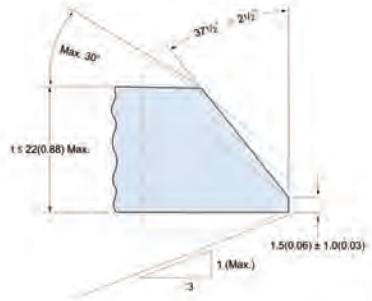
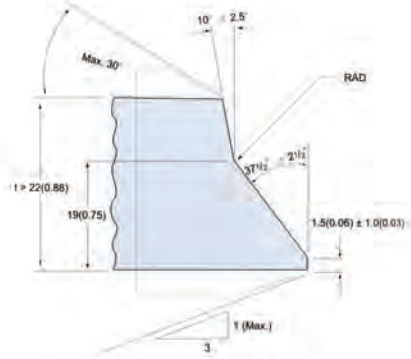
REFERENCES

ASME B16.9



(a) Plain Bevel



(b) Compound Bevel

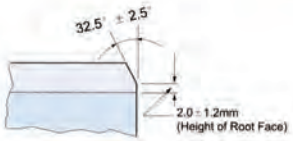
Nominal Pipe Wall Thickness(t)	End Preparation
Less than x*	Cut Square of slightly chamfer, at Mfr's option
x* to 22(0.88), inclusive	Plain bevel as in sketch "a" above
more than 22(0.88)	Compound bevel as in sketch "b" above
*x=5(0.19) for carbon steel, ferritic alloy steel or wrought iron; 3(0.12) for austenitic alloy steel	

Notes : 1. End preparations are in accordance with ASME B16.25 Paragraph 4.2
2. End preparations conforming to customer specifications will be specially manufactured upon consultation.

KS / JIS

1. Steel Butt-Welding Pipe Fittings For Ordinary Use

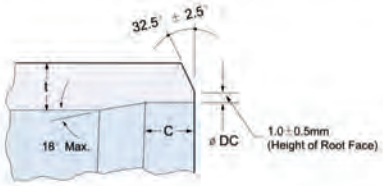
{ KS B1522 / JIS B2311 }



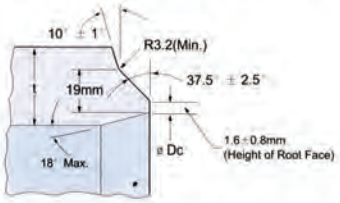
2. Steel Butt-Welding Pipe Fittings For Special Use

{ KS B1541 / JIS B2312 }

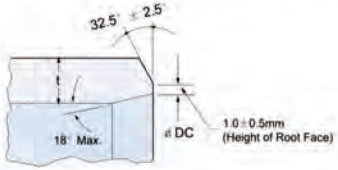
C: In the Case Where t is 22.4mm or Less



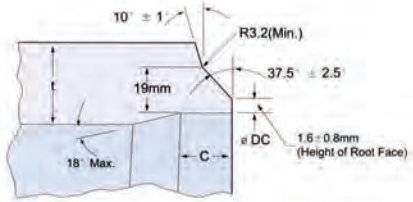
B: In the Case Where t is Over 22.4mm



A: In the Case Where t is 22.4mm or Less



D: In the Case Where t is Over 22.4mm



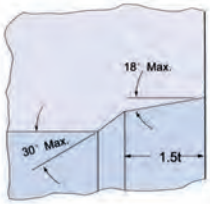
Where t : nominal wall thickness
DC : diameter of machining bore
C : length of machining bore

Remarks

1. Dimeter(Dc) and length(C) of machining bore and dimensional toleraneces shall be as agreed between parties concerned.
2. Relieving of machining bore may be performed by poviding an inclination of 18° or less from the end face to the limits of 1.5 times the wall thickness, or after cutting to the cylindrical surface to the length of machining bore, providing an inclination of 18°or less to the limits above-indicated, and beyond that portion machining with an inclination of 45° or less.

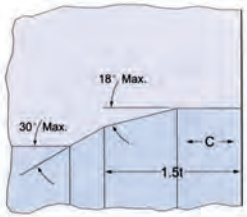
KS / JIS

For Types A and B of Bevel Shape



In the figure,
t: nominal wall thickness

For Types C and D of Bevel Shape



In the figure,
t: nominal wall thickness
c: length of maching bore

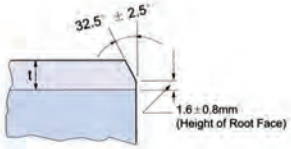
Relieving for outside diameter may be performed by providing an inclination of 30° or less from the end face to the limits of 1.5 times the wall thickness, and beyound that portion machining with an inclination 45° or less

In the figure,
t: nominal wall thickness

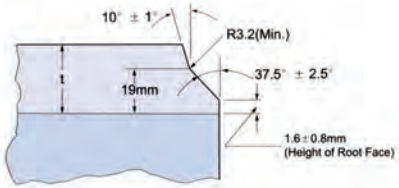
3. Steel Plate Butt-Welding Pipe Fittings

{ KS B1543
JIS B2313 }

Where, t ≤ 22.4mm



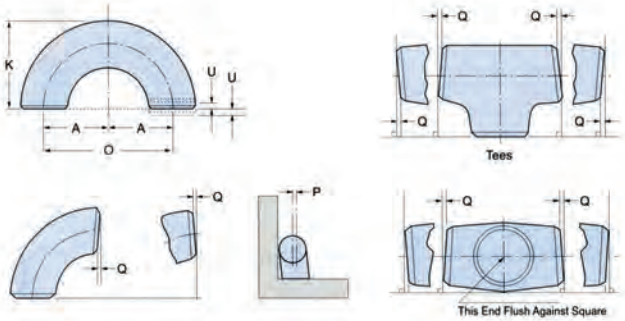
Where, t > 22.4mm



Remarks

The shape and dimensions of the special bevel ends are referred to the reference clause stated in JIB B 2312(KS B 1541)

ASME B16.9



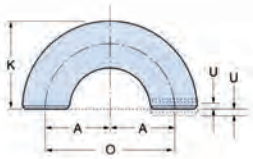
1. Wrought Steel Butt Welding Fittings

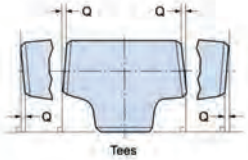
All Fittings				90° and 45° Elbows
Nominal Pipe Size	Outside Diameter at Bevel OD	Inside Diameter at End ID	Wall Thickness T	Center-to-End Dimension A, B
1/2~2 1/2	+ 0.06 − 0.03	± 0.03	Not less than 87 1/2% of nominal thickness	± 0.06
3~4	± 0.06	± 0.06		
5~8	+ 0.09 − 0.06			
10~18	+ 0.16 − 0.12	± 0.12		± 0.09
20~24	+ 0.25 − 0.19	± 0.19		
26~30				± 0.12
32~48				± 0.19

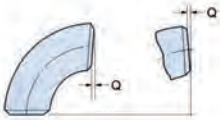
Dimensions are in inches.

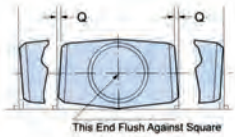
Tees	Reducers	Caps	180° Returns		
Center-to-End Dimension C, M	End to End H	Back to Face E	Center-to-Center Dimension O	Back-to-Face Dimension K	Alignment of Ends U
± 0.06	± 0.06	± 0.12	± 0.25	± 0.25	± 0.03
± 0.09	± 0.09	± 0.25	± 0.38		± 0.06
± 0.12	± 0.19	± 0.38	–	–	–
± 0.19					

ASME B16.9









Nominal Pipe Size	Angularity Tolerance	
	Off Angle Q	Off Plane P
1/2 ~ 4	0.03	0.06
5 ~ 8	0.06	0.12
10 ~ 12	0.09	0.19
14 ~ 16		0.25
18 ~ 24	0.12	0.38
26 ~ 30	0.19	
32 ~ 42		0.5
44 ~ 48		0.75

Dimensions are in inches.

2. Forged Socket Welding Fittings

Nominal Pipe Size	All Fittings			
	Socket Bore Dia	Bore Dia. of Fittings	Concentricity of Bore	Considence of Axis
1/8 ~ 1/4	+0.012 −0.000	±0.03	Socket and Fitting Bores within ±0.030	Maximum variation in alignment of socket and fitting bores for 1/8 in 12
3/8 ~ 3/4	+0.012 −0.000	±0.03		
1 ~ 2	+0.012 −0.000	⊥0.03		
2 1/2 ~ 3	+0.012 −0.000	±0.06		

Nominal Pipe Size	Elbow, Tee, Cross	Coupling	Half Coupling
	Center to Bottom of Socket	Bottom to Bottom of Socket	Bottom of Socket to Opposite Face
1/8 ~ 1/4	±0.03	±0.06	±0.03
3/8 ~ 3/4	±0.06	±0.12	±0.06
1 ~ 2	±0.08	±0.16	±0.08
2 1/2 ~ 3	±0.10	±0.20	±0.10

Dimensions are in inches.
Above table is followed accordingly to ASME B16.11

MSS SP-43

Nominal Pipe Size	All Fittings		90° Elbow 45° Elbow Tee	Reducer Lap Joint Stub Ends
	Outside(1) Diameter at Welding End	Wall Thickness	Center-to-End Dimension A,B,C,M	Overall Length F,H
1/2 ~ 1 1/2	±0.03	Not less than 87 1/2% of nominal thickness	=0.06	±0.06
2 ~ 3 1/2	±0.03		=0.06	±0.06
4	⊥0.03		_0.06	⊥0.06
5 ~ 8	±0.06 −0.03		_0.06	⊥0.06
10 ~ 18	⊥0.09 −0.03		=0.09	±0.09
20 ~ 24	+ 0.12 −0.03		=0.09	±0.09

Nominal Pipe Size	180° Returns		
	Center-to Center Dimension O	Back-to-Face Dimension K	Alignment of Ends U
1/2 ~ 1 1/2	± 0.25	= 0.25	± 0.03
2 ~ 3 1/2	± 0.25	= 0.25	± 0.03
4	⊥ 0.25	_ 0.25	⊥ 0.03
5 ~ 8	⊥ 0.25	_ 0.25	⊥ 0.03
10 ~ 18	± 0.38	= 0.25	± 0.06
20 ~ 24	± 0.38	= 0.25	± 0.06

Dimensions are in inches.

NOTES
1. Out of roundness is the vector sum of the plus and minus tolerance.
2. Fillet B radius is the maximum.

MSS SP-43

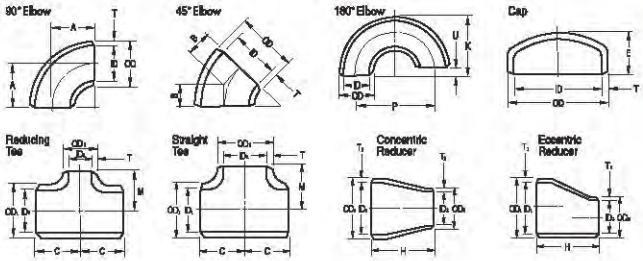
Nominal Pipe Size	All Fittings	
	Outside[1] Diameter at Welding End	Wall Thickness
1/2 ~ 1 1/2	± 0.03	Not less than 87 1/2% of nominal thickness
2 ~ 3 1/2	± 0.03	
4	± 0.03	
5 ~ 8	+ 0.06 − 0.03	
10 ~ 18	± 0.09 − 0.03	
20 ~ 24	+ 0.12 − 0.03	

Nominal Pipe Size	Cap	Lap Joint Stub Ends	
	Overall Length E	Fillet[2] Radius of Lap A	Outside Diameter of Lap G
1/2 ~ 1 1/2	±0.12	+3 −0.03	+0 −0.03
2 ~ 3 1/2	±0.12	+0 −0.03	+0 −0.03
4	±0.12	+0 −0.06	+0 −0.03
5 ~ 8	±0.25	+0 −0.06	+0 −0.03
10 ~ 18	±0.25	+0 −0.06	+0 −0.06
20 ~ 24	±0.25	+0 −0.06	+0 −0.06

Dimensions are in inches.

NOTES
1. Out of roundness is the vector sum of the plus and minus tolerance.
2. Fillet B radius is the maximum.

KS / JIS



1. Steel Butt-Welding Pipe Fittings for Ordinary Use

{ KS B1522 / JIS B2311 }

Item		Type of Pipe Fittings	Nominal Diameter				
			1/2 ~ 2 1/2	3 ~ 4	5 ~ 8	10 ~ 18	20
			Tolerance				
Outside Dia, at end face	(OD)	All pipe Fitting	± 2	± 2.5	± 3.5	± 5 − 4.5	± 6.4 − 4.8
Inside Dia, at end face	(ID)		± 2	± 2.5	± 3.5	± 4.5	± 4.8
Wall thickness	(T)		+ Not specified − 15%				
Center-to-end dimension	(A, B)	90° Elbow, 45° Elbow	± 2.0		± 3.2		± 4.8
Center-to-Center dimension	(P)	180° Elbow	± 6.4		± 9.5		–
Back-to face dimension	(K)		± 6.4				–
Alignment of ends (Max.)	(U)		1.6		3.2		–
End-to-end dimension	(H)	Reducer	± 2.0		± 3.2		
Center-to-end dimension	(C, M)	Tee	± 2.0		± 3.2		
Back-to-face dimension	(E)	Cap	± 3.2		± 6.4		

Dimensions are in millimeters.

KS / JIS

2. Steel Butt-Welding Pipe Fittings for Special Use and Steel Plate Butt-Welding Pipe Fittings

{ KS B1541, JIS B2312
KS B1543, JIS B2313 }

Item		Type of Pipe Fittings	Nominal Diameter						
			1/2 ~ 2 1/2	3 ~ 4	5 ~ 8	10 ~ 18	20 ~ 24	26 ~ 30	32 ~ 36
			Tolerance						
Outside Dia, at end face	(OD)	All pipe Fitting	= 1.6 − 0.8	± 1.6	± 2.4 − 1.6	= 4 − 3.2	± 6.4 − 4.8		
Inside Dia, at end face	(ID)		= 0.8			= 3.2	± 4.8		
Wall thickness	(T)		+ Not specified − 12.5%						
Center-to-end dimension	(A, B)	90° Elbow, 45° Elbow	± 1.6			= 2.4		± 3.2	= 4.8
Center-to-Center dimension	(P)	180° Elbow	⊥ 6.4			⊥ 9.5			
Back-to face dimension	(K)		_ 6.4						
Alignment of ends (Max.)	(U)		* ± 0.8 ** ⊥ 1.6			* = 1.6 ** _ 3.2		–	
End-to-end dimension	(H)	Reducer	⊥ 1.6			_ 2.4		⊥ 4.8	
Center-to-end dimension	(C, M)	Tee	± 1.6			= 2.4		⊥ 3.2	_ 4.8
Back-to-face dimension	(E)	Cap	⊥ 3.2			_ 6.4			
Outside of end Peripheral length		All pipe Fitting	–					⊥ 0.5	

* Application of KS B 1541, JIS B 2312
** Application of KS B 1543, JIS B 2313

Dimensions are in millimeters.

KS / JIS

{ KS B1542 / JIS B2316 }

3. Steel Socket-Welding Pipe Fittings for Special

Item	Type of Pipe Fittings	Nominal Diameter			
		1/8 and 1/4	3/8 to 3/4	1 to 2	2 1/2 and 3
		Tolerance			
Inside Diameter of Socket	All pipe Fitting	± 0.3 0			± 0.4 0
Bore diameter		± 0.4			± 0.8
Eccentricity of inside Diameter of socket to bore diameter		± 0.8			
Inclination of socket hole to fitting bore axis		1.5 / 300 Max.			
Distance from center to bottom of socket	90° Elbow 45° Elbow	± 0.8	± 1.5	± 2	± 2.5
Laying Length	Full coupling	± 1.5	± 3	± 4	± 5
Laying Length	Full coupling	± 0.8	± 1.5	± 2	± 2.5

Dimensions are in millimeters.

KS / JIS

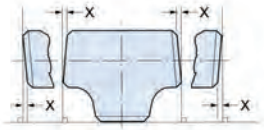
KS B1522, JIS B2311
KS B1541, JIS B2312
KS B1543, JIS B2313

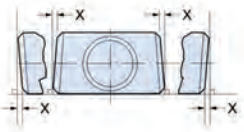
4. Right Angle for Shaft-Center of Pipe Fittings

Item	Type of Pipe Fittings	Nominal Diameter	
		1/2 ~ 4	5 ~ 8
		Tolerance	
Off Angle (X)	All pipe Fitting	0.8	1.6
Off Plane (Y)		1.6	3.2

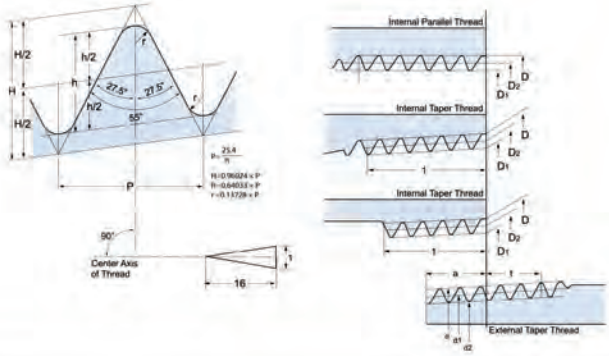
Dimensions are in millimeters.

Nominal Diameter					
10 ~ 12	14 ~ 16	18 ~ 24	26 ~ 30	32 ~ 42	44 ~ 48
Tolerance					
2.4		3.2	4.8		
4.8	6.4	9.5		12.7	19.1





KS B0222 & JIS B0203 Pipe Threads

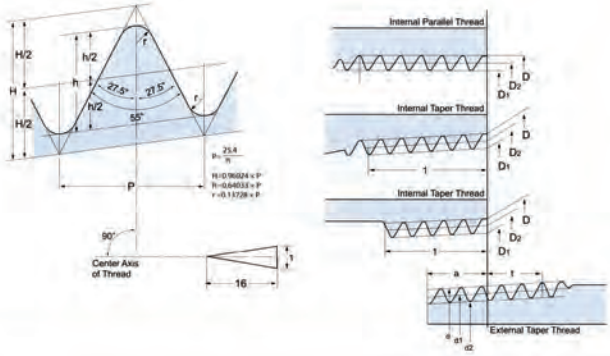


Basic Thread Data

Nominal Size	Number of Threads per Inch	Screw Thread			Basic Diameter		
					External Thread		
					Major Diameter d	Pitch Diameter d_2	Major Diameter d_1
					Internal Thread		
					Major Diameter	Pitch Diameter	Major Diameter
	n	p	h	r	D	D_2	D_1
PT 15 (1/2)	14	1.8143	1.162	0.25	20.955	19.793	18.631
PT 20 (3/4)	14	1.8143	1.162	0.25	26.441	25.279	24.117
PT 25 (1)	11	2.3091	1.479	0.32	33.249	31.770	30.291
PT 32 (1 1/4)	11	2.3091	1.479	0.32	41.910	40.431	38.952
PT 40 (1 1/2)	11	2.3091	1.479	0.32	47.803	46.324	44.845
PT 50 (2)	11	2.3091	1.479	0.32	59.614	58.135	56.656
PT 65 (2 1/2)	11	2.3091	1.479	0.32	75.184	73.705	72.226
PT 80 (3)	11	2.3091	1.479	0.32	87.884	86.405	84.926
PT 90 (3 1/2)	11	2.3091	1.479	0.32	100.330	98.851	97.372
PT 100 (4)	11	2.3091	1.479	0.32	113.030	111.551	110.072
PT 125 (5)	11	2.3091	1.479	0.32	138.430	136.952	135.472
PT 150 (6)	11	2.3091	1.479	0.32	163.830	162.351	160.872

Dimensions are in millimeters.

KS B0222 & JIS B0203 Pipe Threads



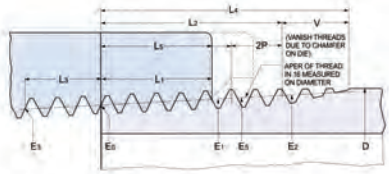
Basic Thread Data

Nominal Size	Position of Basic Diameter			Tolerances on Basic Diameters of Internal Parallel Thread
	External Thread		Internal Thread	
	From the End of Pipe		The End of Pipe	
	Basic Length	Tolerance Axially	Tolerance Axially	
	a	±b	±c	±
PT 15 (1/2)	8.16	1.81	2.27	0.142
PT 20 (3/4)	9.53	1.81	2.27	0.142
PT 25 (1)	10.39	2.31	2.89	0.180
PT 32 (1 1/4)	12.70	2.31	2.89	0.180
PT 40 (1 1/2)	12.70	2.31	2.89	0.180
PT 50 (2)	15.88	2.31	2.89	0.180
PT 65 (2 1/2)	17.46	3.56	3.46	0.217
PT 80 (3)	20.64	3.46	3.46	0.217
PT 90 (3 1/2)	22.23	3.46	3.46	0.217
PT 100 (4)	25.40	3.46	3.46	0.217
PT 125 (5)	25.58	3.46	3.46	0.217
PT 150 (6)	28.58	3.46	3.46	0.217

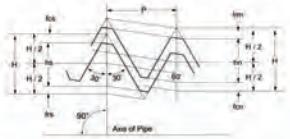
Effective Thread Length (Min.)				Nominal Pipe Size (For Referance)	
External Thread	Internal Thread				
External Thread	When there is an Incomplete thread or More		When there is no Incomplete thread		
	Internal Taper Thread	Internal Parallel Thread	Internal Taper & Parallel Thread	Outside Diameter	Wall Thickness
f	l	l	t		
5.00	12.7	15.0	9.1	21.7	2.8
5.60	14.1	16.3	10.2	27.2	2.8
6.40	16.2	19.0	11.5	34.0	3.2
6.40	18.5	21.4	13.4	42.7	3.5
6.40	18.5	21.4	13.4	48.6	3.5
7.50	22.8	25.7	16.9	60.5	3.8
9.22	26.7	30.2	18.6	76.3	4.2
9.22	29.9	33.3	21.1	89.1	4.2
9.30	31.5	34.9	22.4	101.6	4.2
10.40	35.9	39.3	25.9	114.3	4.5
11.40	40.1	43.6	29.3	139.8	4.5
11.50	40.1	43.6	29.3	165.2	5.0

Dimensions are in millimeters.

ASME B2.1 Taper Pipe Threads. (Except Dryseal)



Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)

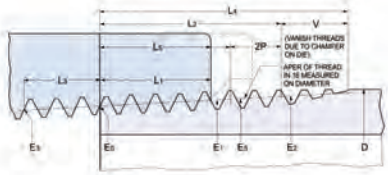


Thread Height Dimensions

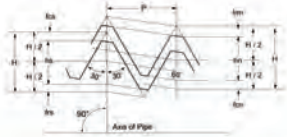
Thread Element	27 Threads per inch P=0.03704	18 Threads per inch P=0.05556	14 Threads per inch P=0.07143	11 1/2 Threads per inch P=0.08696	8 Threads per inch P=0.12500
H = 0.866p	0.0321	0.4810	0.0619	0.0753	0.1082
hs = hn = 0.760p	0.0281	0.0422	0.0543	0.0661	0.0950
frs = frn = 0.033p	0.0012	0.0088	0.0024	0.0029	0.0041
fcs = fcn = 0.073p	0.0027	0.0041	0.0052	0.0063	0.0091

Dimensions are in Inches.

ASME B2.1 Taper Pipe Threads. (Except Dryseal)



Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)



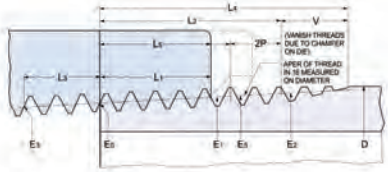
Basic Thread Data

Nominal Pipe Size (NPT)	Outside Diameter of Pipe D	Threads per Inch n	Pitch of Thread P	Pitch Diameter at beginning for External Thread
1	2	3	4	5
1/8	0.405	27.0	0.03704	0.36351
1/4	0.540	18.0	0.05556	0.47739
3/8	0.675	18.0	0.05556	0.61201
1/2	0.840	14.0	0.07143	0.75843
3/4	1.050	14.0	0.07143	0.96768
1	1.315	11.5	0.08696	1.21363
1 1/4	1.660	11.5	0.08696	1.55713
1 1/2	1.900	11.5	0.08696	1.79609
2	2.375	11.5	0.08696	2.26902
2 1/2	2.875	8.0	0.12500	2.71953
3	3.500	8.0	0.12500	3.34062
3 1/2	4.000	8.0	0.12500	3.83750
4	4.500	8.0	0.12500	4.33438
5	5.563	8.0	0.12500	5.39073
6	6.625	8.0	0.12500	6.44609

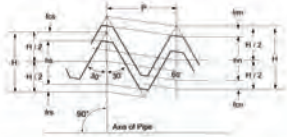
Handtight Engagement			Effective Thread, External		
Lenght L_1		Dia	Lenght L_2		Dia
Ins.	Thds.	D_1	Ins.	Thds.	D_2
6	7	8	9	10	11
0.1615	4.36	0.37360	0.2369	7.12	0.38000
0.2278	4.10	0.79160	0.4018	7.23	0.50250
0.2400	4.32	0.62701	0.4078	7.34	0.63750
0.3200	4.48	0.77843	0.5337	7.47	0.79179
0.3390	4.75	0.98887	0.5457	7.64	1.00179
0.4000	4.60	1.23863	0.6828	7.85	1.25630
0.4200	4.83	1.58338	0.7068	8.13	1.60130
0.4200	4.83	1.82234	0.7235	8.32	1.84130
0.4360	5.01	2.29627	0.7565	8.70	2.31630
0.6820	5.46	2.76216	1.1375	9.10	2.79062
0.7660	6.13	3.38850	1.2000	9.60	3.41562
0.8210	6.57	3.88881	1.2500	10.00	3.91562
0.8440	6.75	4.38712	1.3000	10.40	4.41562
0.9370	7.50	5.44929	1.4063	11.25	5.47862
0.9580	7.66	6.50597	1.5125	12.10	6.54062

Dimensions are in Inches.

ASME B2.1 Taper Pipe Threads. (Except Dryseal)



Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)



Basic Thread Data

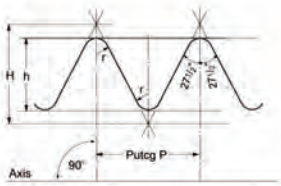
Nominal Pipe Size (NPT)	Wrench Makeup Length for External Thread L_2 L_1		Wrench Makeup Length for Internal Thread			Vanish Thread V	
			Length L_3		Dia[7]		
	In.	Thds.	In.	Thds.	E_3	In.	Thds.
1	12	13	14	15	16	17	18
1/8	0.1024	2.76	0.1111	3	0.35656	0.1285	3.47
1/4	0.1740	3.13	0.1667	3	0.46697	0.1928	3.47
3/8	0.1678	3.02	0.1667	3	0.60160	0.1928	3.47
1/2	0.2137	2.99	0.2143	3	0.74504	0.2478	3.47
3/4	0.2067	2.89	0.2143	3	0.95429	0.2478	3.47
1	0.2828	3.25	0.2609	3	1.19733	0.3017	3.47
1 1/4	0.2868	3.30	0.2609	3	1.54083	0.3017	3.47
1 1/2	0.3035	3.49	0.2609	3	1.77978	0.3017	3.47
2	0.3205	3.69	0.2609	3	2.25272	0.3017	3.47
2 1/2	0.4555	3.64	0.2500	2	2.70391	0.4337	3.47
3	0.4340	3.47	0.2500	2	3.32500	0.4337	3.47
3 1/2	0.4290	3.43	0.2500	2	3.82188	0.4337	3.47
4	0.4560	3.65	0.2500	2	4.31875	0.4337	3.47
5	0.4693	3.75	0.2500	2	5.37511	0.4337	3.47
6	0.5545	4.44	0.2500	2	6.43047	0.4337	3.47

Dimensions are in Inches.

Ovaerall Length External Thread L_4	Nominal, Complete External Threads[5]		Height of Thred h	Increade in Dia per Thread, 0.0625/n	Basic Minor Dia at Small End of Pipe, Ko
	Length L_5	Dia, E_5			
19	20	21	22	23	24
0.3924	0.1898	0.37537	0.2963	0.00231	0.3339
0.5946	0.2907	0.49556	0.4444	0.00347	0.4329
0.6006	0.2967	0.63056	0.4444	0.00347	0.4576
0.7815	0.3909	0.78286	0.5714	0.00446	0.7013
0.7935	0.4029	0.99286	0.5714	0.00446	0.9105
0.9845	0.5089	1.24543	0.6957	0.00543	1.1441
1.0085	0.5329	1.59043	0.6957	0.00543	1.4876
1.0252	0.5496	1.83043	0.6957	0.00543	1.7265
1.0582	0.5826	2.30543	0.6957	0.00543	2.1995
1.5712	0.8875	2.77500	0.100000	0.00781	2.6195
1.6337	0.9500	3.40000	0.100000	0.00781	3.2406
1.6837	1.0000	3.90000	0.100000	0.00781	3.7375
1.7337	1.0500	4.40000	0.100000	0.00781	4.2344
1.8400	1.1563	5.46300	0.100000	0.00781	5.2907
1.9462	1.2625	6.52500	0.100000	0.00781	6.3461

BS21-1973 British Standard Taper Pipe Threads. (Except Dryseal)

Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)



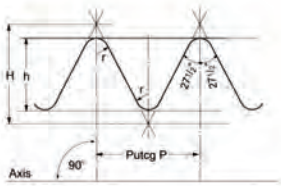
H = 0.960237 × P
h = 0.460327 × P
r = 0.137278 × P

BSP Size (Nominal Bore of Pipe)	No. of Threads per Inch	Pitch		Depth of Thread	
In.		In.	mm	In.	mm
1/2	14	0.07143	1.814	0.0457	1.162
3/4	14	0.07143	1.814	0.0457	1.162
1	11	0.09091	2.039	0.0582	1.479
1 1/4	11	0.09091	2.039	0.0582	1.479
1 1/2	11	0.09091	2.039	0.0582	1.479
2	11	0.09091	2.039	0.0582	1.479
2 1/2	11	0.09091	2.039	0.0582	1.479
3	11	0.09091	2.039	0.0582	1.479
4	11	0.09091	2.039	0.0582	1.479
5	11	0.09091	2.039	0.0582	1.479
6	11	0.09091	2.039	0.0582	1.479

Basic-Diameters at Gauge Plane					
Major (Gauge Diameter)		Effective		Minor	
In.	mm	In.	mm	In.	mm
0.825	20.955	0.7793	19.793	0.7336	18.631
1.041	26.441	0.9953	25.279	0.9496	24.117
1.309	33.249	1.2508	31.770	1.1926	30.291
1.650	41.910	1.5918	40.431	1.5335	38.952
1.882	47.803	1.8238	46.324	1.7656	44.845
2.347	59.614	2.2888	58.135	2.2306	56.656
2.960	75.184	2.9018	73.705	2.8436	72.226
3.460	87.884	3.4018	86.405	3.3436	84.926
4.450	113.030	4.3918	111.551	4.3336	110.072
5.450	138.430	5.3918	136.951	5.3334	135.472
6.450	163.830	6.3918	162.351	6.3336	160.872

BS21-1973 British Standard Taper Pipe Threads. (Except Dryseal)

Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)



H = 0.960237 × P
h = 0.460327 × P
r = 0.137278 × P

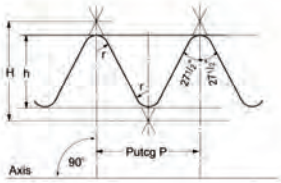
BSP Size (Nominal Bore of Pipe)	No. of Threads per inch	Gauge Length			
		Basic		Tolerance Plus and Minus	
in.		in.	mm	in.	mm
1/2	14	0.3214	9.2	0.0714	1.8
3/4	14	0.3750	9.5	0.0714	1.8
1	11	0.4091	10.4	0.0909	2.3
1 1/4	11	0.5000	12.7	0.0909	2.3
1 1/2	11	0.5000	12.7	0.0909	2.3
2	11	0.6250	15.9	0.0909	2.3
2 1/2	11	0.6875	17.5	0.1364	3.5
3	11	0.8125	20.6	0.1364	3.5
4	11	1.0000	25.4	0.1364	3.5
5	11	1.1250	28.6	0.1364	3.5
6	11	1.1250	28.6	0.1364	3.5

Gauge Length			
Max.		Min.	
in.	mm	in.	mm
0.3928	10.0	0.2500	6.4
0.4464	11.3	0.3036	7.7
0.5000	12.7	0.3182	8.1
0.5909	15.0	0.4091	10.4
0.5909	15.0	0.4091	10.4
0.7159	18.2	0.5341	13.6
0.8239	21.0	0.5511	14.0
0.9486	24.1	0.6761	17.1
1.1364	28.9	0.8636	21.9
1.2614	32.1	0.9886	25.1
1.2614	32.1	0.9886	25.1

BS21-1973 British Standard Taper Pipe Threads. (Except Dryseal)

Taper 1 in 16 on Diameter
(Shown Exaggerated in Diagram)

$H = 0.960237 \times P$
$h = 0.460327 \times P$
$r = 0.137278 \times P$

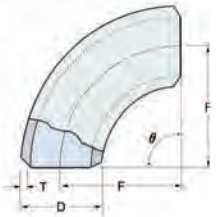


BSP Size (Nominal Bore of Pipe)	No. of Threads per inch	Length of Useful Thread on Pipe End Not Less Than.					
		For Basic Gauge Length		For Max. Gauge Length		For Min. Gauge Length	
in.		in.	mm	in.	mm	in.	mm
1/2	14	0.5178	13.2	0.5892	15.0	0.4464	11.4
3/4	14	0.5714	14.5	0.6428	16.3	0.5000	12.7
1	11	0.6591	16.8	0.7500	19.1	0.5682	14.5
1 1/4	11	0.7500	19.1	0.8509	21.4	0.6591	16.8
1 1/2	11	0.7200	19.1	0.8409	21.4	0.6591	16.8
2	11	0.9204	23.4	1.0113	25.7	0.8295	21.1
2 1/2	11	1.0511	26.7	1.1875	30.2	0.9247	23.2
3	11	1.1761	29.8	1.3125	33.3	1.0397	26.3
4	11	1.4091	35.8	1.5455	39.3	1.2727	32.3
5	11	1.5795	40.1	1.7159	43.6	1.4431	36.6
6	11	1.5795	40.1	1.7159	43.6	1.4431	36.6

Fitting Allowance		Wrenhing Allowance		Tolerance of Position of Gauge Plane Relative to Face of Internally Taper Threaded Parts (Plus and Minus)	
in.	mm	in.	mm	in.	mm
0.1964	5.0	0.1071	2.7	0.0893	2.3
0.1964	5.0	0.1071	2.7	0.0893	2.3
0.2500	6.4	0.1364	3.5	0.1136	2.9
0.2500	6.4	0.1364	3.5	0.1136	2.9
0.2500	6.4	0.1364	3.5	0.1136	2.9
0.2954	7.5	0.1818	4.6	0.1136	2.9
0.3636	9.2	0.2273	5.8	0.1364	3.5
0.3636	9.2	0.2273	5.8	0.1364	3.5
0.4091	10.4	0.2727	6.9	0.1364	3.5
0.4545	11.5	0.3182	8.1	0.1364	3.5
0.4545	11.5	0.3182	8.1	0.1364	3.5

ELBOW, TEE

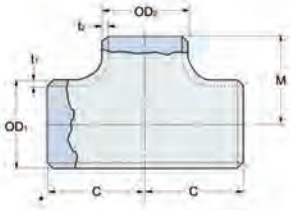
1. ELBOW



$W = 15.4864 \times \theta / 360 \times F \times T \times (D - T) \times 10^{-5}$

W = Weight (kg)
F = Center to End (mm)
D = Outside Diameter (mm)
T = Wall Thickness (mm)
θ = Angle

2. TEE



$W = [0.02466\{2Ct_1(OD_1 -) + (OD_2 - t_2) \times (M - OD_1/2)\} \times 10^{-3} \times K]$

W = Weight (kg)
OD_1 = Outside Diameter (mm)
OD_2 = Outside Diameter (mm)
M = Center to End (mm)
K = 1 (PLATE)
C = Center to End (mm)
t_1 = Wall Thickness (mm)
t_2 = Wall Thickness (mm)
K = 1.363 (PIPE)

REDUCER, CAP

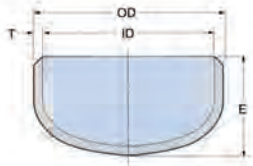
3. REDUCER

$W = 1.3232t_1(OD_1 + OD_2 - 2t_1)l \times 10^{-5}$

$l = \sqrt{H^2 + \frac{(OD_1 + OD_2)^2}{2}}$

W = Weight (kg)
OD_1 = Large Size Outside Diameter (mm)
t_1 = Wall Thickness (mm)
H = End to End (mm)
OD_2 = Small Size

4. CAP



$W = 7.85 \times \frac{\pi}{4}(OD + E)^2 \times T \times 10^{-6}$

W = Weight (kg)
OD = Outside Diameter (mm)
T = Wall Thickness (mm)
E = End to End (mm)

90° Elbow (Long, Short)

Long

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
1/2	0.08	0.08	0.08	0.10	0.10	0.15	0.12
3/4	0.10	0.11	0.11	0.14	0.14	0.22	0.13
1	0.15	0.16	0.16	0.20	0.20	0.36	0.25
1 1/4	0.26	0.26	0.26	0.35	0.35	0.64	0.42
1 1/2	0.35	0.37	0.37	0.50	0.50	0.93	0.65
2	0.64	0.66	0.66	0.90	0.90	1.69	1.33
2 1/2	1.12	1.29	1.29	1.79	1.79	3.43	2.33
3	1.58	2.04	2.04	2.74	2.74	5.25	3.83
4	2.91	3.84	3.84	5.36	5.36	10.20	8.02
5	4.49	6.48	6.48	9.13	9.13	17.60	14.70
6	7.09	9.94	9.94	15.00	15.00	29.10	24.20
8	14.40	20.10	20.10	30.50	30.50	51.40	53.20
10	25.40	35.40	35.40	47.70	57.00	82.00	103.00
12	38.10	52.00	57.00	68.70	94.00	134.00	171.00
14	56.70	67.90	79.10	89.90	133.00	-	236.00
16	74.30	89.00	118.00	118.00	195.00	-	350.00
18	94.20	113.00	169.00	150.00	275.00	-	495.00
20	116.00	140.00	220.00	186.00	373.00	-	676.00
22	141.00	169.00	267.00	225.00	493.00	-	886.00
24	168.00	202.00	366.00	268.00	636.00	-	1160.00
26	198.00	237.00	430.00	315.00	-	-	-
28	230.00	276.00	500.00	367.00	-	-	-
30	264.00	316.00	575.00	421.00	-	-	-
32	301.00	361.00	654.00	480.00	-	-	-
34	340.00	408.00	739.00	543.00	-	-	-
36	380.00	457.00	904.00	608.00	-	-	-

Short

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
1/2	-	-	-	-	-	-	-
3/4	-	-	-	-	-	-	-
1	0.10	0.11	0.11	0.14	0.14	0.22	0.17
1 1/4	0.17	0.18	0.18	0.23	0.23	0.39	0.28
1 1/2	0.24	0.25	0.25	0.33	0.33	0.57	0.43
2	0.43	0.44	0.44	0.60	0.60	1.13	0.89
2 1/2	0.75	0.91	0.91	1.19	1.19	2.19	1.46
3	1.05	1.36	1.36	1.83	1.83	3.49	2.55
4	1.94	2.56	2.56	3.58	3.58	6.79	2.35
5	2.99	4.32	4.32	6.09	6.09	11.80	9.79
6	4.73	6.63	6.63	10.00	10.00	19.50	16.20
8	9.61	13.40	13.40	20.30	20.30	34.30	35.50
10	16.90	23.60	23.60	31.80	38.00	61.00	68.60
12	25.40	34.60	38.00	45.80	63.00	89.50	114.00
14	37.80	45.30	53.00	60.00	89.00	-	158.00
16	49.50	59.10	79.00	78.30	130.00	-	234.00
18	62.80	75.30	113.00	99.90	183.00	-	330.00
20	77.70	93.10	147.00	124.00	249.00	-	451.00
22	94.10	113.00	178.00	150.00	329.00	-	591.00
24	112.00	135.00	244.00	179.00	424.00	-	773.00
26	132.00	158.00	287.00	210.00	-	-	-
28	154.00	184.00	334.00	245.00	-	-	-
30	176.00	211.00	383.00	281.00	-	-	-
32	201.00	241.00	436.00	320.00	-	-	-
34	227.00	272.00	493.00	362.00	-	-	-
36	253.00	304.00	603.00	405.00	-	-	-

90° Elbow (Long, Short)

Long

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
38	425.00	510.00	-	679.00			
40	471.00	565.00	-	753.00			
42	518.00	622.00	-	828.00			
44	570.00	684.00	-	912.00	-	-	-
46	623.00	748.00	-	997.00	-	-	-
48	677.00	814.00	-	1085.00	-	-	-
50	735.00	884.00	-	1178.00	-	-	-
52	796.00	956.00	-	1305.00	-	-	-
54	857.00	1031.00	-	1375.00	-	-	-
56	926.00	1109.00	-	1480.00			
58	991.00	1190.00	-	1588.00			
60	1060.00	1274.00	-	1700.00			

Short

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
38	283.00	340.00	-	453.00	-	-	-
40	314.00	377.00	-	502.00	-	-	-
42	346.00	416.00	-	554.00	-	-	-
44	380.00	456.00	-	608.00	-	-	-
46	415.00	499.00	-	665.00	-	-	-
48	452.00	543.00	-	724.00	-	-	-
50	490.00	589.00	-	786.00	-	-	-
52	530.00	637.00	-	870.00	-	-	-
54	572.00	688.00	-	917.00	-	-	-
56	616.00	740.00	-	976.00	-	-	-
58	661.00	794.00	-	1059.00	-	-	-
60	707.00	849.00	-	1133.00	-	-	-

45° Elbow (Long, Short)

Long

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	XS	S80	XXS	S160
1/2	0.04	0.04	0.04	0.05	0.05	-	-
3/4	0.05	0.06	0.06	0.07	0.07	-	-
1	0.08	0.08	0.08	0.10	0.10	0.18	0.13
1 1/4	0.13	0.13	0.13	0.18	0.18	0.32	0.21
1 1/2	0.18	0.19	0.19	0.25	0.25	0.47	0.33
2	0.32	0.33	0.33	0.45	0.45	0.85	0.67
2 1/2	0.60	0.69	0.69	0.90	0.90	1.72	1.17
3	0.79	1.02	1.02	1.37	1.37	2.63	1.92
4	1.46	1.92	1.92	2.68	2.68	5.09	4.01
5	2.25	3.24	3.24	4.57	4.57	8.80	7.35
6	3.55	4.97	4.97	7.50	7.50	14.50	12.10
8	7.20	10.10	10.10	15.30	15.30	25.70	26.60
10	12.70	17.70	17.70	23.90	28.50	41.00	51.50
12	19.00	26.00	28.50	34.40	47.00	65.00	85.50
14	28.40	34.00	40.10	45.00	66.50	-	118.00
16	37.20	44.50	59.00	59.00	97.50	-	175.00
18	47.10	56.50	84.50	75.50	138.00	-	247.00
20	58.30	70.00	110.00	93.00	187.00	-	338.00
22	70.50	84.50	-	113.00	257.00	-	443.00
24	84.10	101.00	183.00	134.00	318.00	-	580.00
26	99.00	119.00	-	158.00	-	-	-
28	115.00	138.00	-	184.00	-	-	-
30	132.00	158.00	-	211.00	-	-	-
32	150.00	180.00	327.00	240.00	-	-	-

Short

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	XS	S80	XXS	S160
1/2	-	-	-	-	-	-	-
3/4	-	-	-	-	-	-	-
1	0.05	0.06	0.06	0.07	0.07	-	-
1 1/4	0.09	0.09	0.09	0.12	0.12	-	-
1 1/2	0.12	0.13	0.13	0.17	0.17	-	-
2	0.22	0.22	0.22	0.30	0.30	0.57	0.45
2 1/2	0.38	0.46	0.46	0.60	0.60	1.10	0.75
3	0.53	0.68	0.68	0.92	0.92	1.75	1.28
4	0.97	1.28	1.28	1.79	1.79	3.40	2.68
5	1.50	2.16	2.16	3.05	3.05	5.88	4.90
6	2.36	3.32	3.32	5.00	5.00	9.75	8.10
8	4.80	6.71	6.71	10.20	10.20	17.20	17.80
10	8.46	11.80	11.80	15.90	19.00	30.50	34.30
12	12.70	17.30	19.00	22.90	31.50	43.50	57.00
14	18.00	22.60	26.50	30.00	44.50	-	79.00
16	24.00	29.50	39.20	39.20	65.00	-	117.00
18	31.00	37.60	56.50	50.00	91.50	-	165.00
20	38.00	46.60	73.50	62.00	124.00	-	225.00
22	47.00	56.50	-	75.00	164.00	-	295.00
24	56.00	67.30	122.00	89.50	212.00	-	386.00
26	66.00	79.10	-	105.00	-	-	-
28	77.00	92.00	-	122.00	-	-	-
30	87.00	105.00	-	140.00	-	-	-
32	101.00	120.00	218.00	160.00	-	-	-

45° Elbow (Long, Short)

Long

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	XS	S80	XXS	S160
34	170.00	204.00	369.00	272.00	-	-	-
36	190.00	228.00	452.00	304.00	-	-	-
38	212.00	255.00	-	339.00	-	-	-
40	235.00	282.00	-	376.00	-	-	-
42	259.00	311.00	-	414.00	-	-	-
44	285.00	342.00	-	456.00	-	-	-
46	312.00	374.00	-	498.00	-	-	-
48	339.00	407.00	-	542.00	-	-	-

Short

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	XS	S80	XXS	S160
34	114.00	136.00	246.00	181.00	-	-	-
36	127.00	152.00	301.00	202.00	-	-	-
38	142.00	170.00	-	226.00	-	-	-
40	157.00	189.00	-	251.00	-	-	-
42	173.00	208.00	-	277.00	-	-	-
44	190.00	228.00	-	304.00	-	-	-
46	208.00	250.00	-	332.00	-	-	-
48	226.00	272.00		362.00	-	-	-

CAP

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
1/2	0.03	0.04	0.04	0.05	0.05	0.10	0.06
3/4	0.04	0.05	0.05	0.07	0.07	0.13	0.09
1	0.08	0.11	0.11	0.15	0.15	0.29	0.20
1 1/4	0.11	0.14	0.14	0.20	0.20	0.39	0.25
1 1/2	0.15	0.17	0.17	0.24	0.24	0.50	0.35
2	0.23	0.24	0.24	0.33	0.33	0.68	0.54
2 1/2	0.34	0.42	0.42	0.57	0.57	1.33	0.77
3	0.51	0.67	0.67	0.92	0.92	2.18	1.40
4	0.88	1.17	1.17	1.68	1.68	3.80	2.76
5	1.29	1.90	1.90	2.73	2.73	6.22	4.85
6	1.99	2.83	2.83	4.38	4.38	9.85	7.81
8	3.61	5.11	5.11	7.91	7.91	16.40	15.20
10	6.33	8.92	8.92	12.20	16.40	28.35	28.90
12	9.43	13.10	13.10	17.40	26.40	39.40	47.70
14	13.20	15.90	18.60	21.20	34.90	-	61.20
16	16.60	20.00	26.70	26.70	49.00	-	92.80

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
18	21.20	25.50	41.50	34.10	69.00	-	131.00
20	26.40	31.80	54.10	42.50	93.70	-	179.00
22	31.50	38.80	61.40	51.70	116.00	-	219.00
24	36.60	45.10	90.10	60.10	160.00	-	307.00
26	41.00	50.50	92.30	67.30	-	-	-
28	45.50	56.20	103.00	74.90	-	-	-
30	50.30	62.10	114.00	82.80	-	-	-
32	55.40	68.40	126.00	91.20	-	-	-
34	62.30	75.00	138.00	100.00	-	-	-
36	68.00	81.90	164.00	109.00	-	-	-
38	79.00	94.70	-	126.00	-	-	-
40	95.00	102.00	-	137.00	-	-	-
42	98.00	110.00	-	147.00	-	-	-
44	103.00	126.00	-	167.00	-	-	-
46	111.00	134.00	-	179.00	-	-	-
48	118.00	143.00	-	191.00	-	-	-

TEE

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
1/2 X 1/2	0.09	0.09	0.09	0.11	0.11	0.17	0.12
3/4 X 3/4	0.13	0.13	0.13	0.17	0.17	0.26	0.21
1/2	0.12	0.12	0.12	0.16	0.16	0.24	0.19
1 X 1	0.24	0.25	0.25	0.32	0.32	0.53	0.41
3/4	0.23	0.24	0.24	0.30	0.30	0.49	0.38
1/2	0.22	0.23	0.23	0.26	0.26	0.47	0.37
1 1/4 X 1 1/4	0.42	0.43	0.43	0.56	0.56	0.95	0.69
1	0.39	0.40	0.40	0.53	0.53	0.89	0.65
3/4	0.37	0.37	0.37	0.48	0.48	0.84	0.62
1/2	0.36	0.36	0.36	0.47	0.47	0.81	0.59
1 1/2 X 1 1/2	0.58	0.61	0.61	0.81	0.81	1.40	1.07
1 1/4	0.56	0.59	0.59	0.78	0.78	1.35	1.01
1	0.53	0.56	0.56	0.74	0.74	1.28	0.97
3/4	0.51	0.53	0.53	0.70	0.70	1.21	0.92
1/2	0.49	0.51	0.51	0.67	0.67	1.17	0.90
2 X 2	0.86	0.88	0.88	1.20	1.20	2.16	1.78
1 1/2	0.80	0.82	0.82	1.11	1.11	2.00	1.63
1 1/4	0.77	0.79	0.79	1.07	1.07	1.91	1.56
1	0.73	0.75	0.75	1.01	1.01	1.81	1.50
3/4	0.70	0.71	0.71	0.98	0.98	1.76	1.45
2 1/2 X 2 1/2	1.42	1.74	1.74	2.28	2.28	3.92	2.86
2	1.31	1.56	1.56	2.06	2.06	3.56	2.64
1 1/2	1.25	1.51	1.51	1.98	1.98	3.40	2.48
1 1/4	1.22	1.48	1.48	1.94	1.94	3.32	2.42
1	1.18	1.36	1.36	1.80	1.80	3.22	2.36

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
3 X 3	1.87	2.41	2.41	3.25	3.25	5.90	4.55
2 1/2	1.79	2.29	2.29	3.07	3.07	5.53	4.23
2	1.68	2.12	2.12	2.85	2.85	5.18	4.02
1 1/2	1.62	2.06	2.06	2.77	2.77	5.03	3.87
1 1/4	1.60	2.02	2.02	2.74	2.74	4.95	3.80
4 X 4	3.13	4.12	4.12	5.77	5.77	10.60	8.50
3	2.92	3.83	3.83	5.33	5.33	9.76	7.92
2 1/2	2.84	3.71	3.71	5.15	5.15	9.39	7.56
2	2.72	3.53	3.53	4.94	4.94	9.02	7.34
1 1/2	2.66	3.48	3.48	4.83	4.83	8.87	7.23
5 X 5	4.53	6.54	6.54	9.20	9.20	17.30	14.80
4	4.30	6.13	6.13	8.63	8.63	16.10	13.70
3	4.08	5.83	5.83	8.19	8.19	15.30	13.00
2 1/2	4.00	5.71	5.71	8.01	8.01	15.00	12.80
2	3.90	5.58	5.58	7.92	7.92	14.70	12.50
6 X 6	6.84	9.58	9.58	14.50	14.50	27.20	23.30
5	6.45	9.08	9.08	13.60	13.60	25.60	21.90
4	6.23	8.67	8.67	13.00	13.00	24.50	20.80
3	6.01	8.38	8.38	12.60	12.60	23.70	20.10
2 1/2	5.92	8.36	8.36	12.50	12.50	23.30	19.80
8 X 8	12.80	17.90	17.90	27.10	27.10	45.70	47.20
6	11.90	16.60	16.60	25.20	25.20	43.00	43.50
5	11.50	16.10	16.10	24.30	24.30	41.40	42.10
4	11.30	15.70	15.70	23.70	23.70	41.00	40.30

TEE

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
10 X 10	21.80	30.40	30.40	41.00	49.00	79.20	88.00
8	20.40	28.50	28.50	38.90	45.80	54.40	81.40
6	19.50	27.20	27.20	37.00	43.90	71.50	78.50
5	19.20	26.80	26.80	36.20	43.10	70.00	77.00
4	18.90	26.80	26.80	36.20	42.50	68.90	76.30
12 X 12	32.00	43.60	48.70	57.70	79.20	113.00	143.00
10	30.40	41.60	45.30	55.20	74.80	107.00	135.00
8	29.00	39.70	42.50	53.10	71.40	102.00	128.00
6	28.10	38.40	42.00	51.20	69.50	100.00	125.00
5	27.80	38.70	41.70	51.20	68.70	98.30	124.00
14 X 14	44.70	53.50	62.40	70.90	104.00	-	186.00
12	42.70	51.90	60.20	68.80	100.00	-	179.00
10	41.20	49.90	57.60	66.30	95.90	-	174.00
8	40.00	48.20	55.80	64.50	92.90	-	168.00
6	39.00	47.10	54.50	62.60	91.00	-	164.00
16 X 16	55.20	66.10	88.00	87.70	145.00	-	260.00
14	54.20	64.90	86.00	86.10	140.00	-	255.00
12	52.70	63.10	84.00	83.60	136.00	-	248.00
10	51.20	61.30	82.00	81.20	132.00	-	241.00
8	49.40	59.80	79.00	80.00	129.00	-	235.00
6	48.50	58.50	77.00	77.80	127.00	-	230.00
18 X 18	70.00	83.90	125.00	111.00	204.00	-	356.00
16	67.90	81.40	121.00	108.00	197.00	-	352.00
14	66.90	80.20	119.00	106.00	194.00	-	344.00
12	65.40	78.30	117.00	104.00	189.00	-	337.00
10	63.40	76.90	114.00	102.00	186.00	-	329.00

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
20 X 20	86.60	104.00	163.00	138.00	277.00	-	502.00
18	84.20	101.00	158.00	134.00	268.00	-	488.00
16	82.10	98.40	154.00	131.00	262.00	-	475.00
14	81.10	97.20	152.00	129.00	258.00	-	469.00
12	79.20	96.00	150.00	127.00	254.00	-	462.00
10	77.60	94.00	147.00	125.00	250.00	-	452.00
8	76.30	92.10	145.00	123.00	245.00	-	444.00
22 X 22	106.00	126.00	198.00	167.00	365.00	-	657.00
20	103.00	123.00	193.00	163.00	356.00	-	640.00
18	101.00	120.00	188.00	159.00	347.00	-	624.00
16	98.90	117.00	183.00	156.00	340.00	-	610.00
24 X 24	116.00	139.00	252.00	185.00	438.00	-	800.00
22	115.00	138.00	249.00	183.00	432.00	-	790.00
20	114.00	136.00	247.00	181.00	427.00	-	782.00
18	111.00	133.00	241.00	177.00	418.00	-	764.00
26 X 26	147.00	176.00	319.00	234.00	-	-	-
24	144.00	172.00	312.00	229.00	-	-	-
22	141.00	169.00	308.00	225.00	-	-	-
20	138.00	166.00	302.00	221.00	-	-	-
28 X 28	165.00	198.00	359.00	264.00	-	-	-
26	163.00	197.00	356.00	261.00	-	-	-
24	160.00	193.00	350.00	256.00	-	-	-
22	157.00	190.00	347.00	252.00	-	-	-
30 X 30	190.00	228.00	414.00	304.00	-	-	-
28	188.00	226.00	406.00	301.00	-	-	-
26	185.00	222.00	356.00	296.00	-	-	-
24	182.00	218.00	350.00	291.00	-	-	-

TEE

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
32 X 32	217.00	259.00	474.00	347.00	-	-	-
30	213.00	256.00	466.00	341.00	-	-	-
28	209.00	252.00	458.00	335.00	-	-	-
26	208.00	250.00	455.00	333.00	-	-	-
34 X 34	246.00	295.00	535.00	393.00	-	-	-
32	243.00	292.00	526.00	389.00	-	-	-
30	238.00	290.00	518.00	380.00	-	-	-
28	236.00	288.00	511.00	377.00	-	-	-
36 X 36	276.00	331.00	656.00	441.00	-	-	-
34	271.00	329.00	645.00	434.00	-	-	-
32	269.00	326.00	636.00	431.00	-	-	-
30	264.00	323.00	627.00	422.00	-	-	-
38 X 38	308.00	370.00	-	493.00	-	-	-
36	306.00	367.00	-	489.00	-	-	-
34	302.00	362.00	-	481.00	-	-	-
32	298.00	357.00	-	476.00	-	-	-
40 X 40	342.00	411.00	-	547.00	-	-	-
38	340.00	408.00	-	543.00	-	-	-
36	335.00	402.00	-	536.00	-	-	-
34	331.00	397.00	-	529.00	-	-	-
42 X 42	352.00	422.00	-	562.00	-	-	-
40	350.00	420.00	-	559.00	-	-	-
38	348.00	418.00	-	557.00	-	-	-
36	346.00	416.00	-	554.00	-	-	-

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
44 X 44	396.00	475.00	-	633.00	-	-	-
42	394.00	473.00	-	630.00	-	-	-
40	389.00	467.00	-	623.00	-	-	-
38	385.00	462.00	-	616.00	-	-	-
46 X 46	434.00	521.00	-	695.00	-	-	-
44	432.00	519.00	-	691.00	-	-	-
42	427.00	513.00	-	683.00	-	-	-
40	423.00	507.00	-	676.00	-	-	-
48 X 48	474.00	569.00	-	759.00	-	-	-
46	472.00	566.00	-	755.00	-	-	-
44	470.00	564.00	-	751.00	-	-	-
42	462.00	555.00	-	739.00	-	-	-

REDUCER

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
3/4 X 1/2	0.06	0.06	0.06	0.08	0.08	–	–
1 X 3/4	0.11	0.12	0.12	0.15	0.15	0.25	0.19
1/2	0.10	0.11	0.11	0.14	0.14	0.22	0.17
1 1/4 X 1	0.16	0.16	0.16	0.21	0.21	0.35	0.25
3/4	0.15	0.15	0.15	0.19	0.19	0.31	0.23
1/2	0.13	0.14	0.14	0.18	0.18	–	–
1 1/2 X 1 1/4	0.24	0.25	0.25	0.33	0.33	0.57	0.43
1	0.21	0.22	0.22	0.30	0.30	0.50	0.38
3/4	0.20	0.21	0.21	0.27	0.27	0.45	0.35
1/2	0.18	0.18	0.18	0.24	0.24	0.40	0.32
2 X 1 1/2	0.37	0.38	0.38	0.51	0.51	0.91	0.75
1 1/4	0.35	0.36	0.36	0.48	0.48	0.85	0.70
1	0.31	0.33	0.33	0.44	0.44	0.77	0.64
3/4	0.29	0.30	0.30	0.40	0.40	0.69	0.58
2 1/2 X 2	0.60	0.73	0.73	0.95	0.95	1.68	1.20
1 1/2	0.55	0.67	0.67	0.87	0.87	1.51	1.08
1 1/4	0.52	0.64	0.64	0.83	0.83	1.42	1.02
1	0.48	0.56	0.56	0.73	0.73	1.23	0.93
3 X 2 1/2	0.73	0.94	0.94	1.25	1.25	2.25	1.71
2	0.66	0.85	0.85	1.13	1.13	2.01	1.57
1 1/2	0.62	0.79	0.79	1.04	1.04	1.83	1.44
1 1/4	0.59	0.75	0.75	1.00	1.00	1.74	1.37

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
4 X 3	1.10	1.45	1.45	2.02	2.02	3.65	3.00
2 1/2	1.04	1.37	1.37	1.90	1.90	3.41	2.76
2	0.97	1.27	1.27	1.76	1.76	3.11	2.58
1 1/2	0.91	1.19	1.19	1.64	1.64	2.89	2.41
5 X 4	1.74	2.50	2.50	3.52	3.52	6.47	5.59
3	1.58	2.27	2.27	3.18	3.18	5.78	5.30
2 1/2	1.50	2.16	2.16	3.02	3.02	5.46	4.70
2	1.41	2.03	2.03	2.85	2.85	5.12	4.43
6 X 5	2.55	3.57	3.57	5.38	5.38	9.89	8.63
4	2.36	3.30	3.30	4.96	4.96	8.98	7.88
3	2.18	3.04	3.04	4.56	4.56	8.21	7.21
2 1/2	2.09	2.94	2.94	4.38	4.38	7.88	6.80
8 X 6	4.17	5.71	5.71	8.63	8.63	14.30	15.00
5	3.87	5.40	5.40	8.14	8.14	13.40	14.00
4	3.67	5.10	5.10	7.68	7.68	12.60	13.10
10 X 8	6.87	9.58	9.58	12.90	15.40	24.30	27.50
6	6.32	8.78	8.78	11.80	14.20	22.10	25.10
5	6.06	8.42	8.42	11.30	14.50	21.10	23.90
4	5.80	8.20	8.20	11.00	14.00	20.50	22.60
12 X 10	9.97	13.60	14..70	18.00	24.80	35.00	44.60
8	9.29	12.70	13..70	16.70	22.70	33.00	41.00
6	8.69	11.80	12..80	15.60	21.40	32.00	38.00
5	8.39	11.70	12..60	15.30	20.60	31.00	36.40

REDUCER

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
14 X 12	21.20	25.40	29.50	33.60	49.80	–	88.50
10	19.70	23.60	27.40	31.20	46.10	–	81.60
8	18.30	21.80	25.40	28.90	42.20	–	74.70
6	16.90	20.30	23.60	26.80	39.10	–	68.30
16 X 14	25.90	31.00	41.10	41.10	67.70	–	121.00
12	24.10	29.60	39.20	39.20	65.00	–	116.00
10	22.40	27.80	36.80	36.80	60.80	–	108.00
8	21.70	26.20	34.50	34.50	56.60	–	99.90
18 X 16	31.50	37.80	56.20	50.10	91.40	–	165.00
14	29.80	35.70	53.00	47.40	86.40	–	155.00
12	27.70	33.20	51.70	44.00	83.00	–	149.00
10	27.10	32.70	48.40	43.20	78.50	–	140.00
20 X 18	47.00	56.40	88.40	74.90	150.00	–	–
16	44.70	53.50	83.90	71.10	142.00	–	–
14	42.40	50.80	79.60	67.40	136.00	–	233.00
12	40.80	49.20	76.90	65.10	130.00	–	–
22 X 20	52.10	62.40	98.00	82.90	181.00	–	–
18	49.50	59.40	93.20	78.90	172.00	–	–
16	47.00	56.40	98.40	74.80	164.00	–	–
14	45.30	54.30	83.60	72.10	156.00	–	–
24 X 22	57.10	68.40	124.00	91.00	215.00	–	–
20	54.80	65.70	119.00	87.30	206.00	–	–
18	52.60	63.00	114.00	83.80	197.00	–	–
16	50.40	60.50	109.00	80.30	185.00	–	–

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
26 X 24	74.50	89.40	162.00	119.00	–	–	–
22	71.50	85.80	155.00	114.00	–	–	–
20	68.50	82.10	148.00	109.00	–	–	–
18	66.30	79.50	142.00	106.00	–	–	–
28 X 26	80.60	96.60	175.00	129.00	–	–	–
24	77.50	93.00	168.00	124.00	–	–	–
22	74.50	89.40	162.00	119.00	–	–	–
20	72.40	88.80	155.00	115.00	–	–	–
30 X 28	86.60	104.00	188.00	138.00	–	–	–
26	83.60	100.00	182.00	133.00	–	–	–
24	80.60	96.60	175.00	129.00	–	–	–
22	78.50	94.20	168.00	125.00	–	–	–
32 X 30	92.60	111.00	202.00	148.00	–	–	–
28	89.60	108.00	195.00	143.00	–	–	–
26	86.60	104.00	188.00	138.00	–	–	–
24	84.60	102.00	184.00	135.00	–	–	–
34 X 32	98.70	118.00	215.00	158.00	–	–	–
30	95.60	115.00	208.00	153.00	–	–	–
28	92.60	111.00	205.00	148.00	–	–	–
26	90.70	109.00	200.00	145.00	–	–	–
36 X 34	104.60	125.60	250.00	167.30	–	–	–
32	101.60	122.00	243.00	162.40	–	–	–
30	98.60	118.40	238.00	157.60	–	–	–
28	95.60	114.70	234.00	152.80	–	–	–

REDUCER

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
38 X 36	112.00	133.00	-	177.00	-	-	-
34	108.00	129.00	-	172.00	-	-	-
32	105.00	126.00	-	167.00	-	-	-
30	103.00	124.00	-	165.00	-	-	-
40 X 38	117.00	140.00	-	187.00	-	-	-
36	114.00	137.00	-	182.00	-	-	-
34	111.00	133.00	-	177.00	-	-	-
32	109.00	131.00	-	174.00	-	-	-
42 X 40	123.00	147.00	-	196.00	-	-	-
38	120.00	144.00	-	192.00	-	-	-
36	117.00	140.00	-	187.00	-	-	-
34	115.00	138.00	-	184.00	-	-	-

(Unit : kg)

Nominal Pipe Size	SGP	STD	S40	X-S	S80	XX-S	S160
44 X 44	129.00	155.00	-	206.00	-	-	-
42	126.00	151.00	-	201.00	-	-	-
40	123.00	147.00	-	196.00	-	-	-
38	121.00	146.00	-	194.00	-	-	-
46 X 46	157.00	189.00	-	252.00	-	-	-
44	154.00	185.00	-	246.00	-	-	-
42	150.00	180.00	-	241.00	-	-	-
40	148.00	178.00	-	237.00	-	-	-
48 X 46	164.00	197.00	-	263.00	-	-	-
44	161.00	193.00	-	257.00	-	-	-
42	157.00	189.00	-	252.00	-	-	-
40	155.00	186.00	-	248.00	-	-	-

Stainless Steel Fittings

(Unit : kg)

Nominal Pipe Size	90° Elbow (L)			90° Elbow (S)		
	S5s	S10s	S20s	S5s	S10s	S20s
1/2	0.05	0.06	0.07	–	–	–
3/4	0.05	0.06	0.09	–	–	–
1	0.08	0.13	0.14	0.05	0.08	0.09
1 1/4	0.12	0.20	0.22	0.08	0.13	0.15
1 1/2	0.17	0.28	0.30	0.11	0.19	0.20
2	0.29	0.47	0.59	0.19	0.31	0.39
2 1/2	0.55	0.79	0.94	0.37	0.52	0.63
3	0.81	1.16	1.51	0.54	0.77	1.00
4	1.40	2.00	2.60	0.93	1.33	1.74
5	2.83	3.46	4.97	1.89	2.31	3.31
6	4.06	4.96	7.09	2.71	3.31	4.73
8	7.07	9.55	15.90	4.71	6.37	10.70
10	13.50	16.60	25.00	9.01	11.10	16.70
12	22.40	25.80	35.70	15.00	17.20	23.90
14	28.80	34.60	56.90	19.20	23.10	37.80
16	39.80	45.30	74.50	26.50	30.20	49.50
18	50.40	57.40	94.50	33.60	38.30	62.80
20	71.00	82.10	142.00	47.30	54.70	95.00
22	85.90	99.50	170.00	57.30	66.30	114.00
24	118.00	136.00	202.00	79.00	90.40	135.00

(Unit : kg)

Tee			Reducer			Cap		
S5s	S10s	S20s	S5s	S10s	S20s	S5s	S10s	S20s
0.05	0.07	0.08	–	–	–	0.02	0.03	0.03
0.07	0.10	0.11	0.03	0.04	0.05	0.03	0.04	0.04
0.12	0.20	0.22	0.06	0.09	0.10	0.05	0.09	0.10
0.20	0.33	0.36	0.07	0.12	0.13	0.07	0.11	0.12
0.30	0.46	0.50	0.11	0.18	0.20	0.08	0.13	0.14
0.38	0.63	0.79	0.16	0.27	0.34	0.10	0.17	0.21
0.71	1.00	1.18	0.30	0.43	0.50	0.16	0.23	0.28
0.96	1.38	1.78	0.37	0.52	0.69	0.25	0.37	0.48
1.50	2.15	2.80	0.56	0.80	1.04	0.41	0.59	0.78
2.85	3.48	5.01	1.09	1.33	1.92	0.81	0.99	1.44
3.89	4.75	6.83	1.46	1.78	2.55	1.13	1.39	1.99
6.26	8.43	14.30	2.01	2.72	4.56	1.76	2.38	4.05
11.50	14.20	21.50	3.66	4.49	6.77	3.35	4.13	6.23
18.80	21.60	30.20	5.88	6.78	9.40	5.54	6.39	8.89
22.70	27.30	44.80	10.80	13.00	21.20	6.62	7.99	13.20
29.60	33.70	55.20	13.90	15.80	25.90	8.82	10.10	16.70
37.40	42.70	70.00	17.20	19.20	29.80	11.30	12.90	21.30
52.80	61.00	104.00	28.60	33.10	56.00	16.00	18.50	31.80
63.80	74.10	126.20	31.70	36.70	62.50	19.50	22.60	38.80
81.40	93.90	139.40	40.20	46.00	68.60	26.20	30.10	45.10

Lap Joint Stub-end

(Unit : kg)

Size \ Type / Thick	ASME			MSS		
	S5s	S10s	S40s	S5s	S10s	S40s
1/2	0.06	0.08	0.11	0.04	0.06	0.07
3/4	0.09	0.11	0.15	0.06	0.08	0.10
1	0.14	0.24	0.29	0.08	0.13	0.16
1 1/4	0.19	0.31	0.40	0.10	0.17	0.22
1 1/2	0.22	0.37	0.48	0.12	0.21	0.27
2	0.41	0.68	0.95	0.20	0.33	0.47
2 1/2	0.60	0.86	1.41	0.31	0.44	0.74
3	0.80	0.96	2.02	0.40	0.57	1.01
4	1.05	1.51	2.91	0.60	0.87	1.68
5	2.20	2.69	5.09	0.98	1.21	2.28
6	2.64	3.23	6.12	1.34	1.64	3.37
8	3.47	4.69	10.00	1.96	2.65	5.67
10	6.47	7.95	17.30	3.57	4.38	9.55
12	9.13	10.40	21.30	5.85	6.74	13.80
14	11.70	14.10	-	6.42	7.73	-
16	14.30	16.30	-	7.91	9.00	-
18	16.40	18.70	-	9.24	10.50	-
20	20.80	24.10	-	11.70	13.50	-
22	23.10	26.70	-	16.50	18.90	-
24	29.00	33.40	-	16.50	18.90	-

(Unit : kg)

JIS				JPI			
S5s	S10s	S20s	S40s	S5s	S10s	S20s	S40s
0.04	0.05	0.07	0.07	0.04	0.06	0.06	0.07
0.05	0.07	0.08	0.09	0.06	0.08	0.09	0.10
0.10	0.17	0.18	0.20	0.08	0.13	0.14	0.16
0.13	0.21	0.23	0.27	0.10	0.17	0.19	0.22
0.14	0.24	0.25	0.31	0.12	0.21	0.23	0.27
0.18	0.30	0.38	0.42	0.20	0.33	0.43	0.47
0.30	0.43	0.49	0.73	0.31	0.40	0.53	0.74
0.34	0.48	0.64	0.87	0.40	0.57	0.76	1.01
0.43	0.61	0.81	1.21	0.60	0.87	1.12	1.68
0.72	0.87	1.28	1.68	0.98	1.21	1.73	2.28
0.88	1.07	1.57	2.21	1.34	1.64	2.41	3.37
1.36	1.94	3.12	3.92	1.95	2.78	4.47	5.61
2.15	2.53	4.08	5.80	3.51	4.13	6.65	9.45
2.89	3.25	4.67	7.34	5.81	6.52	9.38	14.70
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Comparison of ASTM, KS Specifications and Similar Standards

Steel Composition		ASTM Specification and Grade				KS Specification and Grade		
		Marking Symbol	Pipe	Plate	Forgings	Marking Symbol	Pipe	Plate
Carbon Steel	Carbon Steel	–	A120	A283-A	–	SPP	SPP	SB41
	Carbon Steel	–	A53-B	A242	–	PS38(W), PS38, PT38(W), PT38	SPPS38	SWS41B
	Carbon Steel	–	A53-B	A242	–	PS42(W), PS42, PT42(W), PT42	SPPS42	SWS41B
	Carbon Steel	WPB	A106-B	A515-65 or 70	A181-2 and A105	HT42, HT42(W)	SPHT42	SBB42
	Carbon Steel	WPC	A106-C	–	–	HT49, HT49(W)	SPHT49	SBB49
	Carbon Steel	WPL6	A333 and A334-6	A516-60	A350-LF2	PL39	SPHL39	SLAL39
	High Strength Carbon Steel	WPHY Grade	API 5L-X Grade	API 5L-X Grade	A694-F Grade	–	–	–
Low Temperature Steel	3 1/2% Ni Steel	WPL3	A333 and A334-3	A203-D	A350-LF3	–	–	–
	2% Ni-1% Cu Steel	WPL9	A333 and A334-9	A203-A	A350-LF9	–	–	–
Alloy Steel	Carbon-Molybdenum Steel	WP1	A335-P1	A204-B	A182-F1	PA12, FA12	SPA12	SBB46M
	1% Cr-1/2% Molybdenum Steel	WP12	A335-P12	A387-12	A182-F12	PA22, FA22	SPA22	SCMV2
	1 1/4% Cr-1/2% Molybdenum Steel	WP11	A335-P11	A387-11	A182-F11	PA23, FA23	SPA23	SCMV3
	2 1/4% Cr-1% Molybdenum Steel	WP22	A335-P22	A387-22	A182-F22	PA24, FA24	SPA24	SCMV4
	5% Cr-1/2% Molybdenum Steel	WP5	A335-P5	A387-5	A182-F5	PA25, FA25	SPA25	SCMV6
Alloy Steel	7% Cr-1/2% Molybdenum Steel	WP7	A335-P7	–	A182-F7	–	–	–
	9% Cr-1% Molybdenum Steel	WP9	A335-P9	–	A182-F9	–	–	–
	9% Cr-1% Mo - 0.2%V + Cb + N	WP91	A335-P91	A387-91	A182-F91	–	–	–
Stainless Steel	18% Cr-8% Ni Steel	WP304	A312-TP304	A240-Type 304	A182-F304	STS304, STS304W, STS304F	STS304TP	STS304
	18% Cr-8% Ni-(0.04-0.10)% C Steel	WP304H	A312-TP304H	A240-Type 304H	A182-F304H	–	–	–
	18% Ni-0.035% C Steel	WP304L	A312-TP304L	A240-Type 304L	A182-F304L	STS304L, STS304LW, STS304LF	STS304LTP	STS304L
	22% Cr-12% Ni Steel	WP309	A312-TP309	A240-Type 309S	-	STS309S, STS309SW, STS309SF	STS309STP	STS309S
	25% Cr-20% Ni Steel	WP310	A312-TP310	A240-Type 310S	A182-F310	STS310S, STS310SW, STS310SF	STS310STP	STS310S
	18% Cr - 8% Ni - Cb + Ta Steel	WP347	A312-TP347	A240-Type 347	A182-F347	STS347, STS347W, STS347F	STS347TP	STS347
	18% Cr-8% Ni-Mo Steel	WP316	A312-TP316	A240-Type 316	A182-F316	STS316, STS316W, STS316F	STS316TP	STS316
	18% Cr-8% Ni-Mo-(0.04-0.10)% C Steel	WP316H	A312-TP316H	A240-Type 316H	A182-F316H	STS316H, STS316HF	STS316HTP	-
	18% Cr-8% Ni-Mo-0.035% C Steel	WP316L	A312-TP316L	A240-Type 316L	A182-F316L	STS316L, STS316LW, STS316LF	STS316LTP	STS316L
	18% Cr-8% Ni-Ti Steel	WP321	A312-TP321	A240-Type 321	A182-F321	STS321, STS321W, STS321F	STS321TP	STS321
	18% Cr-8% Ni-Ti-(0.04-0.10)% C Steel	WP321H	A312-TP321H	A240-Type 321H	A182-F321H	–	-	–
	18% Cr-8% Ni-Cb+Ta-(0.04-0.10)% C Steel	WP347H	A312-TP347H	A240-Type 347H	A182-F347H	STS347H, STS347HF	STS347HTP	–
	Duplex Stainless Steel	UNS S31803	A790 S31803	A240-S31803	A182-F51	–	–	–
	Super Duplex Stainless Steel	UNS S32750	A790 S32750	A240-S32750	A182-F53	–	–	–
	Super Duplex Stainless Steel	UNS S32760	A790 S32760	A240-S32760	A182-F55	–	–	–

Comparison of JIS Specifications and Similar Standards

Steel Composition		JIS Specification and Grade			B.S. Specification and Grade (Pipe)	DIN Specification and Grade (Pipe)
		Marking Symbol	Pipe	Plate		
Carbon Steel	Carbon Steel	FSGP or SGP	SGP	SS41	1378-M	2440-ST33-1
	Carbon Steel	PG370(W), PS370(W), PT370(W), PT370	STPG370	SM41B	3602-ERW 23	1626-ST37
	Carbon Steel	PG410(W), PS410(W), PT410(W), PT410	STPG410	SM41B	3602-ERW 27	–
	Carbon Steel	PS410(W), PT410(W)	STPT410	SB42	3602-Steel 27	17175-ST 45.8
	Carbon Steel	PS480(W), PT480(W)	STPT480	SB49	3602-Steel 35	–
	Carbon Steel	PL380(W)	STPL380	–	3603-Steel 27 LT30	–
Low Temperature Steel	3 1/2% Ni Steel	PL450(W)	STPL450	–	3603-Steel 503 LT100	–
	2% Ni-1% Cu Steel	PL690(W)	STPL690	–	–	–
Alloy Steel	Carbon-Molybdenum Steel	PA12(W), FA12	STPA12	–	–	17175-15 Mo3
	1% Cr-1/2% Molybdenum Steel	PA22(W), FA22	STPA22	–	3604-HF620	17175-13 Cr Mo 44
	1 1/4% Cr-1/2% Molybdenum Steel	PA23(W), FA23	STPA23	–	3604-HF621	–
	2 1/4% Cr-1% Molybdenum Steel	PA24(W), FA24	STPA24	–	3604-HF622,27	17175-10 Cr Mo 910
Alloy Steel	5% Cr-1/2% Molybdenum Steel	PA25(W), FA25	STPA25	–	3604-HF625	–
	7% Cr-1/2% Molybdenum Steel	–	–	–	–	–
	9% Cr-1% Molybdenum Steel	PA26(W), FA26	STPA26	–	–	–
	9% Cr-1% Mo - 0.2%V + Cb + N	–	–	–	–	–
Stainless Steel	18% Cr-8% Ni Steel	SUS304, SUS304W, SUS304F	SUS304TP	SUS304	3605-801	17440-X5 Cr Ni 189
	18% Cr-8% Ni-(0.04-0.10)% C Steel	SUS304H, SUS304HF	SUS304HTP	–	3605-811	–
	18% Cr-8% Ni-0.035% C Steel	SUS304L, SUS304LW	SUS304LTP	SUS304L	3605-811L	17440-X2 Cr Ni 189
	22% Cr-12% Ni Steel	SUS309S, SUS309SW, SUS309SF	SUS309STP	SUS309S	–	–
	25% Cr-20% Ni Steel	SUS310S, SUS310SW, SUS310SF	SUS310STP	SUS310S	3605-805S	–
	18% Cr - 8% Ni - Cb + Ta Steel	SUS347, SUS347W, SUS347F	SUS347TP	SUS347	3605-822 Nb	17440-X 0 Cr Ni Nb 189
	18% Cr-8% Ni-Mo Steel	SUS316, SUS316W, SUS316F	SUS316TP	SUS316	3605-845	17440-X5 Cr Ni Mo1810
	18% Cr-8% Ni-Mo-(0.04-0.10)% C Steel	SUS316H, SUS316HF	SUS316HTP	–	3605-855	–
	18% Cr-8% Ni-Mo-0.035% C Steel	SUS316L, SUS316LW	SUS316LTP	SUS316L	3605-845L	17440-X2 Cr Ni Mo1810
	18% Cr-8% Ni-Ti Steel	SUS321, SUS321W, SUS321F	SUS321TP	SUS321	3605-822Ti	17440-X10 Cr Ni Ti89
	18% Cr-8% Ni-Ti-(0.04-0.10)% C Steel	SUS321H, SUS321HF	SUS321HTP	–	3605-832Ti	–
	18% Cr-8% Ni-Cb+Ta-(0.04-0.10)% CSteel	SUS347H, SUS347HF	SUS347HTP	–	3605-832Nb	–

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Chemical Composition (Percent)								
					Max. or Range (Unless otherwise indicated)								
		Grage	Thick		C	Si	Mn	P	S	Ni	Cr	Mo	Ti	Other Elements
A234	WPB	A106 Gr. B		P	-	0.10min	0.29-1.06	0.035	0.035	0.40	0.40	0.15	-	-
		A515 Gr. 65	0~25mm	PL	0.28	0.025	0.90	0.025	0.025	-	-	-	-	-
			25~50		0.31					-	-	-	-	-
			50~100		0.33					-	-	-	-	-
		A515 Gr. 70	0~25mm	PL	0.31	0.15-0.40	1.20	0.025	0.025	-	-	-	-	-
			25~50		33					-	-	-	-	-
			50~100		0.35					-	-	-	-	-
	WPC	A106 Gr. C		P	0.35	0.10min	0.29-1.06	0.035	0.035	0.40	0.40	0.15	-	-
	WP1	A335 Gr. P1		P	0.10-0.20	0.10-0.50	0.30-0.80	0.025	0.025	-	-	0.44-0.65	-	-
		A204 Gr. B		PL	0.20-0.27	0.15-0.40	0.90	0.025	0.025	-	-	0.45-0.60	-	-
	WP12	A335 Gr. P12		P	0.05-0.15	0.50	0.30-0.61	0.025	0.025	-	0.80-1.25	0.44-0.65	-	-
		A387 Gr. 12		PL	0.05-0.17	0.15-0.40	0.40-0.65	0.025	0.025	-	0.80-1.15	0.45-0.60	-	-
	WP11	A335 Gr. P11		P	0.05-0.15	0.50-1.00	0.30-0.60	0.025	0.025	-	1.00-1.50	0.44-0.65	-	-
		A387 Gr. 11		PL	0.05-0.17	0.50-0.80	0.40-0.65	0.025	0.025	-	1.00-1.50	0.45-0.65	-	-
	WP22	A335 Gr. P22		P	0.05-0.15	0.50	0.30-0.60	0.025	0.025	-	1.90-2.60	0.87-1.13	-	-
		A387 Gr. 22		PL	0.05-0.15	0.50	0.30-0.60	0.025	0.025	-	2.00-2.50	0.90-1.10	-	-
	WP23	A335 P23		P	0.04-0.10	0.50	0.10-0.60	0.030	0.010	-	1.90-2.60	0.05-0.30	-	V : 0.20-0.30 Cb 0.02-0.08 B : 0.0010-0.006 N : 0.030 Al : 0.030 W : 1.45-1.75
	WP5	A335 Gr. P5		P	0.15	0.50	0.30-0.60	0.025	0.025	-	4.00-6.00	0.45-0.65	-	-
		A387 Gr. 5		PL	0.15	0.50	0.30-0.60	0.025	0.025	-	4.00-6.00	0.45-0.65	-	-

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Chemical Composition (Percent) Max. or Range (Unless otherwise indicated)							
		Grage	Thick		C	Si	Mn	P	S	Ni	Cr	Mo	Ti	Other Elements
A234	WP9	A335 P9		P	0.15	0.25-1.00	0.30-0.60	0.025	0.025	-	8.00-10.00	0.90-1.10	-	-
		A387 Gr. 9		PL	0.15	1.00	0.30-0.60	0.025	0.025	-				
	WP91	A335 P91 A387 Gr. 91		P PL	0.08-0.12	0.20-0.50	0.30-0.60	0.020	0.010	0.40	8.00-9.50	0.85-1.05	-	V : 0.18-0.25 Cb : 0.06-0.10 N : 0.030-0.070 AL : 0.02 Ti : 0.01max Zr : 0.01max
	WP92	A335 P92		P	0.07-0.13	0.50	0.30-0.60	0.020	0.010	0.40	8.50-9.50	0.30-0.60	-	V : 0.15-0.25 Cb : 0.04-0.09 B : 0.001-0.006 N : 0.03-0.07 Al : 0.02 W : 1.50-2.00 Ti : 0.01max Zr : 0.01max
A403	WP304	A312 Gr. TP304		P	0.08	1.00	2.00	0.045	0.030	8.00-11.00	18.00-20.00	-	-	-
		A240 Type 304		PL	0.07	1.00	2.00	0.045	0.030	8.00-10.50	17.50-19.50	-	-	-
	WP304H	A312 Gr. TP304H		P	0.04-0.10	1.00	2.00	0.045	0.030	8.00-11.00	18.00-20.00	-	-	-
		A240 Type 304H*		PL	0.04-0.10	0.75	2.00	0.045	0.030	8.00-10.50	18.00-20.00	-	-	-
	WP304L	A312 Gr. TP304L†		P	0.035	1.00	2.00	0.045	0.030	8.00-13.00	18.00-20.00	-	-	-
		A240 Type 304L†		PL	0.030	0.75	2.00	0.045	0.030	8.00-12.00	17.50-19.50	-	-	-
	WP309	A312 Gr. TP309		P	0.08	1.00	2.00	0.045	0.030	12.00-15.00	22.00-24.00	0.75	-	-
		A240 Type 309S		PL	0.08	0.75	2.00	0.045	0.030	12.00-15.00	22.00-24.00	-	-	-
	WP310	A312 Gr. TP310		P	0.08	1.00	2.00	0.045	0.030	19.00-22.00	24.00-26.00	0.75	-	-
		A240 Type 310S		PL	0.08	1.50	2.00	0.045	0.030	19.00-22.00	24.00-26.00	-	-	-

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Chemical Composition (Percent)									
					Max. or Range (Unless otherwise indicated)									
		Grage	Thick		C	Si	Mn	P	S	Ni	Cr	Mo	Ti	Other Elements
A403	WP347	A312 Gr. TP347		P	0.08	1.00	2.00	0.045	0.030	9.00-13.00	17.00-19.00	-	-	Ca+Ta10X C-1.00
		A240 Type 347		PL	0.08	0.75	2.00	0.045	0.030	9.00-13.00	17.00-19.00	-	-	Ca+Ta10X C-1.10
	WP316	A312 Gr. TP316		P	0.08	1.00	2.00	0.045	0.030	11.00-14.00	16.00-18.00	2.00-3.00	-	-
		A240 Type 316		PL	0.08	0.75	2.00	0.045	0.030	10.00-14.00	16.00-18.00	2.00-3.00	-	-
	WP316H	A312 Gr. TP316H		P	0.04-0.10	1.00	2.00	0.045	0.030	11.00-14.00	16.00-18.00	2.00-3.00	-	-
		A240 Type 316H*		PL	0.40-1.10	1.00	2.00	0.045	0.030	10.00-14.00	16.00-18.00	2.00-3.00	-	-
	WP316L	A312 Gr. TP316L		P	0.035	1.00	2.00	0.040	0.030	10.00-14.00	16.00-18.00	2.00-3.00	-	-
		A240 Type 316L†		PL	0.030	1.00	2.00	0.045	0.030	10.00-14.00	16.00-18.00	2.00-3.00	-	-
	WP321	A312 Gr. TP321		P	0.08	0.75	2.00	0.045	0.030	9.00-12.00	17.00-19.00	-	-	-
		A240 Type 321		PL	0.08	1.00	2.00	0.045	0.030	9.00-12.00	17.00-19.00	-	5X C-0.70	-
	WP321H	A312 Gr. TP321H		P	0.04-0.10	1.00	2.00	0.045	0.030	9.00-12.00	17.00-19.00	-	-	-
		A240 Type 321H*		PL	0.04-0.10	1.00	2.00	0.045	0.030	9.00-13.00	17.00-19.00	-	4X C-0.70	-
	WP347H	A312 Gr. TP347H		P	0.04-0.10	1.00	2.00	0.045	0.030	9.00-13.00	17.00-19.00	-	-	-
		A240 Type 347H*		PL	0.04-0.10	1.00	2.00	0.045	0.030	9.00-13.00	17.00-19.00	-	-	Ca+Ta8X C-1.0
	WP S31254	A312 S31254		P	0.020	0.80	1.00	0.030	0.010	17.5-18.5	19.5-20.5	6.00-6.50	-	N:0.18-0.22
		A240 S31254		PL										-
A420	WPL6	A333 and A334 Gr. 6		P	0.30	0.10min	0.29-1.06	0.025	0.025	0.40 Max	-	0.12	-	-
		A516 Gr. 60	0~25mm		0.21									
			26~50	PL	0.23	0.15-0.40	0.60-1.30	0.025	0.025	-	-	-	-	-
			50~100		0.25									
	WPL3	A333 and A334 Gr. 3		P	0.19	0.18-0.37	0.31-0.64	0.025	0.025	3.25-3.75	-	-	-	-
		A203 Gr. D	0~50mm		0.17									
			50~100	PL	0.20	0.13-0.45	0.70-0.80	0.025	0.025	3.25-3.75	-	-	-	-
	WPL9	A333 and A334 Gr. 8		P	0.13	-	0.90 Max	0.025	0.025	8.40-9.60	-	-	-	-
		A203 Gr. A		PL	0.17	0.15-0.40	0.70	0.035	0.040	2.10-2.50	-	-	-	-

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Chemical Composition (Percent) Max. or Range (Unless otherwise indicated)							
		Grage	Thick		C	Si	Mn	P	S	Ni	Cr	Mo	Ti	Other Elements
A815	S31803	A790 S31803 A240 S31803		P PL	0.030	1.0	2.0	0.030	0.020	4.50-6.50	21.0-23.0	2.50-3.50	- -	N:0.08-0.20
	S32750	A790 S32750 A240 S32750		P PL	0.030	0.8	1.2	0.035	0.020	6.0-8.0	24.0-26.0	3.0-5.0	- -	N:0.24-0.43
	S32760	A790 S32760 A240 S32760		P PL	0.05 0.030	1.00	1.00	0.030	0.010	6.00-8.00	24.00-26.00	3.00-4.00	N:0.20-0.30 Cu:0.50-1.00 W:0.50-1.00 Cr+3.3 Mo+16N=40Min.	
A860	WPHY42	API 5L Gr. X42		P PL	0.14	0.40	1.35	0.020	0.010	- -	- -	- -	- 0.04	- -
	WPHY60	API 5L Gr. X60		P PL	0.16	0.45	1.65	0.020	0.010	- -	- -	- -	- -	
	WPHY65	API 5L Gr. X65		P PL	0.16	0.45	1.65	0.020	0.010	- -	- -	- -	-	

- Asterisks(*) denote that the carbon content shall be 0.04 to 0.10%
- Daggers(†) denote that the minimum tensile strength shall be 65,000 psi(450 MPa), and that the minimum yield strength shall be 25,000 psi(170 MPa)
- The yield strength shall be determined by the offset method at 0.2% limiting permanent set in accordance with ASTM A370 Specification. An alternative method of determining yield strength may be based on a total extension under load of 0.5%
- The basic minimum elongation for walls 3/16 (7.94mm) and over in thickness shall be determined according to strip tests;all small sizes are tested in their full section.
- **P-denotes Pipe, PL Plate.**

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Tensile Requirements			
		Grage	Thick		Tensile Strength Min. or Range Ksi (Mpa)		Yied Strength Min. Ksi(Mpa)	Longitudinal Elongation in 2 in (50mm) Min. %
A234	WPB	A106 Gr. B		P	60	(415)	35 (240)	30
		A515 Gr. 65	0~25mm 56~50 50~100	PL	65-85	(450-585)	35 (240)	23
		A515 Gr. 70	0~25mm 26~50 50~100	PL	70-90	(485-620)	38 (260)	21
	WPC	A106 Gr. C		P	70	(485)	40 (275)	30
	WP1	A335 Gr. P1		P	55	(380)	30 (205)	30
		A204 Gr. B		PL	70-90	(485-620)	40 (275)	21
	WP12	A335 Gr. P12		P	60	(415)	30 (205)	30
		A387 Gr. 12		PL	65-80	(450-585)	40 (275)	22
	WP11	A335 Gr. P11		P	60	(415)	30 (205)	30
		A387 Gr. 11		PL	70-100	(515-690)	45 (310)	22
	WP22	A335 Gr. P22		P	60	(415)	30 (205)	30
		A387 Gr. 22		PL	75-100	(515-690)	45 (310)	18
	WP23	A335 P23		P	74	(510)	58 (400)	20
	WP5	A335 Gr. P5		P	60	(415)	30 (205)	30
		A387 Gr. 5		PL	75-100	(515-690)	45 (310)	18
	WP9	A335 P9		P	60	(415)	30 (205)	30
		A387 Gr. 9		PL	75-100		45 (310)	18
	WP91	A335 P91		P	85	(585)	60 (415)	20
		A387 Gr. 91		PL	85-100		60 (415)	18
	WP92	A335 P92		P	90	(620)	64 (440)	20

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form	Tensile Requirements			
		Grage	Thick		Tensile Strength Min. or Range Ksi (Mpa)		Yied Strength Min. Ksi(Mpa)	Longitudinal Elongation in 2 in (50mm) Min. %
A403	WP304	A312 Gr. TP304		P	75	(515)	30 (205)	35
		A240 Type 304		PL	75	(515)	30 (205)	40
	WP304H	A312 Gr. TP304H		P	75	(515)	30 (205)	35
		A240 Type 304H*		PL	75	(515)	30 (205)	40
	WP304L	A312 Gr. TP304L †		P	70	(485)	25 (170)	35
		A240 Type 304L †		PL	70	(485)	25 (170)	40
	WP309	A312 Gr. TP309		P	75	(515)	30 (205)	35
		A240 Type 309S		PL	75	(515)	30 (205)	40
	WP310	A312 Gr. TP310		P	75	(515)	30 (205)	35
		A240 Type 310S		PL	75	(515)	30 (205)	40
	WP347	A312 Gr. TP347		P	75	(515)	30 (205)	35
		A240 Type 347		PL	75	(515)	30 (205)	40
	WP316	A312 Gr. TP316		P	75	(515)	30 (205)	35
		A240 Type 316		PL	75	(515)	30 (205)	40
	WP316H	A312 Gr. TP316H		P	75	(515)	30 (205)	35
		A240 Type 316H*		PL	75	(515)	30 (205)	40
	WP316L	A312 Gr. TP316L		P	70	(485)	25 (170)	35
		A240 Type 316L †		PL	70	(485)	25 (170)	40
	WP321	A312 Gr. TP321		P	75	(515)	30 (205)	35
		A240 Type 321		PL	75	(515)	30 (205)	40
	WP321H	A312 Gr. TP321H		P	75	(515)	30 (205)	35
		A240 Type 321H*		PL	75	(515)	30 (205)	40
	WP347H	A312 Gr. TP347H		P	75	(515)	30 (205)	35
		A240 Type 347H*		PL	75	(515)	30 (205)	40
	WP S31254	A312 S31254		P	94	(650)	44(300)	35
		A240 S31254		PL	119	(820)		

Materials Specifications for Butt-Welding Fittings ASTM Materials

Marking Symbol		Materials		Form
		Grage	Thick	
A420	WPL6	A333 and A334 Gr. 6		P
		A516 Gr. 60	0~25mm 26~50 50~100	PL
	WPL3	A333 and A334 Gr. 3		P
		A203 Gr. D	0~50mm 50~100	PL
	WPL9	A333 and A334 Gr. 8		P
		A203 Gr. A		PL
A815	S31803	A790 S31803		P
		A240 S31803		PL
	S32750	A790 S32750		P
		A240 S32750		PL
	S32760	A790 S32760		P
		A240 S32760		PL
A860	WPHY42	API 5L Gr. X42		P
		A572 Gr. 42		PL
	WPHY60	API 5L Gr. X60		P
		A572 Gr. 60		PL
	WPHY65	API 5L Gr. X65		P
		A572 Gr. 65		PL

Tensile Requirements			
Tensile Strength Min. or Range Ksi (Mpa)		Yied Strength Min. Ksi(Mpa)	Longitudinal Elongation in 2 in (50mm) Min. %
60	(415)	35 (240)	30
60-80	(415-550)	32 (220)	25
65	(450)	35 (240)	30
65-85	(450-585)	37 (255)	23
63	(435)	46 (315)	28
65-85	(450-585)	37 (255)	23
90	(620)	65 (450)	25
116	(800)	80 (550)	15
116	(795)		
109	(750)	80 (550)	25
108	(750)		
60	(415)	42 (290)	24
75	(520)	60 (415)	18
77	(535)	65 (450)	17
80	(550)		

Asterisks(*) denote that the carbon content shall be 0.04 to 0.10%

Daggers(†) denote that the minimum tensile strength shall be 65,000 psi(450 MPa), and that the minimum yield strength shall be 25,000 psi(170 MPa)

The yield strength shall be determined by the offset method at 0.2% limiting permanent set in accordance with ASTM A370 Specification. An alternative method of determining yield strength may be based on a total extension under load of 0.5%

The basic minimum elongation for walls 3/16 (7.94mm) and over in thickness shall be determined according to strip tests;all small sizes are tested in their full section.

P-denotes Pipe, PL Plate.

Materials Specifications for Fittings JIS Materials

Marking Symbol		Chemical Composition (percent)							
		C	Si	Mn	P	S	Ni	Cr	Mo
G3452	SGP	-	-	-	0.040 Max.	0.040 Max.	-	-	-
G3454	STPG370	0.25 Max	0.35 Max.	0.30-0.90	0.040 Max.	0.040 Max.	-	-	-
	STPG410	0.30 Max.	0.35 Max.	0.30-1.00	0.040 Max.	0.040 Max.	-	-	-
G3456	STPT370	0.25 Max.	0.10-0.35	0.30-0.90	0.035 Max.	0.035 Max.	-	-	-
	STPT410	0.30 Max.	0.10-0.35	0.30-1.00	0.035 Max.	0.035 Max.	-	-	-
	STPT480	0.33 Max.	0.10-0.35	0.30-1.00	0.035 Max.	0.035 Max.	-	-	-
G3455	STS370	0.25 Max.	0.10-0.35	0.30-1.10	0.035 Max.	0.035 Max.	-	-	-
	STS410	0.30 Max.	0.10-0.35	0.30-1.40	0.035 Max.	0.035 Max.	-	-	-
	STS480	0.33 Max.	0.10-0.35	0.30-1.50	0.035 Max.	0.035 Max.	-	-	-
G3457	STPY400	0.25 Max.	-	-	0.040 Max.	0.040 Max.	-	-	-
G3459	SUS304TP	0.08 Max.	1.00 Max.	2.00 Max.	0.045 Max.	0.030 Max.	8.00-11.00	18.00-20.00	-
	SUS304HTP	0.04-1.00	0.75 Max.	2.00 Max.	0.040 Max.	0.030 Max.	8.00-11.00	18.00-20.00	-
	SUS304LTP	0.03 Max.	1.00 Max.	2.00 Max.	0.045 Max.	0.030 Max.	9.00-13.00	18.00-20.00	-
	SUS316TP	0.08 Max.	1.00 Max.	2.00 Max.	0.045 Max.	0.030 Max.	10.00-14.00	16.00-18.00	2.00-3.00

Materials Specifications for Fittings JIS Materials

Marking Symbol		Chemical Composition (percent)							
		C	Si	Mn	P	S	Ni	Cr	Mo
G3459	SUS316HTP	0.04-0.10	0.75 Max.	2.00 Max.	0.030 Max.	0.030 Max.	11.00-14.00	16.00-18.00	2.00-3.00
	SUS316LTP	0.03 Max.	1.00 Max.	2.00 Max.	0.045 Max.	0.030 Max.	12.00-16.00	16.00-18.00	2.00-3.00
G3460	STPL380	0.25 Max.	0.35 Max.	1.35 Max.	0.035 Max.	0.035 Max.	-	-	-
	STPL450	0.18 Max.	0.10-0.35	0.30-0.60	0.030 Max.	0.030 Max.	3.20-3.80	-	-
G3101	SS400	-	-	-	0.050 Max.	0.050 Max.	-	-	-
G3106	SM400B	0.20 Max.	0.35 Max.	0.60-1.50	0.035 Max.	0.035 Max.	-	-	-
	SM490B	0.18 Max.	0.55 Max.	1.65 Max.	0.035 Max.	0.035 Max.	-	-	-
G3103	SB410	0.24 Max.	0.15-0.40	0.90 Max.	0.020 Max.	0.020 Max.	-	-	-
	SB450	0.28 Max.	0.15-0.40	0.90 Max.	0.020 Max.	0.020 Max.	-	-	-
G4051	S20C	0.18-0.23	0.15-0.35	0.30-0.60	0.030 Max.	0.035 Max.	-	-	-
	S25C	0.22-0.28	0.15-0.35	0.30-0.60	0.030 Max.	0.035 Max.	-	-	-
	S45C	0.42-0.48	0.15-0.35	0.60-0.90	0.030 Max.	0.035 Max.	-	-	-
G3201	SF45	0.60 Max.	0.15-0.50	0.30-1.20	0.030 Max.	0.035 Max.	-	-	-
	SF50	0.60 Max.	0.15-0.50	0.30-1.20	0.030 Max.	0.035 Max.	-	-	-

Materials Specifications for Fittings JIS Materials

Marking Symbol		Mechanical Requirements		Mechanical Requirements	Reduction of Area	Hardness (HB)
		Tensile Strength kgf/mm² (N/mm²)	Yield Strength kgf/mm² (N/mm²)	Elongation (%) Test Piece No.		
G3452	SGP	30 Min. (290) Min.	-	(11.12) 30 Min. (5) 25 Min.	-	-
G3454	STPG370	38 Min. (370) Min.	22 Min. (215) Min.	(11.12) 30 Min. (5) 25 Min.	-	-
	STPG410	42 Min. (410) Min.	25 Min. (245) Min.	(11.12) 25 Min. (5) 20 Min.	-	-
G3456	STPT370	38 Min. (370) Min.	22 Min. (215) Min.	(11.12) 30 Min. (5) 25 Min.	-	-
	STPT410	42 Min. (410) Min.	25 Min. (245) Min.	(11.12) 25 Min. (5) 20 Min.	-	-
	STPT480	49 Min. (480) Min.	28 Min. (275) Min.	(11.12) 25 Min. (5) 20 Min.	-	-
G3455	STS370	38 Min. (370) Min.	22 Min. (215) Min.	(11.12) 30 Min. (5) 25 Min.	-	-
	STS410	42 Min. (410) Min.	25 Min. (245) Min.	(11.12) 25 Min. (5) 20 Min.	-	-
	STS480	49 Min. (480) Min.	28 Min. (275) Min.	(11.12) 25 Min. (5) 20 Min.	-	-
G3457	STPY400	41 Min. (400) Min.	23 Min. (225) Min.	(5) 18 Min.	-	-
G3459	SUS304TP	53 Min. (520) Min.	21 Min. (205) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
	SUS304HTP	53 Min. (520) Min.	21 Min. (205) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
	SUS304LTP	49 Min. (480) Min.	18 Min. (175) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
	SUS316TP	53 Min. (520) Min.	21 Min. (205) Min.	(11.12) 35 Min. (5) 25 Min.	-	-

Materials Specifications for Fittings JIS Materials

Marking Symbol		Mechanical Requirements		Mechanical Requirements	Reduction of Area	Hardness (HB)
		Tensile Strength kgf/mm² (N/mm²)	Yield Strength kgf/mm² (N/mm²)	Elongation (%) Test Piece No.		
G3459	SUS316HTP	53 Min. (520) Min.	21 Min. (205) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
	SUS316LTP	49 Min. (481) Min.	18 Min. (175) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
G3460	STPL380	39 Min. (380) Min.	21 Min. (205) Min.	(11.12) 35 Min. (5) 25 Min.	-	-
	STPL450	46 Min. (450) Min.	25 Min. (245) Min.	(11.12) 30 Min. (5) 20 Min.	-	-
G3101	SS400	41-52 (400-510)	16tMax.25 Min. (245)	(5) 21 Min. (14) 17 Min.	-	-
G3106	SM400B	41-52 (400-510)	16tMax.25 Min. (245)	(5) 23 Min. (1A) 18 Min.	-	-
	SM490B	50-62 (490-610)	16tMax.33 Min. (325)	(5) 22 Min. (1A) 17 Min.	-	-
G3103	SB410	42-56 (410-550)	23 Min. (225) Min.	(1A) 21 Min. (10) 25 Min.	-	-
	SB450	46-60 Min. (450-590)	25 Min. (245) Min.	(1A) 19 Min. (10) 23 Min.	-	-
G4051	S20C	41 Min. (402) Min.	(N)25 Min. (245) Min.	-	-	-
	S25C	45 Min. (441) Min.	(N)27 Min. (265) Min.	-	-	-
	S45C	58 Min. (569) Min.	(N)35 Min. (343) Min.	-	-	-
G3201	SF45	45-55 (440-540)	(N)23 Min. (225) Min.	(14A)(A) 24 Min. (T) 19 Min.	(A) 45 (T) 35	121 Min.
	SF50	50-60 (490-590)	(N)25 Min. (245) Min.	(14A)(A) 22 Min. (T) 17 Min.	(A) 40 (T) 30	134 Min.

Wall Thickness of Welded and Seamless Pipe Carbon, Alloy & Stainless Steel

(Unit : mm)

Nominal Pipe Size		Outside Diameter		Nominal Wall Thickness	
Inch	A	ASME	KJ/JIS	SPP SGP	Sch 5S
1/8	6	10.29	10.50	-	-
1/4	8	13.72	13.80	-	-
3/8	10	17.14	17.30	-	-
1/2	15	21.34	21.70	2.8	1.65
3/4	20	26.67	27.20	2.8	1.65
1	25	33.40	34.00	3.2	1.65
1 1/4	32	42.16	42.70	3.5	1.65
1 1/2	40	48.26	48.60	3.5	1.65
2	50	60.32	60.50	3.8	1.65
2 1/2	65	73.02	76.30	4.2	2.11
3	80	88.90	89.10	4.2	2.11
3 1/2	90	101.60	101.60	4.2	2.11
4	100	114.30	114.30	4.5	2.11
5	125	141.30	139.80	4.5	2.77
6	150	168.30	165.20	5.0	2.77
8	200	219.08	216.30	5.8	2.77
10	250	273.05	267.40	6.6	3.40
12	300	323.80	318.50	6.9	3.96
14	350	355.60	355.60	7.9	3.96
16	400	406.40	406.40	7.9	4.19
18	450	457.20	457.20	7.9	4.19
20	500	508.00	508.00	7.9	4.78
22	550	558.80	558.80	-	4.78
24	600	609.60	609.60	-	5.54

Nominal Wall Thickness						
Sch 10S	Sch 10	Sch 20S	Sch 20	Sch 30	Sch 40S	STD
1.24	-	1.5	-	-	1.73	1.73
1.65	-	2.0	-	-	2.24	2.24
1.65	-	2.0	-	-	2.31	2.31
2.11	-	2.5	-	-	2.77	2.77
2.11	-	2.5	-	-	2.87	2.87
2.77	-	3.0	-	-	3.38	3.38
2.77	-	3.0	-	-	3.56	3.56
2.77	-	3.0	-	-	3.68	3.68
2.77	-	3.5	3.20	-	3.91	3.91
3.05	-	3.5	4.50	-	5.16	5.16
3.05	-	4.0	4.50	-	5.49	5.49
3.05	-	4.0	4.50	-	5.74	5.74
3.05	-	4.0	4.90	-	6.02	6.02
3.40	-	5.0	5.10	-	6.55	6.55
3.40	-	5.0	5.50	-	7.11	7.11
3.76	-	6.5	6.35	7.04	8.18	8.18
4.19	-	6.5	6.35	7.80	9.27	9.27
4.57	-	6.5	6.35	8.38	9.52	9.52
4.78	6.35	8.0	7.92	9.52	*9.52	9.52
4.78	6.35	8.0	7.92	9.52	*9.52	9.52
4.78	6.35	8.0	7.92	11.12	*9.52	9.52
5.54	6.35	9.5	9.52	12.70	*9.52	9.52
5.54	6.35	-	9.52	12.70	*9.52	9.52
6.35	6.35	-	9.52	14.27	*9.52	9.52

Wall Thickness of Welded and Seamless Pipe Carbon, Alloy & Stainless Steel

(Unit : mm)

Nominal Pipe Size		Outside Diameter		Nominal Wall Thickness	
Inch	A	ASME	KJ/JIS	SPP SGP	Sch 5S
26	650	660.40	660.40	-	-
28	700	711.20	711.20	-	-
30	750	762.00	762.00	-	6.35
32	800	812.80	812.80	-	-
34	850	863.60	863.60	-	-
36	900	914.40	914.40	-	-
38	950	965.20	965.20	-	-
40	1000	1016.00	1016.00	-	-
42	1050	1066.80	1066.80	-	-
44	1100	1117.60	1117.60	-	-
46	1150	1168.40	1168.40	-	-
48	1200	1219.20	1219.20	-	-

Nominal Wall Thickness						
Sch 10S	Sch 10	Sch 20S	Sch 20	Sch 30	Sch 40S	STD
*7.92	7.92	-	12.70	-	*9.52	9.52
*7.92	7.92	-	12.70	15.88	*9.52	9.52
*7.92	7.92	-	12.70	15.88	*9.52	9.52
*7.92	7.92	-	12.70	15.88	*9.52	9.52
*7.92	7.92	-	12.70	15.88	*9.52	9.52
*7.92	7.92	-	12.70	15.88	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52
*7.92	-	-	-	-	*9.52	9.52

Asterisks(*) denote TK Corporation Standrd as no internationally
Recognized Standards for these wall thickness have been established.

Wall Thickness of Welded and Seamless Pipe Carbon, Alloy & Stainless Steel

(Unit : mm)

Nominal Pipe Size		Outside Diameter		Nominal Wall Thickness		
Inch	A	ASME	KJ/JIS	Sch 40	Sch 60	Sch 80S
1/8	6	10.29	10.50	1.73	2.20	2.41
1/4	8	13.72	13.80	2.24	2.40	3.02
3/8	10	17.14	17.30	2.31	2.80	3.20
1/2	15	21.34	21.70	2.77	3.20	3.73
3/4	20	26.67	27.20	2.87	3.40	3.91
1	25	33.40	34.00	3.38	3.90	4.55
1 1/4	32	42.16	42.70	3.56	4.50	4.85
1 1/2	40	48.26	48.60	3.68	4.50	5.08
2	50	60.32	60.50	3.91	4.90	5.54
2 1/2	65	73.02	76.30	5.16	6.00	7.01
3	80	88.90	89.10	5.49	6.60	7.62
3 1/2	90	101.60	101.60	5.74	7.00	8.08
4	100	114.30	114.30	6.02	7.10	8.56
5	125	141.30	139.80	6.55	8.10	9.53
6	150	168.30	165.20	7.11	9.30	10.97
8	200	219.08	216.30	8.18	10.31	12.70
10	250	273.05	267.40	9.27	12.70	12.70
12	300	323.80	318.50	10.31	14.27	*12.70
14	350	355.60	355.60	11.13	15.09	*12.70
16	400	406.40	406.40	12.70	16.66	*12.70
18	450	457.20	457.20	14.27	19.05	*12.70
20	500	508.00	508.00	15.09	20.62	*12.70
22	550	558.80	558.80	-	22.22	*12.70
24	600	609.60	609.60	17.48	24.61	*12.70

Nominal Wall Thickness						
X-S	Sch 80	Sch 100	Sch 120	Sch 140	Sch 160	XX-S
2.41	2.41	-	-	-	3.15	4.83
3.02	3.02	-	-	-	3.68	6.05
3.20	3.20	-	-	-	4.01	6.40
3.73	3.73	-	-	-	4.78	7.47
3.91	3.91	-	-	-	5.56	7.82
4.55	4.55	-	-	-	6.35	9.09
4.85	4.85	-	-	-	6.35	9.70
5.08	5.08	-	-	-	7.14	10.16
5.54	5.54	-	-	-	8.74	11.07
7.01	7.01	-	-	-	9.52	14.02
7.62	7.62	-	-	-	11.12	15.24
8.08	8.08	-	-	-	-	-
8.56	8.56	-	11.12	-	13.49	17.12
9.53	9.53	-	12.70	-	15.88	19.05
10.97	10.97	-	14.27	-	18.26	21.94
12.70	12.70	15.09	18.26	20.62	23.01	22.22
12.70	15.09	18.26	21.44	25.40	28.58	25.40
12.70	17.48	21.44	25.40	28.58	33.32	25.40
12.70	19.05	23.83	27.79	31.75	35.71	-
12.70	21.44	26.19	30.96	36.52	40.49	-
12.70	23.82	29.36	34.92	39.67	45.24	-
12.70	26.19	32.54	38.10	44.45	50.01	-
12.70	28.58	34.92	41.28	47.62	53.98	-
12.70	30.96	38.89	46.02	52.37	59.54	-

Wall Thickness of Welded and Seamless Pipe Carbon, Alloy & Stainless Steel

(Unit : mm)

Nominal Pipe Size		Outside Diameter		Nominal Wall Thickness		
Inch	A	ASME	KJ/JIS	Sch 40	Sch 60	Sch 80S
26	650	660.40	660.40	-	-	*12.70
28	700	711.20	711.20	-	-	*12.70
30	750	762.00	762.00	-	-	*12.70
32	800	812.80	812.80	17.48	-	*12.70
34	850	863.60	863.60	17.48	-	*12.70
36	900	914.40	914.40	19.05	-	*12.70
38	950	965.20	965.20	-	-	*12.70
40	1000	1016.00	1016.00	-	-	*12.70
42	1050	1066.80	1066.80	-	-	*12.70
44	1100	1117.60	1117.60	-	-	*12.70
46	1150	1168.40	1168.40	-	-	*12.70
48	1200	1219.20	1219.20	-	-	*12.70

Nominal Wall Thickness						
X-S	Sch 80	Sch 100	Sch 120	Sch 140	Sch 160	XX-S
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-
12.70	-	-	-	-	-	-

Asterisks(*) denote TK Corporation Standrd as no internationally
Recognized Standards for these wall thickness have been established.

APPENDIX

About Weld Fittings and Flanges

Even with all the advances in technology today, the wholly welded piping system has for decades remained the best choice for use in high pressure and high temperature applications.

Many piping jobs in schools, industrial plants, and factories have benefitted from the inherent advantages of a completely welded system. For instance, they become a closed container joining sections of pipe, valves, fittings and flanges, Also, a welded joint actually becomes part of the section, minimizing leak potential and extending service life. This provides greater margins of safety, especially under conditions of internal pressure. Additionally, welding fittings form a continuous metal structure with the pipe, adding forged-in strength to any piping system.
Furthemore, smoother joints simplify insulation and take up less space.

By taking a detailed look at the type of fittings and flanges specifically designed for use in welded systems, one notes immediately their gain in both recognition and preference. Here is a quick rundown on the many fittings available.

What are Fittings?

A fitting is any part used in a piping system to change direction or function and joined to that system by some mechanical means or by welding.

The simplest way to change the direction of a pipe would be to bend it. However, besides restricting the flow, this method often distorts the shape of the pipe and reduces the wall strength.

Another method of altering direction is with mitered joints, I.e. straight pieces of pipe cut for the required turn and welded together. This type lowers flow efficiency considerably by creating greater turbulence. A single mitered bend has about six times the resistance of a smooth elbow. Fittings are preferable for most piping systems where rate of flow, internal pressure and protection against a corrosive environment are primary design considerations.

Fittings fall into these main categories:

Screwed

These fittings are joined to a system by means of threads.
Cutting of threads may penetrate as deeply as one-half the wall thickness, thus weakening the pipe in the joint area.

However, threaded systems usually take more time to prepare and install as they almost always require a substantial amount of field fabrication such as threading pipe ends, etc.

Unnecessary field fabrication and threaded joints present potential problem areas at higher operation pressures.

Flanges

These are forged fittings with an integral flanges for bolting to mated parts. Chief disadvantages of flaged fittings atr high weight loads and increased space occupancy.

Socket Weld

These fittings have an inside diameter that accommoates a specific pipe size.

The pipe is inserted into the fitting and then welded outside circumferentially.

A major disadvantage is a potential "mismatch" inside the fitting where a recess is formed, allowing initiation of corrosion.

Butt Weld

In addition to having some of the previously mentioned advantages, these fittings utilize less spacem offer smoother inner surfaces and provide more gradual directional changes

Some useful tips in the selection of specific welding fittings for a variety of piping jobs will now be discussed.

90° and 45° Elbows

Since elbows are very commonly used fittings, they will be considered first.

Generally, their size designations are either **long** radius or **short** radius. The long radius elbow is usually adequate for standard service conditions .The center-to-end dimension is always 1-1/2times the nominal size of the elbow. Short radius elbows have a center-to-end measurement equl to pipe diameter.

90° Long Radius Elbow

For a particular job, the type of elbow selected is usually a compromise based on three considerations, namely, the material flow rate, space available and initial cost.

90° Short Radius Elbow

For service where the flow rate is critical and space is available, the user may select the long radius fittings. This gives him the least reduction in flow and pressure drop from internal frictional resestance and stream turbulence.

When space is limited and the flow rate is non-critical, a short radius elbow is often selected.

When fluids are moved long distances or must encounter many directinal changes, short radius elbows are not recommended because of their greater friction loss, which may require installation of larger pumping equipment.

A long radius elbow costs less than a short radius fittings. Long radius elbows offer minimum resistance to flow consistent with space savings and presently account for more than 90 percent of all elbows in use.

Because of the countless variations occurring in piping systems, fitting manufacturers produce a number of fittings with special shapes and parts as standard items. Some of the major welding fittings and flanges currently available are described below.

90° Reducing Elbow

The 90° **reducing** elbow is designed to change direction as well as reduce the length of flow within a piping system. Usng both a standard 90° elbow and reducer could do this or a 90° long radius-reducing elbow could do this. The latter is normally preferred because it eliminates one fitting and reduces the necessary welding by more than one-third. Also, the gradual reduction in diameter throughout the arc of the reducing elbow provides lower resistance to flow and reduces the effect of stream turbulence and potential internal eosion. These features prevent sizeable pressure drops in the line.

Because this fitting takes up less space than the straight elbow and reducer combination, the application of piping insulation is simplified.

The reducing elbow is more difficult to make and costs more than the elbow and reducer combination. However, since less welding is required and installation is faster, the actual cast differential may be very little.

45° long Radius Elbow

The **45° long reducing** elbow has all the flow advantages of the 90°long radius elbow. It is generally used when a partial or gradual change in direction is desired. The demand for 45°long radius elbow is somewhat limited and they constitute a very small segment of the market.

180° Returns

180°Long Radius Return

180°Short Radius Return

The recommended procedure for a 180°change in direction is to use a formed 180°return fitting rather than combine two 90° elbows or field fabricate a 180° pipe bend from a straight pipe piece. Returns are used primarily in heater coils and heat exchangers. The number of coils the space has available determines whether a **short** or **long** radius return is desirable. All long and short 180°radius returns have center-to center dimensions that are double those of matching 90°elbows.

Tees

Stright Tee

Reducing Tee

A tee is a branched, reinforced outlet fitting that permits flow at 90° to the main flow. The main flow passes through the "run" of the tee. The 90° outlet is called the "branch" of the tee. A **straingt** tee is manufactured with all three outlets, the run as well as the branchm the same size. A **reducing** tee is made with the branch outlet smaller than the run to accoomodate the design flow rate.

Lap Joint Stub End

Lap Joint Stub Ends

These fittings are used in lines that might require a quick-disconnect system. They are also used to facilitate lining up the bolt holes of flanges when there flanges are now welded or fastened to the pipe. Normally, **stub ends** are installed in pairs, the paired fittings mating with two lap joint flanges. This allows wasy opening of the line for future cleaning and inspection and if the line requires replacement, the flanges can be reused because they are not fastened to the system. They ride freely in the outside of the pipe. Lap joint stub ends are made with serrated gasket surfaces for improved sealing of the connection and prevention of leakage at the joint. This surface has replaced the raised gasket surface of a flange.

Eccentric Reducer

Reducers

All reducers, either **eccentric** or **concentric**, decrease the effective size of the pipe. With smaller cross-sectional area there is increased frictional resistance to the flowing material and an increase system pressure.

Concentric Reducer

The eccentric reducer has the reducing outlet end off center. It will line up straight with one side of the inlet but not with the other outlet. This reducer is harder to manufacture than the concentric reducer and costs more.

One advantage over the concentric reducer is that can be hung or suspended flush against a flat ceilling or wall. This lends greater support to the piping system and many times reduces the required space. When used in horizontal piping systems with the straight side up, it acts as a trap for foreign material. When installed straight side down, it prevents trapping of foreign material.

The concentric reducer is made with both inlet and outlet on a common center line. This reducer is less ostly t manufacture than the eccentric type and is adaptable to most piping installations.

Cap

Caps

The function of a **cap** is to block off the end of a line. The cap is placed over the open end and welded around the joint.

Flanges

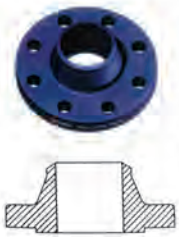
A flange is forged or cast ring of metal designed to join two sections of a piping system or originate a piping system at a pressure vessel outlet, valve, or any other integral flanged assembly. Flanges are joined to the piping system by threading or welding and are joined to each other with bolts. For example, every pressure vessel made has at least one flanged outlet. This outlet has a predetermined bolt circle and number of holes. Flanges are designed and made to match the bolt circle and bolt holes so the two can be mated together. From this flange the piping system is started. Normally, the thickness and O.D.(Outside Diameter) of the flange increase as the pressure rating of the piping system increases. The most important part of a flange is its face. Flange faces are machined to provide adequate surface contact area for a gasket. Flange classifications are:

Raised-Face : The contact area is raised 0.0625 inched for classes 150 and 300. For classed above 300, the contact area is raised 0.25 inches.
Flat-Face : When bolting class 150 or 300 flanges to cast iron flanges, flat-face should be used.
Ring Type Joint : Normal use is with flanges in classes 400 and over but can be designed for lower classes if desired.

Flanges are designed specifically for classes 150, 300, 400, 600, 900, 1500 and 2500. Common types of flanges are "high-hub" weld neck, "low-hub" slip-on, lap joint, threaded, socket and blind.

Weld Neck Flanges

The weld neck flange is normally referred to as the "high-hub" flanges. It is designed to transfer and eaually distribute stresses to the pipe, thereby reducing any concentration of high stress at the bottom of the flange after connections are made. The weld neck flange is the best-designed flange for butt-welding because of its inherent strength. A long tapered hub and gradual transition of thickness in the region of the butt-weld joint adds reinforcement from the standpoint of strength and resestance to dishing. The smooth transition from the flange thickness to the pipe wall thickness effected by the taper is extremely beneficial under conditions of repreated bending caused by line expansion or other variable forces.



Weld Neck Flange

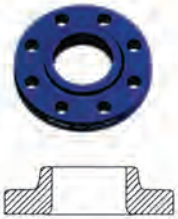
Weld neck flanges are used in serve services generally involving high pressure and sub-zero or high temperatures. Wld neck flnges are bored to match the I.D.(Inside Diameter) of the matching pipe. Therefore, the lighter(lower schedule) the pipe, the larger is the bore of the flanges.

The flange is bored to match the I.D. of the pipe after joining so there is no restriction in flow that could increase stream turbulence and contribute to metal erosion.

Slip-on, Lap Joint Threaded

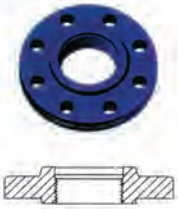
Slip-on Flange

A Slip-on flange has a low hub because the pipe slips into the flange prior to welding. It is welded both inside and out to provide sufficient strength and prevent leakage. Slip-on flanges are all bored slightly larger than the O.D. of the matching pipe. Their lower cost makes them preferable to weld neck flanges to many users. However, installed cost is not much less than for a weld neck flange because of the additional welding involved.



Lap Joint Flange

The lap joint flange is almost identical to a slip-on flange except for the radius at the intersection of the bore and flange face. This radius is necessary to accommodate connection to a lap joint stub end. Normally, a lap joint flange and a lap joint stub end assembly is used mainly in piping systems that are frequently dismantled for inspection or cleaning. These flanges are advantageous in systems where the ability to swivel flanges and align bolt holes simplifies erection of large diameter and hard-to-adjust piping.

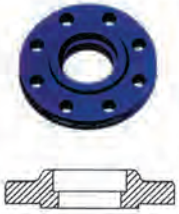


Threaded Flange

A threaded flange is similar to the slip-on flange, but the bore is threaded. Its chief merit is that it can be assembled without welding. This feature makes it preferable for services operating at low pressures and ambient temperatures. Threaded flanges can be installed in highly dangerous areas where welding might be hazardous.

Threaded flanges are unsuited for extreme temperature conditions or bending stresses of any great magnitude.

Widely fluctuating conditions could cause leakage through the threads after only a fer cycles of heating or repeated exposure to stresses. "Seal" welding around the joint is sometimes performed to overcome the possibility of leakage, but this is not always satisfactory, nor possible.



Socket Weld Flange

Socket Weld

Socket weld flanges were initially developed for use in small-size high-pressure piping and slightly more expensive than the slip-ons.

When provided with an internal weld, their static strength is equal to, but their fatigue strength is much greater than double-welded slip-on flanges.

Blind Flange

Blind

The blind flange is a solid forging used to blank off the end of a pipiing system and for gaining access to interior of the line. These flanges from the stance of internal pressure and bolt load are the most highly stressed type of all. However, since the maximum stresses in a blind flange are bending stesses at the center, they can safely be permitted to be higher than in other types of flanges. However, they are not apt for repeated severe water hammer or when temperature is a critical factor.

For these situations, a welding cap is better suited.

GEOMETRIC FORMULAS

Where:

A = Plane Area
V = Volume
C = Circumference
S = Surface Area of Solid
L = Arc on Chord

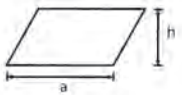
For Capacity solid containers:

Capacity in gallons = V / 231
when V is cubic inches

Capacity in gallons = 7.48 × V
when V is cubic feet

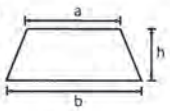
Parallelogram

$A = ah$



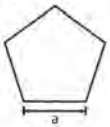
Trapezoid

$A = \frac{h}{2}(a+b)$



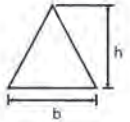
Regular Pentagon

$A = 1.720\ a^2$



Triangle

$A = \frac{bh}{2}$

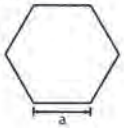


Regular Octagon

$A = 4.828\ a^2$

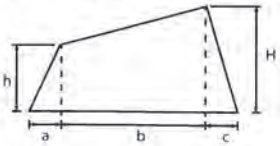
Regular Hexagon

$A = 2.598\ a^2$



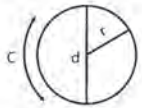
Trapezium

$A = \frac{1}{2}[b(H+h) + ah + cH]$



Circle

$C = 2\pi r$
$= \pi d$
$A = \pi r^2$
$D = 2r$
$R = \frac{d}{2}$

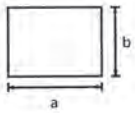


Square

$A = b^2$

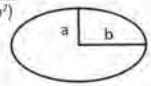
Rectanle

$A = ab$



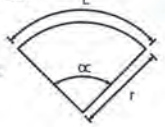
Ellipse

$A = \pi ab$
$C = \pi\sqrt{2(a^2+b^2)}$



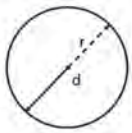
Sector of Circle

$A = \frac{\pi r^2 \alpha}{360}$
$L = .01745r\alpha$



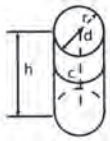
Sphere

$S = 4\pi r^2$
$= \pi d^2$
$V = \frac{3}{4}\pi r^3$
$V = \frac{1}{6}\pi d^3$



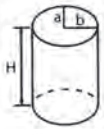
Cylinder

$S = 2\pi r\,(r+h)$
$V = \pi r^2 h$
$V = \frac{c^2 h}{4\pi}$



Elliptical Tank

$S = 6.283 \times \sqrt{\frac{a^2+b^2}{2}} \times H + 6.283 \times a \times b$
$V = 3.142 \times a \times b \times H$

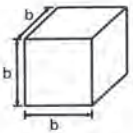


Cone

$S = \pi r(H+r)$
$= \pi r(\sqrt{r^2+h^2}+r)$
$V = \frac{\pi r^2 h}{3}$
$= 1.047r^2h$
$= 0.2618d^2h$

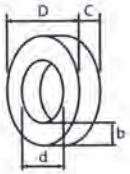
Cube

$S = 6b^2$
$V = b^3$



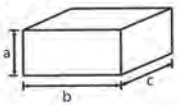
Ring of Rectangular Cross Section

$V = \frac{\pi c}{4}(D^2 - d^2)$
$= \frac{(D+d)}{2}\pi bc$

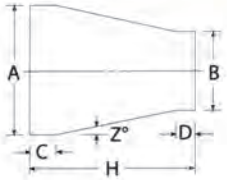


Rectangular Solid

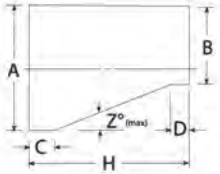
$S = 2(ab + bc + ac)$
$V = abc$



Calculation of Transition Slope



$$\text{Tan } Z = \frac{\frac{A-B}{2}}{H-(C+D)}$$



$$\text{Tan } Z\ (Max) = \frac{\frac{A-B}{2}}{H-(C+D)}$$

Compression Ratio or Pressure Ratio

$$\frac{\text{ABSOLUTE DISCHARGE PRESSURE}}{\text{ABSOLUTE SUCTION PRESSURE}} = \text{PRESSURE RATIO}$$

Barlow's Formula

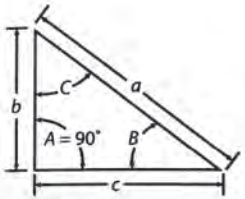
Barlow's Formular is used to find the relationship between internal fluid pressure and stress in the pipe wall. It is simple to use and is conservative; the results are safe. Barlow's Formular is sometimes known as the "outside diameter" formular because it utilizes the outside diameter of the pipe. Bursting tests on commercial steel pipe of the commonly used thickness have shown that Barlow's Formular predicts the pressure at which the pipe will rupture with an accuracy well within the limits of uniformity of commercial pipe thickness.

$$P = \frac{2 \times t \times S}{D}$$

Where:

P = Internal units pressure, psi
S = unit stress, psi
D = outside diameter of pipe, in.
t = wall thickness, in.

RIGHT-ANGLED TRIANGLES



As Shown in the illustrations, the sides of the right angled triangle are designated a, b, and c. the angles opposite each of these sides are designated A, B, and B respectively.

Angle A, opposite the hypotenuse a is the right angle and is therefore always one of the known quantities.

SOLUTION OF RIGHT-ANGLED TRAIANGLES

Sides and Angles Known	Formulas for Sides and Angles to be Found		
Sides a and b	$c = \sqrt{a^2 - b^2}$	$\sin B = \frac{b}{a}$	$C = 90° - B$
Sides a and c	$b = \sqrt{a^2 - c^2}$	$\sin C = \frac{c}{a}$	$B = 90° - C$
Sides b and c	$a = \sqrt{b^2 - c^2}$	$\tan B = \frac{b}{c}$	$C = 90° - B$
Sides a ; angle B	$b = a \times \sin B$	$c = a \times \cos B$	$C = 90° - B$
Sides a ; angle C	$b = a \times \cos C$	$c = a \times \sin C$	$B = 90° - C$
Sides b ; angle B	$a = \frac{b}{\sin B}$	$c = b \times \cot B$	$C = 90° - B$
Sides b ; angle C	$a = \frac{c}{\cos C}$	$c = b \times \tan C$	$B = 90° - C$
Sides c ; angle B	$a = \frac{c}{\cos B}$	$b = c \times \tan B$	$C = 90° - B$
Sides c ; angle C	$a = \frac{c}{\sin C}$	$b = c \times \tan C$	$B = 90° - C$

PRESSURE	
1 lb. per sq. in.	= 2.31 ft. water at 60°F
	= 2.04 in. hg at 60°F
1 ft. water at 60°F	= 0.433 lb. per sq. in.
	= 0.844 in. hq at 60°F
1 in. hg at 60°F	= 2.31 ft. water at 60°F
	= 2.04 in. hg at 60°F
lb. per sq. in. Absolute(pisa)	= lb. per sq. in. quage(pisg) + 14.7

TEMPERATURE	
°C	= (0°F –32) × 0.5556

WEIGHT OF LIQUID	
1 gal. (US)	= 8.34 lb. × sp. gr.
1 cu. ft.	= 62.4 lb. × sp. gr.
1 lb.	= 0.12 US gal. ÷ sp. gr.
	= 448.8 gal. per hr. (gph)

FLOW	
1 gpm	= 0.134 cu. ft. per min.
	= 500 lb. per hr. × sp. gr.
500 lb. per hr.	= 1 gpm ÷ sp. gr.
1 cu. ft. per min. (cfm)	= 448.8 gal. per hr. (gph)

WORK	
1 Btu (mean)	= 778 ft. lb.
	= 0.293 watt hr.
	= 0.0056 of heat required to change temp of 1 lb. water from 32° F to 212° F
1 hp-hr	= 2.545 Btu (mean)
	= 0.746 kwhr
1 kwhr	= 3416 Btu (mean)
	= 1.34 hp-hr

POWER	
1 Btu per hr.	= 0.293 watt
1 Btu per hr.	= 12.96 ft. lb. per min.
	= 0.00039 hp
1 ton refrigeration (US)	= 288,000 Btu per 24 Hr.
	= 12,000 Btu per hr.
	= 12,000 Btu per min.
	= 83.33 lb. ice melted per hr. from and at 32°F
	= 2,000 lb. ice melted per hr. from and at 32°F
1 hp	= 550 ft. lb. per sec.
	= 746 watt
	= 2,545 Btu per hr.
1 boiler hp.	= 33,480 Btu per hr.
	= 34.5 lb. water evap. per hr. from and at 212°F
	= 9.8 kw

MASS	
1 lb.(qvoir.)	= 16 oz. (avoir.)
	= 7,000 grain
1 ton (short)	= 2,000 lb.
1 ton (long)	= 2,240 lb.

VOLUME	
1 gal. (US)	= 128 fl.oz. (US)
	= 231 cu. in.
	= 0.833 gal. (Brit.)
1 cu. ft.	= 7.48 gal. (US)

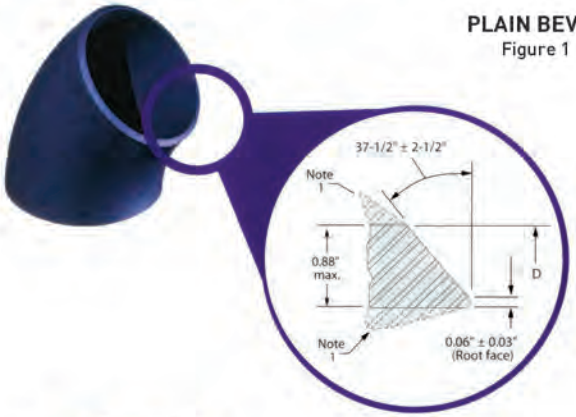
WEIGHT OF WATER
1 cu. ft. at 50°F weighs 62.41 lb.
1 gal at 50°Fweoghs 8.34 lb.
1 cu. ft. of ice weighs 57.2 lb.
Water is at its greatest density at 39.2°F
1 cu. ft. at 39.2°F weighs 62.43 lb.

CONVERSION CONTANTS		
To Change	To	Multiply By
Inches	Feet	0.0833
Inches	Millimeters	25.4
Feet	Inches	12
Feet	Yards	0.3333
Yards	Feet	3
Square inches	Squre feet	0.00694
Square feet	Squre inches	144
Square feet	Squre yards	0.11111
Square yards	Squre feet	9
Cubic inches	Cubic feet	0.00058
Cubic feet	Cubic inches	1728
Cubic feet	Cubic yards	0.303703
Cubic yards	Cubic feet	27
Cubic inches	Gallons	0.00433
Cubic feet	Gallons	7.48
Gallons	Cubic inches	231
Gallons	Cubic feet	0.1337
Gallons	Pounds of water	8.33
Pounds of Water	Gallons	0.12004
Ounces	Pounds	0.0625
Pounds	Ounces	16
Inches of Water	Pounds per square inch	0.0361
Inches of Water	Inches of mercury	0.0735
Inches of Water	Ounces per square inch	0.578
Inches of Water	Pounds per square inch	5.2
Inches of mercury	Inches of Water	13.6
Inches of mercury	Feet of water	1.1333
Inches of mercury	Pounds per square inch	0.4914
Ounces per square inch	Inches of mercury	0.127
Ounces per square inch	Inches of Water	1.733
Pounds per square inch	Inches of Water	27.72
Pounds per square inch	Feet of water	2.310
Pounds per square inch	Inches of mercury	2.04
Pounds per square inch	Atmospheres	0.0681
Feet of water	Pounds per square inch	0.434
Feet of water	Pounds per square foot	62.5
Feet of water	Inches of mercury	0.8824
Atmospheres	Pounds per square inch	14.696
Atmospheres	Inches of mercury	29.92
Atmospheres	Feet of water	34
Long tons	Pounds	2240
Short tons	Pounds	2000
Short tons	Long tons	0.89285

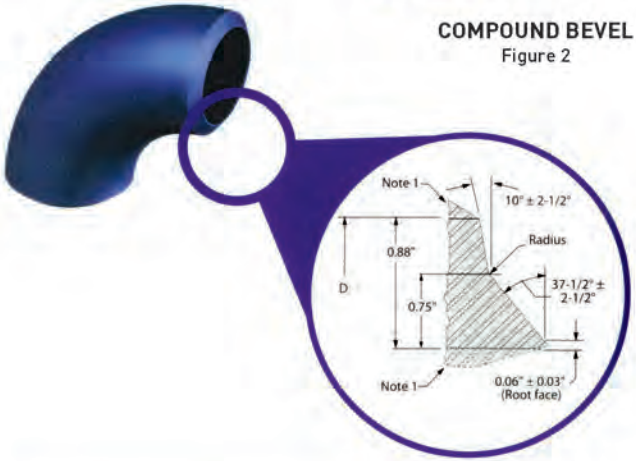
ENGLISJ-METRIC CONVERSION FACTORS		
Multiply	By	To Obtain
Millimeters	0.03937	Inches
Inches	25.4	Millimeters
Centimeters	0.3937	Inches
Inches	2.54	Centimeters
Meters	39.37	Inches
Inches	0.0254	Meters
Millimeters^2	0.00155	Inches^2
Inches^2	654.16	Millimeters^2
Millimeters^2	0.0000107639	Foot^2
Foot^2	92903.04	Millimeters^2
Kilograms	2.204624	Pounds
Pounds	0.453592	Kilograms
Kilograms/Centimeters^2	14.223	Pounds/Inches^2
Pounds/Inches^2	0.070307	Kilograms/Centimeters^2
Bars	14.504	Pounds/Inches^2
Pounds/Inches^2	0.0689	Bars
Millimeters of mercury	0.03937	Inches of mercury
Inches of mercury	25.4	Millimeters of mercury
Liters per minute	0.26417	Gallons per minute
Gallons per minute	3.785	Liters per minute
Liters	0.26414	Gallons
Gallons	3.785	Liters
Meters per second	3.281	Feet per second
Feet per second	0.3048	Meters per second
Cubic meters	35.3144	Cubic feet
Cubic feet	0.028317	Cubic meters

BEVEL DETAIL - WELDING FITTINGS

PLAIN BEVEL
Figure 1



COMPOUND BEVEL
Figure 2

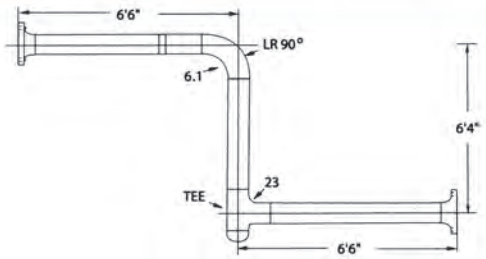


Wall Thickness(T)	End Preparation
Less than x [2]	Cut square or slightly chamfer, at manufacturer's option (not illustrated).
x to 0.88, inclusive	Plain bevel as in Figure 1 above.
More than 0.88	Compound bevel as in Figure 2 above.

Note:
1. See ASME B16.9 for transition contours.
2. x = 0.19 ″ for carbon steel or ferritic alloy steel and 0.12″ for austenitic alloy steel.

FLOW RESISTANCE EQUIVALENT LENGTH OF WELDBEND ELBOWS AND TEES

Nominal Pipe Size	Long Radius	Short Radius	Welding Tee
1	1.1	1.4	3.9
1-1/4	1.4	1.8	5.2
1-1/2	1.6	2.1	6.0
2	2.1	2.8	7.8
2-1/2	2.6	3.3	9.3
3	3.1	4.1	11.0
4	4.0	5.4	15.0
5	5.1	6.7	19.0
6	6.1	8.1	23.0
8	8.0	11.0	30.0
10	10.0	12.0	38.0
12	12.0	16.0	45.0
14	13.0	18.0	49.0
16	15.0	20.0	56.0
18	17.0	23.0	63.0
20	19.0	25.0	71.0
24	23.0	30.0	85.0
30	30.0	36.0	140.0
36	38.0	42.0	170.0
42	45.0	50.0	200.0
48	52.0	58.0	240.0



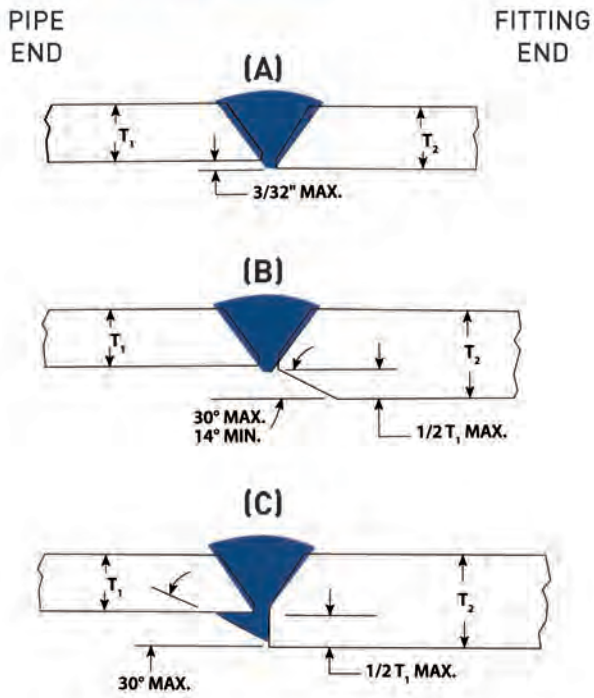
The infrmation given in the chart above illustrates the resestance of fittings ti the flow of liquids. This resistance is given in the equivalent of the straight pipe, and should be assumed as approximate information. Allowances have been made p for the curvature of elbows, so that the resistance values should be added to the total center-to end dimensions of the piping configuration.

Example using 6 ″ pipe:

Resistance of Pipe:	(6.6+6.4+6.6)	= 19.6
+ Resistance of Elbow:		= 6.1
Resistance of Tee:		= 23.0
		= 48.7

Therefore, the total resistance of the entire assembly to the flow of liquid would be equal to the resistance of 48.7 Linear feet of 6 ″ straight pipe.

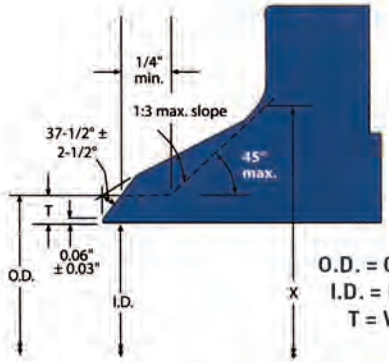
JOINING BUTTWELDING FITTINGS TO PIPE of equal or less wall thickness



NOTES

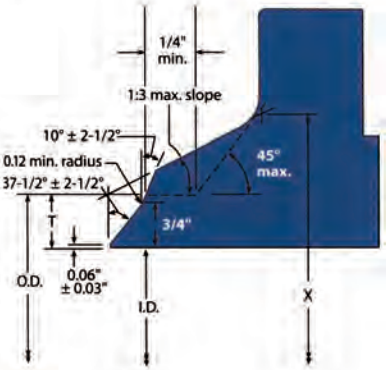
1. Buttwelding fittings can be joined to pipe of lesser wall thickness with proper end preparation and joint design.
2. Above diagrams and recommendations that follow apply to components with ends originally prepared as standard 37-1/2° or 30° degree bevels and where the wall thickness of the thicker end to be jined does not exceed 1-1/2times the thinner (pipe) end.
3. The nominal thickness T (pipe) end T (fitting) shall comply with the design requirements of the applicable section of the ASME B3¹1 Code For Pressure Piping.
4. Where the total nominal offser(T>T₁) dose not exceed 3/32" and full penetration and bonding is obtained during welding, no special treatment is required [see (A)].
5. When the internal offset exceeds 3/32", taper cut in accordance with (B) ... or tape weld in accordance with (C)
6. When joining ends with materials of unequal minimum specified yield strenghs (or unequal allowable stress), the deposited weld metal shall have mechanical properties at least equal to thoes of the higher strengh (pipe) end.
7. For treatments of ends with inequal external diameters and/or where T₂ is thicker than 1-1/2 times T₁, refer to the applicable section of the ASME Code, e., B31.4 or B31.8 or B16.9.

BEVEL FOR WELDNECK FLANGES



Bevel for Wall Thickness (T) from 0.19 in. to 0.88 in. Inclusive

O.D. = Outside Diameter of pipe
I.D. = Inside Diameter of pipe
T = Wall thickness of pipe



Bevel for Wall Thickness (T) Greater Than 0.88 in.

NOTES

1. All dimensions are in inches/
2. When the thickness of the hub at the bevel is greater than that of the pipe to which the flange is joined and the additional thickness is provided on the outside diameter, a taper weld having a slope not exceeding 1 to 3 may be employed ot, alternatively, the greater outside diameter may be tapered at the same maximum slope or less, from a point on the welding bevel equal to the outside diameter of the mating pipe. Similarly, when the greater thickness is provided on the inside of the flange, it shall be taper-bored from the welding end at the slope not exceeding 1 to 3. When flanges covered by this Standard are intended for services with light wall, hugher stengh pipe, the thickness of the hub at the bevel may be greater than that of the pipe to shich the flange is joined. Under there conditions, a single taper hub may be provided, and the outside diameter of the hub at the base (dimension X) may also be modified. The additional thickness may be provided on either inside or outside or partially on each side, but the total additional thickness shall not exceed one-half times the nominal wall thickness of intended mating pipe. See page 58.
3. The hub transition from the outside diameter to the X diameter shall fall within the maximum and minimum envelope outlined by the 1:3 max. slope and dashed line.
4. For welding end dimensions, refer to ASME B16.25.

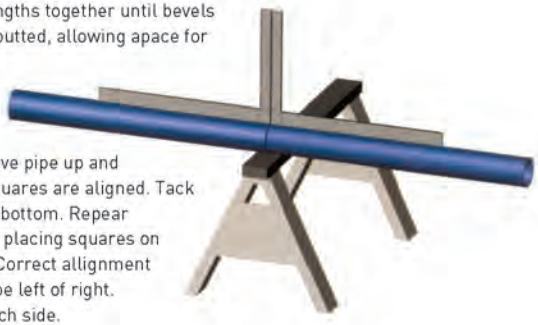
PIPE ALIGNMENT

Proper alignment is one of the most important tasks performed by the pipe filter.If done correctly, welding will be much easier and the piping system will be properly fabricated. if alignment is poor, however, welding will be difficult and the piping system may not function property.

Many device are available to aid alignment and methods of alignment vary widely throughout the trade. There is no best system ... any number of methods have proven successful. The procedures suggested by this manual are popular with many craftsmen and will enable you to quickly obtain good alignment.

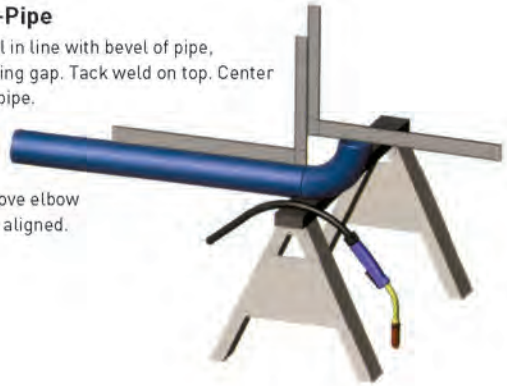
Pipe-to-Pipe

Move pipe lengths together until bevels are nearby abutted, allowing apace for welding gap. Center squares on top of both pipes and move pipe up and dawn until squares are aligned. Tack weld top and bottom. Repear procedure by placing squares on side of pipe. Correct allignment by moving pipe left of right. Tack weld each side.



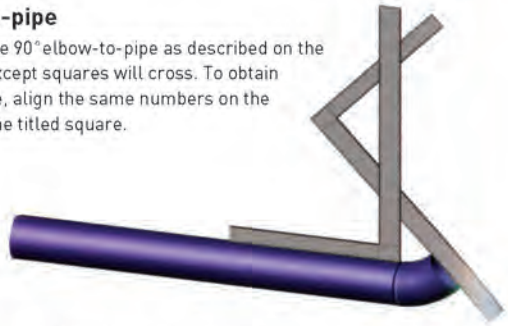
90° Elbow-to-Pipe

Place fitting bevel in line with bevel of pipe, allowing for welding gap. Tack weld on top. Center square on top of pipe. Center second square on elbow's alternate face. Move elbow until squares are aligned.



45° Elbow-to-pipe

Follow procedure 90° elbow-to-pipe as described on the previous page except squares will cross. To obtain correct 45° angle, align the same numbers on the inside scale of the titled square.

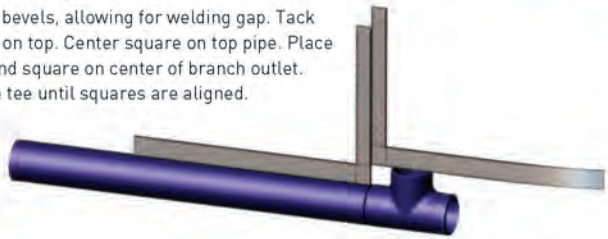


Alternate Method for 45° Elbow-to-pipe

Use same procedure to abut pipe and fitting. Center spirit level pipe. Next, center 45° spirit level on face of elbow and move elbow until 45° bubble is centered.

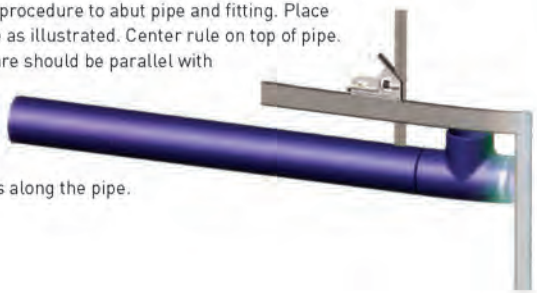
Tee-to-Pipe

Abut bevels, allowing for welding gap. Tack weld on top. Center square on top pipe. Place second square on center of branch outlet. Move tee until squares are aligned.



Alternate Method for Tee-to-Pipe

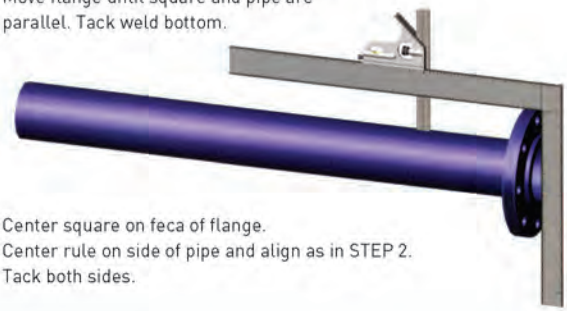
Follow same procedure to abut pipe and fitting. Place square on tee as illustrated. Center rule on top of pipe. Blade of square should be parallel with pipe. Check by measuring with rule at several points along the pipe.



Flange-to-Pipe

STEP 1. Abut flange to pipe. Align top two holes of flange with spirit level. Move flange until bubble centerd. Make one tack weld on top.

STEP 2. Center square on feca of flange. Center rule on top of pipe. Move flange until square and pipe are parallel. Tack weld bottom.



STEP 3. Center square on feca of flange. Center rule on side of pipe and align as in STEP 2. Tack both sides.

JIG FOR SMALL DIAMETER PIPING

Many pipe fitters have found this simple jig to be helpful in aligning small diameter pipe and elbows. It is made from channel iron approximately 3'9"long. Use 1/8" × 1-1/2" for pipe sizes 1-1/4" thru 3";, 1/8" ×3/4" for sizes 1" or smaller.

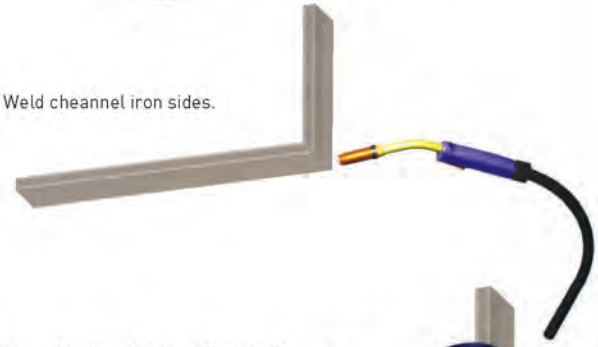
STEP 1. Mark 90° notch on side of channel iron about 9" from end. Make equal notch on other side.

STEP 2. Cut out notches with hack saw.

STEP 3. Heat Bottome of channel iron between the notches.

STEP 4. Bend channel iron to 90° angle.

STEP 5. Weld cheannel iron sides.



STEP 6. Place 90° Long Radius Elbow in jig. Saw half thru both sides of channel iron as shown in illustration. Repeat with other size elbows so jig may be used for several sizes.

STEP 7. Place used hack saw blade in slot to obtain proper alignment and correct welding gap.