be used as a supplementary identification.

## Wrought Austenitic Stainless Steel Pipe Fittings A 403

### Ordering Information

Item	Notes
Specification number	ASTM A 403/A 403M - 96
Quantity	Number of fittings of each kind
Description of fitting and nominal dimension.	Standard or special
Grade of steel	Selected from chemical composition table
Class	WP or CR. WP fittings may also be WP-S, WP-W, WP-WX or WP-WU. If not specified, furnished at the option of the supplier.
Additional requirements	Refer to optional and supplementary requirements S1 to S10

### Finish and Repair

- **Surface discontinuities** deeper than 5% of nominal wall thickness to be removed.
- **Defect removal by grinding or machining.** The following are removed:
  - Surface discontinuity as above.
  - Surface checks (fishscale) deeper than  $1/64$  in (0.4 mm).
  - Mechanical marks deeper than  $1/16$  in (1.6 mm).
  - When removal reduces wall thickness below  $87^{1/2}\%$  of nominal, the fitting is rejected or repaired.
- **Defect repair by welding**
  - Permitted for fitting made to specifications.
  - Purchaser agreement is necessary for weld repair of special fitting.
  - Repair is limited to 10% of outside surface and  $33^{1/3}\%$  of nominal wall thickness.
  - All weld repairs are examined using liquid penetration test.
  - There should be no cracks in prepared cavities, or in finished weld, or in the surrounding

### Mandatory Testing

- **Heat Analysis.** Composition of each cast or heat is required to conform to the chemical composition table. Weld material conforms to the same requirements, except as identified in Manufacture above.
- **Tensile Tests.** Tension test made on starting material is acceptable provided the heat treatments are the same. If they differ, one test is made on material representative of the fitting from each heat and in the same heat treated condition as the fittings.
- **Visual Inspection.** All fittings are to be examined for surface imperfections.
- **Hydrostatic Test.** Not required. However:
  - Class WP fittings** shall be capable of withstanding pressures prescribed for the specified matching pipe or equivalent material.
  - Class CR fittings** shall be capable of withstanding pressures based on ratings in MSS SP-43, except for CR tees fabricated using intersection welds which shall withstand pressures based on 70% of the ratings in MSS SP-43.
- **Nondestructive Testing.** Radiographically or ultrasonically examined in accordance with the Class of fitting. (See Manufacture above).

### Optional and Supplementary Requirements.

- S1 **Product Analysis.** Analysis made for each heat of base metal and from each lot number of welding material if appropriate
  - S1 **Tension Test.** One test on one fitting or representative test piece per lot. A weld should be at the centre of any test piece, if the fitting is of welded construction.
  - S1 **Interganular Corrosion Bend Test.** One test on one fitting or representative test piece per lot.
- A weld should be at the centre of and at position of maximum bend, if the fitting is of welded construction. Grades 304L, 316L, 317L, 321, 347 and 348 are tested after a heat treatment capable of producing sensitisation.

## A 403 Wrought Austenitic Stainless Steel Pipe Fittings

### Optional and Supplementary Requirements (Continued)

- S1 **Ultrasonic Test.** Each fitting of the raw material from which each fitting is made will be ultrasonically tested to determine soundness.
- S1 **Photomicrographs.** A photomicrograph at 100 diameters shall be made, for information only, of the base metal structure from one fitting per lot. The lot is to be defined by the purchaser.
- S1 **Surface Finish.** Machined surfaces will have a maximum roughness of 250 µin (6.4 µm). Other surfaces will be suitable for ultrasonic tests.
- S1 **Liquid Penetrant Test.** All surfaces will be liquid penetrant tested in accordance with Practice E 165.
- S1 **Special Filler Metal.** Fittings shall be welded using either filler metal AWS Type E16-8-2 or ER16-8-2 and shall be marked WP \_\_\_\_\_HRW or CR \_\_\_\_\_HRW.
- S1 **Special Fittings.** Fittings whose size and shape do not completely conform to the dimensions specified in the ANSI or MSS specification will meet all the other requirements of these specification and be marked S9.
- S1 **Stabilisation Treatment.** Grades 321, 347 and 348 to receive a stabilisation treatment instead of a solution anneal. Stabilisation treatment will hold the fitting at 1500 - 1600 °F {815 - 870 °C} for a minimum of 2 hrs/in (4.7 min/mm) of thickness. Marking is to include S10 after grade.

### Tensile Requirements

Grade	UNS	Tensile Strength, min		Yield Strength, min		Elongation min% in 4D	
		ksi	MPa	ksi	MPa	Longit %	Trans%
All	All	75	515	30	205	28	20
304L	S30403	70	485	25	170	28	20
316L	S31603	70	485	25	170	28	20
304N	S30451	80	550	35	240	28	20
316N	S31651	80	550	35	240	28	20
	S31726	80	550	35	240	28	20
XM-19	S20910	100	690	55	380	28	20
	S31254	94-119	650-820	44	300	28	20
	S34565	115	795	60	415	28	20
	S33228	73	500	27	185	28	20

**Notes**

- Grades or UNS designations are prefixed with letters 'WP' or 'CR' to indicate class.
- All = All grades listed in the chemical composition table except as identified.

### Heat Treatment

Grade <sup>1</sup>	UNS	Temperature °F	Temperature °C	Treatment
All	All	1900	1040	Solution annealing until chromium carbides are in solution. Cooling at a rate to prevent reprecipitation. <sup>2</sup>
321	S32100	1900-2100	1040-1150	Solution annealing as above
321H	S32109	1925-2100	1050-1150	Solution annealing as above
347	S34700	1900-2100	1040-1150	Solution annealing as above
347H	S34709	1925-2100	1050-1150	Solution annealing as above
348H	S34809	1925-2100	1050-1150	Solution annealing as above
XM-19	S20910	1900	1040	Solution annealing as above
	S31254	2100	1150	Solution annealing as above
	S34565	2050-2140	1120-1170	Solution annealing as above
	S33228	2050	1120	Solution annealing as above

**Notes:**

- 1 Grades or UNS designations are prefixed with letters 'WP' or 'CR' to indicate class.
- 2 All fittings will be supplied heat treated. All welding will be done before heat treatment. Fittings machined directly from solution-annealed forgings and bar need not be resolution annealed.
- All = All grades listed in the chemical composition table except as identified in this table.

## Wrought Austenitic Stainless Steel Pipe Fittings A 403

### Chemical Compositions

Grade	UNS	Composition Percentage, max or range								
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Note
304	S30400	0.08	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	-	
304H	S30409	0.04-0.10	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	-	
304L	S30403	0.035	2.00	0.045	0.030	1.00	8.0-13.0	18.0-20.0	-	2
304LN	S30453	0.030	2.00	0.045	0.030	0.75	8.0-10.5	18.0-20.0	-	1
304N	S30451	0.08	2.00	0.045	0.030	0.75	8.0-11.0	18.0-20.0	-	1
309	S30900	0.15	2.00	0.045	0.030	1.00	12.0-15.0	22.0-24.0	-	
310	S31000	0.15	2.00	0.045	0.030	1.50	19.0-22.0	24.0-26.0	-	
316	S31600	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	
316H	S31609	0.04-0.10	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	
316LN	S31653	0.030	2.00	0.045	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	1
316L	S31603	0.035	2.00	0.045	0.030	1.00	10.0-16.0	16.0-18.0	2.00-3.00	2,3
316N	S31651	0.08	2.00	0.045	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	1
317	S31700	0.08	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0	
317L	S31703	0.030	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.0-4.0	
321	S32100	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	4
321H	S32109	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	5
347	S34700	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	6
347H	S34709	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	7
348	S34800	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	6,8
348H	S34809	0.04-0.10	2.00	0.045	0.030	1.00	9.0-13.0	17.0-20.0	-	7,8
XM-19	S20910	0.060	4.0-6.0	0.040	0.030	1.00	11.5-13.5	20.5-23.5	1.5-3.00	9,10
	S31254	0.020	1.00	0.030	0.010	0.80	17.5-18.5	19.5-20.5	6.0-6.5	11
	S31725	0.030	2.00	0.045	0.030	0.75	13.5-17.5	18.0-20.0	4.0-5.0	12
	S31726	0.030	2.00	0.045	0.030	0.75	13.5-17.5	17.0-20.0	4.0-5.0	13
	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	14
	S33228	0.04-0.08	1.0	0.020	0.015	0.30	31.0-33.0	26.0-28.0	-	15

**Note**

- Grades or UNS designations are prefixed with letters 'WP' or 'CR' to indicate class.

### Composition Notes

- 1 Nitrogen 0.10-0.16%
- 2 Carbon 0.040% max is necessary where many drawing passes are required, as with outside diameter <0.5 in (12.7 mm), or nominal wall thickness <0.049 (1.2 mm).
- 3 On pierced tube, Nickel may be 11.0-16.00%
- 4 Titanium  $\geq 5 \times$  Carbon, 0.70% max
- 5 Titanium  $\geq 4 \times$  Carbon, 0.70% max
- 6 Niobium + Tantalum:  $\geq 10 \times$  Carbon, 1.10% max
- 7 Niobium + Tantalum:  $\geq 8 \times$  Carbon, 1.00% max
- 8 Tantalum 0.10%
- 9 Niobium + Tantalum 0.10-0.30%, Vanadium 0.10-0.30%
- 10 Nitrogen 0.20-0.40%
- 11 Nitrogen 0.18-0.22%, Copper 0.50-1.00%
- 12 Nitrogen 0.10% max, Copper 0.75%
- 13 Nitrogen 0.10-0.20%, Copper 0.75%
- 14 Nitrogen 0.4-0.6%, Niobium 0.1%
- 15 Cerium 0.05-0.10%, Aluminium 0.025%, Niobium 0.6-1.0%

**Note**

- Niobium is sometimes referred to as Columbium

## ASTM A 774/A 774M - 95a

### As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

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.

Refer to ASTM A 403/A 403M for products requiring heat treatment or full pressure rating.

#### Dimensions and Tolerances

- **Dimensions.** Fittings covered are butt and socket welding parts such as 45° and 90° elbows, tees, reducers, wyes, laterals, crosses and stub-ends. Sizes range from 3 in to 48 in (75 mm to 1225 mm) outside diameter and from 0.062 in to 0.500 in (1.6 mm to 12.7 mm) wall thickness. Refer to page 4-18 for tables of common tubular fitting outside diameters and wall thicknesses.
- **Tolerances.** MSS SP-43 tolerances apply (see page 6-2). For fittings not covered by MSS SP-43, limits are as agreed with the purchaser.
- **Wall thickness.** Minimum thickness must not be encroached.

#### Manufacture

- **Materials.** Refer to chemical composition table.
  - **Manufacture.** Fittings will be made from flat-rolled steel which has been solution annealed. The fittings may be hot or cold formed and then welded by a shielded welding process, with or without the addition of filler metal.
  - **Welding:** All joints will be full penetration double welded or single welded butt joints using a fusion-welding process, with or without the addition of filler metal.
  - **Weld Materials:** Any deposited weld metal should conform in its alloy content to that of the fitting base metal, or as given in the AWS filler metal specification A5.4 or A5.9.
- Exceptions are when welding on 304L or 321 base metal, in which cases the weld metal should correspond to AWS Types E308 (ER308L), or E347 (ER347 or ER321) respectively.
- **Heat Treatment.** Not required.
  - **Marking.** Manufacturers name or brand, schedule number or pressure class or thickness, size, specification number, grade, heat number or heat identification. Also 'HT-0' to indicate not heat treated.
- Bar coding may be used. If used on small fittings the bar code may be applied to the box or to a substantial tag.

#### Finish and Repair

- **Finish.** Fitting are to be furnished clean and free of scale.
- **Surface discontinuities** deeper than 5% of nominal wall thickness to be removed.
- **Defect removal by grinding or machining.** The following are removed:
  - Surface discontinuity as above.
  - Surface checks (fish scale) deeper than 1/64 in (0.4 mm)
  - Mechanical marks deeper than 1/16 in (1.6 mm) wall thickness tolerance
  - When removal reduces wall thickness below 87 1/2% of nominal, the fitting is rejected or repaired.
- **Defect repair by welding**
  - Permitted for fittings made to specifications.
  - Purchaser agreement is necessary for weld repair of special fittings.
  - Defects must be entirely removed by chipping, machining or grinding before welding. Weld materials must comply with manufacturing requirements.

## As-Welded Austenitic Fittings for Gen. Corrosive Service A 774

### Ordering Information

Item	Notes
Specification number	ASTM A 774/A 774M - 95a
Quantity	Number of fittings of each kind
Description of fitting	Standard or special
Dimension	Outside diameter and specified wall thickness. See common fitting sizes, page 4-18.
Grade	Material selected from chemical composition table
End use	If known
Additional requirements	Refer to optional and supplementary requirements S1 to S5

### Mandatory Testing

- Heat Analysis.** Mill certificates of analysis of each heat provided on request. Composition shall comply with the chemical composition table. No unspecified elements shall be present.
- Tensile and Hardness Tests.** Manufacturers tests on the sheet or plate qualify material before manufacture. Fittings need not be mechanically tested after manufacture unless requested by purchaser (see S2, S3).
- Visual Inspection.** All fittings are to be examined for surface imperfections.
- Hydrostatic Tests.** Not required by the specification.

### Optional and Supplementary Requirements

- S1 **Product Analysis.** This will be made for each heat of base metal and for each heat of welding material if appropriate.
- S1 **Tension Test.** One test on one fitting per lot. A weld should be at the centre of any test piece, if of welded construction.
- S1 **Ultrasonic Examination.** The base material from which each fitting is made is tested for soundness.
- S1 **Liquid Penetrant Test.** All surfaces shall be liquid penetrant examined in accordance with Practice E 165.
- S1 **Nondestructive Electromagnetic Test (Eddy Current Test).** Tested against a calibration tube with a drilled hole, transverse tangential notch or longitudinal notch discontinuity in the surface, to establish minimum sensitivity level for rejection.

### Tensile and Hardness Requirements

Grade	UNS	Tensile Strength, min		Yield Strength, min		Elongation in 2 in (50 mm) min %	Brinell Hardness HB max	Rockwell Hardness HRB max
		ksi	MPa	ksi	MPa			
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

### Heat Treatment

Heat treatment is not required for fittings provided under this specification.

## A 774 As-Welded Austenitic Fittings for Gen. Corrosive Service

### Chemical Composition

Grade	UNS	Composition Percentage, max or range								Note
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	
TP304L	S30403	0.030	2.00	0.045	0.030	1.00	8.0-13.0	18.0-20.0	-	1
TP316L	S31603	0.030	2.00	0.045	0.030	1.00	10.0-15.0	16.0-18.0	2.00-3.00	1
TP317L	S31703	0.030	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.00-4.00	1
TP321	S32100	0.08	2.00	0.045	0.030	1.00	9.0-12.0	17.0-19.0	-	2
TP347	S34700	0.08	2.00	0.045	0.030	1.00	9.0-13.0	17.0-19.0	-	3
Tolerance <sup>A</sup>		0.005	0.040	0.010	0.005	0.050	0.100	0.200	0.100	4

Note

A Tolerances = Product analysis tolerances (% over the max or under the min limit). These are not applicable to heat analysis.

### Composition Notes

- 1 Nitrogen max 0.10%
- 2 Titanium  $\geq 5 \times$  Carbon, 0.7% max
- 3 Niobium + Tantalum  $\geq 10 \times$  Carbon, 1.10% max
- 4 Product analysis tolerance for Nitrogen = 0.005

Note

- Niobium is sometimes referred to as Columbium

### Common Fitting Sizes

#### Common tubular fitting sizes

Outside Diameter	
in	mm
3	76
3 <sup>1</sup> / <sub>2</sub>	90
4	100
4 <sup>1</sup> / <sub>2</sub>	115
6	150
6 <sup>5</sup> / <sub>8</sub>	170
8	205
8 <sup>5</sup> / <sub>8</sub>	220
10	255
10 <sup>3</sup> / <sub>4</sub>	275
12	305

Outside Diameter	
in	mm
12 <sup>3</sup> / <sub>4</sub>	325
14	355
16	405
18	460
20	510
24	610
30	760
36	915
40	1015
42	1070
48	1220

#### Common tubular fitting nominal thickness

Gauge or inches	Nominal Thickness	
	in	mm
16 gauge	0.062	1.6
14 gauge	0.078	2.0
12 gauge	0.109	2.8
11 gauge	0.125	3.2
10 gauge	0.140	3.6
8 gauge	0.172	4.4
<sup>3</sup> / <sub>16</sub> in.	0.187	4.8
<sup>1</sup> / <sub>4</sub> in.	0.250	6.4
<sup>5</sup> / <sub>16</sub> in.	0.312	8.0
<sup>3</sup> / <sub>8</sub> in.	0.375	9.5
<sup>1</sup> / <sub>2</sub> in.	0.500	12.7

## ASTM A 815/A 815M - 96

Wrought Ferritic, Ferritic/Austenitic (Duplex), and Martensitic  
Stainless Steel Pipe Fittings

This specification covers two general classes (WP and CR) of wrought ferritic, duplex and martensitic stainless steel fittings, of both welded or seamless construction.

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## Dimensions and Tolerances

- **Dimensions and Tolerances.** ASME/ANSI B16.9, B16.11 and B16.28, and MSS SP-43 and SP-79 apply. Supplementary requirement S8 applies for non-standard fittings.
  - **Butt Weld Fittings Dimensions and Tolerances** are covered in **Section 6** (see page 6-1).
  - **Socket Weld and Threaded Fittings Dimensions and Tolerances** are covered in Section 7 (see page 7-1)
- **Wall Thicknesses** are as defined in appropriate pipe specifications (see Section 5). Minimum thickness must not be encroached.

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## Manufacture

- **Materials.** Refer to chemical composition table. Fittings may be made from forgings, bars, plates, or seamless or welded tubular products, provided the materials conform to the chemical composition table.
- **The steel** may be melted using an electric furnace vacuum furnace or by a two stage electric furnace melt.
- **Forming.** Fittings may be formed by hammering, pressing, piercing, extruding, upsetting, rolling, bending, fusion welding, machining or any combination of these processes.
- **Heat Treatment.** All fittings are heat treated in accordance with the heat treatment table. All welding must be done prior to final heat treatment.
- **Class WP-S Fittings.** Fittings marked WP-S are of seamless construction and meet all the requirements of ANSI B16.9 or B16.11, B16.28 or MSS SP-79.
- **Class WP-W Fittings.** Fittings marked WP-W contain welds with or without filler metal. All welds made with filler metal are radiographically examined throughout the entire length. The fittings conform with ANSI B16.9 or B16.28.
- **Class WP-WX Fittings.** Fittings marked WP-WX are of welded construction and have *all* welds radiographically examined throughout their entire length. The fittings conform to the requirements of ANSI B16.9 or B16.28.
- **Class CR fittings.** These fittings are manufactured to the requirements of MSS SP-43. They need not be radiographically examined.
- **Small Fittings** machined from bar shall be restricted to NPS 4 or smaller. Supplementary requirement S7 applies to caps machined from bar.
- **Weld Materials.** Any deposited weld metal should conform in its alloy content to that of the fitting base metal. Exceptions are S23950 which requires 26% Cr, 8% Ni, 2% Mo weld metal, and S31803 which requires 22% Cr, 8-10% Ni, 3% Mo weld metal.
- **Marking.** MSS SP-25 applies. For butt-welded fittings: manufacturer's name or trademark, schedule number or nominal wall thickness, size, class, grade, heat number or heat identification. For threaded or socket welding fittings: pressure rating may be used in place of schedule number. Supplementary bar coding may be used.

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## Finish and Repair

- **Surface discontinuities** deeper than 5% of nominal wall thickness to be removed.
- **Defect repair by grinding or machining.** As detailed for ASTM A 774 on page 4-16.
- **Defect repair by welding** is permitted for fitting made to specifications, but purchaser must agree for special fittings.
  - Repair is limited to 10% of outside surface and 33<sup>1</sup>/<sub>3</sub>% of nominal wall thickness.
  - All weld repairs are examined using liquid penetration test.
  - There should be no cracks in prepared cavities or in finished weld, or in the surrounding 1/2 in (13 mm) of base metal.

## A 815 Wrought Ferritic, Duplex & Martensitic Fittings

### Ordering Information

Item	Notes
Specification number	ASTM A 403/A 403M - 96
Quantity	Number of fittings of each kind
Description of fitting and nominal dimension	Standard or special
Grade of steel	Selected from chemical composition table
Class	WP or CR. WP fittings may also be WP-S, WP-W, WP-WX or WP-WU. If not specified, furnished at the option of the supplier (CR fittings may not be furnished in place of WP fittings)
Additional requirements	Refer to optional and supplementary requirements S1 to S8

### Mandatory Testing

- **Heat Analysis.** Composition of each cast or heat is required to conform to the chemical composition table. Weld material conforms to same requirements, except as identified in Manufacture above.
- **Tensile Tests.** Tension test made on starting material is acceptable provided the heat treatments are the same. If they differ, one test is made on material representative of the fitting from each heat and in the same heat treated condition as the fittings.
- **Visual Inspection.** All fittings are to be examined for surface imperfections.
- **Hydrostatic Test.** Not required. However:  
**Class WP fittings** shall be capable of withstanding pressures prescribed for the specified matching pipe or equivalent material.  
**Class CR fittings** shall be capable of withstanding pressures based on ratings in MSS SP-43 (see page 6-2), except for CR tees fabricated using intersection welds which shall withstand pressures based on 70% of the ratings in MSS SP-43.
- **Nondestructive Testing.** Radiographically examined in accordance with the Class of fitting. (See Manufacture above).

### Optional and Supplementary Requirements

- S1 **Product Analysis.** This will be made for each heat of base metal and for each heat of welding material if appropriate.
- S1 **Tension Tests.** One test on one fitting per lot. A weld should be at the centre of any test piece, if welded construction.
- S1 **Intergranular Corrosion Bend Test.** One test on one fitting or test piece per lot. A weld should be at the centre of and at position of maximum bend if welded construction. Testing is in accordance with Practice A 262 or Practice A 763.
- S1 **Ultrasonic Test.** Each fitting OR the raw material from which each fitting is made will be ultrasonically tested.
- S1 **Photomicrographs.** A photomicrograph at 100 diameters shall be made, for information only, of the base metal structure from one fitting per lot.
- The lot is to be defined by the purchaser.
- S1 **Surface Finish.** Machined surfaces shall have a maximum roughness of 250 RMS (root mean square) or 6.3  $\mu\text{in}$  AA (arithmetical average). All other surfaces shall be suitable for ultrasonic tests.
- S1 **Liquid Penetrant Test.** All surfaces shall be liquid penetrant tested in accordance with Practice E 165, by suitably qualified personnel.
- S1 **Special Fittings.** Fittings whose size and shape do not completely conform to the dimensions specified in the ANSI or MSS specification will meet all the other requirements of these specification and be marked S8.

## Wrought Ferritic, Duplex & Martensitic Fittings A 815

### Tensile and Hardness Requirements

Grade	UNS	Tensile Strength min		Yield Strength min		Elongation in 2 in (50 mm) or 4D, min	Brinell Hardness max
		ksi	MPa	ksi	MPa	%	B scale
<b>Ferritic Stainless Steels:</b>							
WP27		65-90	450-620	40	275	20.0	190
WP33		68-93	470-640	45	310	20.0	241
WP429		60-85	415-585	35	240	20.0	190
WP430		65-90	450-620	35	240	20.0	190
WP430Ti		60-85	415-585	35	240	20.0	190
WP446		70-95	485-655	40	275	18.0	207
<b>Duplex Stainless Steels:</b>							
	S31803	90	620	65	450	20.0	290
	S32750	116-140	800-965	80	550	15.0	310
	S32760	109-130	750-895	80	550	25.0	270
	S32950	100	690	70	485	15.0	290
	S39274	116	800	80	550	15.0	310
	S32550	110	760	80	550	15.0	302
<b>Martensitic Stainless Steels:</b>							
WP410		70-95	485-655	30	205	20.0	207
	S41500	110-135	760-930	90	620	15.0	295

### Heat Treatment

Grade	UNS	Temperature °F	Temperature °C	Treatment
<b>Ferritic Stainless Steels:</b>				
All	All	1200	650	Minimum heat treatment temperature. Cooled at a rate appropriate to the grade.
<b>Duplex Stainless Steels:</b>				
	S31803	1870-2010	1020-1100	Heat treatment temperature range. Quench in water or rapidly cooled by other means.
	S32750	1920-2060	1025-1125	Heat treatment temperature range. Quench in water or rapidly cooled by other means.
	S32760	2010-2085	1100-1140	Heat treatment temperature range, held for an appropriate period. Quench in water or rapidly cooled by other means.
	S32950	-	-	Not specified in A 815.
	S39274	1920-2060	1025-1125	Heat treatment temperature range. Quench in water or rapidly cooled by other means.
	S32550	1950-1975	1065-1080	Heat treatment temperature range. Quench in water.
<b>Martensitic Stainless Steels:</b>				
WP410		1200	650	Minimum heat treatment temperature. Cooled at a rate appropriate to the grade.
	S41500	1050-1150	565-620	Heat to 1750 °F[955 °C], air cool to 200 °F[95 °C] or lower prior to any intermediate temper. Then a final temper at the temperatures given and quench.

**Note**

- All = All ferritic grades listed in the chemical composition table.

## A 815 Wrought Ferritic, Duplex & Martensitic Fittings

### Chemical Composition

Grade	UNS	Composition Percentage, max or range								
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Note
<b>Ferritic Stainless Steels:</b>										
WP27		0.010	0.75	0.020	0.020	0.40	0.50	25.0-27.5	0.75-1.50	1
WP33		0.06	0.75	0.040	0.020	0.75	0.50	25.0-27.0	0.75-1.50	2
WP429		0.12	1.0	0.040	0.030	0.75	0.50	14.0-16.0	-	
WP430		0.12	1.00	0.040	0.030	1.00	0.50	16.0-18.0	-	
WP430Ti		0.10	1.00	0.040	0.030	1.00	0.75	16.0-19.5	-	3
WP446		0.20	1.50	0.040	0.030	0.75	0.50	23.0-30.0	-	4
<b>Duplex Stainless Steels:</b>										
	S31803	0.030	2.0	0.030	0.020	1.0	4.5-6.5	21.0-23.0	2.5-3.5	5
	S32750	0.030	1.2	0.035	0.020	0.8	6.0-8.0	24.0-26.0	3.0-5.0	6
	S32760	0.030	1.00	0.030	0.010	1.00	6.00-8.00	24.0-26.0	3.00-4.00	7,8
	S32950	0.03	2.00	0.035	0.010	0.60	3.5-5.2	26.0-29.0	1.00-2.50	9
	S39274	0.030	1.0	0.030	0.020	0.80	6.0-8.0	24.0-26.0	2.50-3.50	8,10
	S32550	0.04	1.5	0.040	0.030	1.00	4.5-6.5	24.0-27.0	2.9-3.9	11
<b>Martensitic Stainless Steels:</b>										
WP410		0.15	1.00	0.040	0.030	1.00	0.50	11.5-13.5	-	
	S41500	0.05	0.5-1.0	0.030	0.030	0.60	3.5-5.5	11.5-14.0	0.5-1.0	12
Product Analysis Tolerances <sup>A</sup> (% over max or under min)		0.005 if ≤0.030, 0.01 if >0.030	0.03 if ≤1.00, 0.04 if >1.00	0.005	0.005	0.05	0.03 if ≤1.00, 0.07 if ≤5.00, 0.10 if ≤10.00	0.10 if ≤10.00, 0.15 if ≤15.00, 0.20 if ≤20, 0.25 if ≤27.50	0.03 if ≤0.60, 0.05 if ≤2.00, 0.10 if ≤7.00	13

Note

A The product analysis tolerances are not applicable to heat analysis.

### Composition Notes

- 1 Copper 0.20% max, Nitrogen 0.015% max, Niobium 0.05-0.20%
- 2 Copper 0.20% max, Nitrogen 0.040% max, Titanium 0.20-1.00% and 7 x (Carbon+Nitrogen) min
- 3 Titanium 0.75% max and 5 x Carbon min
- 4 Nitrogen 0.10-0.25%
- 5 Nitrogen 0.08-0.20%
- 6 Copper 0.5% max, Nitrogen 0.24-0.32%
- 7 Copper 0.50-1.00%, Nitrogen 0.20-0.30%.
- 8 % Chromium + 3.3 x % Molybdenum + 16 x % Nitrogen = 40 min
- 9 Nitrogen 0.15-0.35%
- 10 Tungsten 1.50-2.50%, Copper 0.20-0.80%, Nitrogen 0.24-0.32%
- 11 Copper 1.5-2.5%, Nitrogen 0.10-0.25%
- 12 Tungsten 0.50-1.00%
- 13 Tolerances (% over max or under min) for other elements are as follows:
  - 0.05 for Titanium
  - 0.03 for Copper if ≤0.50%
  - 0.01 for Nitrogen if ≤0.19%
  - 0.02 for Nitrogen if ≤0.25%
  - 0.03 for Nitrogen if ≤0.35%
  - 0.04 for Nitrogen if ≤0.45%
  - 0.01 for Niobium if in range 0.05-0.20%
  - 0.04 for Tungsten if ≤1.00%

Note

- Niobium is sometimes referred to as Columbium