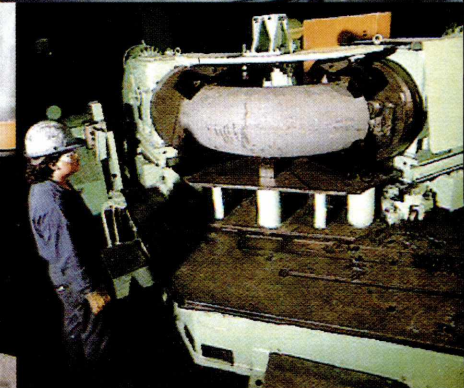
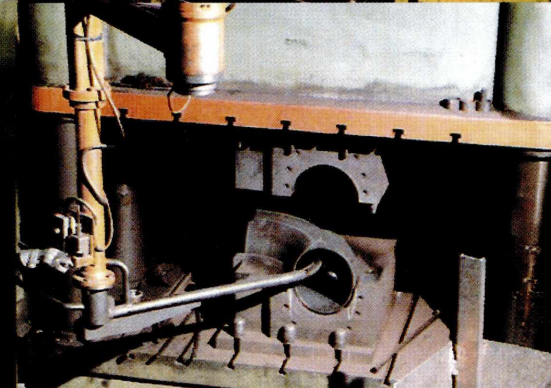
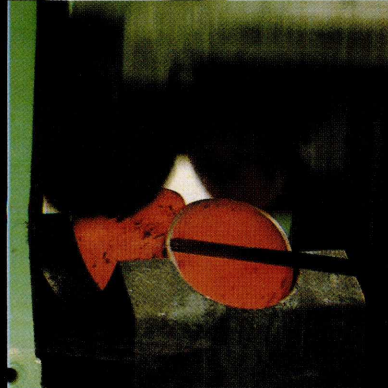
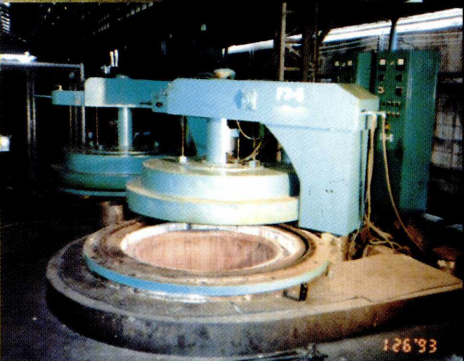
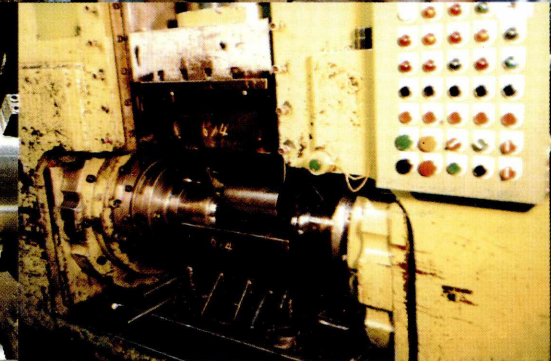
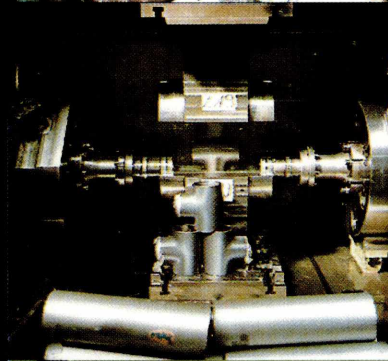
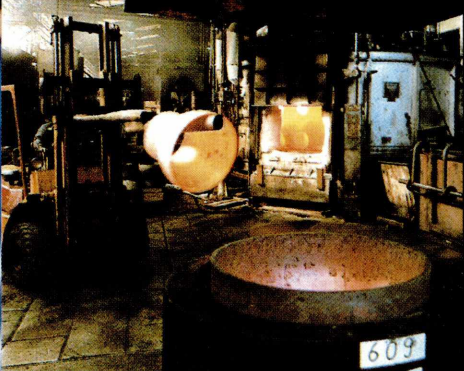
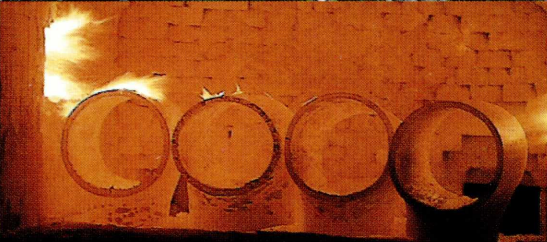
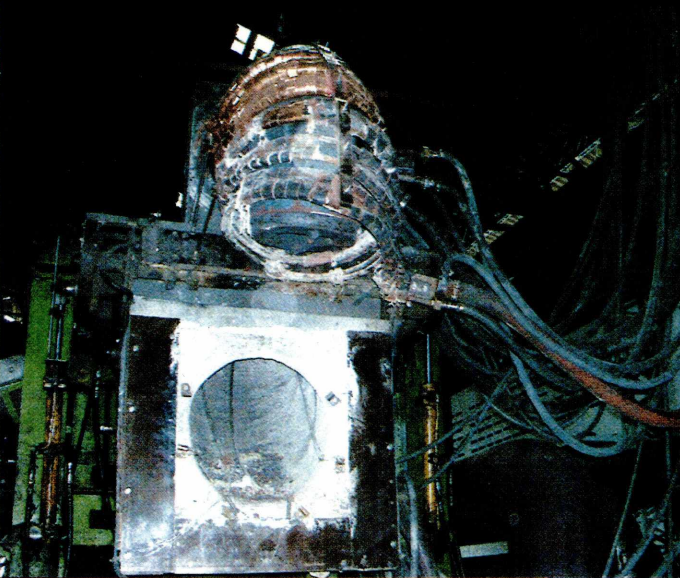
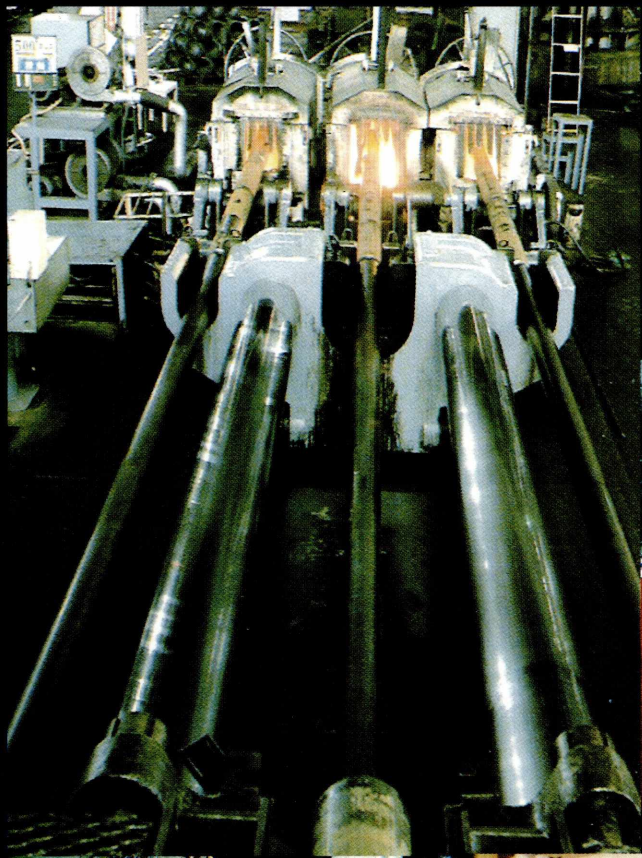


TTU BUTT WELDING FITTINGS



TTU Fittings

MARK OF QUALITY



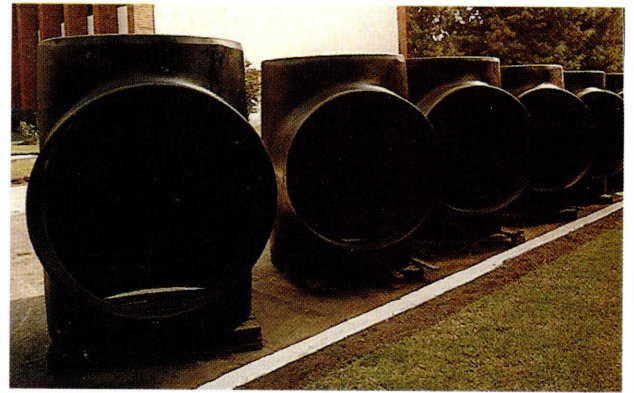


TTU's Butt Welding Fittings

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The Fittings Specialist
Mark of Quality



TTU : Introduction

TTU is the producer of quality *BUTT-WELDING FITTINGS*. Our products are found in various fields such as the petrochemical, chemical, shipbuilding and construction industries.

We are accepted worldwide for our excellence in quality, reliability and our uncompromising services to each of our customers.

PROFILE

OUR FACTORY covers 16,800 square meters on the fastest growing industrial region of South East Asia. With the work force of 150 employees working around the clock, we are able to process over **12,000 metric tons of fittings annually**.

SERVICES

OUR WAREHOUSE holds one of the largest and the most complete lines of fittings available from any single source. We offer fast and on time delivery to our clients. Furthermore, we also tailor each order to suite each of our customer's needs.

QUALITY ASSURANCE

We maintain one of the most strict quality control standards for all of our products to meet the most updated **ASTM, ANSI and MSS standard** specifications. All fittings are subjected to a comprehensive and stringent company's established quality assurance system that begins with careful selection of raw material from qualified steel mills and continues through our all production stages up to delivery. We guarantee traceability from the unfurnished pipes to the complete final fittings. Destructive and non-destructive testing such as hardness, tensile, and yield strength tests are performed periodically to ensure consistent high quality.

WORLDWIDE SALES NETWORK

We maintain one of the most extensive sales networks around the world. The following are some of the countries that we regularly contact.

Argentina	Australia	Bahrain
Bangladesh	Brazil	Brunei
Canada	Chile	Colombia
Cyprus	Egypt	France
Germany	India	Indonesia
Iran	Israel	Italy
Japan	Korea	Kuwait
Malaysia	Mexico	New Zealand
Nigeria	Oman	Pakistan
Philippines	Portugal	Qatar
Russia	Saudi Arabia	Singapore
South Africa	Taiwan	UAE
West Indies		



CALTEX



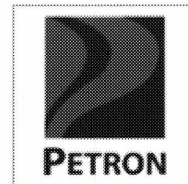
TOTAL



PETRO-CANADA



SASOL
nothing new from us



PETRON



Lanka IOC

ABB



PETRONAS



tüprasa (TÜRKİYE PETROL Rafinerileri Anonim Şirketi)

nacap

Technip



Saipem

BAPCO

IHI

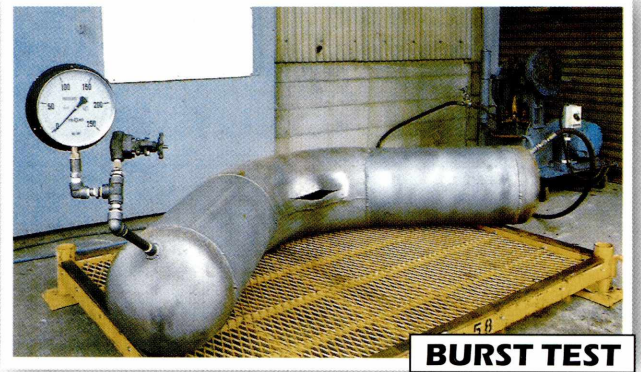
BHP



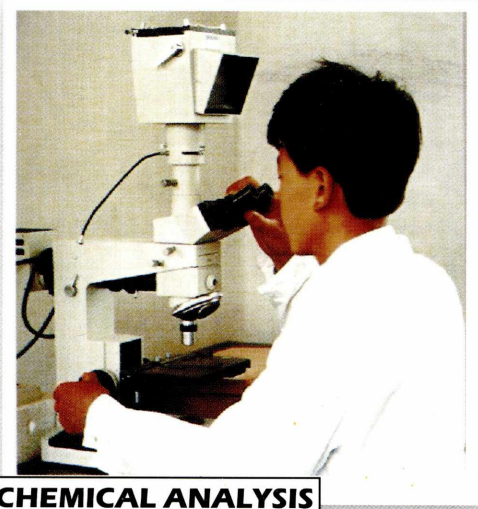
Thai Nippon Steel Engineering & Construction

Tüprás
TÜRKİYE PETROL RAFİNERİLERİ ANONİM ŞİRKETİ

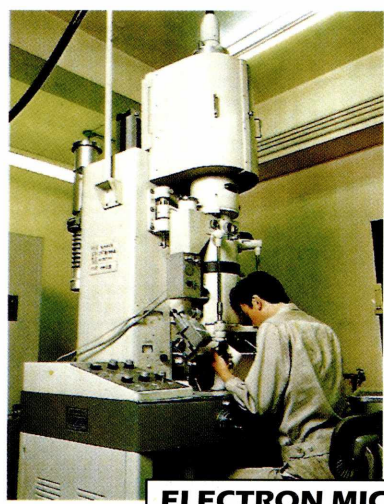
QUALITY ASSURANCE



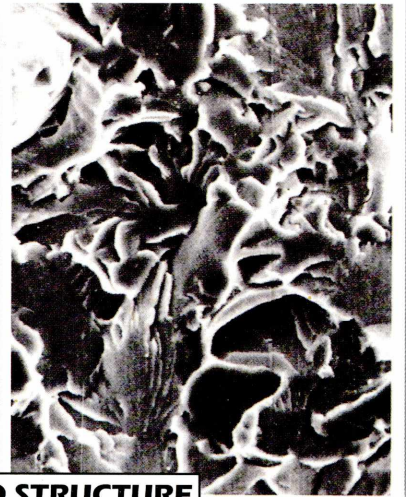
BURST TEST



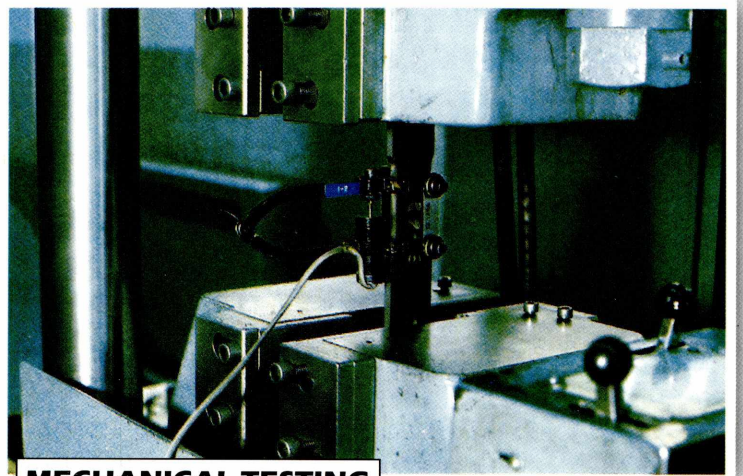
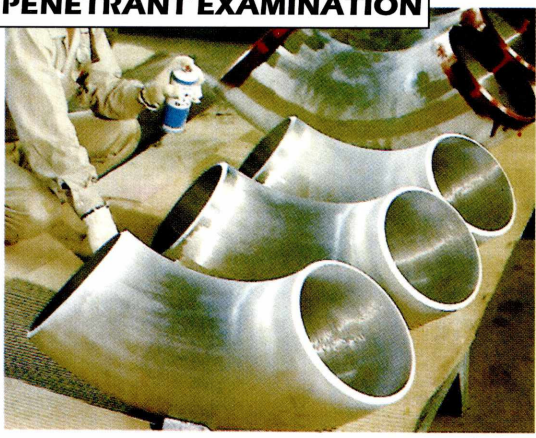
CHEMICAL ANALYSIS



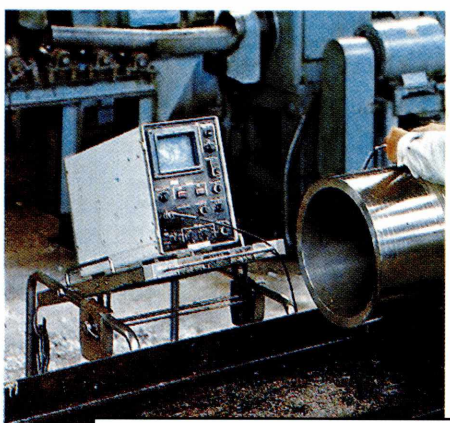
ELECTRON MICRO STRUCTURE



PENETRANT EXAMINATION

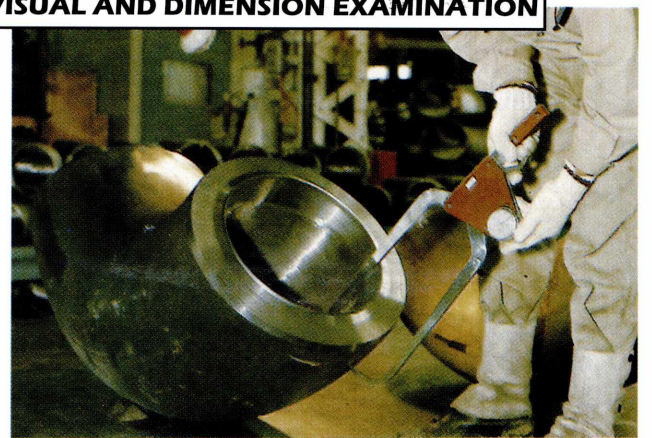


MECHANICAL TESTING



ULTRASONIC EXAMINATION

VISUAL AND DIMENSION EXAMINATION



Quality Assurance

TTU's Butt Welding Fittings are stringently manufactured in accordance to applicable standard ASTM, ANSI, ASME, MSS codes and standards from initial incoming raw material till final shipping. Strict in-process inspections are carried out and tested to ensure conformity to standards.

Quality, Quantity and Fast Service is the principle of our company.

Applicable Specifications

TTU Butt Welding Fittings are manufactured according to the following standard specifications

- Dimensions, Shapes & Tolerance
ANSI B 16.9
ANSI B 16.28
- Weld End Preparation
ANSI B 16.25
- Manufacturing Methods
ASTM A234
ASTM A403
ASTM A420
- On Application
MSS SP-43
MSS SP-75

Inspection Procedure

Raw Material

- Dimensional Inspection
- Surface Visual Inspection
- Traceability Identification
- Random Physical and Chemical Analysis

In-Process Inspection

- Visual Inspection
- Dimensional Inspection
- Shape Inspection
- Hardness Test
- Forming Temperature Check
- Traceability Identification
- Ultrasonic Examination
- Magnetic Particle Examination
- Liquid Penetrate Examination
- Ultrasonic Thickness Check
- Impact Test

Final Inspection

- Visual Inspection
- Special Inspection (on demand)
- Third Party Inspection (on demand)
- Inspection Certification issued
- Quantity Surve
- Packing Inspection



UNIVERSAL CODE COMPLIANCE SDN. BHD.



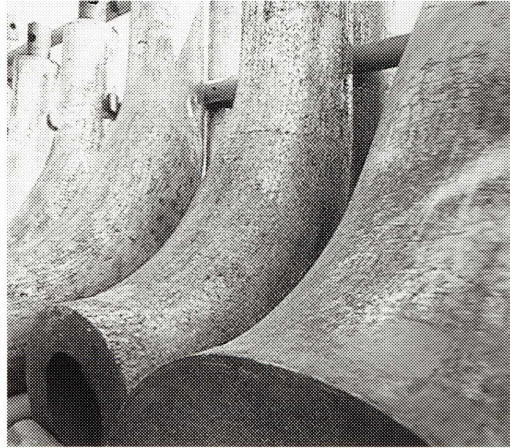
Technitrol • Eco
recherches • research



Applicable Standards

ANSI Standards

- B16.9 Wrought Steel Butt-Welding Fittings
- B16.28 Wrought Steel Butt-Welding Fittings Short Radius Elbows and Returns
- B16.11 Forged Steel Fittings Socket Welding and Threaded
- B36.10 Welded & Seamless Wrought Steel Pipe
- B36.19 Stainless Steel Pipe



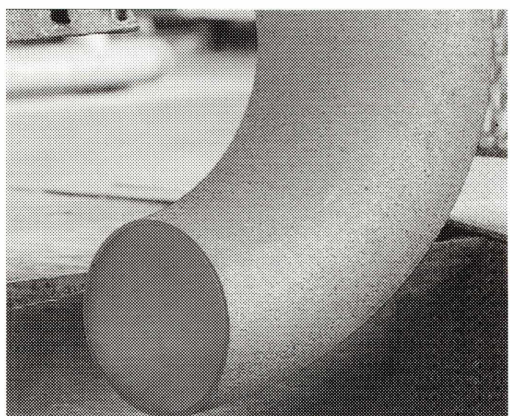
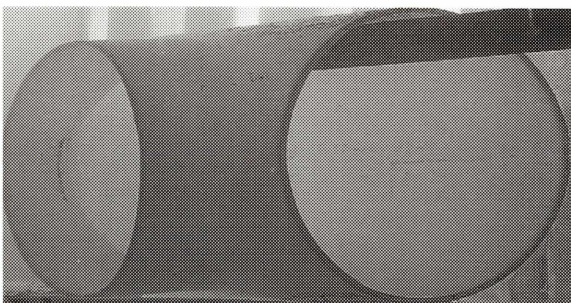
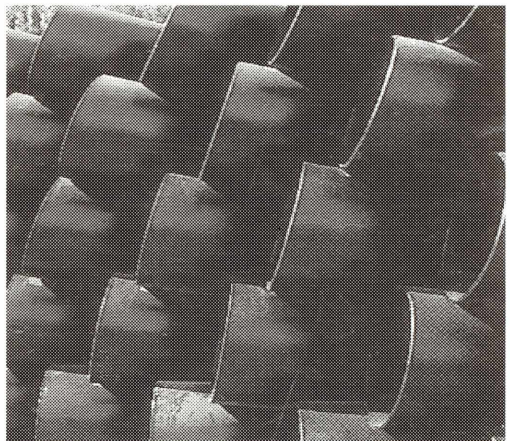
ASTM Standards

- A234 Piping Fittings of Wrought Carbon Steel and Alloy Steel of Moderate and Elevated Temperatures
- A403 Wrought Austenitic Stainless Steel Piping Fittings
- A420 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Service
- A182 Forges or Rolled Alloy-Steel Pipe Flanges, Forges Fittings, and Valves and Parts for High Temperatures Service
- A105 Forgings, Carbon Steel, For Piping Components
- B361 Wrought Aluminium and Aluminium-Alloy Welding Fittings
- B363 Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
- B366 Wrought Nickel and Nickel Alloy Welding Fittings



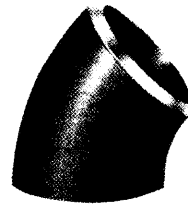
MSS Standards

- SP-43 Wrought Stainless Steel Butt-Welding Fittings
- SP-75 Specification for High Test Wrought Welding Fittings

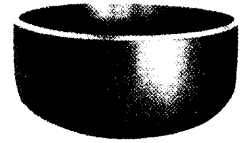


Wrought Steel Butt-Welding Fittings

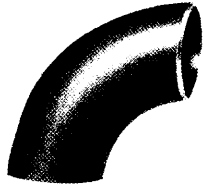
(Carbon and Alloy Steel)



45° Elbow (Long)



Cap



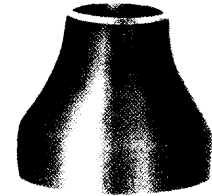
90° Elbow (Long)



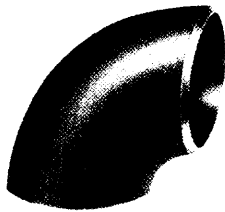
180° Elbow (Long)



T (Straight)



Reducer (Concentric)



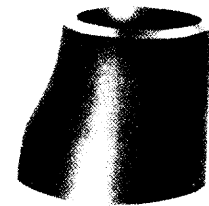
90° Elbow (Short)



180° Elbow (Short)

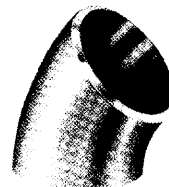


T (Reducing)

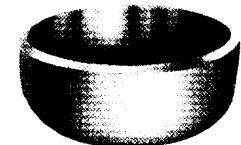


Reducer (Eccentric)

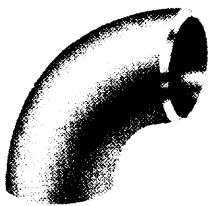
Stainless Steel Butt-Welding Fittings



45° Elbow (Long)



Cap



90° Elbow (Long)



T (Straight)



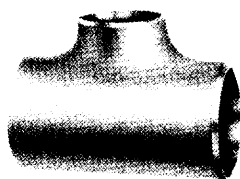
Reducer (Concentric)



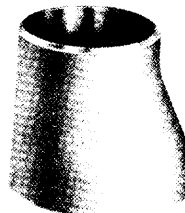
Lap Joint Stub End



90° Elbow (Short)

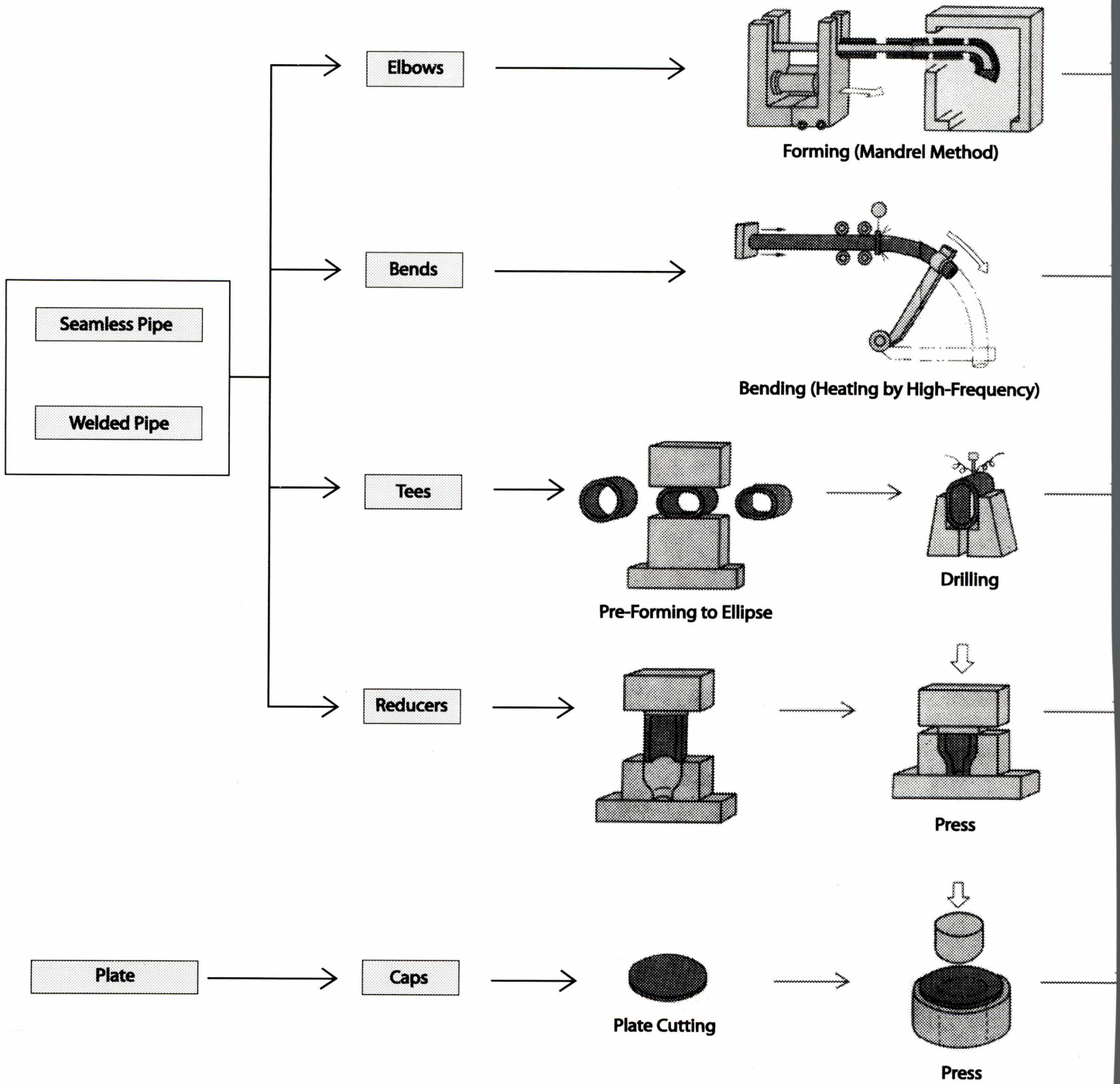


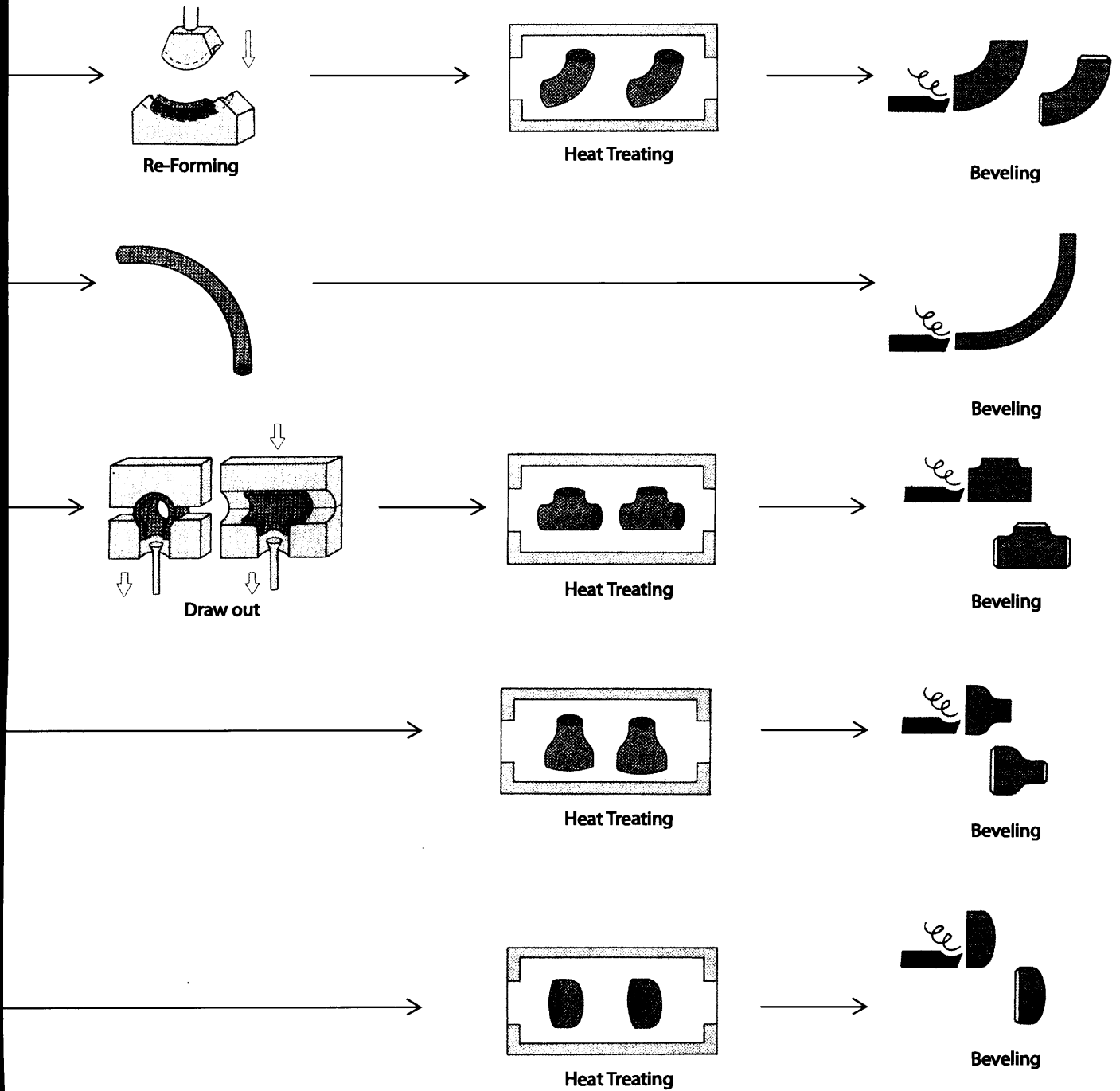
T (Reducing)



Reducer (Eccentric)

MANUFACTURING PROCESS OF TTU BUTT-WELDING FITTINGS





Wall Thickness Schedules

Nominal Pipe Size		Outside Diameter		Nominal Wall Thickness								
A	B	JIS	ANSI	Sch 5S	Sch 10S	Sch 20S	GS	Sch 10	LG (7.9)	Sch 20	Sch 30	STD
8	1/4	13.8	13.7	1.2	1.65	2.0	2.3	--	--	--	--	(2.2)
10	3/8	17.3	17.1	1.2	1.65	2.0	2.3	--	--	--	--	(2.3)
15	1/2	21.7	21.3	1.65	2.1	2.5	2.8	--	--	--	--	(2.8)
20	3/4	27.2	26.7	1.65	2.1	2.5	2.8	--	--	--	--	(2.9)
25	1	34.0	33.4	1.65	2.8	3.0	3.2	--	--	--	--	(3.4)
32	1-1/4	42.7	42.2	1.65	2.8	3.0	3.5	--	--	--	--	(3.6)
40	1-1/2	48.6	48.3	1.65	2.8	3.0	3.5	--	--	--	--	(3.7)
50	2	60.5	60.3	1.65	2.8	3.5	3.8	--	--	--	--	(3.9)
65	2-1/2	76.3	73.0	2.1	3.0	3.5	4.2	--	--	--	--	(5.2)
80	3	89.1	88.9	2.1	3.0	4.0	4.2	--	--	--	--	(5.5)
90	3-1/2	101.6	101.6	2.1	3.0	4.0	4.2	--	--	--	--	(5.7)
100	4	114.3	114.3	2.1	3.0	4.0	4.5	--	--	--	--	(6.0)
125	5	139.8	141.3	2.8	3.4	5.0	4.5	--	--	--	--	(6.6)
150	6	165.2	168.3	2.8	3.4	5.0	5.0	--	5.0**	--	--	(7.1)
175	7	190.7	--	--	--	--	5.3	--	--	--	--	--
200	8	216.3	219.1	2.8	3.8	6.5	5.8	--	5.8**	6.4	7.0	(8.2)
225	9	241.8	--	--	--	--	6.2	--	--	--	--	--
250	10	267.4	273.1	3.4	4.2	6.5	6.6	--	6.6**	6.4	7.8	(9.3)
300	12	318.5	323.9	4.0	4.6	6.5	6.9	--	6.9**	6.4	8.4	9.5
350	14	355.6	355.6	4.0	4.8	7.9	7.9	6.4	7.9	7.9	9.5	9.5
400	16	406.4	406.4	4.2	4.8	7.9	7.9	6.4	7.9	7.9	9.5	9.5
450	18	457.2	457.2	4.2	4.8	7.9	7.9	6.4	7.9	7.9	11.1	9.5
500	20	508.0	508.0	4.8	5.5	7.9	7.9	6.4	7.9	9.5	12.7	9.5
550	22	558.8	558.8	4.8	5.5	--	--	6.4	7.9	9.5	12.7	9.5
600	24	609.6	609.6	5.5	6.4	--	--	6.4	7.9	9.5	14.3	9.5
650	26	660.4	660.4	--	--	--	--	7.9	7.9	12.7	--	9.5
700	28	711.2	711.2	--	--	--	--	7.9	7.9	12.7	15.9	9.5
750	30	762.0	762.0	6.4	7.9	--	--	7.9	7.9	12.7	15.9	9.5
800	32	812.8	812.8	--	--	--	--	7.9	7.9	12.7	15.9	9.5
850	34	863.6	863.6	--	--	--	--	7.9	7.9	12.7	15.9	9.5
900	36	914.4	914.4	--	--	--	--	7.9	7.9	12.7	15.9	9.5
950	38	965.2	965.2	--	--	--	--	--	7.9	--	--	9.5
1000	40	1016.0	1016.0	--	--	--	--	--	7.9	--	--	9.5
1050	42	1066.8	1066.8	--	--	--	--	--	7.9	--	--	9.5
1100	44	1117.6	1117.6	--	--	--	--	--	7.9	--	--	9.5
1150	46	1168.4	1168.4	--	--	--	--	--	7.9	--	--	9.5
1200	48	1219.2	1219.2	--	--	--	--	--	7.9	--	--	9.5
1250	50	1270.0	1270.0	--	--	--	--	--	*7.9	--	--	*9.5
1300	52	1320.8	1320.8	--	--	--	--	--	*7.9	--	--	*9.5
1350	54	1371.6	1371.6	--	--	--	--	--	*7.9	--	--	*9.5
1400	56	1422.4	1422.4	--	--	--	--	--	*7.9	--	--	*9.5
1450	58	1473.2	1473.2	--	--	--	--	--	*7.9	--	--	*9.5
1500	60	1524.0	1524.0	--	--	--	--	--	*7.9	--	--	*9.5

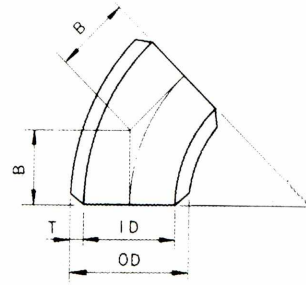
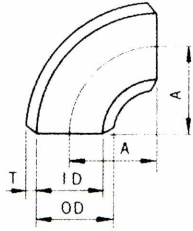
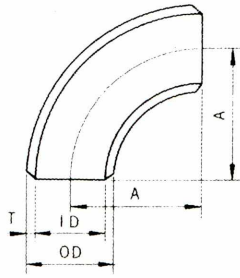
- Note : 1. * TTU's standard
 2. ** Applied only small end side of the tee and reducers.
 3. The numerical values in parenthesis are the same thickness as Sch. 40 or Sch. 80.

JIS G3448 ANSI B36.10M
JIS G3454 ANSI B36.19M
JIS G3455
JIS G3459

(in mm)

Nominal Wall Thickness									Outside Diameter		Nominal Pipe Size	
Sch 40	Sch 60	XS	Sch 80	Sch 100	Sch 120	Sch 140	Sch 160	XXS	JIS	ANSI	A	B
2.2	2.4	(3.0)	3.0	—	—	—	—	—	13.8	13.7	8	1/4
2.3	2.8	(3.2)	3.2	—	—	—	—	—	17.3	17.1	10	3/8
2.8	3.2	(3.7)	3.7	—	—	—	4.7	7.5	21.7	21.3	15	1/2
2.9	3.4	(3.9)	3.9	—	—	—	5.5	7.8	27.2	26.7	20	3/4
3.4	3.9	(4.5)	4.5	—	—	—	6.4	9.1	34.0	33.5	25	1
3.6	4.5	(4.9)	4.9	—	—	—	6.4	9.7	42.7	42.2	32	1-1/4
3.7	4.5	(5.1)	5.1	—	—	—	7.1	10.2	48.6	48.3	40	1-1/2
3.9	4.9	(5.5)	5.5	—	—	—	8.7	11.1	60.5	60.3	50	2
5.2	6.0	(7.0)	7.0	—	—	—	9.5	14.0	76.3	73.0	65	2-1/2
5.5	6.6	(7.6)	7.6	—	—	—	11.1	15.2	89.1	88.9	80	3
5.7	7.0	(8.1)	8.1	—	—	—	12.7	—	101.6	101.6	90	3-1/2
6.0	7.1	(8.6)	8.6	—	11.1	—	13.5	17.1	114.3	114.3	100	4
6.6	8.1	(9.5)	9.5	—	12.7	—	15.9	19.0	139.8	141.3	125	5
7.1	9.3	(11.0)	11.0	—	14.3	—	18.2	21.9	165.2	168.3	150	6
—	—	—	—	—	—	—	—	—	190.7	—	175	7
8.2	10.3	(12.7)	12.7	15.1	18.2	20.6	23.0	22.2	216.3	219.1	200	8
—	—	—	—	—	—	—	—	—	241.8	—	225	9
9.3	12.7	12.7	15.1	18.3	21.4	25.4	28.6	25.4	267.4	273.1	250	10
10.3	14.3	12.7	17.4	21.4	25.4	28.6	33.3	25.4	318.5	323.9	300	12
11.1	15.1	12.7	19.0	23.8	27.8	31.8	35.7	—	355.6	355.6	350	14
12.7	16.7	12.7	21.4	26.2	30.9	36.5	40.5	—	406.4	406.4	400	16
14.3	19.0	12.7	23.8	29.4	34.9	39.7	45.2	—	457.2	457.2	450	18
15.1	20.6	12.7	26.2	32.5	38.1	44.4	50.0	—	508.0	508.0	500	20
—	22.2	12.7	28.6	34.9	41.3	47.6	54.0	—	558.8	558.8	550	22
17.5	24.6	12.7	31.0	38.9	46.0	52.4	59.5	—	609.6	609.6	600	24
—	—	12.7	—	—	—	—	—	—	660.4	660.4	650	26
—	—	12.7	—	—	—	—	—	—	711.2	711.2	700	28
—	—	12.7	—	—	—	—	—	—	762.0	762.0	750	30
17.5	—	12.7	—	—	—	—	—	—	812.8	812.8	800	32
17.5	—	12.7	—	—	—	—	—	—	863.6	863.6	850	34
19.1	—	12.7	—	—	—	—	—	—	914.4	914.4	900	36
—	—	12.7	—	—	—	—	—	—	965.2	965.2	950	38
—	—	12.7	—	—	—	—	—	—	1016.0	1016.0	1000	40
—	—	12.7	—	—	—	—	—	—	1066.8	1066.8	1050	42
—	—	12.7	—	—	—	—	—	—	1117.6	1117.6	1100	44
—	—	12.7	—	—	—	—	—	—	1168.4	1168.4	1150	46
—	—	12.7	—	—	—	—	—	—	1219.2	1219.2	1200	48
—	—	*12.7	—	—	—	—	—	—	1270.0	1270.0	1250	50
—	—	*12.7	—	—	—	—	—	—	1320.8	1320.8	1300	52
—	—	*12.7	—	—	—	—	—	—	1371.6	1371.6	1350	54
—	—	*12.7	—	—	—	—	—	—	1422.4	1422.4	1400	56
—	—	*12.7	—	—	—	—	—	—	1473.2	1473.2	1450	58
—	—	*12.7	—	—	—	—	—	—	1524.0	1524.0	1500	60

Long and Short Radius Elbows

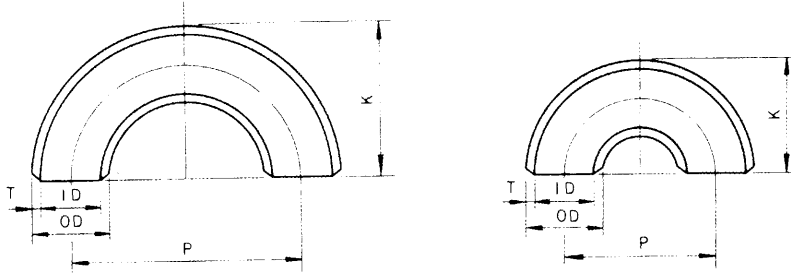


ANSI B16.9 B16.28

* TTU's standard (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D	Center-to-End			
		Long Radius Elbow		Short Radius Elbow	
		90 Deg. A	45 Deg. B	90 Deg. A	45 Deg. B
1/2	21.3	38.1	15.7	—	—
3/4	26.7	28.4	11.2	—	—
1	33.4	38.1	22.4	25.4	—
1-1/4	42.2	47.8	25.4	31.8	—
1-1/2	48.3	57.2	28.4	38.1	—
2	60.3	76.2	35.1	50.8	—
2-1/2	73.0	95.2	44.4	63.5	—
3	88.9	114.3	50.8	76.2	31.6
3-1/2	101.6	133.4	57.2	88.9	36.8
4	114.3	152.4	63.5	101.6	42.1
5	141.3	190.5	79.2	127.0	52.6
6	168.3	228.6	95.2	152.4	63.4
8	219.1	304.8	127.0	203.2	84.2
10	273.1	381.0	158.8	254.0	105.2
12	323.9	457.2	190.5	304.8	126.3
14	355.6	533.4	222.2	355.6	147.3
16	406.4	609.6	254.0	406.4	168.3
18	457.2	685.8	285.8	457.2	189.4
20	508.0	762.0	317.5	508.0	210.4
22	558.8	838.2	342.9	558.8	231.5
24	609.6	914.4	381.0	609.6	252.5
26	660.4	990.6	406.4	660.4	273.5
28	711.2	1066.8	438.2	711.2	294.6
30	762.0	1143.0	469.9	762.0	315.6
32	812.8	1219.2	501.6	812.8	378.1
34	863.6	1295.4	533.4	863.6	357.7
36	914.4	1371.6	565.2	914.4	378.8
38	965.2	1447.8	599.9	—	—
40	1016.0	1524.0	632.0	1016.0	420.8
42	1066.8	1600.2	660.4	1066.8	441.9
44	1117.6	1676.4	695.5	1117.6	462.9
46	1168.4	1752.6	726.9	—	—
48	1219.2	1828.8	759.0	1219.2	505.0
54*	1371.6	2057.4	852.2	1371.6	568.1
52*	1320.8	—	—	1320.8	547.1
56*	1422.4	2133.6	883.8	1422.4	589.2
60*	1524.0	2286.0	946.9	1524.0	631.3
66*	1676.4	2514.6	1041.6	—	—

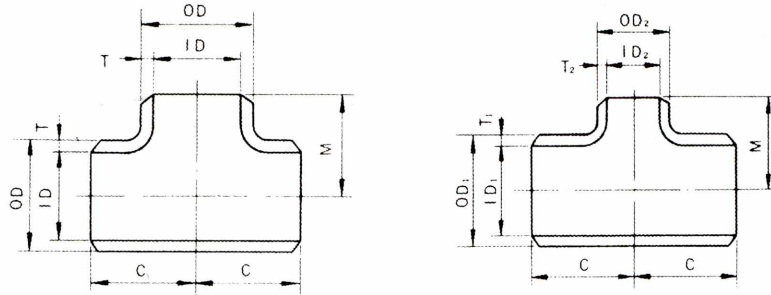
Long and Short Radius Return Elbows



ANSI B16.9
ANSI B16.28 (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D	Long Radius		Short Radius	
		Center-to-Center P	Back-to-Face K	Center-to-Center P	Back-to-Face K
1/2	21.3	76.2	47.8	—	—
3/4	26.7	57.2	42.9	—	—
1	33.4	76.2	55.6	50.8	41.1
1-1/4	42.2	95.2	69.8	63.5	52.3
1-1/2	48.3	114.3	82.6	76.2	62.0
2	60.3	152.4	106.4	101.6	81.0
2-1/2	73.0	109.5	131.8	127.0	100.1
3	88.9	228.6	158.8	152.4	120.7
3-1/2	101.6	266.7	184.2	177.8	139.7
4	114.3	304.8	209.6	203.2	158.8
5	141.3	381.0	261.9	254.0	196.9
6	168.3	457.2	312.7	304.8	236.5
8	219.1	609.6	414.3	406.4	312.7
10	273.1	762.0	517.7	508.0	390.7
12	323.9	914.4	619.3	609.6	466.9
14	355.6	1066.8	711.2	711.2	533.4
16	406.4	1219.2	812.8	812.8	609.6
18	457.2	1371.6	914.4	914.4	685.8
20	508.0	1524.0	1016.0	1016.0	762.0
22	558.8	1676.4	1117.6	1117.6	838.2
24	609.6	1828.8	1219.2	1219.2	914.4

Straight and Reducing Tees



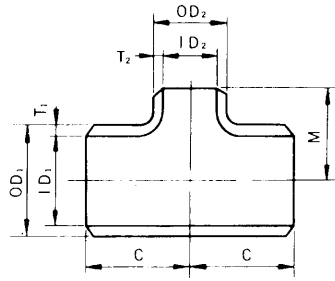
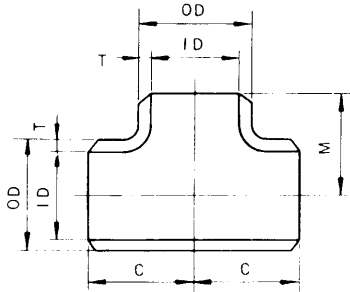
**MSS SP-75
ANSI B16.9**

* TTU's standard (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End	
	Run	Outlet	Run C	Outlet(1) M		Run	Outlet	Run C	Outlet(1) M
1/2 x 1/2	21.3	21.3	25.4	25.4	5 x 5	141.3	141.3	124.0	124.0
3/8		17.1		25.4	4		114.3		117.3
1/4		13.7		25.4	3-1/2		101.6		114.3
3/4 x 3/4	26.7	26.7	28.4	28.4	3		88.9		111.3
1/2		21.3		28.4	2-1/2		73.0		108.0
3/8		17.1		28.4	2		60.3		104.6
1 x 1	33.4	33.4	38.1	38.1	1-1/2*		48.3		
3/4		26.7		38.1	6 x 6	168.3	168.3	142.7	142.7
1/2		21.3		38.1	5		141.3		136.7
1-1/4 x 1-1/4	42.2	42.2	47.8	47.8	4		114.3		130.0
1		33.4		47.8	3-1/2		101.6		127.0
3/4		26.7		47.8	3		88.9		124.0
1/2		21.3		47.8	2-1/2		73.0		120.6
1-1/2 x 1-1/2	48.3	48.3	57.2	57.2	2*		60.3		
1-1/4		42.2		57.2	8 x 8	219.1	219.1	177.8	177.8
1		33.4		57.2	6		168.3		168.1
3/4		26.7		57.2	5		141.3		162.1
1/2		21.3		57.2	4		114.3		155.4
2 x 2	60.3	60.3	63.5	63.5	3-1/2		101.6		152.4
1-1/2		48.3		60.5	3*		88.9		
1-1/4		42.2		57.2	10 x 10	273.1	273.1	215.9	215.9
1		33.4		50.8	8		219.1		203.2
3/4		26.7		44.4	6		168.3		193.5
1/2*		21.3			5		141.3		190.5
2-1/2 x 2-1/2	73.0	73.0	76.2	76.2	4		114.3		184.2
2		60.3		69.8	12 x 12	323.9	323.9	254.0	254.0
1-1/2		48.3		66.5	10		273.1		241.3
1-1/4		42.2		63.5	8		219.1		228.6
1		33.4		57.2	6		168.3		218.9
3 x 3	88.9	88.9	85.9	85.9	5		141.3		215.9
2-1/2		73.0		82.6	14 x 14	355.6	355.6	279.4	279.4
2		60.3		76.2	12		323.9		269.7
1-1/2		48.3		73.2	10		273.1		257.0
1-1/4		42.2		69.8	8		219.1		247.6
1*		33.4			6		168.3		238.3
3-1/2 x 3-1/2	101.6	101.6	95.2	95.2	16 x 16	406.4	406.4	304.8	304.8
3		88.9		91.9	14		355.6		304.8
2-1/2		73.0		88.9	12		323.9		295.1
2		60.3		82.6	10		273.1		282.4
1-1/2		48.3		79.2	8		219.1		273.0
4 x 4	114.3	114.3	104.6	104.6	6		168.3		263.7
3-1/2		101.6		101.6	18 x 18	457.2	457.2	342.9	342.9
3		88.9		98.6	16		406.4		330.2
2-1/2		73.0		95.2	14		355.6		330.2
2		60.3		88.9	12		323.9		320.5
1-1/2		48.3		85.9	10		273.1		307.8
1-1/4*		42.2			8		219.1		298.4
1*		33.5							

Note (1) Outlet dimension "M" for run sizes 14 and larger is recommended but not mandatory.

Straight and Reducing Tees



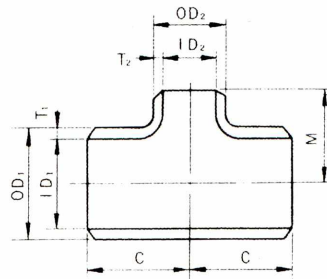
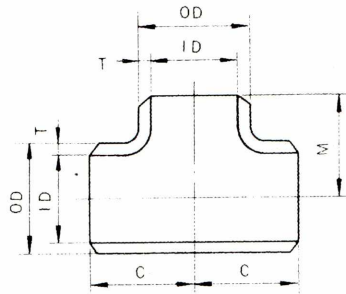
**MSS SP-75
ANSI B16.9**

* TTU's standard (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End															
	Run	Outlet	Run C	Outlet ⁽¹⁾ M		Run	Outlet	Run C	Outlet ⁽¹⁾ M														
20 x 20	508.0	508.0	381.0	381.0	30 x 12	762.0	323.9	558.8	472.6														
18		457.2		369.3	10		273.1		460.2														
16		406.4		355.6	32 x 32	812.8	812.8	596.9	596.9														
14		355.6		355.6						30	762.0		584.2										
12		323.9		345.9						28	711.2		571.5										
10		273.1		333.2						26	660.4		571.5										
8		219.1		323.8						24	609.6		558.8										
22 x 22	558.8	558.8	419.1	419.1						22	558.8		546.1										
										20	508.0		533.4										
					18	457.2		520.7															
					16	406.4		508.0															
					14	355.6		508.0															
24 x 24	609.6	609.6	431.8	431.8	34 x 34	863.6	863.6	635.0	635.0														
										32	812.8		622.3										
										30	762.0		609.6										
										28	711.2		596.9										
										26	660.4		596.9										
										24	609.6		584.2										
										22	558.8		571.5										
										20	508.0		558.8										
26 x 26	660.4	660.4	495.3	495.3	36 x 36	914.4	914.4	673.1	673.1														
										34	863.6		660.4										
										32	812.8		647.7										
										30	762.0		635.0										
										28	711.2		622.3										
										26	660.4		622.3										
										24	609.6		609.6										
										22	558.8		596.9										
28 x 28	711.2	711.2	520.7	520.7	20	508.0	508.0	584.2	584.2														
										18	457.2		571.5										
										16	406.4		558.8										
										14	355.6		546.1										
										12	323.1		533.4										
										30 x 30	762.0	762.0	558.8	558.8	38 x 38	965.2	965.2	711.2	711.2				
																				36	914.4		711.2
																				34	863.6		698.5
32	812.8		685.8																				
30	762.0		673.1																				
28	711.2		647.7																				
26	660.4		647.7																				
24	609.6		635.0																				
22	558.8		622.3																				
20	508.0		609.6																				
18	457.2		596.9																				
16	406.4		482.6																				
14	355.6		482.6																				

Note (1) Outlet dimension "M" for run sizes 14 and larger is recommended but not mandatory.

Straight and Reducing Tees



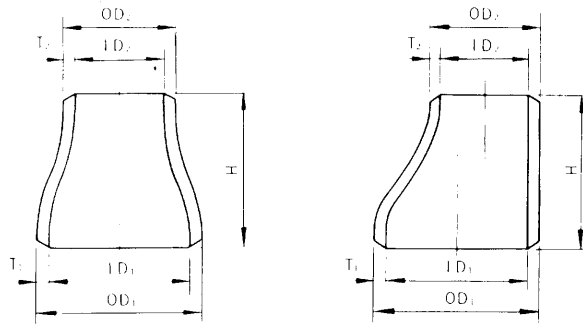
**MSS SP-75
ANSI B16.9**

* TTU's standard (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End	
	Run	Outlet	Run C	Outlet ⁽¹⁾ M		Run	Outlet	Run C	Outlet ⁽¹⁾ M
40 x 40	1016.0	1016.0	749.3	749.3	46 x 26	1168.4	660.4	850.9	736.6
38		965.2		749.3	24		609.6		723.9
36		914.4		736.6	20*		508.0		723.9
34		863.6		723.9	48 x 48	1219.2	1219.2	889.0	838.2
32		812.8		711.2	46		1168.4		838.2
30		762.0		698.5	44		1117.6		838.2
28		711.2		673.1	42		1066.8		812.8
26		660.4		673.1	40		1016.0		812.8
24		609.6		660.4	38		965.2		812.8
22		558.8		647.7	36		914.4		787.4
20		508.0		635.0	34		863.6		787.4
18		457.2		622.3	32		812.8		787.4
					30		762.0		762.0
42 x 42	1066.8	1066.8	762.0	711.2	28		711.2		762.0
40		1016.0		711.2	26		660.4		762.0
38		965.2		711.2	24		609.6		736.6
36		914.4		711.2	22		558.8		736.6
34		863.6		711.2	52 x 52*	1320.8	1320.8	965.2	914.4
32		812.8		711.2	48*		1219.2		863.6
30		762.0		711.2	44*		1117.6		812.8
28		711.2		698.5	40*		1016.0		762.0
26		660.4		698.5	54 x 54*	1371.6	1371.6	1003.3	952.5
24		609.6		660.4	52*		1320.8		914.4
22		558.8		660.4	48*		1219.2		863.6
20		508.0		660.4	44*		1117.6		863.6
18		457.2		647.7	40*		1016.0		812.8
16		406.4		635.0	28*		711.2		787.4
					20*		508.0		787.4
44 x 44	1117.6	1117.6	812.8	762.0	56 x 56*	1422.4	1422.4	1041.4	965.2
42		1066.8		762.0	52*		1320.8		914.4
40		1016.0		749.3	48*		1219.2		863.6
38		965.2		736.6	44*		1117.6		812.8
36		914.4		723.9	40*		1016.0		812.8
34		863.6		723.9	28*		711.2		812.8
32		812.8		711.2	20		508.0		812.8
30		762.0		711.2	60 x 60*	1524.0	1524.0	1117.6	1016.0
28		711.2		698.5	56*		1422.4		965.2
26		660.4		698.5	52*		1320.8		914.4
24		609.6		698.5	48*		1219.2		863.6
22		558.8		685.8	40*		1016.0		863.6
20		508.0		685.8	28*		711.2		863.6
					20*		508.0		863.6
46 x 46	1168.4	1168.4	850.9	800.1	66 x 66*	1676.4	1676.4	1219.2	1066.8
44		1117.6		800.1					
42		1066.8		787.4					
40		1016.0		774.7					
38		965.2		762.0					
36		914.4		762.0					
34		863.6		749.3					
32		812.8		749.3					
30		762.0		736.6					
28		711.2		736.6					

Note (1) Outlet dimension "M" for run sizes 14 and larger is recommended but not mandatory.

Concentric and Eccentric Reducers

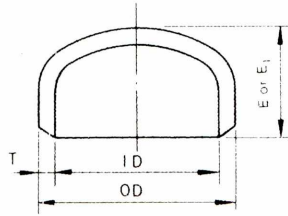


**MSS SP-75
ANSI B16.9**

* TTU's standard (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End
	Large End	Small End			Large End	Small End			Large End	Small End	
3/4 x 1/2 3/8	26.7	21.3 17.3	38.1	10 x 8 6	273.1 29.1 168.3	177.8	34 x 32 30	863.6 812.8	609.6	762.0	609.6
1 x 3/4 1/2	33.4	26.7 21.3	50.8	5 4	141.3 114.3		26 24	711.2 660.4			
1-1/4 x 1 3/4 1/2	42.2	33.4 26.7 21.3	50.8	12 x 10 8 6 5	323.9 273.1 219.1 168.3 141.3	203.2	36 x 34 32 30 26	914.4 863.6 812.8 762.0 711.2 660.4	609.6		
1-1/2 x 1-1/4 1 3/4 1/2	48.3	42.2 33.4 26.7 21.3	63.5	14 x 12 10 8 6	355.6 323.9 273.1 219.1 168.3	330.2	38 x 36 34 32	965.2 914.4 863.6 812.8	609.6		
2 x 1-1/2 1-1/4 1 3/4	60.3	48.3 42.2 33.4 26.7	76.2	16 x 14 12 10 8	406.4 355.6 323.9 273.1 219.1	355.6	30 28 26	762.0 711.2 660.4			
2-1/2 x 2 1-1/2 1-1/4 1	73.0	60.3 48.3 42.2 33.4	88.9	18 x 16 14 12 10	457.2 406.4 355.6 323.9 273.1	381.0	40 x 38 36 34 32 30	1016.0 965.2 914.4 863.6 812.8 762.0	609.6		
3 x 2-1/2 2 1-1/2 1-1/4	88.9	73.0 60.3 48.3 42.2	88.9	20 x 18 16 14 12	508.0 457.2 406.4 355.6 323.9	508.0	42 x 40 38 36 34 32 30	1066.8 1016.0 965.2 914.4 863.6 812.8 762.0	609.6		
3-1/2 x 3 2-1/2 2 1-1/2 1-1/4	101.6	88.9 73.0 60.3 48.3 42.2	101.6	22 x 20 18 16 14	558.8 508.0 457.2 406.4 355.6	508.0	44 x 42 40 38 36	1117.6 1066.8 1016.0 965.2 914.4	609.6		
4 x 3-1/2 3 2-1/2 2 1-1/2	114.3	101.6 88.9 73.0 60.3 48.3	101.6	24 x 22 20 18 16	609.6 558.8 508.0 457.2 406.4	508.0	46 x 42 42 40 38	1168.4 1117.6 1066.8 1016.0 965.2	711.2		
5 x 4 3-1/2 3 2-1/2 2	141.3	114.3 101.6 88.9 73.0 60.3	127.0	26 x 24 22 20 18	660.4 609.6 558.8 508.0 457.2	609.6	48 x 46 44 42 40	1219.2 1168.4 1117.6 1066.8 1016.0	711.2		
6 x 5 4 3-1/2 3 2-1/2	168.3	141.3 114.3 101.6 88.9 73.0	139.7	28 x 26 24 20 18	711.2 660.4 609.6 508.0 457.2	609.6					
8 x 6 5 4 3-1/2	219.1	168.3 141.3 114.3 101.6 88.9 73.0	152.4	30 x 28 26 24 20	762.0 711.2 660.4 609.6 508.0	609.6					
				32 x 30 28 26 24	812.8 762.0 711.2 660.4 609.6	609.6					

Caps



MSS SP-75 ANSI B16.9 (in mm)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D	Length ⁽²⁾ E	Limiting Wall Thickness for Length E	Length ⁽³⁾ E ₁
1/2	21.3	25.4	4.6	25.4
3/4	26.7	25.4	3.8	25.4
1	33.4	38.1	4.6	38.1
1-1/4	42.2	38.1	4.8	38.1
1-1/2	48.3	38.1	5.1	38.1
2	60.3	38.1	5.6	44.4
2-1/2	73.0	38.1	7.1	50.8
3	88.9	50.8	7.6	63.5
3-1/2	101.6	63.5	8.1	76.2
4	114.3	63.5	8.6	76.2
5	141.3	76.2	9.7	88.9
6	168.3	88.9	10.9	101.6
8	219.1	101.6	12.7	127.0
10	273.1	127.0	12.7	152.4
12	323.9	152.4	12.7	177.8
14	355.6	165.1	12.7	190.5
16	406.4	177.8	12.7	203.2
18	457.2	203.2	12.7	228.6
20	508.0	228.6	12.7	254.0
22	558.8	254.0	12.7	254.0
24	609.6	266.7	12.7	304.8

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D	Length ⁽²⁾ E
26	660.4	266.7
28	711.2	266.7
30	762.0	266.7
32	812.8	266.7
34	863.6	266.7
36	914.4	266.7
38	965.2	304.8
40	1016.0	304.8
42	1066.8	304.8
44	1117.6	342.9
46	1168.4	342.9
48	1219.2	342.9

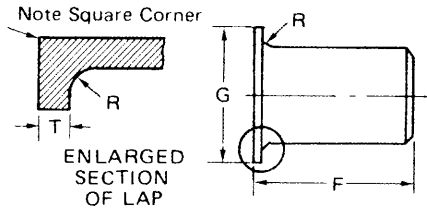
- Wall thicknesses for Caps up to and including 36" conform to ANSI B36.10 Specifications; Caps 38" and larger conform to XS Specifications for wall thicknesses of 36". These are TTU Standards as no Internationally Recognized Standards have been set for such large size wall thickness.

(1) The shape of these caps shall be ellipsoidal and shall conform to the shape requirements as given in the ASME Boiler and Pressure Vessel Code.

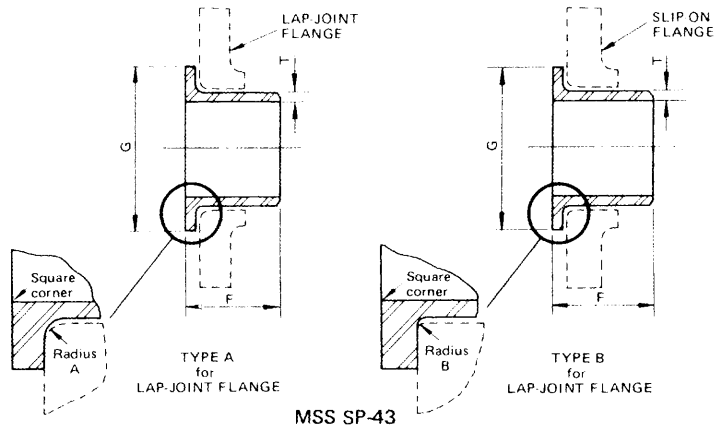
(2) Length E applies for thickness not exceeding that given in column "Limiting Wall Thickness for Length E".

(3) Length E₁ applies for thickness greater than that given in column "Limiting Wall Thickness" for NPS 24 and smaller. For NPS 26 and larger, Length E₁ shall be by agreement between manufacturer and purchaser.

Lap Joint Stub Ends



ANSI B16.9



MSS SP-43

ANSI B16.9
MSS SP-43 (in mm)

NPS	Outside Diameter at Bevel	Outside Diameter of Barrel		Length F		Radius of Fillet R		Diameter of Lap G
		min	max	ANSI	MSS	ANSI & MSS Type A	MSS Type B	
1/2	21.3	20.55	22.76	76.2	50.8	3.0	0.8	35.0
3/4	26.7	25.88	28.09	76.2	50.8	3.0	0.8	42.9
1	33.4	32.61	34.95	101.6	50.8	3.0	0.8	50.8
1-1/4	42.2	41.38	43.59	101.6	50.8	4.8	0.8	63.5
1-1/2	48.3	47.47	49.94	101.6	50.8	6.4	0.8	73.2
2	60.3	59.54	62.38	152.4	63.5	7.9	0.8	91.9
2-1/2	73.0	72.24	75.34	152.4	63.5	7.9	0.8	104.6
3	88.9	88.11	91.34	152.4	63.5	9.7	0.8	127.0
3-1/2	101.6	100.81	104.04	152.4	76.2	9.7	0.8	139.7
4	114.3	113.51	116.66	152.4	76.2	11.2	0.8	157.2
5	141.3	140.51	144.35	203.2	76.2	11.2	1.5	185.7
6	168.3	167.49	171.27	203.2	88.9	12.7	1.5	215.9
8	219.1	218.29	222.07	203.2	101.6	12.7	1.5	269.7
10	273.1	272.26	277.19	254.0	127.0	12.7	1.5	323.9
12	323.9	323.06	327.99	254.0	152.4	12.7	1.5	381.0
14	355.6	354.81	359.92	304.8	152.4	12.7	1.5	412.8
16	406.4	405.61	410.97	304.8	152.4	12.7	1.5	469.9
18	457.2	456.41	462.03	304.8	152.4	12.7	1.5	533.4
20	508.0	507.21	514.10	304.8	152.4	12.7	1.5	584.2
22	558.8	558.01	564.90	304.8	152.4	12.7	1.5	641.4
24	609.6	608.81	615.70	304.8	152.4	12.7	1.5	692.2

ANSI Dimensional Tolerances

ANSI B16.9, B16.28

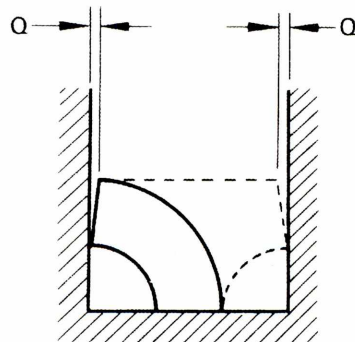
(in mm)

All Fittings				90° and 45° Elbows	Tees	Reducers	Caps	180° Returns									
Nominal Pipe Size	Outside Diameter at Bevel OD	Inside Diameter at End ID	Wall Thickness T	Center-to-End Dimension A, B	Center-to-End Dimension C, M	Overall Length H	Overall Length E	Center-to-Center Dimension P	Back-to-Face Dimension K	Alignment of Ends U							
1/2-2-1/2	+1.5 -0.7	±0.7	Not less than 87-1/2% of nominal thickness	±1.5	±1.5	±1.5	±3.0	±6.3	±6.3	±0.7							
3-4	±1.5	±1.5															
5-8	+2.2 -1.5	±1.5															
10-18	+4.0 -3.0	±3.0									±2.2	±2.2	±2.2	±6.3	±9.6	±0.7	
20-24	+6.3 -4.8	±4.8									±3.0	±3.0	±4.8	±9.6			
26-30											±4.8	±4.8					
32-48													±4.8	±4.8			
*50-60	+9.5 -6.4	±6.4									±9.5	±9.5	±9.5				
*62-70	+12.7 -9.5	±9.5									±12.7						
*72-80	+15.9 -11.9	±11.9									±15.9						

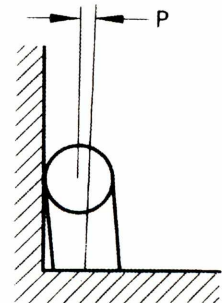
* TTU's Standard

(in mm)

Nominal Pipe Size	Angularity Tolerance	
	Off Angle Q	Off Plane P
1/2-4	0.7	1.5
5-8	1.5	3.0
10-12	2.2	4.8
14-16		6.3
18-24	3.0	9.6
26-30	4.8	12.7
32-42		19.0
44-48		
*50-60	6.4	
*62-70	9.5	
*72-80	11.9	



Off Angle



Off Plane

MSS Dimensional Tolerances

MSS SP-43 (in mm)

Nominal Pipe Size	All Fittings		90° Elbows 45° Elbows Tees	Reducers Lap Joint Stub Ends	180° Returns			Caps
	Outside ⁽¹⁾ Diameter at Welding End	Wall Thickness	Center-to- End Dimension A, B, C, M	Overall Length F, H	Center-to- Center Dimension O	Back-to- Face Dimension K	Alignment of Ends U	Overall Length E
1/2 1-1/2	±0.8	Not less than 87-1/2% of nominal thickness	±1.6	±1.6	±6.4	±6.4	±0.8	±3.0
2 3-1/2	±0.8		±1.6	±1.6	±6.4	±6.4	±0.8	±3.0
4	±0.8		±1.6	±1.6	±6.4	±6.4	±0.8	±3.0
5- 8	+1.6 -0.8		±1.6	±1.6	±6.4	±6.4	±0.8	±6.4
10-18	+2.3 -0.8		±2.3	±2.3	±9.7	±6.4	±1.6	±6.4
20-24	+3.0 -0.8		+2.3	+2.3	±9.7	±6.4	±1.6	±6.4

(in mm)

Nominal Pipe Size	All Fittings		Lap Joint Stub Ends	
	Outside ⁽¹⁾ Diameter at Welding End	Wall Thickness	Fillet ⁽²⁾ Radius of Lap A	Outside Diameter of Lap G
1/2 1-1/2	±0.8	Not less than 87-1/2% of nominal thickness	+0 -0.8	+0 -0.8
2 3-1/2	±0.8		+0 -0.8	+0 -0.8
4	±0.8		+0 -1.6	+0 -0.8
5- 8	+1.6 -0.8		+0 -1.6	+0 -0.8
10-18	+2.3 -0.8		+0 -1.6	+0 -1.6
20-24	+3.0 -0.8		+0 -1.6	+0 -1.6

Notes:

(1) Out of roundness is the vector sum of the plus and minus tolerance.

(2) Fillet B radius is the maximum.

MSS Dimensional Tolerances

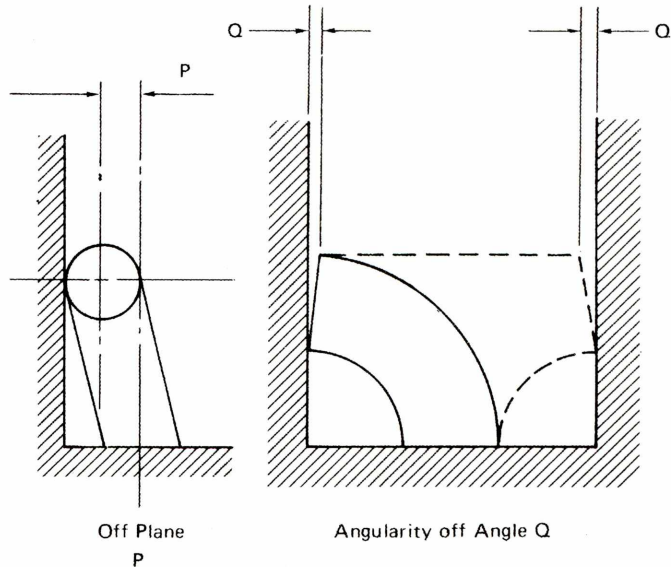
MSS SP-75

(in mm)

NPS	Inside(1) Diameter At End	Minimum(3) Wall Thickness	Out-of-Roundness(2)			90°, 60°, 45° & 30° Elbows & Tees Center-to-End Dimension A, B, C, M		Reducers Overall Length H	Caps Overall Length E
			At Ends of Fittings		Throughout(4) Body of Elbows	1-1/2 R & Tee	3R		
			Elbows(5)	Other					
16-24	±2.3	Nominal	4.8	3.0	2.5%	±2.3	±3.0	±2.3	±6.4
26-36	±2.3	-0.25	(5)	3.0	2.5%	±3.0	±6.4	±4.8	±9.6
38-48	±3.0		(5)	3.0	2.5%	±4.8	±9.6	±9.6	±9.6

(in mm)

NPS	Angularity Off Angle Q	Elbows Off Plane P	Eccentric and Concentric Reducers Off Plane p(6)
16-24	1.5	6.4	2.5%
26-36	2.3	12.7	2.5%
38-48	3.0	19.1	2.5%

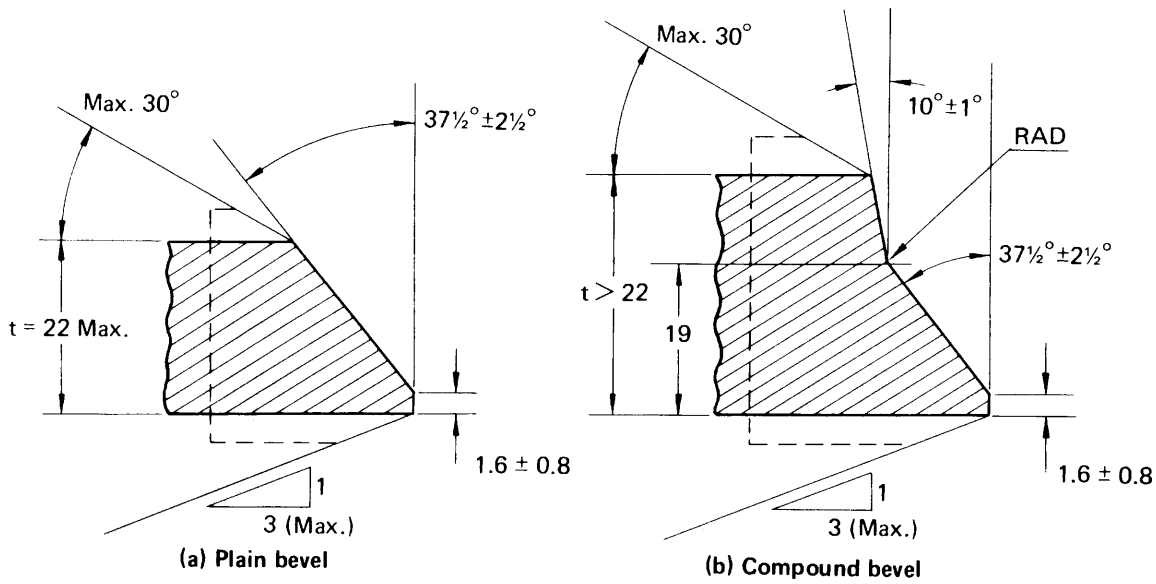


NOTE:

- (1) The inside diameter at end shall be determined by circumferential measurement, and the tolerance refers to variations from nominal I.D. calculation by $(OD\ nom. - 2t_{nom})$.
- (2) Out-of-roundness tolerances shall be the difference between the maximum and minimum diameters measured on any radial cross-section.
- (3) Minus 0.01 in. except that isolated non-continuous reductions are permitted in accordance with subsection 13.2.1. Excess thickness whether on inside or outside is to be treated in accordance with sketch given in Figure 3.
- (4) When elbows are intended for field segmenting, out-of-roundness tolerance may be furnished to 1% by agreement between the the Manufacturer and the Purchase. It is recognized that extra thickness, if any, may be on the I.D.
- (5) Out-of-roundness tolerances at ends shall be 1% of diameter for NPS 26 and larger.
- (6) Percent of O.D.

NOTE: Outside diameter may be tapered at angle up to 30° beyond weld bevel.

Welding End Preparation



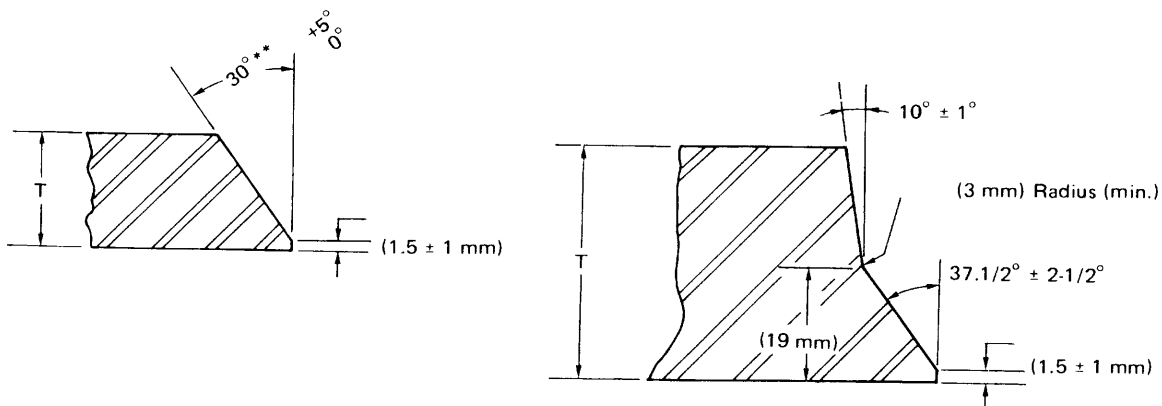
(in mm)

Nominal Pipe Wall Thickness (t)	End Preparation
Less than x*	Cut square or slightly chamfer, at mfr.'s option
x* to 22 incl.	Plain bevel as in sketch "a" above
More than 22	Compound bevel as in sketch "b" above

*x = 5 for carbon steel, ferritic alloy steel or wrought iron;
4 for austenitic alloy steel

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

MSS SP-75, API 5L



* Or 1 in. (25 mm) at option of the manufacturer.

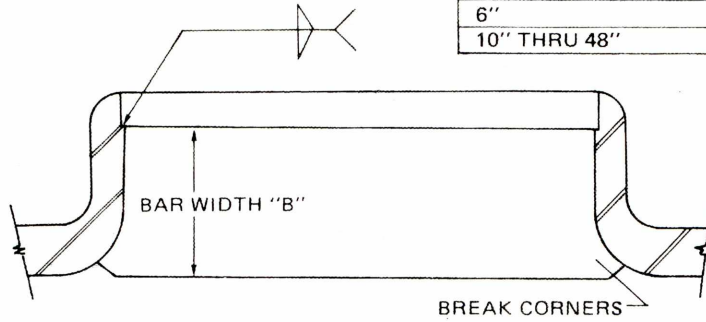
** Fittings size 24 and smaller may be furnished with 37-1/2 bevel at option of manufacturer.

RECOMMENDED BEVEL FOR WALL THICKNESS (T)
AT END OF FITTING, 19 mm* OR LESS

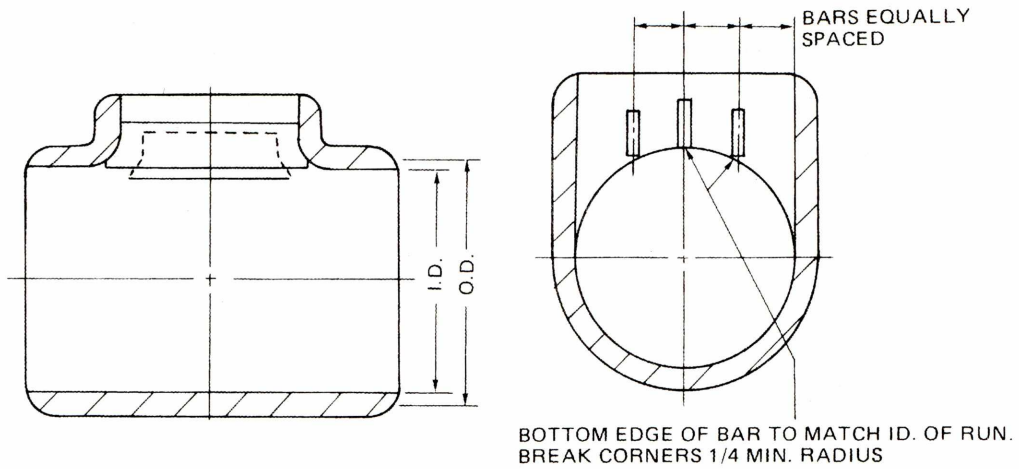
RECOMMENDED BEVEL FOR WALL THICKNESS (T)
AT END OF FITTING, GREATER THAN 19 mm

Scraper Bar Tees

RANGE OF OUTLET SIZE	"B"
4"	40 mm
5" AND 8"	50 mm
6"	60 mm
10" THRU 48"	60 mm



"I" BEING SCRAPER BAR THICKNESS (INDICATED ON CHART)



RUN	BRANCH																			
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	42	48	
4	6																			
6	6	6																		
8	6	6	6																	
10	6	6	6	6																
12	12	12	12	12	12															
14	12	12	12	12	12	12														
16	12	12	12	12	12	12	12													
18	12	12	12	12	12	12	12	12												
20	12	12	12	12	12	12	12	12	12											
22	12	12	12	12	12	12	12	12	12	12										
24	12	12	12	12	12	12	12	12	12	12	19									
26	12	12	12	12	12	12	12	12	12	12	19	19								
28	12	12	12	12	12	12	12	12	12	12	19	19	19							
30	12	12	12	12	12	12	12	12	12	12	19	19	19	19						
32	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19					
34	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19	19				
36	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19			
42	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19		
48	12	12	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
NO. OF BARS	1			2			3			4			5			6				

Materials Specifications for Butt-Welding Fittings

STANDARD PRACTICE SP-75 SPECIFICATION FOR HIGH TEST WROUGHT BUTT WELDING FITTINGS

MAXIMUM LIMIT OF CHEMICAL ELEMENTS WHICH MAY BE USED IN MATERIAL UNDER THIS STANDARD

	(% Max.)
Carbon	0.30
Manganese	1.60
Phosphorus	0.05
Sulphur	0.06
Copper	1.50
Nickel	1.00
Silicon	0.50
Chromium	0.25
Molybdenum	0.25
Vanadium	0.13
Columbium	0.10

Alternate alloy elements may be used but they shall be discussed with the user prior to delivery of the material. This table is not intended to represent the composition of any heat of steel, but merely to record the maximum permissible amounts of an element. The combination of elements of any heat must conform to carbon equivalent, following C. E.

Carbon equivalent shall be computed by the following equation:

$$C.E. = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

and shall not exceed 0.50%.

TABLE 2. Tensile Requirements

Class Symbol	Yield Strength Min. psi	Tensile Strength, Min. psi		Minimum Elongation In 2 in., %
		Thickness 0.375 in. and under	Thickness Greater than 0.375 in.	
WPHY-42	42 000	60 000	60 000	25
WPHY-46	46 000	63 000	63 000	25
WPHY-52	52 000	72 000	66 000	25
WPHY-60	60 000	78 000	75 000	20
WPHY-65	65 000	80 000	77 000	20
WPHY-70	70 000	82 000	80 000	18

Materials Specifications for Butt-Welding Fittings

ASTM A234-86

Standard Specification for

PIPING FITTINGS OF WROUGHT CARBON STEEL AND
ALLOY STEEL FOR MODERATE AND ELEVATED
TEMPERATURES

Grade and Marking Symbol ^D	Composition, %					
	Carbon, max	Manganese	Phosphorus, max	Sulfur, max	Silicon	Chromium
WPB ^{A,B,C}	0.30	0.29–1.06	0.050	0.058	0.10 min	...
WPC ^{B,C}	0.35	0.29–1.06	0.050	0.058	0.10 min	...
WP1	0.28	0.30–0.90	0.045	0.045	0.10–0.50	...
WP12	0.20	0.30–0.80	0.045	0.045	0.60 max	0.80–1.25
WP12b	0.20	0.30–0.80	0.045	0.045	0.60 max	0.80–1.25
WP11	0.20	0.30–0.80	0.040	0.040	0.50–1.00	1.00–1.50
WP11a	0.20	0.30–0.80	0.040	0.040	0.50–1.00	1.00–1.50
WP11b	0.15	0.30–0.60	0.030	0.030	0.50–1.00	1.00–1.50
WP22	0.15	0.30–0.60	0.040	0.040	0.50 max	1.90–2.60
WP22a	0.15	0.30–0.60	0.040	0.040	0.50 max	1.90–2.60
WP5	0.15	0.30–0.60	0.040	0.030	0.50 max	4.00–6.00
WP7	0.15	0.30–0.60	0.030	0.030	0.50–1.00	6.00–8.00
WP9	0.15	0.30–0.60	0.030	0.030	0.25–1.00	8.00–10.00
WPR	0.20	0.40–1.06	0.045	0.050	...	...
WP91	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.00–9.50

^A Fittings made from plate may have 0.35 max carbon.

^B Fittings made from forgings may have 0.35 max carbon and 0.35 max silicon with no minimum.

^C For each reduction of 0.01% carbon below 0.30%, an increase of 0.05% manganese above 1.06% will be permitted to a maximum of 1.35% manganese.

^D When fittings are of welded construction, the grade and marking symbol shown above shall be supplemented by letter "W"

	Elongation Requirements					
	Grades					
	All Grades except WPR and WP91		WPR		WP91	
	Longi- tudinal	Trans- verse	Longi- tudinal	Trans- verse	Longi- tudinal	Trans- verse
Elongation:						
Standard round specimen, or small proportional specimen, min % in 4D	22	14	20	...	20	...
Rectangular specimen for wall thickness 7.94mm and over, and for all small sizes tested in full section; min % in 50mm	30	20 ^A	29	...	...	...
Rectangular specimen for wall thickness less than 7.94mm, min % in 50mm (40-mm wide specimen)	xx ^B	xx ^B	xx ^B	...	...	...

^A WPB and WPC fittings manufactured from plate shall have a minimum elongation of 17%.

^B For each 0.79mm decrease in wall thickness below 7.94mm, a deduction of 1.5% for longitudinal and 1.0% for transverse from the values shown above is permitted.

				Tensile Requirements		Marking Symbols
Molybdenum	Nickel	Copper	Others	Tensile Strength Min. or Range ksi (MPa)	Yield Strength Min. ksi (MPa)	
...	60 [415]	35 [240]	WPB
...	70 [485]	40 [275]	WPC
0.44–0.65	55 [380]	30 [205]	WP1
0.44–0.65	70 [485]	40 [275]	WP12
0.44–0.65	60 [415]	30 [205]	WP12b
0.44–0.65	70 [485]	40 [275]	WP11
0.44–0.65	75 [515]	45 [310]	WP11a
0.44–0.65	60 [415]	30 [205]	WP11b
0.87–1.13	75 [515]	45 [310]	WP22
0.87–1.13	60 [415]	30 [203]	WP22a
0.44–0.65	60 [415]	30 [205]	WP5
0.44–0.65	60 [415]	30 [205]	WP7
0.90–1.10	60 [415]	30 [205]	WP9
...	1.60–2.24	0.75–1.25	...	63 [435]	46 [315]	WPR
0.85–1.05	0.40 max	...	Vanadium 0.18–0.25 Columbium 0.06–0.10 Nitrogen 0.03–0.07 Aluminum 0.04 max	85 [585]	60 [415]	WP91

The following table gives the minimum value for various wall thicknesses.

Wall Thickness	Grades		Grade	
	All Grades except WPR		WPR	
	Longitudinal	Transverse	Longitudinal	Transverse
mm				
7.94	30.0	20.0	28.0	...
7.14	28.5	19.0	26.5	...
6.35	27.0	18.0	25.0	...
5.56	25.5	...	23.5	...
4.76	24.0	...	22.0	...
3.97	22.5	...	20.5	...
3.17	21.0	...	19.0	...
2.38	19.5	...	17.5	...
1.59	18.0	...	16.0	...

NOTE— This table gives the computed minimum elongation values for each 0.79-mm decrease in wall thickness. Where the wall thickness lies between two values above, the minimum elongation value is determined by the following equations:

Direction of Test:	Equation
Longitudinal	$E = 48t + 15.00$
Transverse	$E = 32t + 10.00$

where:

E = elongation in 2 in. or 50 mm, % and
 t = actual thickness of specimens, mm

Materials Specifications for Butt-Welding Fittings

ASTM A420

PIPING FITTINGS OF WROUGHT CARBON STEEL AND ALLOY STEEL FOR LOW-TEMPERATURE SERVICE

Grade and Marking Symbol ^A	Chemical Composition (Percent)						
	Max. or Range (Unless otherwise indicated)						
	C	Mn	P	S	Si	Ni	Cu
WPL 6 ^{B,C}	0.30	0.39–1.06	0.048	0.058	0.10 min	—	—
WPL 9	0.20	0.40–1.06	0.045	0.050	—	1.60–2.24	0.75–1.25
WPL 3 ^D	0.20	0.31–0.64	0.05	0.05	0.13–0.37	3.18–3.82	—
WPL 8 ^E	0.13	0.90	0.045	0.045	0.13–0.37	8.40–9.60	—

^AWhen fittings are of welded construction, the symbols above shall be supplemented by the letter "W".

^BFor each reduction of 0.01% carbon below 0.30%, an increase of 0.05% manganese above 1.06% will be permitted to a maximum of 1.35% manganese.

^CFittings made from forgings may have 1.35% max manganese.

^DFittings made from plate or forgings may have 0.90% max manganese.

^EFittings made from plate may have 0.98% max manganese.

Charpy Impact Requirements for WPL6, WPL9, and WPL3^A

Size of Specimen, mm	Charpy V-Notch Impact Value Re- quired for Accept- ance (Average of Three Specimens)		Minimum Charpy V-Notch Impact Value Without Requiring Retest (One Specimen Only of a Set)	
	ft·lbf	J	ft·lbf	J
	10 by 10.0	13	17.6	10	13.6
10 by 7.5	10	13.6	8	10.8
10 by 5.0	7	9.5	5	7.0
10 by 2.5	4	5.4	3	4.1

^A Straight-line interpolation for intermediate values permitted.

Charpy Impact Requirements for WPL8

Size of Specimen, mm	Charpy V-Notch Impact Value Re- quired for Accept- ance (Average of Specimens)		Minimum Charpy V-Notch Impact Value Without Requiring Retest (One Specimen Only of a Set)	
	ft·lbf	J	ft·lbf	J
	10 by 10.0	25.0	33.9	20.0	27.1
10 by 7.5	21.0	28.5	17.0	23.1
10 by 5.0	17.0	23.1	14.0	19.0
10 by 2.5	8.0	10.8	6.0	8.1

Impact Test Temperature

Grade	Impact Test Temperature °F (°C)
WPL6	–50 (–50)
WPL9	–100 (–75)
WPL3	–150 (–100)
WPL8	–320 (–195)

Tensile Requirements

	WPL 6		WPL 9		WPL 3		WPL 8	
	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
	Longi- tudinal	Transverse	Longi- tudinal	Transverse	Longi- tudinal	Transverse	Longi- tudinal	Transverse
Tensile strength, min	60	415	63	435	65	450	100	690
Yield strength, min	35	240	46	315	35	240	75	515
Elongation in 2 in. or 50mm, min. %:								
Basic minimum elongation for walls 7.94mm and over in thickness, strip tests, and for all small sizes tested in full section	30	16.5	28	18	30	20	22	...
When standard round 2-in or 50-mm gage length test specimen is used	22	12	20	...	22	14	16	...
For strip tests, a deduction for each 0.80mm decrease in wall thick- ness below 7.94mm from the basic minimum elongation of the fol- lowing percentage points:	1.50 ^A	1.00 ^A	1.50 ^A	1.00 ^A	1.50 ^A	1.00 ^A	1.25 ^A	...

^A The following table gives the calculated minimum values:

Wall Thicknesses	Elongation in 2 in. or 50mm, min, %							
	WPL 6		WPL 9		WPL 3		WPL 8	
	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
mm								
7.94	30.00	16.50	28.00	18.00	30.00	20.00	22.00	...
7.14	28.50	15.50	26.50	17.00	28.50	19.00	20.75	...
6.35	27.00	14.50	25.00	16.00	27.00	18.00	19.50	...
5.56	25.50	...	23.50	15.00	25.50	...	18.25	...
4.76	24.00	...	22.00	14.00	24.00	...	17.00	...
3.97	22.50	...	20.50	13.00	22.50	...	15.75	...
3.17	21.00	...	19.00	12.00	21.00	...	14.50	...
2.38	19.50	...	17.50	11.00	19.50	...	13.25	...
1.59	18.00	...	16.00	10.00	18.00	...	12.00	...

Materials Specifications for Butt-Welding Fittings

ASTM A403 Standard Specification for WROUGHT AUSTENITIC STAINLESS STEEL PIPING FITTINGS

Marking Symbol ^A Class and Grade		C ^I	Mn ^I	P ^I	S ^I	Si ^I	Ni	Cr	Mo	Ti	N ₂ ^H	Others
WP Class Fittings	CR Class Fittings											
WP 304	CR 304	0.08	2.00	0.045	0.030	1.00	8.00-11.0	18.0-20.0	...	...	...	...
WP 304H	CR 304H	0.04-0.10	2.00	0.045	0.030	1.00	8.00-11.0	18.0-20.0	...	...	...	...
WP 304L	CR 304L	0.035 ^B	2.00	0.045	0.030	1.00	8.00-13.0	18.0-20.0	...	...	...	...
WP 304L	CR 304LN	0.030	2.00	0.040	0.030	0.75	8.00-10.50	18.0-20.0	...	...	0.10-0.16	...
WP 304N	CR 304N	0.08	2.00	0.040	0.030	0.75	8.00-11.0	18.0-20.0	...	...	0.10-0.16	...
WP 309	CR 309	0.15	2.00	0.045	0.030	1.00	12.0-15.0	22.0-24.0	...	...	...	...
WP 310	CR 310	0.15	2.00	0.045	0.030	1.50	19.0-22.0	24.0-26.0	...	...	...	...
WP 316	CR 316	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	...	...	...
WP 316H	CR 316H	0.04-0.10	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	...	...	...
WP 316LN	CR 316LN	0.030	2.00	0.040	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	...	0.10-0.16	...
WP 316L	CR 316L	0.035 ^B	2.00	0.045	0.030	1.00	10.0-15.0 ^C	16.0-18.0	2.00-3.00	...	...	...
WP 316N	CR 316N	0.08	2.00	0.040	0.030	0.75	11.0-14.0	16.0-18.0	2.00-3.00	...	0.10-0.16	...
WP 317	CR 317	0.08	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.00-4.00	...	...	...
WP 317L	CR 317L	0.030	2.00	0.045	0.030	1.00	11.0-15.0	18.0-20.0	3.00-4.00	...	...	...
WP 321	CR 321	0.08	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	<i>D</i>	...	...
WP 321H	CR 321H	0.04-0.10	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	<i>E</i>	...	...
WP 347	CR 347	0.08	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	...	...	<i>F</i>
WP 347H	CR 347H	0.04-0.10	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	...	...	<i>G</i>
WP 348	CR 348	0.08	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	...	...	Ta ^F = 0.10 max
WP 348H	CR 348H	0.04-0.10	2.00	0.045	0.030	1.00	9.00-13.0	17.0-20.0	...	...	...	Ta ^G = 0.10 max
WP XH-19	CR XH-10	0.060	4.00-6.00	0.040	0.030	1.00	11.5-13.5	20.5-23.5	1.50-3.00	...	0.20-0.40	<i>J</i>

^A In addition to the WP class designation, WP fittings shall be marked with the additional symbols indicated in 1.1.1 (that is; WP 304S, WP 304W, WP 304WX).

^B For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in grades TP 304L and TP 316L. Small outside diameter tubes are defined as those less than 12.7mm in outside diameter and light wall tubes as those less than 1.24mm in average wall thickness.

^C On pierced tubing, the nickel may be 11.0-16.00%.

^D The titanium content shall be not less than five times the carbon content and not more than 0.70%.

^E The titanium content shall be not less than four times the carbon content and not more than 0.70%.

^F The columbium plus tantalum content shall be not less than ten times the carbon content and not more than 1.10%.

^G The columbium plus tantalum content shall be not less than eight times the carbon content and not more than 1.00%.

^H The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.

^I Maximum, unless otherwise indicated.

^J Columbium plus tantalum, 0.10-0.30%; vanadium, 0.10-0.30%.

Grade	Yield Strength, min, ksi [MPa]	Tensile Strength, min, ksi [MPa]	Elongation	
			Longitudinal	Transverse
304, 304LN, 304H, 309, 310, 316, 316LN, 316H, 317, 317L, 321, 321H, 347, 347H, 348, 348H	30 [205]	75 [515]	Elongation:	
			Standard round specimen, or small proportional specimen, minimum % in 4D	
			28	20
304L, 316L	25 [170]	70 [485]	Rectangular specimen for wall thickness 7.94mm and over, and for all small sizes tested in full section; minimum % in 50mm	
	35 [240]	80 [550]	35	25
304L, 316N	55 [380]	100 [690]	Rectangular specimen for wall thickness less than 5/16 in. [7.94mm]; minimum % in 50mm (40mm wide specimen)	
XM-19			... ^A	... ^A

^A For each 0.79mm decrease in wall thickness below 7.94mm, a deduction of 1.5% for longitudinal and 1.0% for transverse from the values shown above is permitted. The following table gives the minimum value for various wall thickness

Wall Thickness	Elongation in 2 in. or 50 mm, min, %		
	mm	Longitudinal	Transverse
7.94		35.00	25.00
7.14		33.25	23.75
6.35		31.50	22.50
5.56		29.75	...
4.76		28.00	...
3.97		26.25	...
3.17		24.50	...
2.38		22.75	...
1.59		21.00	...

Note — The above table gives the computed minimum elongation values for each 0.8-mm decrease in wall thickness. When the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

$$\begin{aligned} \text{Longitudinal} \quad E &= 56t + 17.50 \\ \text{Transverse} \quad E &= 40t + 12.50 \end{aligned}$$

where:

E = elongation in 2 in. or 50 mm, %, and
 t = actual thickness of specimen, mm.

Comparison of ASTM Specifications and Similar Standards

Steel Composition	ASTM Specification and Grade			
	Marking Symbol	Pipe	Plate	Forgings
Carbon Steel	WPA	A106-A	A285-B	A181-1
Carbon Steel	WPB	A106-B	A515-65 or 70	A181-2 and A106
Carbon Steel	WPC	A106-C	—	—
Carbon Steel	WPL6	A333 and A334-6	A516-60	A350-LF2
3½% Ni Steel	WPL3	A333 and A334-3	A203-D	A350-LF3
Carbon-Molybdenum Steel	WP1	A335-P1	A204-B	A182-F1
1% Cr-½% Molybdenum Steel	WP12	A335-P12	A387-12	A182-F12
1¼% Cr-½% Molybdenum Steel	WP11	A335-P11	A387-11	A182-F11
2¼% Cr-1% Molybdenum Steel	WP22	A335-P22	A387-22	A182-F22
5% Cr-½% Molybdenum Steel	WP5	A335-P5	A387-5	A182-F5
7% Cr-½% Molybdenum Steel	WP7	A335-P7	—	A182-F7
9% Cr-1% Molybdenum Steel	WP9	A335-P9	—	A182-F9
13% Cr-8% Ni Steel	WP304	A312-TP304	A240-Type 304	A182-F304
18% Cr-8% Ni-(0.04 – 0.10)% C Steel	WP304H	A312-TP304H	A240-Type 304	A182-F304H
18% Cr-8% Ni-0.035% C Steel	WP304L	A312-TP304L	A240-Type 304L	A182-F304L
22% Cr-12% Ni Steel	WP309	A312-TP309	A240-Type 309S	—
25% Cr-20% Ni Steel	WP310	A312-TP310	A240-Type 310S	A182-F310
18% Cr-8% Ni-Cb+Ta Steel	WP347	A312-TP347	A240-Type 347	A182-F347
18% Cr-8% Ni-Mo Steel	WP316	A312-TP316	A240-Type 316	A182-F316
18% Cr-8% Ni-Mo-(0.04 – 0.10)% C Steel	WP316H	A312-TP316H	A240-Type 316	A182-F316H
18% Cr-8% Ni-Mo-0.035% C Steel	WP316L	A312-TP316L	A240-Type 316L	A182-F316L
18% Cr-8% Ni-Ti Steel	WP321	A312-TP321	A240-Type 321	A182-F321
18% Cr-8% Ni-Ti-(0.04 – 0.10)% C Steel	WP321H	A312-TP321H	A240-Type 321	A182-F321H
18% Cr-8% Ni-Cb+Ta-(0.04 – 0.10)% C Steel	WP347H	A312-TP347H	A240-Type 347	A182-F347H

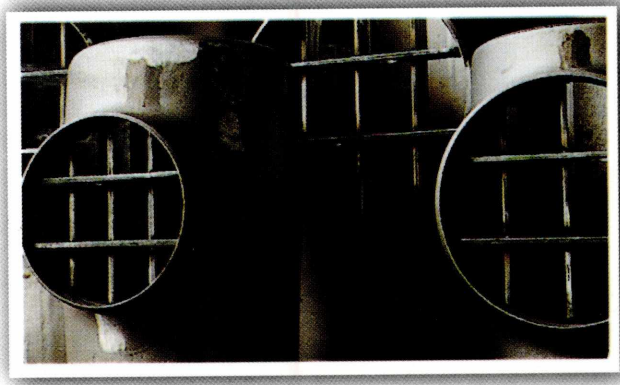
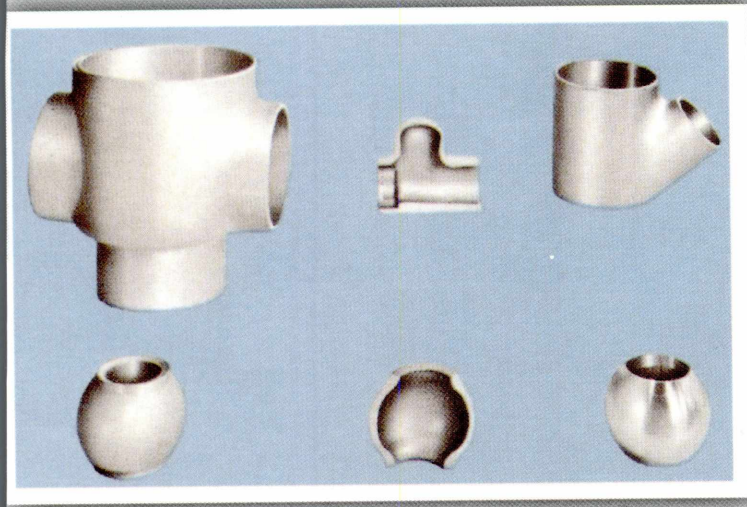
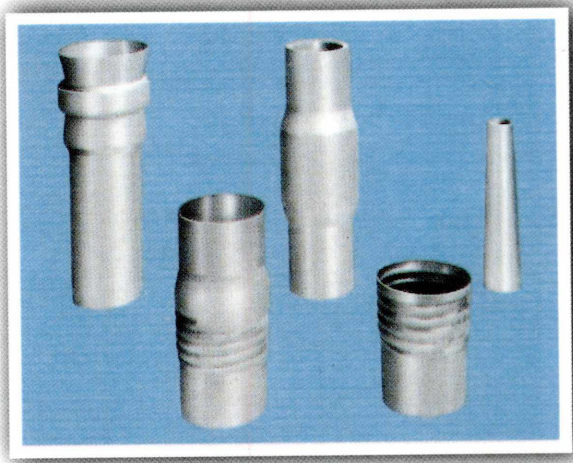
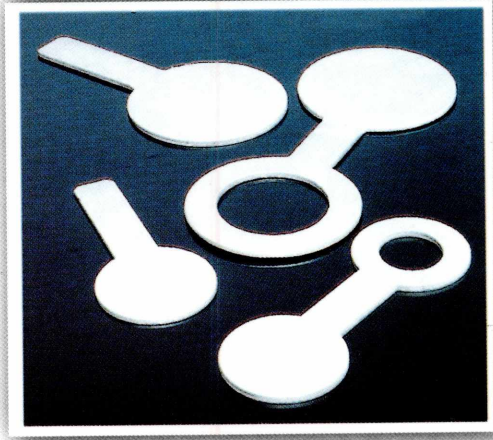
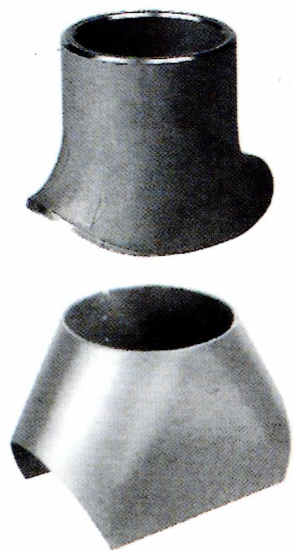
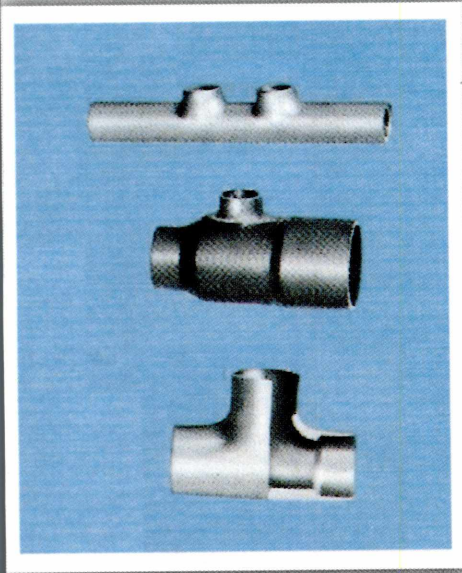
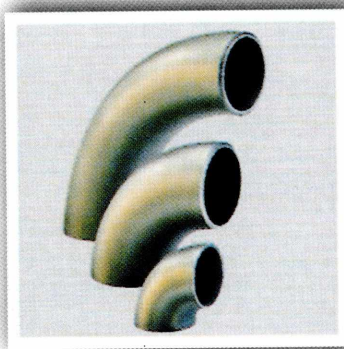
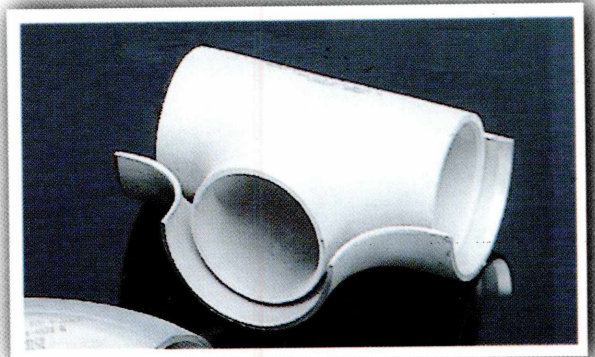
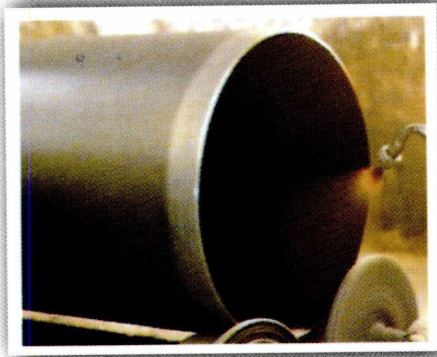
JIS Grade		B.S. Specification and Grade	DIN Specification and Grade	Steel Composition
Pipe	Plate	Pipe	Pipe	
STPT38	SB42	3602-Steel 23	17175-St 35.8	Carbon Steel
STPT42	SB42	3602-Steel 27	17175-St 45.8	Carbon Steel
STPT49	SB49	3602-Steel 35	—	Carbon Steel
STPL39	—	3603-Steel 27 LT30	—	Carbon Steel
STPL46	—	3603-Steel 503 LT100	—	3½% Ni Steel
STPA12	—	—	17175-15Mo3	Carbon-Molybdenum Steel
STPA22	—	3604-HF620	17175-13CrMo44	1% Cr-½% Molybdenum Steel
STPA23	—	3604-HF621	—	1¼% Cr-½% Molybdenum Steel
STPA24	—	3604-HF622, 27	17175-10CrMo910	2¼% Cr-1% Molybdenum Steel
STPA25	—	3604-HF625	—	5% Cr-½% Molybdenum Steel
—	—	—	—	7% Cr-½% Molybdenum Steel
STPA26	—	—	—	9% Cr-1% Molybdenum Steel
SUS304TP	SUS304	3605-801	17440-X5CrNi189	18% Cr-8% Ni Steel
SUS304HTP	—	3605-811	—	18% Cr-8% Ni-(0.04 – 0.10)% C Steel
SUS304LTP	SUS304L	3605-811L	17440-X2CrNi189	18% Cr-8% Ni-0.035% C Steel
SUS309STP	SUS309S	—	—	22% Cr-12% Ni Steel
SUS310STP	SUS310S	3605-805S	—	25% Cr-20% Ni Steel
SUS347TP	SUS347	3605-822Nb	17440-X10CrNiNb189	18% Cr-8% Ni-Cb+Ta Steel
SUS316TP	SUS316	3605-845	17440-X5CrNiMo1810	18% Cr-8% Ni-Mo Steel
SUS316HTP	—	3605-855	—	18% Cr-8% Ni-Mo-(0.04 – 0.10)% C Steel
SUS316LTP	SUS316L	3605-845L	17440-X2CrNiMo1810	18% Cr-8% Ni-Mo-0.035% C Steel
SUS321TP	SUS321	3605-822Ti	17440-X10CrNiTi189	18% Cr-8% Ni-Ti Steel
SUS321HTP	—	3605-832Ti	—	18% Cr-8% Ni-Ti-(0.04 – 0.10)% C Steel
SUS347HTP	—	3605-832Nb	—	18% Cr-8% Ni-Cb+Ta-(0.04 – 0.10)% C Steel



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MARK OF QUALITY

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