

Introduction

Tube

Seamless to ASTM A269, imperial sizes from 1/8" O/D x 24swg to 4" O/D x 1/4" wall in grade 316L

Seamless to ASTM A269, grades 304L & 316L, in metric sizes 6mm O/D x 0.5mm wall to 38mm O/D x 4mm wall

Decorative – Round, Square, Rectangular

Structural – Square and Rectangular up to 250mm Hygienic (see below)

Welded Metric Nominal Internal Diameter (see below)

Pipe

Seamless and Welded to ASTM A312 from 1/8" to 24" in grades 304L & 316L

Flanges

ASTM A182 / ANSI B16.5

BS 10 Table E, Grade 316L

BS 4504 / EN 1092 Raised Face, 16 Bar

Backing Flanges in Aluminium and Coated Mild Steel

Fittings

Butt Weld Fittings, Seamless and Welded, to ASTM A403 in grades 304L & 316L including elbows, tees & reducers

BSP Screwed Fittings, grade 316 from 1/8" to 3"

Hygienic fittings (see below)

Welded Metric Nominal Internal Diameter (see below)

Hygienic Tube and Fittings

Grades 304L & 316L 3/4" O/D to 4" O/D:

Tube – As Welded & Descaled, Annealed & Polished or Bright Annealed

Bends, Fitted Bends, Tees, Reducers, Clamps & Tube Hangers

Unions – RJT, IDF & DIN

Metric – Welded Nominal Internal Diameter (ND) From 18mm O/D x 1.5mm wall to 910mm O/D x 5mm wall

Grades 1.4432 (316L High Molybdenum) & 1.4307 (304L)

Tube, Elbows, Tees, Reducers, Collars, End Caps, Tube Clamps & Clips

Backing Flanges in Aluminium & Coated Mild Steel

ASTM Pipe Introduction

The term pipe covers a specific range of sizes laid down by ANSI specifications. Any sizes not covered by these specifications are tube. Stainless Steel Pipe dimensions determined by ASME B36.19 covering the outside diameter and the Schedule wall thickness. Note that stainless wall thicknesses to ANSI B36.19 all have an 'S' suffix. Sizes without an 'S' suffix are to ANSI B36.10 which is intended for carbon steel pipes.

Seamless and Welded

ASTM A312: Seamless and straight-seam welded austenitic pipe intended for high temperature and general corrosive service. Filler metal not permitted during welding.

ASTM A358: Electric fusion welded austenitic pipe for corrosive and/or high temperature service. Typically only pipe up to 8 inch is produced to this specification. Addition of filler metal is permitted during welding.

ASTM A790: Seamless and straight-seam welded ferritic/austenitic (duplex) pipe intended for general corrosive service, with a particular emphasis on resistance to stress corrosion cracking.

ASTM A409: Straight-seam or spiral-seam electric fusion welded large diameter austenitic light-wall pipe in sizes 14" to 30" with walls Sch 5S and Sch 10S for corrosive and/or high temperature service.

ASTM A376: Seamless austenitic pipe for high temperature applications.

ASTM A813: Single-seam, single- or double- welded austenitic pipe for high temperature and general corrosive applications.

ASTM A814: Cold-worked welded austenitic pipe for high temperature and general corrosive service.

Note: Welded pipes manufactured to ASTM A312, A790 and A813 must be produced by an automatic process with NO addition of filler metal during the welding operation.

Welded pipe specifications

Usually it will be to ASTM A312. If it is to ASTM A358 then there are various Classes available as shown below. The Class Number dictates how the pipe is welded and what non-destructive tests:

Class 1: Pipe shall be double welded by processes employing filler metal in all passes and shall be completely radiographed.

Class 2: Pipe shall be double welded by processes employing filler metal in all passes. No-radiography is required.

Class 3: Pipe shall be welded in one pass by processes employing filler metal and shall be completely radiographed.

Class 4: Same as Class 3 except that the welding process exposed to the inside pipe surface may be made without the addition of filler metal.

Class 5: Pipe shall be double welded by processes employing filler metal in all passes and shall be spot radiographed.

Markings on pipe

The full identification of the pipe should be continuously marked down its whole length, including:

Nominal Pipe Size (Nominal Bore)

Schedule (Wall Thickness)

Specification

Grade

Method of Manufacture (Seamless or Welded) Heat Number

Manufacturer's Name or Symbol

ASTM PIPE Pipe Sizes - ANSI/ASME B36.19M

Dimensions and Weights per metre - Stainless Steel Pipe

Nominal Pipe Size	OD		Schedule 5S ¹			Schedule 10S ¹			Schedule 40S			Schedule 80S		
	in	mm	in	mm	kg/m	in	mm	kg/m	in	mm	kg/m	in	mm	kg/m
1/8	0.405	10.3	-	-	-	0.049	1.24	0.28	0.068	1.73	0.37	0.095	2.41	0.47
1/4	0.540	13.7	-	-	-	0.065	1.65	0.49	0.088	2.24	0.63	0.119	3.02	0.80
3/8	0.675	17.1	-	-	-	0.065	1.65	0.63	0.091	2.31	0.84	0.126	3.20	1.10
1/2	0.840	21.3	0.065	1.65	0.80	0.083	2.11	1.00	0.109	2.77	1.27	0.147	3.73	1.62
3/4	1.050	26.7	0.065	1.65	1.03	0.083	2.11	1.28	0.113	2.87	1.69	0.154	3.91	2.20
1	1.315	33.4	0.065	1.65	1.30	0.109	2.77	2.09	0.133	3.38	2.50	0.179	4.55	3.24
1 1/4	1.660	42.2	0.065	1.65	1.65	0.109	2.77	2.70	0.140	3.56	3.39	0.191	4.85	4.47
1 1/2	1.900	48.3	0.065	1.65	1.91	0.109	2.77	3.11	0.145	3.68	4.05	0.200	5.08	5.41
2	2.375	60.3	0.065	1.65	2.40	0.109	2.77	3.93	0.154	3.91	5.44	0.218	5.54	7.48
2 1/2	2.875	73.0	0.083	2.11	3.69	0.120	3.05	5.26	0.203	5.16	8.63	0.276	7.01	11.41
3	3.500	88.9	0.083	2.11	4.51	0.120	3.05	6.45	0.216	5.49	11.29	0.300	7.62	15.27
3 1/2	4.000	101.6	0.083	2.11	5.18	0.120	3.05	7.40	0.226	5.74	13.57	0.318	8.08	18.63
4	4.500	114.3	0.083	2.11	5.84	0.120	3.05	8.36	0.237	6.02	16.07	0.337	8.56	22.32
5	5.563	141.3	0.109	2.77	9.47	0.134	3.40	11.57	0.258	6.55	21.77	0.375	9.53	30.97
6	6.625	168.3	0.109	2.77	11.32	0.134	3.40	13.84	0.280	7.11	28.26	0.432	10.97	42.56
8	8.625	219.1	0.109	2.77	14.79	0.148	3.76	19.96	0.322	8.18	42.55	0.500	12.70	64.64
10	10.750	273.1	0.134	3.40	22.63	0.165	4.19	27.78	0.365	9.27	60.31	0.500 ²	12.70 ²	96.01 ²
12	12.750	323.9	0.156	3.96	31.25	0.180	4.57	36.00	0.375 ²	9.53 ²	73.88 ²	0.500 ²	12.70 ²	132.08 ²
14	14.000	355.6	0.156	3.96	34.36	0.188 ²	4.78 ²	41.30 ²	-	-	-	-	-	-
16	16.000	406.4	0.165	4.19	41.56	0.188 ²	4.78 ²	47.29 ²	-	-	-	-	-	-
18	18.000	457	0.165	4.19	46.81	0.188 ²	4.78 ²	53.26 ²	-	-	-	-	-	-
20	20.000	508	0.188	4.78	59.25	0.218 ²	5.54 ²	68.61 ²	-	-	-	-	-	-
22	22.000	559	0.188	4.78	65.24	0.218 ²	5.54 ²	75.53 ²	-	-	-	-	-	-
24	24.000	610	0.218	5.54	82.47	0.250	6.35	94.45	-	-	-	-	-	-
30	30.000	762	0.250	6.35	118.31	0.312	7.92	147.36	-	-	-	-	-	-

Notes

1 Schedules 5S and 10S wall thicknesses do not permit threading in accordance with ANSI/ASME B1.20.1. 2 These dimensions and weights do not conform to ANSI/ASME B36.10M.

- The suffix 'S' after the schedule number indicates that the pipe dimensions and weight are in compliance with this stainless steel pipe specification, ANSI/ASME B36.19M-1985, and not the more general ANSI/ASME B36.10M-1995 specification.
- Although this specification is applicable to stainless steel, quoted weights are for carbon steel pipe and should be multiplied by 1.014 for austenitic and duplex steels, or by 0.985 for ferritic and martensitic steels.

ASTM Pipe (ASTM A530/A530M)

Standard cross-section and weight tolerances

NPS	Outside Diameter (OD) ¹				Wall Thickness (t) ²		Weight ³	
	Under		Over		Under	Over	Under	Over
	in	mm	in	mm	%	%	%	%
>1½ to 4	0.031	0.8	0.015	0.4	12.5	20	3.5	10
>4 to 8	0.031	0.8	0.031	0.8	12.5	20	3.5	10
>8 to 12	0.031	0.8	0.062	1.6	12.5	22.5	3.5	10
⅛ to 1½	0.031	0.8	0.093	2.4	12.5	22.5	3.5	10
>12 to 18	0.031	0.8	0.093	2.4	12.5	22.5	5	10
>18 to 26	0.031	0.8	0.125	3.2	12.5	22.5	5	10
>26 to 34	0.031	0.8	0.156	4.0	12.5	22.5	5	10
>34 to 48	0.031	0.8	0.187	4.8	12.5	22.5	5	10

Notes

1 Includes ovality tolerance except for thin wall pipe (i.e. $t > 3\%$ OD).

2 Min wall thickness = Nominal wall thickness (t) x 0.875. Not applicable if filler metal added.

3 Refer to pages 1-2 to 1-5 for standard pipe weights. For non standard pipes $W(\text{lb/ft}) = 10.68(\text{OD}-t)t$, or $W(\text{kg/m}) = 0.02466(\text{OD}-t)t$

Standard Cut Lengths. Pipe ordering alternatives are:

- **Random.** Standard lengths are in the range 15 to 24 feet. Shorter lengths as agreed with the purchaser.
- **Specified Lengths.** Cut lengths as specified, with end finish also specified.

Length tolerances. No pipe shall be shorter than specified. No pipe shall be more than ¼ in (6mm) longer than specified. Tighter tolerances may be specified, e.g. for bevelled pipe.

Straightness. All finished pipe shall be reasonably straight. For metal-arc welded pipe maximum deviation from straight = ⅛ in (3.2mm) in 10 ft (3 m).

ASTM Pipe Specifications - ASTM A312/A312M

Seamless and welded austenitic stainless steel pipes

This specification covers austenitic steel pipe intended for high temperature and general corrosive service. H grades in the chemical composition table are specifically for high temperature service.

Manufacture

Manufacture. In order to comply with this specification welded pipe must be manufactured by an automatic welding process using no filler metal, or it must be a seamless pipe. If a welded pipe has a nominal pipe size greater than 14 then it may be constructed from two longitudinal sections, and hence have two longitudinal welds. The pipe may be either hot finished or cold finished.

Finish and repair

Finish. The surface of the pipe must be clean and free of scale and contaminating iron particles. It can be bright annealed but may be pickled, blasted or can be passivated.

Repair by welding. Permitted on $\leq 20\%$ of the weld seam length of welded pipe if \geq NPS 6 and having a wall thickness ≥ 0.200 in (mm). Tungsten-arc welding process is used for repairs, with filler metal to a grade as specified in A 312 (not repeated here). Weld repairs must be identified on the pipe and in test certificate.

Tensile requirements

Grade	UNS	Tensile Strength min		Yield Strength min		Elongation in 2 in (50mm) or 4D min	
		ksi	MPa	ksi	MPa	Longit %	Trans %
All	All	75	515	30	205	35	25
All = All grades listed in the chemical composition table except those listed below							
TP304L	S30403	70	485	25	170	35	25
TP304N	S30451	80	550	35	240	35	25
	S31272	65	450	29	200	35	25
TP316L	S31603	70	485	25	170	35	25
TP316N	S31651	80	550	35	240	35	25
TP321	S32100	75(70 ¹)	515(485 ¹)	30(25 ¹)	205(170 ¹)	35	25
TP321H	S32109	75(70 ¹)	515(485 ¹)	30(25 ¹)	205(170 ¹)	35	25

Notes

1 Values for wall thickness $> \frac{3}{8}$ in (9.5mm)

ASTM Tube Introduction

Tube specifications

ASTM Standards covered in this section	
ASTM Tube – General Requirements	
A450/A450M	General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes
A370	Mechanical Testing of Steel Products
A213/A213M	Seamless Ferritic and Austenitic Alloy- Steel Boiler, Superheater and Heat Exchanger and Condenser Tubes
A249/A249M	Welded Austenitic Steel Boiler, Superheater, Heat Exchanger and Condenser Tubes
A268/A268M	Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
A270	Seamless and Welded Austenitic Stainless Steel Sanitary Tubing
A511	Seamless Stainless Steel Mechanical Tubing
A554	Welded Stainless Steel Mechanical Tubing
A632	Seamless and Welded Austenitic Stainless Steel Tubing (small diameter) for General Service
A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products
A789/A789M	Seamless and Welded Ferritic/ Austenitic (Duplex) Stainless Steel Tubing for General Service
A791/A791M	Welded, Unannealed Ferritic Stainless Steel Tubing
A803/A803M	Welded Ferritic Stainless Steel Feedwater Heater Tubes

Markings on the tube

The full identification should be continuously marked down the whole length, including:

Size – Outside Diameter (O/D) and Wall Thickness Specification

Grade

Method of Manufacture (Seamless or Welded) Heat Number

Manufacturer's Name or Symbol

Hygienic Tubing

Please see separate section on page 6-1.

Metric ND Tubing

Please see separate section on page 7-1.

Tube size ranges

An extensive size range is available. Non-standard tube sizes may be subject to mill quantity restrictions and extended delivery times.

Below is a guide to the sizes readily available on an ex-stock basis:

Hypodermic tube from 0.4mm to 5mm O/D with wall thickness 0.05mm to 0.4mm

Instrumentation tube in straight lengths or continuous coils of up to 1,000 metres long: O/Ds 6mm, 8 mm, 10 mm and 12mm with heavy wall thicknesses, typically 0.5mm, 1mm, 1.5mm or 2mm

Metric sizes from 6mm O/D to 610mm O/D with wall thickness 1mm to 6mm

Imperial sizes from 1/8" O/D to 6" O/D with wall thickness from 24swg to 10swg

Hygienic/Sanitary Tube

Imperial sizes to ASTM A270: 1/2", 1", 1 1/2", 2", 2 1/2", 3" & 4" O/D with 16swg wall and 4" O/D with 14swg wall

- Metric sizes to DIN 11850: 1", 1 1/2", 2", 2 1/2" & 3" O/D with 1.5mm wall and 4" O/D with 2mm wall

Welded Tubes for the water industry from 18mm O/D x 1.5mm wall to 910mm O/D x 5mm wall

Welded Tube for automotive exhaust systems, mostly in grade 409 – A limited size range from 35mm to 63 mm O/D with wall thickness 1.2mm to 2mm

Decorative and structural tubes (welded)

- Round in metric and imperial O/D sizes from 6mm O/D x 1.0mm wall to 100mm O/D x 3mm wall and 1/8" O/D x 24swg to 4" O/D x 1/4" wall
- Square in metric and imperial O/D sizes from 12.7 mm O/D x 1.5mm wall to 250mm x 250 x 10mm wall
- Rectangular in metric sizes from 20mm x 10mm x 1.2mm wall to 300mm x 200mm x 10mm wall
- Other items include Oval, Handrail and Textured Finish – Most common oval size is 60mm x 33mm x 2.0mm wall
- Note that most decorative tubes are supplied with a polished finish

ASTM Tube

Tube Sizes: Instrumentation and Hydraulic Control

OD mm	Wall thickness, mm			
	0.5	1.0	1.5	2.0
	Weight, kg/m (conventional weights)			
6	0.069	0.126	0.170	
8		0.176	0.245	
10		0.226	0.321	0.403
12		0.277	0.369	0.503
14			0.462	0.604
15		0.352	0.510	0.654

Notes

-Conventional weights are quoted in the table above.

For austenitic stainless steels multiply the quoted weight by 1.014. For ferritic and martensitic steels multiply the quoted weight by 0.985.

Capillary or hypodermic tubing - typical sizes

Outside Diameter		Wall thickness
in	mm	mm
1/32	0.79	0.20
0.040	1.02	0.20
0.049	1.25	0.20
0.050	1.27	0.20
1/16	1.63	0.15 / 0.20 / 0.25 / 0.30 / 0.40 / 0.51 / 0.56
0.072	1.83	0.23
0.083	2.11	0.25
3/32	2.38	0.15 / 0.20 / 0.30 / 0.40 / 0.51 / 0.91
0.118	3.00	0.30 / 0.50 / 0.70 / 0.90
1/8	3.18	0.20 / 0.25 / 0.51 / 0.81 / 0.91 / 1.22
0.138	3.51	0.40
5/32	3.97	0.25 / 0.40 / 0.56 / 0.71 / 0.91
0.157	4.00	0.70 / 0.90 / 1.00
0.177	4.50	0.50
3/16	4.76	0.13 / 0.20 / 0.25 / 0.40 / 0.46 / 0.51 / 0.56 / 0.71 / 0.81 / 0.91 / 1.22 / 1.63
0.197	5.00	0.50 / 0.75 / 1.00 / 1.50

Notes
- When this tubing is used with compression fittings there is a maximum hardness requirement.

Seamless ferritic and austenitic alloy-steel boiler, superheater and heat exchanger tubes

This specification covers minimum wall thickness seamless ferritic and austenitic steel, boiler and superheater tubes and austenitic steel heat exchanger tubes.

Finish. Austenitic grades are pickled free of scale. Bright annealed tube need not be pickled. Ferritic cold drawn tubes shall be free of scale, but slight oxidation is allowed. Ferritic hot formed tubes shall be free of loose scale.

Tensile and hardness requirements

Grade	UNS	Tensile Strength min		Yield Strength min		¹ Elongation in 2 in (50 mm) or 4D, min	Brinell Hardness HB	Vickers Hardness HV	Rockwell Hardness HRB or C
		ksi	MPa	ksi	MPa				
18Cr-2Mo		60	415	40	275	201	217	230	B96
TP201	S20100	95	655	38	260	35	219	230	B95
TP202	S20200	90	620	45	310	35	219	230	B95
TP304	S30400	75	515	30	205	35	192	200	B90
TP304H	S30409	75	515	30	205	35	192	200	B90
TP304N	S30451	80	550	35	240	35	192	200	B90
TP304L	S30403	70	485	25	170	35	192	200	B90
TP304LN	S30453	75	515	30	205	35	192	200	B90
TP309Cb	S30940	75	515	30	205	35	192	200	B90
TP309H	S30909	75	515	30	205	35	192	200	B90
TP309HCb	S30941	75	515	30	205	35	192	200	B90
TP309S	S30908	75	515	30	205	35	192	200	B90
TP310Cb	S31040	75	515	30	205	35	192	200	B90
TP310H	S31009	75	515	30	205	35	192	200	B90
TP310HCb	S31041	75	515	30	205	35	192	200	B90
TP310HCbN	S31042	95	655	43	295	30	256	-. ³	B100
TP310S	S31008	75	515	30	205	35	192	200	B90
	S31272	65	450	29	200	35	217	-. ³	B95
TP316	S31600	75	515	30	205	35	192	200	B90
TP316H	S31609	75	515	30	205	35	192	200	B90
TP316L	S31603	70	485	25	170	35	192	200	B90
TP316N	S31651	80	550	35	240	35	192	200	B90
TP316LN	S31653	75	515	30	205	35	192	200	B90
TP317	S31700	75	515	30	205	35	192	200	B90
TP317L	S31703	75	515	30	205	35	192	200	B90
TP321	S32100	75	515	30	205	35	192	200	B90
TP321H	S32109	75	515	30	205	35	192	200	B90
TP347	S34700	75	515	30	205	35	192	200	B90
TP347H	S34709	75	515	30	205	35	192	200	B90
TP347LN	S34751	75	515	30	205	35	192	200	B90
TP347HFG		80	550	30	205	35	192	200	B90
TP348	S34800	75	515	30	205	35	192	200	B90
TP348H	S34809	75	515	30	205	35	192	200	B90
XM-15	S38100	75	515	30	205	35	192	200	B90
XM-19	S20910	100	690	55	380	35	250	265	C25
	S30615	90	620	40	275	35	192	200	B90
	S30815	87	600	45	310	40	217	-. ³	B95
	S31050	84 (78 ²)	580 (540 ²)	39 (37 ²)	270 (255 ²)	25	217	-. ³	B95
	S33228	73	500	27	185	30	192	200	B90
	S21500	78	540	33	230	35	192	200	B90
	S31725	75	515	30	205	35	192	200	B90
	S31726	80	550	35	240	35	192	200	B90
	S32615	80	550	32	220	25	192	200	B90
	S25700	78	540	35	240	50	192	200	B90

Tube Specifications - ASTM A269

Seamless and welded austenitic stainless steel tubing for general service

This specification covers nominal wall thickness austenitic stainless steel tubing for general corrosion resisting and low or high temperature service.

Tolerances

Cut Length. No tube may be shorter than specified. For tube $<1\frac{1}{2}$ in (38.1mm) cut length may be up to $\frac{1}{8}$ in (3 mm) longer than specified. For tube $\geq 1\frac{1}{2}$ in (38.1mm) cut length may be up to $\frac{3}{16}$ in (4.8mm) longer than specified. These tolerances are increased by $\frac{1}{8}$ in (3mm) for every 10 ft (3 m) over 24 ft (7.3 m), up to a maximum tolerance of $\frac{1}{2}$ in (13mm).

Cross-sectional tolerances

Outside Diameter (OD)		Wall Thickness (t)		Variations in OD				Variation in t	
in	mm	in	mm	Under		Over		Under	Over
in	mm	in	mm	in	mm	in	mm	%	%
$<1\frac{1}{2}$	<12.7	All	All	0.005	0.13	0.005	0.13	15	15
$1\frac{1}{2}$ to $<1\frac{1}{2}$	12.7 to <38.1	≥ 0.065	≥ 1.6	0.005	0.13	0.005	0.13	10	10
$1\frac{1}{2}$ to $<1\frac{1}{2}$	12.7 to <38.1	$<0.065^1$	$<1.6^1$	0.005	0.13	0.005	0.13	10	10
$1\frac{1}{2}$ to $<3\frac{1}{2}$	38.1 to <88.9	≥ 0.095	≥ 2.4	0.010	0.25	0.010	0.25	10	10
$1\frac{1}{2}$ to $<3\frac{1}{2}$	38.1 to <88.9	$<0.095^1$	$<2.4^1$	0.010	0.25	0.010	0.25	10	10
$3\frac{1}{2}$ to $<5\frac{1}{2}$	88.9 to <139.7	≥ 0.150	≥ 3.8	0.015	0.38	0.015	0.38	10	10
$3\frac{1}{2}$ to $<5\frac{1}{2}$	88.9 to <139.7	$<0.150^1$	$<3.8^1$	0.015	0.38	0.015	0.38	10	10
$5\frac{1}{2}$ to ≤ 8	139.1 to ≤ 203.2	≥ 0.150	≥ 3.8	0.030	0.76	0.030	0.76	10	10
$5\frac{1}{2}$ to ≤ 8	139.1 to ≤ 203.2	$<0.150^1$	$<3.8^1$	0.030	0.76	0.030	0.76	10	10

Notes
1 Thin walled tubes. Therefore ovality tolerance increases, but mean OD at a cross section must be within permissible variation.

Finish

Finish. Tubes to be pickled, free of scale. Where bright annealed, pickling is not necessary.

Butt Weld Fittings Introduction

Butt Weld Fittings are a family of fittings used for forming circumferential butt weld joints in pipework systems.

They are used only in conjunction with ANSI Pipe and are available in the same size range. They are used in areas where pipe-work is permanent and are designed to provide good flow characteristics.

Manufacture

Materials. Refer to chemical composition table ASTM A240 on page 1-6. 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.

Manufacturing standards

Wrought pipe fittings are manufactured to dimensions and tolerances in ANSI B16.9 with the exception of short radius elbows and return bends which are made to ANSI B16.28. Light-weight corrosion resistant fittings are made to MSS SP43.

Butt Weld Fittings are available to ASTM A403, ASTM A815 and MSS SP43. These standards require the fittings to be manufactured as follows:

Seamless austenitic fittings are made from seamless pipe to ASTM A312.

Welded fittings in austenitic grades are manufactured from welded pipe to ASTM A312 or plate to ASTM A240. Note that welded fittings manufactured from plate may have two-welds.

Duplex (ferritic/austenitic) grades are manufactured from pipe to ASTM A790 or plate to ASTM A240.

ASTM A403/A815 Butt Weld Fittings are sub-divided into four classes:

WP-S: Made from seamless pipe to ASTM A312 (Austenitic) or ASTM A790 (Duplex).

WP-W: Manufactured from welded pipe to ASTM A312 (Austenitic) or ASTM A790 (Duplex). There is no requirement for radiography unless a manufacturer's weld has been introduced or there are welds made with the addition of filler metal.

WP-WX: Of welded construction. All welds must be 100% radiographed in accordance with Paragraph UW-51 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

WP-WU: Of welded construction. All welds must be 100% examined ultrasonically in accordance with Paragraph UW-51 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code. Note that this Class only applies to austenitic fittings made to ASTM A403.

CR Fittings are manufactured to the requirements of MSS SP43. These are light-weight fittings and do not require radiography.

Notes:
WP: Means Wrought Pipe
CR: Means Corrosion Resistant

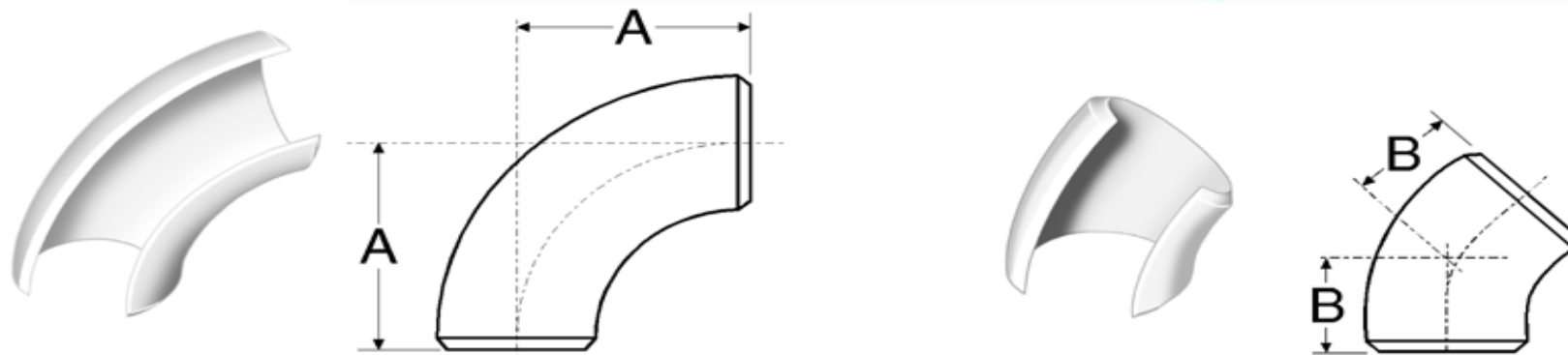
Markings on tube and fittings

The full identification of the fitting should be marked on it including:

- Nominal Pipe Size (Nominal Bore)
- Schedule (Wall Thickness)
- Specification
- Grade
- Method of Manufacture (Seamless or Welded) Heat Number
- Manufacturer's Name or Symbol

Butt Weld Fittings

Range/Sizes - 90° and 45° Long Radius Elbows - ANSI B16.9



Dimensions (based on ASME/ANSI B16.9) and example weights for long radius elbows

Nominal Pipe Size	Common		90° Elbow			45° Elbow		
	OD at Bevel		A		40S/STD ¹	B		40S/STD ¹
	in	mm	in	mm	kg/piece	in	mm	kg/piece
1/2	0.84	21	1.50	38	0.08	0.62	16	0.04
3/4	1.05	27	1.50	38	0.10	0.75	19	0.05
1	1.32	33	1.50	38	0.15	0.88	22	0.07
1 1/4	1.66	42	1.88	48	0.25	1.00	25	0.12
1 1/2	1.90	48	2.25	57	0.36	1.12	29	0.18
2	2.38	60	3.00	76	0.65	1.38	35	0.32
2 1/2	2.88	73	3.75	95	1.29	1.75	44	0.64
3	3.50	89	4.50	114	2.02	2.00	51	1.01
3 1/2	4.00	102	5.25	133	2.83	2.25	57	1.41
4	4.50	114	6.00	152	3.84	2.50	64	1.92
5	5.56	141	7.50	190	6.51	3.12	79	3.25
6	6.62	168	9.00	229	10.1	3.75	95	5.05
8	8.62	219	12.00	305	20.3	5.00	127	10.15
10	10.75	273	15.00	381	36.0	6.25	159	18.0
12	12.75	324	18.00	457	53.0	7.50	190	26.5
14	14.00	356	21.00	533	68.0	8.75	222	34.0
16	16.00	406	24.00	610	89.2	10.00	254	44.6
18	18.00	457	27.00	686	113.0	11.25	286	56.5
20	20.00	508	30.00	762	140.0	12.50	318	70.0
22	22.00	559	33.00	838	170.0	13.50	343	85.0
24	24.00	610	36.00	914	202.0	15.00	381	101.0
26	26.00	660	39.00	991	241.4	16.00	406	120.5
28	28.00	711	42.00	1067	279.9	17.25	438	140.0
30	30.00	762	45.00	1143	321.3	18.50	470	160.5
32	32.00	813	48.00	1219	365.6	19.75	502	183.0
34	34.00	864	51.00	1295	-	21.00	533	-
36	36.00	914	54.00	1372	462.7	22.25	565	231.0
38	38.00	965	57.00	1448	-	23.62	600	-
40	40.00	1016	60.00	1524	571.3	24.88	632	285.5
42	42.00	1067	63.00	1600	629.8	26.00	660	315.0
44	44.00	1118	66.00	1676	-	27.38	695	-
46	46.00	1168	69.00	1753	-	28.62	727	-
48	48.00	1219	72.00	1829	-	29.88	759	-

Notes

- Dimensions quoted in mm are 'Nominal' values from B16.9 (i.e. rounded equivalents of the inch dimensions). Refer to ASME/ANSI B16.9 for additional 'Max' and 'Min' metric dimensions.
- For tolerances see page 3-14.
- 1 Weights are approximate and based on manufacturers' data (where available) for Schedule 40S/Standard fittings.

Butt Weld Fittings

Specifications - ASTM A403

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 (0.4mm).
- Mechanical marks deeper than $1/16$ in (1.6mm).
- 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 $1/2$ in (13mm) of base metal.

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
All = All grades listed in the chemical composition table except those listed below							
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
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.

Butt Weld Fittings Specifications - General

Applicable specifications

Specifications applicable to butt welding fittings are as follows:

ASME/ANSI B16.9-2007 - Factory-made wrought steel butt welding fittings.

ASME/ANSI B16.28-1997 - Wrought steel butt welding short radius elbows and returns.

MSS SP-43 1991, Reaffirmed 1996 - Wrought stainless steel butt welding fittings. This applies to 5S, 10S, and 40S wall thicknesses only.

ASME/ANSI B16.25-1997 - Butt welding ends. This defines various weld bevel designs and dimensions, beyond the scope of this manual.

Wall Thicknesses. Fittings are manufactured to match the wall thicknesses of pipe.

Weights quoted in the fitting tables are based on manufacturers' data and are approximate. Actual weights may vary from those quoted depending on the type of construction. For austenitic and duplex stainless steel, multiply the quoted weight by 1.014. For ferritic and martensitic stainless steel, multiply the quoted weight by 0.985.

Manufacture and test

Materials and Manufacture. ASME/ANSI and MSS stainless steel butt welding fittings are most commonly manufactured to ASTM A403.

Production Testing. Test requirements are defined in ASTM A430.

ASME/ANSI Test Requirements. B16.9 and B16.28 do not require production testing of fittings although they must be capable of withstanding the rated pressure:

Pressure Ratings. The rated pressure is as for straight seamless pipe of equivalent NPS, wall

thickness and material.

Proof testing to qualify the fitting design comprises a bursting strength test. The fitting is required to pressure P

°F
100 225 275 withstand, without rupture, 105% of the
255 given by: $P = (2St) / D$ 200

200 150 215
240 where

S = Actual ultimate tensile strength of a specimen from a representative fitting. t = Nominal wall thickness
D = Outside diameter

MSS SP-43 Test Requirements. SP-43 does not require hydrostatic testing of fittings although they must be capable of withstanding 1.5 times the pressure ratings at 100 °F:

Pressure Ratings. Fittings produced to MSS SP-43 have the pressure ratings shown in this table.

Temperature	Schedule 5S	Schedule 10S
100	225	275
150	215	255
200	200	240
250	190	225
300	175	210
350	165	195
400	150	180
450	Not recommended for use at these temperatures	165
500		150
600		130
700		110
750		100

BSP Fittings Sizes/Specifications

BSP fittings are a family of fittings used to connect up threaded pipe and equipment.

They are manufactured from pipe, bar, hollow bar, castings or forgings.

The pipe to be threaded must have a wall thickness of Schedule 40S minimum.

The fittings are used in non-critical, low pressure applications where welding is not possible or required. They therefore provide a relatively low cost method of connection.

BSP fittings are usually fitted with a sealant (paste or tape such as PTFE) and are considered to be permanent pipe-work.

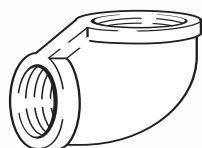
Low Pressure BSP Fittings are rated at 150lb and are made to wrought iron specification BS 1740.

BSP fittings are made only in type 316.

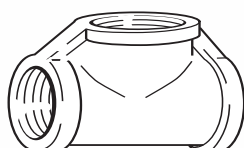
They are provided with a Certificate of Conformity only, and not a full Test Certificate.

Sizes 1/8 to 3 inch are the most commonly used and thus the most readily available.

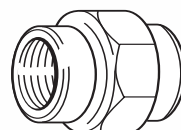
External MALE threads are tapered and Internal FEMALE threads are parallel. The threads are cut to BS21: Part 1: 1985 and are called Whitworth Threads – See below.



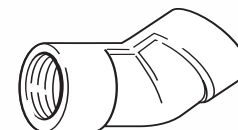
90° Elbow



Equal Tee



Union



45° Elbow



Half Socket



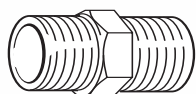
Socket



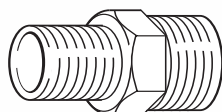
Round Nut



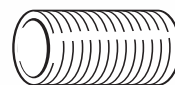
Reducing Socket



Hexagon Nipple



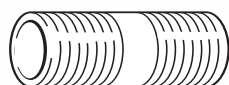
Reducing Nipple



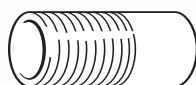
Equal Nipple



Cap



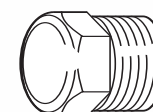
Barrel Nipple



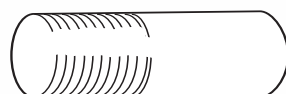
Welding Nipple



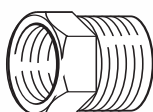
Square Head Plug



Hexagon Head Plug



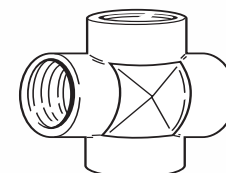
Hose Connector



Reducing Bush


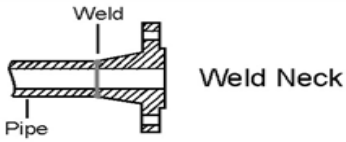

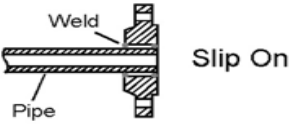

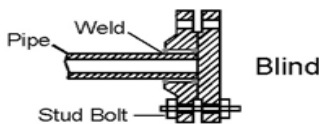



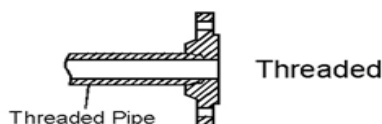

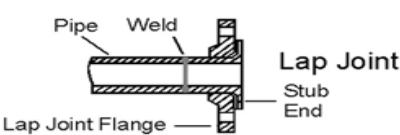
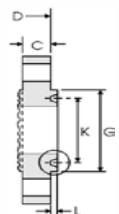



Hexagon Nut



Cross

Flanges Introduction

Type	Joining Method	General Description
<p>Weld Neck</p> 		<p>Used in critical applications. These are circumferentially welded onto the system at their necks which means that the integrity of the butt-welded area can easily be examined by X-ray radiography. The bores of both pipe and flange match thus reducing turbulence and erosion.</p>
<p>Slip On</p> 		<p>This is slipped over the pipe and then fillet welded. Easy to use in fabricated applications.</p>
<p>Blind</p> 		<p>Sometimes called a blanking flange, this is used for blanking off pipelines, valves and pumps and as an inspection cover.</p>
<p>Socket Weld</p> 		<p>This is counter-bored to accept the pipe, which is then fillet welded. The bore of both the pipe and the flange are the same to ensure good flows.</p>
<p>Screwed/Threaded</p> 		<p>This requires no welding and is used to connect other threaded components in low pressure noncritical applications.</p>
<p>Lap Joint</p> 		<p>These are always used with either a stub end or a taft which is butt-welded to the pipe with the flange loose behind it. Thus the stub end or the taft always provides the sealing face. Easily assembled and aligned, it is favoured in low pressure applications. To reduce cost these 'backing' flanges can be supplied without a hub and/or made from coated carbon steel.</p>
<p>Ring Type Joint</p> 		<p>This can be employed on Weld Neck, Slip On or Blind Flanges for leak-proof connection at high pressures. The seal is made by a metal ring being compressed into a hexagonal groove on the flange face.</p>

Flanges Specifications - ASTM A182/A182M

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** (see page 5-12).

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 A234 apply for martensitic steels, in A403 for austenitic steels and A815 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.

Marking. Each forging is marked with manufacturers name, heat number (or heat identification), designation of service rating, specification number, grade (e.g. F304) 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 $\frac{1}{16}$ in (1.6mm).

Defect repair by welding:

- Permitted unless purchaser prohibits.
- Defect removal by chipping or grinding is verified by magnetic particle inspection.
- Repair is limited to 10% of surface area and $33\frac{1}{3}\%$ of nominal wall thickness.
- Repair welding electrodes and post weld repair heat treatments are defined in A182 but are not detailed in this summary.

Flange

Flange Range/Sizes - EN 1092 / (BS4504)

BS4504 is now obsolete and has been replaced by EN 1092. However the dimensions and tolerances have not changed.

Flange types and methods of manufacture

ISO EN	BS	Type of Flange and Collar	Forged ^a	Cast	Made from flat products (plates)	Machined from rolled or forged bars and forged sectional steel	Bent and electric welded from bars, sectional steel or strip ^{b,c,d,e}
01	101	Plate flange for welding	yes	no	yes	yes	yes
05	105	Blind flange	yes	no	yes	yes	no
11	111	Weld-neck flange	yes	no	no	yes	yes, for \geq DN 700
12	112	Hubbed slip-on flange for welding	yes	no	no	yes	no

a Seamless rolled, pressed, forged.

b Only one radial weld is allowed under DN 1800.

c Welded flanges allowed only for an application up to 370°C in conformance with EN 13480-3:2002, D.4.4.

d In case flanges are made by cold forming of a base material e.g. flat product, some mechanical properties, like elongation after fracture (A) and impact

energy (KV), will be impaired due to cold forming without subsequent heat treatment.

Repairs by welding

With the exception of weld repairs carried out according to BSEN 1092-1:2007 (E) clause 5.11, repairs by welding are permitted only by written agreement of the purchaser.

Within the certificate for material or component relevant documents shall be noted, that approved welding procedure and welders qualification have been applied.

Bolting

Flanges shall be suitable for use with the number and size of bolting as specified in the Tables on pages 5-14 to 5-18. The bolting shall be chosen by the equipment manufacturer according to the pressure, temperature, flange material and gasket so that the flanged joint remains tight under the expected operating conditions. For selection of bolting, see EN 1515-1, for combination of the materials of flanges and bolting see EN 1515-2, for information.

Gaskets

The various gasket types, dimensions, design characteristics and materials used are not within the scope of this European Standard, Dimensions of gaskets are given in the series of standards EN 1514.

Hygienics RJT Unions - BS 4825 : Part 5

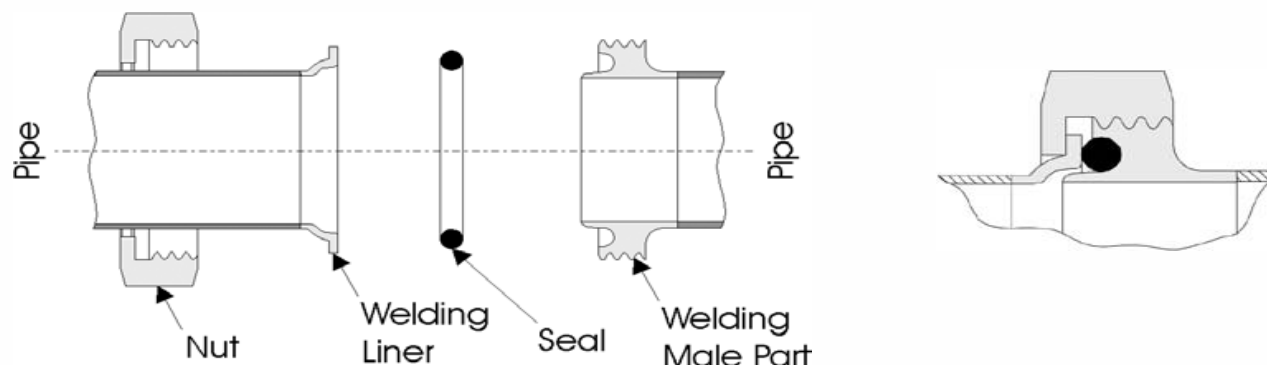


Ring Joint Type, RJT, unions are easily assembled and dismantled for cleaning purposes, this being a result of their having a Whitworth form thread. The RJT joint is not crevice free and may accumulate a deposit of the product being passed. However, present day cleaning systems are able to sanitise this area successfully without dismantling in the majority of applications. RJT unions may be operated at pressures up to 1.0 MPa.

RJT type couplings comprise four parts – a male part, a liner, an O-ring seal and a hexagonal nut. The ends of the tubes and/or fittings to be joined have a male part and liner fitted by welding (or expansion on to expanded type parts if used). The joint is made by positioning the male part and the liner together, with a seal inserted between. The nut is then slipped over the liner, screwed on to the male part and tightened against the liner to compress the seal.

BS 4825: Part 5 requirements for RJT union parts follow. Additional RJT components are also available (see page 6-11).

Assembly



The illustration above shows the assembly of an RJT union with welded parts. Options:

Expanded RJT expanded type union parts are available.

Hygienics Specifications - ASTM A270

Seamless and welded austenitic stainless steel sanitary (hygienic) tubing

This specification covers seamless and welded austenitic stainless steel hygienic tubing having special surface finishes.

Dimensions and tolerances

Dimensions. Tube sizes normally furnished to this specification are ≤ 4 in (101.6mm) OD.

Cut lengths shall be no less than specified and not more than $\frac{1}{8}$ in (3.2mm) over that specified.

Cross-sectional tolerances

Outside Diameter (OD)		Variations in OD				Variation in t	
in	mm	Under		Over		Under	Over
		in	mm	in	mm	%	%
≤ 1	≤ 25.4	0.005	0.13	0.005	0.13	12.5	12.5
>1 to 2	>25.4 to 50.8	0.008	0.20	0.008	0.20	12.5	12.5
>2 to 3	>50.8 to 76.2	0.010	0.25	0.010	0.25	12.5	12.5
>3 to 4	>76.2 to 101.6	0.015	0.38	0.015	0.38	12.5	12.5

Notes
1 For $t < 0.049$ in (1.24mm) tolerances to be agreed with purchaser. 2 There are no ovality requirements.

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	
TP304	S30400	0.08	2.00	0.045	0.030	1.00	8.00-11.00	18.00-20.00	-	
TP304L	S30403	0.035	2.00	0.045	0.030	1.00	8.00-12.00	18.00-20.00	-	1
TP316	S31600	0.08	2.00	0.045	0.030	1.00	10.00-14.00	16.00-18.00	2.00-3.00	
TP316L	S31603	0.035	2.00	0.045	0.030	1.00	10.00-14.00	16.00-18.00	2.00-3.00	1

Notes
1 Carbon 0.040% max is necessary for tubes where many drawing passes are required, as with outside diameter < 0.5 in (12.7mm) or nominal wall thickness < 0.049 in (1.2mm) (minimum wall thickness < 0.044 in (1.12mm))

BS 4825 Part 1 / EN20286 - dimensions and tolerances

O/D Tolerance. $\pm 0.5\%$ or 0.1mm whichever is the greater.

Wall Thickness Tolerance. $\pm 12.5\%$.

Surface Finish. Internal 1.0Ra Maximum / External 2.5Ra Maximum.

Length. For lengths up to and including 6 metres $+3\text{mm} -0\text{mm}$ / For lengths over 6 metres $+6\text{mm} -0\text{mm}$.

Metric Tube & Fittings

Introduction/Specifications

Stainless steel metric tubulars range

A complete range of fittings including elbows, tees, reducers, end caps, collars, backing flanges and clamps is available.

Advantages

This ID based system brings many advantages including:

- Light weight
- Systems flexibility including ease of alteration Fast welding times
- Low consumables usage
- Attractive appearance
- Clean/hygienic/high-tech image
- Low environmental impact
- Recyclability
- Simple fabrication and erection
- Good mechanical properties
- Good ductility
- Low maintenance
- Long service life
- Smooth surface with no coatings or linings

Grades

A range of grades is available from stock or on fast-track production:

- BSEN 1.4307 (304L)
- BSEN 1.4404 (316L)
- BSEN 1.4432 (316L High Molybdenum)

Sizes shown throughout are the most popular. Many more are available, please contact your local Aalco service centre for details.

Specifications

Dimensional tolerances to EN/ISO 1127

- **Outside Diameter (Class D3):** $\pm 0.75\%$ / minimum $\pm 0.3\text{mm}$
- **Outside Diameter for tubes 168.3mm O/D & above (Class D2):** $\pm 1.0\%$ / minimum $\pm 0.5\text{mm}$
- **Wall Thickness (Class T3):** $\pm 10\%$ / minimum $\pm 0.15\text{mm}$

Lengths

- 6 metre random lengths with plain ends.

Finish

- Unannealed, Pickled.

General Information/General Data

Calculation of tube weights

Form	Dimensions mm	Weight for Alloys of Density p Kg/dm ³
Pipe/Tube (Round)	Outside diameter = D Inside diameter = d Wall thickness = t	0.0031416 (D-t)tp, or 0.0031416 (d+t)tp Kg/m
Square/Rectangular Tube	Sides = a ₁ , a ₂ , Wall thickness = t	0.001 (2a ₁ + 2a ₂ -4t)tp Kg/m

Elements and symbols

Aluminium – Al	Cobalt – Co	Lithium – Li	Oxygen – O	Tin – Sn
Arsenic – As	Columbium – Cb*	Manganese – Mn	Phosphorus – P	Titanium – Ti
Boron – B	Copper – Cu	Molybdenum – Mo	Selenium – Se	Zinc – Zn Zirconium –
Cadmium – Cd	Hydrogen – H Iron –	Nickel – Ni Niobium –	Silicon – Si Sulphur	Zr
Carbon – C	Fe	Nb Nitrogen – N	– S Tellurium – Te	
Chromium – Cr	Lead – Pb			

* The American designation for Niobium

Densities

Material	Density Kg/dm ³
Aluminium	2.70
Stainless Steel	
– Ferritic/Martensitic	7.75
– Austenitic	7.75
Copper	8.90
Brass	8.47
Bronze	8.89
INCOLOY Alloy 800	7.95
INCOLOY Alloy 800H	7.95
INCOLOY Alloy 825	8.14
INCOLOY Alloy 903	8.14
INCOLOY Alloy DS	7.92
INCONEL Alloy 600	8.42
INCONEL Alloy 601	8.06

Densities

Material	Density Kg/dm ³
INCONEL Alloy 617	8.36
INCONEL Alloy 625	8.44
INCONEL Alloy 690	8.19
INCONEL Alloy 718	8.19
INCONEL Alloy X-750	8.25
MONEL Alloy 400	8.83
MONEL Alloy K-500	8.46
Nickel 200	8.89
Nickel 201	8.89
UNS 31803	7.80
17-4 PH	7.75

Comparitive densities

Material	Density Kg/dm ³
Stainless Steel	1.000
Stainless Steel	
– Ferritic/Martensitic	0.977
Mild and Carbon Steel	0.994
Low Alloy Steel	0.987
Aluminium	0.341
Copper	1.134
Brass	1.066
Aluminium Bronze	0.970
Titanium	0.571
Lead	1.440

Abbreviations for Standards Organisations

Abbreviations for standards organisations and documents, referred to in this manual, are expanded below:

AFNOR French Standards Association

AISI American Iron and Steel Institute
ANSI American National Standards Institute, Inc. American
API Petroleum Institute
ASME The American Society of Mechanical Engineers American
ASTM Society for Testing and Materials British Standards issued
BS by
 British Standards Institution (BSI)
DIN German Standards

EN European Norm (Standard) issued by European Committee for
 Standardisation (CEN) International Organisation for
ISO Standardisation Japanese Industrial Standards issued by
JIS Japanese Standards Authority (JSA)
MSS Manufacturers Standardisation Society of the Valve and Fittings
 Industry, Inc.
SIS Swedish Standards
SMS Swedish Mechanical Standards
UNI Italian Standards