

PRODUCTS HANDBOOK



ABADI Group
Committed to Quality



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QUALITY POLICY

The Company is committed to provide and supply goods and services that are consistent, reliable, cost effective and to the highest quality standards that meet and exceed the needs and expectation of our Customers.

In order to achieve the above, the Company will :

- Supply products at the right quality, right time and right price with total Customer satisfaction.
- Ensure conformity to the specified requirements of our Customers while complying with all legal and regulatory requirements, and international and national standards.
- Work closely with our Customers and Suppliers in seeking to establish the highest Quality Standards.
- Adopt a forward-looking view on future business decisions which may have an impact on Quality.
- Ensure continual Quality improvement at every level of business practices, processes and management.

Date : 2 January 2020

Y. K. Leong
Executive Director

Introduction

Company Profile

Abadi Group was established in 1997 as a trader and supplier of steel products. **Abadi Group** specializes in a wide range of steel products for the Oil & Gas, Chemical and Petrochemical, Process Industry and Marine industries. Its Management has more than 30 years of experience in the steel business and has extensive trade ties and strategic alliances with World-Class steel mills in the Asia-Pacific Region.

The Group underwent significant corporate re-structuring in 2003 with the recruitment of a highly experienced and skilled management team. The team has since taken the Group to higher plateaus of professionalism and profitability. In 2004, the Group diversified and expanded its product range for the oil and gas industry and other sectors. Today, **Abadi Group** is arguably among the most prestigious steel pipes, fittings, flanges, plates and section suppliers for the oil & gas and process industries in the region.

Abadi Group has gained international recognition in the steel industry for its outstanding service and superior quality. Quality and complete customer satisfaction is the core of its business practices. Using its in-depth knowledge, extensive network and expertise, **Abadi Group** is able to identify its customers' needs and deliver premium quality products that ensure effective usage on a timely, cost efficient and reliable manner.

Apart from being a supplier of a comprehensive range of quality steel products, **Abadi Group** aims to extend its commitment and enhance its service to customers through specialized technical support in advising and assisting customers with the proper selection and usage of steel products. A dedicated team is tasked with providing technical support as to the different types of products, their specifications, grades and sizes, and its related pertinent trade information.

Key Management Personnel

Y. K. Leong, Executive Director and shareholder in ABADI Group, graduated with a B.Sc. in Economics and MBA from U.S.A.. He has extensive experience of 30 years in banking, property and trading. He joined ABADI Group in 2002 and has brought significant corporate management proficiency and professionalism to the Group since then.

In addition, as a result of Mr Y. K. Leong's expertise and knowledge in steel, he was also been appointed to the following positions :-

1. Member of the Technical Committee in the Malaysian Steel Council (MSC) under the **Ministry of International Trade and Industry (MITI)**
2. Director of the Commerce and Industry Bureau of the **Malaysia Steel and Metal Distributors' Association (MSMDA)**
3. Committee Member of the Construction Material Quality Control Committee under the **Construction Industry Development Board (CIDB)**

Marcus Yong, Executive Director and shareholder in ABADI Group, graduated with a B.A. (Hons) in Law & Business Management and Masters of Law (LL.M.) from the U.K.. He has more than 25 years' experience in the banking industry, construction industry and trading prior to joining ABADI Group in 2008. Since joining ABADI Group, he had been instrumental in expanding the Group's business to include welding equipment and consumables, as well as other specialised steel products.

General Information

To serve the increasing demand for more concise information on steel products and to create awareness on the proper selection and use of steel products, this new handbook has a wide range of products, and useful technical and trade information. This handbook aims to serves as a resource book, and technical and design reference for customers, consultants, procurement staff and project owners, offering time and cost savings in product selection and procurement.

Note : Care has been taken to ensure that all data and information contained herein are factual and that numerical values are accurate. Abadi Group assumes no responsibility for errors in or misinterpretation of the information contained in this handbook or in its use.

3. Pipes and Tubes

General

There are generally 4 types of pipes based on the mode of production.

1. **Seamless Carbon Steel Pipes (SMLS)**

Seamless Pipes are made of carbon steel in a process which results in pipes without any welded seams. Generally, a steel billet is pierced at high temperature (1,300° C) and then rolled to form blank tubes which are seamless. The tube blanks are either worked continuously into finished seamless pipes (hot rolled process) or subsequently cold drawn in tool and die to form seamless pipes (cold drawn process). The pipes are then cut to length before heat treatment, final straightening, inspection, and hydrostatic testing.

Seamless pipes are generally used for oil and gas transmissions pipelines and other industrial and structural uses where medium and high pressure service are required.

To produce good quality seamless pipes, manufacturers, first of all, must start with good quality raw material which is round steel billet. Our partner mills are very selective in their raw material input and only source their billet material from established steel mills with good reputation. Quality materials are then manufactured into seamless carbon steel pipes in accordance with the respective standards such as API or ASTM specification.

Commonly available Pipe Diameter from 1/8" to 34".

Wall thickness is up to 25mm.

Pipe length in 6 or 12 metres. Customized fixed length can be made to order.

2. **Longitudinal Submerged Arc Welded Pipes (LSAW)**

LSAW pipes are manufactured out of flat plates (skelp) that are formed, bent and prepared for welding. Double submerged arc welded (DSAW) pipe is a welded pipe whose longitudinal butt joint is welded in at least two passes, one of which is on the inside of the pipe. Filler material is used for the welding process. For diameters above 36 inches, double seam welded pipe (DSAW) is specified as an alternative in API 5L. This has two longitudinal seams 180° apart, formed by the SAW process. Finished pipes are normally 40 feet (12 m) and occasionally 60 feet (18 m) long, depending on the capacity of the pipe mill and the ease of transport to the pipeline. LSAW pipes are used in transmission service where high pressure and large diameter and wall thickness are specified.

Commonly available Pipe Diameter from 16" to 64".

Wall thickness is up to 40mm.

Pipe length in 6, 12 or 18 metres. Customized fixed length can be made to order.

3. **Electric Resistance Welded (ERW) and High Frequency Induction (HFI) Welded Pipe**

ERW pipes are produced using resistance heating to make the longitudinal weld but most pipe mills now use high frequency induction heating (HFI) for better control and consistency. However, the product is still often referred to as ERW pipe, even though the weld may have been produced by the HFI process.

With recent technical improvement, modern ERW/HFI pipe has much better performance than the traditional product and has been accepted by a number of operators for high pressure gas transmission. In particular, accurate tracking of the weld line by the automatic ultrasonic inspection equipment is used to minimize any rotation of the weld line as the pipe leaves the welding station.

In addition, the standard of heat treatment of the weld line, which is necessary to ensure durability, has been improved and some specifications call for local weld line heat treatment using induction coils followed by full body normalizing of the whole pipe in a furnace. ERW/HFI pipes can be produced to API 5L Grade X70.

Commonly available Pipe Diameter from 4" to 24".

Wall thickness is up to 20mm.

Pipe length in 6 or 12 meters. Customized fixed length can be made to order.

4. **Spiral Submerged Arc Welded (SSAW) Pipes**

SSAW pipes are produced through spiral weld construction which allows large diameter pipe to be produced from plates. The defects that occur in spiral welded pipe are mainly those associated with the SAW weld, and are similar in nature to those for longitudinally welded SAW pipe. In addition, SSAW pipes may have dimensional tolerances problem particularly out of roundness at the pipe ends. This led to problems of poor fit-up during field girth welding. However, with improved production technique from premium quality suppliers, modern SSAW pipe is of a quality equivalent to straight seam welded LSAW pipe, and have been used extensively high pressure gas pipelines in grades up to API X70.

Commonly available Pipe Diameter from 16" to 120".

Wall thickness is up to 22mm.

Pipe length in 6, 12 or 18 meters. Customized fixed length can be made to order.

Pipes and tubes can also be categorised by its general application and use.

Specification	Classification	Grade		Application
ASTM	Standard pipe Seamless & Welded	A53 SA53	A, B	General use, line pipe for steam, water and air.
	Seamless Pipe High Pressure	A106	A, B, C	General use, line pipe for steam, water, gas and air.
	Seamless Alloy Steel Tube	A213	T11, T12, T22	Boiler tube
	Seamless Carbon Steel Tube	A210	A1, C	
		A192	-	
		A179	-	Heat exchanger
	Seamless and Welded Stainless Steel Pipe	A312	TP304, TP316, TP321	General corrosive service
API	Welded Pipe	5L	A25, B, X42, X46, X52, X56, X60, X70	Line pipe for water, oil and gas, and other conveyance use.
	Seamless Pipe	5L	A25, B, X42, X46, X52, X56, X60, X70	

Chemical Composition

The chemical composition for selected pipes and tubes are as shown below.

Spec. / Std.	Grade	Delivery Condition	Chemical Composition % max (PSL 1 for API 5L)				Chemical Composition % max (PSL 2 for API 5L)			
			C	Mn	P	S	C	Mn	P	S
API 5L	A	S	0.22	0.90	0.03	0.03				
	B	S	0.28	1.20	0.03	0.03	0.24	1.20	0.025	0.015
	X42	S	0.28	1.30	0.03	0.03	0.24	1.30	0.025	0.015
	X46, X52, X56	S	0.28	1.40	0.03	0.03	0.24	1.40	0.025	0.015
	X60	S	0.28	1.40	0.03	0.03	0.24	1.40	0.025	0.015
	X65, X70	S	0.28	1.40	0.03	0.03	0.24	1.40	0.025	0.015
	X80	S					0.24	1.40	0.025	0.015
	A	W	0.22	0.90	0.03	0.03				
	B	W	0.26	1.20	0.03	0.03	0.22	1.20	0.025	0.015
	X42	W	0.26	1.30	0.03	0.03	0.22	1.30	0.025	0.015
	X46, X52, X56	W	0.26	1.40	0.03	0.03	0.22	1.40	0.025	0.015
	X60	W	0.26	1.45	0.03	0.03	0.22	1.40	0.025	0.015
	X65	W	0.26	1.45	0.03	0.03	0.22	1.45	0.025	0.015
	X70	W	0.25	1.65	0.03	0.03	0.22	1.65	0.025	0.015
	X80	W					0.22	1.85	0.025	0.015
ASTM A53	A	S-W	0.25	0.95	0.05	0.06				
	B	S-W	0.30	1.20	0.05	0.06				
ASTM A106	A	S	0.25	0.93	0.035	0.035				
	B	S	0.30	1.06	0.035	0.035				
	C	S	0.35	1.06	0.035	0.035				
ASTM A210	A1	S	0.27	0.93	0.035	0.035				
	C	S	0.35	1.06	0.035	0.035				
ASTM A192	-	S	0.18	0.63	0.035	0.25				
ASTM A179	-	S	0.18	0.63	0.035	0.035				
ASTM A213	T11	S	0.15	0.60	0.025	0.025	0.65	1.50	-	0.10
	T12	S	0.15	0.60	0.025	0.025	0.65	1.25	-	0.50
	T22	S	0.15	0.60	0.025	0.025	1.3	2.60	-	0.50

Spec. / Std.	Grade	Delivery Condition	Chemical Composition % max (PSL 1 for API 5L)				Chemical Composition % max (PSL 2 for API 5L)			
			C	Mn	P	S	C	Mn	P	S
ASTM A312	TP304	S	0.08	2.00	0.045	0.030		20.0	11.0	0.75
	TP316	S	0.08	2.00	0.045	0.030	3.00	18.0	14.0	0.75
	TP321	S	0.08	2.00	0.045	0.030		19.0	12.0	0.75
	TP347	S	0.08	2.00	0.045	0.030		20.0	12.0	0.75

Mechanical Properties

The mechanical properties for selected pipes and tubes are as shown below.

Spec. / Standards	Grade	Mechanical Prop.		Mechanical Prop. (PSL2 for API 5L)		Hydro Testing
		Min. Yield (MPa)	Min. Tensile (MPa)	Max Yield (MPa)	Max Tensile (MPa)	
API 5L	A	207	331			Yes
	B	241	414	448	758	
	X42	290	414	496	758	
	X46	317	434	524	758	
	X52	359	455	531	758	
	X56	386	490	544	758	
	X60	414	517	565	758	
	X65	448	531	600	758	
	X70	483	565	621	758	
	X80	552	621	690	827	
ASTM A53	A	205	330			Yes
	B	240	415			
ASTM A106	A	206	330			Yes
	B	240	415			
	C	275	485			
ASTM A210	A1	255	415			Yes
	C	275	485			
ASTM A192	A192	180	325			Yes
ASTM A179	A179	180	325			Yes
ASTM A213	T11	170	415			No
	T12	205	415			
	T22	205	415			
ASTM A312	TP304	205	515			No
	TP316	205	515			
	TP321	205	515			
	TP347	205	515			

Reference Weight (Mass) Calculation

Weight per meter for standard wall thickness are listed in the respective specifications. The following formula is used for calculation of reference weight (mass) of carbon steel pipe :

$$M = (D - T) \times T \times 0.0246615 \text{ (kg/m)}$$

where, D is outside diameter and T is wall thickness of pipe in mm.

For weight (mass) per meter of pipe and tube of other materials, the following constant should be used :

Aluminium	=	0.00848
Stainless steel	=	0.02504

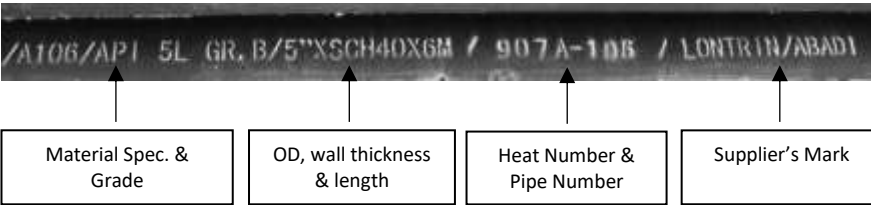
Dimensional Tolerances

Dimensional tolerances are specified in the respective standards and summarized below :

Spec.	OD Tolerance	WT Tolerance	Length
API 5L	<20 in. $\pm 0.75\%$ ≥ 20 in. (S) $\pm 1.0\%$ ≥ 20 in. (W) $-0.25\%, +0.75\%$ Pipe end : $-0.8\text{mm}, +2.4\text{mm}$	<20 in. $-12.5\%, +15.0\%$ ≥ 20 in. (S) $-12.5\%, +15.0\%$ ≥ 20 in. (W) $-12.5\%, +17.5\%$ Weight : $-3.5\%, +10.0\%$	Nominal 20 ft., 6 m : Min. Av. 5.33 m - Max 6.86 m Nominal 40 ft., 12 m : Min. Av. 10.67 m - Max 13.72 m
ASTM A53	NPS $\leq 1 \frac{1}{2}"$ $\pm 0.4\text{mm}$ NPS $\geq 2"$ $\pm 1.0\%$	-12.5% Weight : $\pm 10.0\%$	N/A
ASTM A106	NPS $\leq 1 \frac{1}{2}"$ $\pm 0.4\text{mm}$ NPS $1 \frac{1}{2}" - 4"$ $\pm 0.8\text{mm}$ NPS $4" - 8"$ $-0.8\text{mm}, +1.6\text{mm}$ NPS $8" - 18"$ $-0.8\text{mm}, +2.4\text{mm}$ NPS $18" - 26"$ $-0.8\text{mm}, +3.2\text{mm}$	-12.5% Weight : $-3.5\%, +10.0\%$	N/A
ASTM A450 (covering A192, A210, A213)	NPS $\leq 4"$ $-0.8\text{mm}, +0.4\text{mm}$ NPS $4" - 7 \frac{1}{2}"$ $-1.2\text{mm}, +0.4\text{mm}$ NPS $7 \frac{1}{2}" - 9"$ $-1.6\text{mm}, +0.4\text{mm}$	NPS $\leq 1 \frac{1}{2}"$ $-0\%, +20\%$ NPS $\geq 1 \frac{1}{2}"$ $-0\%, +22\%$ Weight : NPS $\leq 1 \frac{1}{2}"$ $-0\%, +12\%$ NPS $\geq 1 \frac{1}{2}"$ $-0\%, +13\%$	NPS $\leq 2"$ $-0\text{mm}, +3\text{mm}$ NPS $\geq 2"$ $-0\text{mm}, +5\text{mm}$

Pipe and bundle marking

Pipes and tubes are marked in white stencil marking or stamp marking on the outside surface, in accordance with the relevant standards or buyer’s requirement, as shown.



Bundles or individual pipes are marked with one or more metal or plastic tags with the required information.



Coating and Surface Protection

Pipes and tubes are supplied with temporary external coating to minimise rusting in transit i.e. standard mill varnish (black) unless otherwise specified by Buyer. The temporary coating shall be hard to touch and smooth.

Other types of coating and surface protection that can be supplied upon request by Buyer are primer, liquid epoxy, FBE and 3-Layer PE.

Packaging, Handling and Transportation

Pipes and tubes (OD of 10" or less) are packed in bundles with weight between 1,000 - 3,500 kg, fastened by steel strips. Pipes with OD above 10" are normally handled individually. Bevel protectors or end caps are used to cover both ends of pipes. Jute / plastic ropes around the individual pipe diameter at intermittent points along pipe length are used upon request by Buyer to provide additional protection. Pipes with FBE or 3-Layer PE are also wrapped with fabric tarp.

In loading and unloading operations, caution is exercised to prevent damage through contact with sharp projections of cranes and forklifts. For lifting operations, wide slings made of nylon or other suitable materials are used. Hooks with sufficient width and depth to fit the inside of pipes are used for handling of large diameter pipes.

Sides and floor of containers are lined with treated wood planks to prevent damage to pipes during loading, unloading and shipping. Wood dunnage are used to prevent damage from hard protrusions and secure pipes in container. Where necessary, strappings are used to restrict movement during transport and shipping.

Additional trade information

Mill Tolerance

One of the most important factors in buying steel pipes is understanding mill's or manufacturer's tolerance especially when it comes to wall thickness tolerance. It is a major misconception that "mill tolerance is the allowance for variation in the thickness of pipe from nominal pipe thickness which is 12.5% according to API 5L." Based on the above, some mills / suppliers have a questionable market practice of supplying, for example, 10" Sch. 40 pipe (which has a nominal wall thickness of 9.27mm) with 8.2mm wall thickness while claiming that is within the allowable mill tolerance according to API 5L. A thinner pipe means that it is lighter and as such, uses "less" material therefore allowing these mills / suppliers to "profit" from the mill tolerance.

Firstly, the best way to understand mill tolerance is that it comes about from the manufacturing process of pipes itself. Seamless pipes are made from piercing of a billet and rolling through a series of rollers. There may be some wall thickness differences caused by the manufacturing process leading to possible eccentricity. Welded pipes do not have this issue because it's easier to get high accuracy when producing steel plates. However, welded pipes need to take into account the weld joint efficiency factor meaning that there may be some differences in wall thickness at the weld joint area. The allowable differences in wall thickness are defined under the tolerance for wall thickness under the various standards and codes.

Mill tolerance for wall thickness under API 5L cannot be read in isolation from other tolerances ie. OD and weight tolerance. It is important to note that API 5L implies that wall thickness tolerance of 12.5% is limited by weight tolerance of 3.5%. For example, 10" Sch. 40 welded pipe should have a constant wall thickness of not less than 8.94mm across the entire pipe body in order to be within tolerances under API 5L.

"Fake" Seamless Pipe

"Fake" seamless pipes or semi seamless steel pipes are becoming more prevalent in the market. "Fake" seamless pipes are ERW pipes that have been "heat treated" and "rolled" to erase the weld seam. These pipes are cheaper to produce than seamless pipes but sold at premium prices albeit discounted price to seamless pipes. "Fake" seamless pipes are inferior quality products and, if used as a direct substitute for seamless pipes, is dangerous as it is likely to fail or leak in high pressure usage. However, "fake" seamless pipes are deemed most popular and prevalent in our local market when used to circumvent AP and import duty as there are no restrictions in import of seamless pipes.

"Fake" seamless pipes are difficult to spot as there is no visible weld seam on the surface of the pipe. However, it is still possible to identify "fake" seamless pipes as follows :-

1. Pitted surface appearance
2. Surface prone to scarring
3. No metallic lustre

Dimension and weight of Seamless and Welded steel pipe – ANSI B36.10

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
1/8"	0.405	10.3	0.07	1.70	0.24	0.36	STD	40
			0.10	2.40	0.31	0.46	XS	80
1/4"	0.540	13.7	0.09	2.20	0.42	0.63	STD	40
			0.12	3.00	0.54	0.80	XS	80
3/8"	0.675	17.1	0.09	2.30	0.57	0.85	STD	40
			0.13	3.20	0.74	1.10	XS	80
1/2"	0.840	21.3	0.11	2.80	0.85	1.26	STD	40
			0.15	3.70	1.09	1.62	XS	80
			0.19	4.80	1.31	1.95		160
			0.29	7.50	1.71	2.54	XXS	
3/4"	1.050	26.7	0.11	2.90	1.13	1.68	STD	40
			0.15	3.90	1.47	2.19	XS	80
			0.22	5.60	1.94	2.88		160
			0.31	7.80	2.44	3.63	XXS	
1"	1.315	33.4	0.13	3.40	1.68	2.50	STD	40
			0.18	4.50	2.17	3.23	XS	80
			0.25	6.40	2.84	4.23		160
			0.36	9.10	3.66	5.45	XXS	
1-1/4"	1.660	42.2	0.14	3.60	2.27	3.38	STD	40
			0.19	4.90	3.00	4.46	XS	80
			0.25	6.40	3.76	5.60		160
			0.38	9.70	5.21	7.75	XXS	
1-1/2"	1.900	48.3	0.15	3.70	2.72	4.05	STD	40
			0.20	5.10	3.63	5.40	XS	80
			0.28	7.10	4.86	7.23		160
			0.40	10.20	6.41	9.54	XXS	
2"	2.375	60.3	0.08	2.10	2.03	3.02		
			0.11	2.80	2.64	3.93		
			0.13	3.20	3.00	4.47		
			0.14	3.60	3.36	5.00		
			0.15	3.90	3.65	5.44	STD	40
			0.17	4.40	4.05	6.03		
			0.19	4.80	4.39	6.54		
			0.22	5.50	5.02	7.48	XS	80
			0.25	6.40	5.67	8.45		
			0.28	7.10	6.28	9.35		
			0.34	8.70	7.46	11.10		160
			0.44	11.10	9.03	13.40	XXS	
2-1/2"	2.875	73.0	0.08	2.10	2.47	3.68		
			0.11	2.80	3.22	4.80		
			0.13	3.20	3.67	5.46		
			0.14	3.60	4.12	6.12		
			0.16	4.00	4.53	6.75		
			0.17	4.40	4.97	7.40		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.19	4.80	5.40	8.04		
			0.20	5.20	5.79	8.62	STD	
			0.22	5.50	6.13	9.13		
			0.25	6.40	7.01	10.40		
			0.28	7.00	7.66	11.40	XS	80
			0.38	9.50	10.00	14.90		160
			0.55	14.00	13.70	20.40	XXS	
3"	3.500	88.9	0.08	2.10	3.03	4.51		
			0.11	2.80	3.95	5.88		
			0.13	3.20	4.57	6.72		
			0.14	3.60	5.06	7.54		
			0.16	4.00	5.57	8.30		
			0.17	4.40	6.11	9.10		
			0.19	4.80	6.65	9.91		
			0.22	5.50	7.58	11.30	STD	40
			0.25	6.40	8.68	12.90		
			0.28	7.10	9.66	14.40		
			0.30	7.60	10.30	15.30	XS	80
			0.44	11.10	14.30	21.30		160
			0.60	15.20	18.60	27.70	XXS	
3-1/2"	4.000	101.6	0.08	2.10	3.47	5.17		
			0.11	2.80	4.53	6.75		
			0.13	3.20	5.17	7.70		
			0.14	3.60	5.81	8.65		
			0.16	4.00	6.40	9.53		
			0.17	4.40	7.03	10.50		
			0.19	4.80	7.65	11.40		
			0.23	5.70	9.11	13.60	STD	40
			0.25	6.40	10.00	14.90		
			0.28	7.10	11.20	16.60		
			0.32	8.10	12.50	18.60	XS	80
			0.11	2.80	5.11	7.61		
			0.13	3.20	5.84	8.70		
			0.14	3.60	6.56	9.77		
			0.16	4.00	7.24	10.80		
			0.17	4.40	7.95	11.80		
			0.19	4.80	8.66	12.90		
			0.20	5.20	9.32	13.90		
			0.22	5.60	10.00	14.90		
			0.24	6.00	10.80	16.10	STD	40
			0.25	6.40	11.40	16.90		
			0.28	7.10	12.70	18.90		
			0.31	7.90	14.00	20.80		
			0.34	8.60	15.00	22.30	XS	80
			0.44	11.10	19.00	28.30		120
			0.53	13.50	22.50	33.50		160
			0.67	17.10	27.50	41.00	XXS	

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
5"	5.563	141.3	0.67	17.10	27.50	41.00	XXS	
			0.08	2.10	4.86	7.24		
			0.13	3.20	7.26	10.80		
			0.16	4.00	9.01	13.40		
			0.19	4.80	10.80	16.10		
			0.22	5.60	12.50	18.60		
			0.26	6.60	14.60	21.80	STD	40
			0.28	7.10	15.80	23.60		
			0.31	7.90	17.50	26.10		
			0.34	8.70	19.20	28.60		
			0.38	9.50	20.80	31.00	XS	80
			0.50	12.70	27.00	40.30		120
			0.63	15.90	33.00	49.10		160
			0.75	19.00	38.60	57.40	XXS	
6"	6.625	168.3	0.08	2.10	5.80	8.64		
			0.11	2.80	7.59	11.30		
			0.13	3.20	8.68	12.00		
			0.14	3.60	9.76	14.50		
			0.16	4.00	10.80	16.10		
			0.17	4.40	11.80	17.60		
			0.19	4.80	12.90	19.20		
			0.20	5.20	13.90	20.70		
			0.22	5.60	15.00	22.30		
			0.25	6.40	17.0	25.40		
			0.28	7.10	19.0	28.30		
			0.31	7.90	21.0	31.30		
			0.34	8.70	23.1	34.40	STD	40
			0.38	9.50	25.0	37.30		
			0.43	11.00	28.6	42.60	XS	80
			0.50	12.70	32.7	48.70		
			0.56	14.30	36.4	54.20		120
			0.63	15.90	40.0	59.60		
			0.72	18.30	45.4	67.60		160
			0.86	21.90	53.2	79.20	XXS	
8"	8.625	219.1	0.13	3.20	11.4	19.90		
			0.16	4.00	14.1	21.00		
			0.19	4.80	16.9	25.20		
			0.20	5.20	18.3	27.30		
			0.22	5.60	19.7	29.30		
			0.25	6.40	22.4	33.30		20
			0.28	7.00	24.7	36.80		30
			0.31	7.90	27.7	41.30		
			0.32	8.20	28.6	42.50	STD	40
			0.34	8.70	30.4	45.30		
			0.38	9.50	33.0	49.20		
			0.41	10.30	35.7	53.10		60
			0.44	11.10	38.3	57.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.50	12.70	43.4	64.60	XS	80
			0.56	14.30	48.4	72.10		
			0.59	15.10	50.9	75.80		100
			0.63	15.90	53.4	79.50		
			0.72	18.30	60.7	90.40		120
			0.81	20.60	67.8	101.00		140
			0.88	22.60	72.4	108.00	XXS	
			0.91	29.00	74.4	111.00		160
10"	10.750	273	0.16	4.00	17.6	26.30		
			0.19	4.80	21.2	31.60		
			0.20	5.20	22.9	34.10		
			0.22	5.60	24.6	36.70		
			0.25	6.40	28.0	41.80		20
			0.28	7.10	31.2	46.50		
			0.31	7.80	34.2	51.00		30
			0.34	8.70	38.2	56.90		
			0.37	9.30	40.5	60.30	STD	40
			0.44	11.10	48.2	71.80		
			0.50	12.70	54.7	81.50	XS	60
			0.56	14.30	61.2	91.10		
			0.59	15.10	64.4	95.80		80
			0.63	15.90	67.7	101.00		
			0.72	18.30	77.0	115.00		100
			0.81	20.60	86.2	128.00		
			0.84	21.40	89.3	133.00		120
			1.00	25.40	104.1	155.00	XXS	140
			1.13	28.60	115.6	172.00		160
12"	12.750	323.8	0.17	4.40	23.1	34.40		
			0.19	4.80	25.2	37.60		
			0.20	5.20	27.2	40.50		
			0.22	5.60	29.3	43.70		
			0.25	6.40	33.4	49.70		20
			0.28	7.10	37.4	55.70		
			0.31	7.90	41.4	61.70		
			0.33	8.40	43.8	65.20		30
			0.34	8.70	45.6	67.90		
			0.38	9.50	49.6	73.80	STD	
			0.41	10.30	53.5	79.70		40
			0.44	11.10	57.6	85.80		
			0.50	12.70	65.4	97.40	XS	
			0.56	14.30	73.1	109.00		60
			0.63	15.90	80.9	121.00		
			0.69	17.50	88.6	132.00		80
			0.75	19.00	96.1	143.00		
			0.81	20.60	104	154.00		
			0.84	21.40	107	160.00		100
			0.88	22.20	111	165.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			1.00	25.40	125	187.00	XXS	120
			1.13	28.60	140	208.00		140
			1.31	33.30	160	239.00		160
14"	14.000	355.6	0.19	4.80	27.7	41.30		
			0.20	5.20	29.9	44.60		
			0.21	5.30	30.9	46.10		
			0.22	5.60	32.2	48.00		
			0.25	6.40	36.7	54.70		10
			0.28	7.10	41.2	61.30		
			0.31	7.90	45.6	67.90		20
			0.34	8.70	50.2	74.70		
			0.38	9.50	54.6	81.30	STD	30
			0.41	10.30	58.9	87.80		
			0.44	11.10	63.4	94.50		40
			0.47	11.90	67.8	101.00		
			0.50	12.70	72.1	107.00	XS	
			0.56	14.30	80.7	120.00		
			0.59	15.10	85.0	127.00		60
			0.63	15.90	89.3	133.00		
			0.69	17.50	97.8	146.00		
			0.75	19.00	106	158.00		80
			0.81	20.60	114	170.00		
			0.88	22.20	123	183.00		
			0.94	23.80	131	195.00		100
			1.09	27.80	151	224.00		120
			1.25	31.80	170	253.00		140
			1.41	35.70	189	281.00		160
			2.00	50.80	256	381.00		
			2.13	54.00	270	401.00		
			2.20	55.90	277	413.00		
			2.50	63.50	307	457.00		
16"	16.000	406.6	0.19	4.80	31.8	47.30		
			0.20	5.20	34.2	51.00		
			0.22	5.60	36.9	55.00		
			0.25	6.40	42.0	62.60		10
			0.28	7.10	47.2	70.30		
			0.31	7.90	52.3	77.90		20
			0.34	8.70	57.7	85.70		
			0.38	9.50	62.6	93.20	STD	30
			0.41	10.30	67.6	101.00		
			0.44	11.10	72.8	108.00		
			0.47	11.90	77.8	116.00		
			0.50	12.70	82.8	123.00	XS	40
			0.56	14.30	92.7	138.00		
			0.63	15.00	103	153.00		
			0.66	16.70	108	160.00		60
			0.69	17.50	113	168.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.75	19.00	122	182.00		
			0.81	20.60	132	196.00		
			0.84	21.40	137	203.00		80
			0.88	22.20	141	211.00		
			0.94	23.80	151	225.00		
			1.00	25.40	160	239.00		
			1.03	26.20	165	245.00		100
			1.06	26.90	169	253.00		
			1.13	28.60	179	266.00		
			1.22	31.00	192	286.00		120
			1.44	36.50	224	333.00		140
			1.59	40.50	245	365.00		160
18"	18.000	457.2	0.19	4.80	35.8	53.30		
			0.22	5.60	41.6	62.00		
			0.25	6.40	47.4	70.60		10
			0.28	7.10	53.2	79.20		
			0.31	7.90	58.9	87.80		20
			0.34	8.70	64.9	96.60		
			0.38	9.50	70.6	105.00	STD	
			0.41	10.30	76.3	114.00		
			0.44	11.10	82.2	122.00		30
			0.47	11.90	87.8	131.00		
			0.50	12.70	93.4	139.00	XS	
			0.56	14.30	105	156.00		40
			0.63	15.90	116	173.00		
			0.69	17.50	127	189.00		
			0.75	19.00	138	206.00		60
			0.81	20.60	149	222.00		
			0.88	22.20	160	238.00		
			0.94	23.80	171	255.00		80
			1.00	25.40	182	270.00		
			1.06	27.00	192	286.00		
			1.13	28.60	203	302.00		
			1.16	29.40	208	310.00		100
			1.19	30.80	213	317.00		
			1.25	31.80	224	333.00		
			1.38	34.90	244	363.00		120
			1.56	39.70	274	408.00		140
			1.78	45.20	309	459.00		160
20"	20.000	508	0.22	5.60	46.3	68.90		
			0.25	6.40	52.7	78.50		10
			0.28	7.10	59.2	88.20		
			0.31	7.90	65.6	97.70		
			0.34	8.70	72.2	108.00		
			0.38	9.50	78.6	117.00	STD	20
			0.41	10.30	85.0	127.00		
			0.44	11.10	91.5	136.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.47	11.90	97.8	146.00		
			0.50	12.70	104	155.00	XS	30
			0.56	14.30	117	174.00		
			0.59	15.10	123	183.00		40
			0.63	15.90	129	193.00		
			0.69	17.50	142	211.00		
			0.75	19.00	154	230.00		
			0.81	20.60	166	248.00		60
			0.88	22.20	179	266.00		
			0.94	23.80	191	284.00		
			1.00	25.40	203	302.00		
			1.03	26.20	209	311.00		80
			1.06	27.00	216	320.00		
			1.13	28.60	227	338.00		
			1.19	30.20	238	355.00		
			1.25	31.80	250	372.00		
			1.28	32.50	256	381.00		100
			1.31	33.30	262	390.00		
			1.38	34.90	274	407.00		
			1.50	38.10	296	441.00		120
			1.75	44.40	341	508.00		140
			1.97	50.00	379	564.00		160
22"	22.000	559	0.22	5.60	50.9	75.90		
			0.25	6.40	58.1	86.50		10
			0.28	7.10	65.2	97.10		
			0.31	7.90	72.3	108.00		
			0.34	8.70	79.6	118.00		
			0.38	9.50	86.6	129.00	STD	20
			0.41	10.30	93.6	139.00		
			0.44	11.10	101	150.00		
			0.47	11.90	108	161.00		
			0.50	12.70	115	171.00	XS	30
			0.56	14.30	129	192.00		
			0.63	15.90	143	213.00		
			0.69	17.50	157	233.00		
			0.75	19.00	170	254.00		
			0.81	20.60	184	274.00		
			0.88	22.20	197	294.00		60
			0.94	23.80	211	314.00		
			1.00	25.40	224	334.00		
			1.06	27.00	237	354.00		
			1.13	28.60	251	374.00		80
			1.19	30.20	264	393.00		
			1.25	31.80	277	413.00		
			1.31	33.30	290	432.00		
			1.38	34.90	303	451.00		100
			1.44	36.50	316	470.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			1.50	38.10	328	489.00		
			1.63	41.30	354	526.00		120
			1.88	47.60	403	600.00		140
			2.13	54.00	451	671.00		160
24"	24.000	610	0.25	6.40	63.4	94.40		10
			0.28	7.10	71.2	108.00		
			0.31	7.90	78.9	118.00		
			0.34	8.70	86.9	129.00		
			0.38	9.50	94.6	141.00	STD	20
			0.41	10.30	102	152.00		
			0.44	11.10	110	164.00		
			0.47	11.90	118	176.00		
			0.50	12.70	125	187.00	XS	
			0.56	14.30	141	210.00		30
			0.63	15.90	156	232.00		
			0.69	17.50	171	255.00		40
			0.75	19.00	186	277.00		
			0.81	20.60	201	300.00		
			0.88	22.20	216	322.00		
			0.94	23.80	231	344.00		
			0.97	24.60	238	355.00		60
			1.00	25.40	246	366.00		
			1.06	27.00	260	342.00		
			1.13	28.60	275	409.00		
			1.19	30.20	289	431.00		
			1.22	31.00	297	441.00		80
			1.25	31.80	304	452.00		
			1.31	33.30	318	474.00		
			1.38	34.90	332	495.00		
			1.44	36.50	346	516.00		
			1.50	38.10	360	537.00		
			1.53	38.90	367	547.00		100
			1.56	39.70	374	558.00		
			1.81	46.00	430	639.00		120
			2.06	52.40	483	719.00		140
			2.34	59.50	542	807.00		160
26"	26.000	660	0.25	6.40	68.8	102.00		
			0.28	7.10	77.2	115.00		
			0.31	7.90	85.6	128.00		10
			0.34	8.70	94.3	140.00		
			0.38	9.50	103	153.00	STD	
			0.41	10.30	111	165.00		
			0.44	11.10	120	178.00		
			0.47	11.90	128	190.00		
			0.50	12.70	136	203.00	XS	20
			0.56	14.30	153	227.00		
			0.63	15.90	169	252.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.69	17.50	186	277.00		
			0.75	19.00	202	301.00		
			0.81	20.60	218	325.00		
			0.88	22.20	235	350.00		
			0.94	23.80	251	374.00		
28"	28.000	711	1.00	25.40	267	398.00		
			0.25	6.40	74.1	110.00		
			0.28	7.10	83.2	124.00		
			0.31	7.90	92.3	137.00		10
			0.34	8.70	102	151.00		
			0.38	9.50	111	165.00	STD	
			0.41	10.30	120	178.00		
			0.44	11.10	129	192.00		
			0.47	11.90	138	205.00		
			0.50	12.70	147	219.00	XS	20
			0.56	14.30	165	245.00		
			0.63	15.90	183	272.00		30
			0.69	17.50	201	299.00		
			0.75	19.00	218	325.00		
			0.81	20.60	236	351.00		
			0.88	22.20	253	378.00		
			0.94	23.80	271	404.00		
			1.00	25.40	288	430.00		
30"	30.000	762	0.25	6.40	79.4	118.00		
			0.28	7.10	89.2	133.00		
			0.31	7.90	98.9	147.00		10
			0.34	8.70	109	162.00		
			0.38	9.50	119	177.00	STD	
			0.41	10.30	128	191.00		
			0.44	11.10	138	206.00		
			0.47	11.90	148	220.00		
			0.50	12.70	158	235.00	XS	20
			0.56	14.30	177	263.00		
			0.63	15.90	196	292.00		30
			0.69	17.50	215	321.00		
			0.75	19.00	234	349.00		
			0.81	20.60	253	377.00		
			0.88	22.20	272	405.00		
			0.94	23.80	291	434.00		
			1.00	25.40	310	461.00		
32"	32.000	813	0.25	6.40	84.8	126.00		
			0.28	7.10	95.2	142.00		
			0.31	7.90	106	157.00		10
			0.34	8.70	116	173.00		
			0.38	9.50	127	189.00	STD	
			0.41	10.30	137	204.00		
			0.44	11.10	148	220.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.47	11.90	158	235.00		
			0.50	12.70	168	251.00	XS	20
			0.56	14.30	189	281.00		
			0.63	15.90	209	312.00		30
			0.69	17.50	230	343.00		40
			0.75	19.00	250	373.00		
			0.81	20.60	270	403.00		
			0.88	22.20	291	433.00		
			0.94	23.80	311	463.00		
34"	34.000	864	1.00	25.40	331	493.00		
			0.25	6.40	90.1	134.00		
			0.28	7.10	101	151.00		
			0.31	7.90	112	167.00		10
			0.34	8.70	124	184.00		
			0.38	9.50	135	201.00	STD	
			0.41	10.30	146	217.00		
			0.44	11.10	157	234.00		
			0.47	11.90	168	250.00		
			0.50	12.70	179	266.00	XS	20
			0.56	14.30	201	299.00		
			0.63	15.90	223	332.00		30
			0.69	17.50	245	365.00		40
			0.75	19.00	266	397.00		
			0.81	20.60	288	429.00		
			0.88	22.20	310	461.00		
			0.94	23.80	331	493.00		
36"	36.000	914	1.00	25.40	352	525.00		
			0.25	6.40	95.4	142.00		
			0.28	7.10	107	160.00		
			0.31	7.90	119	177.00		10
			0.34	8.70	131	195.00		
			0.38	9.50	143	213.00	STD	
			0.41	10.30	154	230.00		
			0.44	11.10	166	248.00		
			0.47	11.90	178	265.00		
			0.50	12.70	190	282.00	XS	20
			0.56	14.30	213	317.00		
			0.63	15.90	236	352.00		30
			0.69	17.50	259	386.00		
			0.75	19.00	282	421.00		40
			0.81	20.60	305	455.00		
			0.88	22.20	328	489.00		
			0.94	23.80	351	523.00		
38"	38.000	965	1.00	25.40	374	557.00		
			0.31	7.90	126	187.00		
			0.34	8.70	138	206.00		
			0.38	9.50	151	224.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.41	10.30	163	243.00		
			0.44	11.10	176	262.00		
			0.47	11.90	188	280.00		
			0.50	12.70	200	298.00		
			0.56	14.30	225	335.00		
			0.63	15.90	249	372.00		
			0.69	17.50	274	408.00		
			0.75	19.00	298	444.00		
			0.81	20.60	322	480.00		
			0.88	22.20	347	517.00		
			0.94	23.80	371	553.00		
			1.00	25.40	395	589.00		
40"	40.000	1016	0.31	7.90	132	197.00		
			0.34	8.70	146	217.00		
			0.38	9.50	159	235.00		
			0.41	10.30	172	256.00		
			0.44	11.10	185	276.00		
			0.47	11.90	198	295.00		
			0.50	12.70	211	314.00		
			0.56	14.30	237	353.00		
			0.63	15.90	263	391.00		
			0.69	17.50	289	430.00		
			0.75	19.00	314	468.00		
			0.81	20.60	340	505.00		
			0.88	22.20	366	545.00		
			0.94	23.80	391	583.00		
			1.00	25.40	417	620.00		
42"	42.000	1067	0.34	8.70	153	228.00		
			0.38	9.50	167	248.00		
			0.41	10.30	180	269.00		
			0.44	11.10	194	290.00		
			0.46	11.90	208	310.00		
			0.50	12.70	222	330.00		
			0.56	14.30	249	370.00		
			0.63	15.90	276	411.00		
			0.69	17.50	304	452.00		
			0.75	19.00	330	492.00		
			0.81	20.60	357	532.00		
			0.88	22.20	384	572.00		
			0.94	23.80	411	615.00		
			1.00	25.40	438	652.00		
44"	44.000	1118	0.34	8.70	160	239.00		
			0.38	9.50	175	260.00		
			0.41	10.30	189	282.00		
			0.44	11.10	204	304.00		
			0.47	11.90	218	325.00		
			0.50	12.70	232	346.00		

Size in.	Outside Diameter		Wall Thickness		Weight		Identification	
	in.	mm	in.	mm	lb/ft	kg/m	STD XS, XXS	Schedule
			0.56	14.30	261	388.00		
			0.63	15.90	290	431.00		
			0.69	17.50	318	474.00		
			0.75	19.00	346	516.00		
			0.81	20.60	375	558.00		
			0.88	22.20	403	600.00		
			0.94	23.80	431	643.00		
46"	46.000	1168	1.00	25.40	474	684.00		
			0.34	8.70	168	250.00		
			0.38	9.50	183	272.00		
			0.41	10.30	198	294.00		
			0.44	11.10	213	317.00		
			0.47	11.90	228	340.00		
			0.50	12.70	243	362.00		
			0.56	14.30	273	406.00		
			0.63	15.90	303	451.00		
			0.69	17.50	333	496.00		
			0.75	19.00	362	540.00		
			0.81	20.60	392	584.00		
			0.88	22.20	422	628.00		
48"	48.000	1219	0.94	23.80	451	602.00		
			1.00	25.40	481	715.00		
			0.34	8.70	175	261.00		
			0.38	9.50	191	284.00		
			0.41	10.30	206	307.00		
			0.44	11.10	222	331.00		
			0.47	11.90	238	355.00		
			0.50	12.70	254	378.00		
			0.56	14.30	285	424.00		
			0.63	15.90	316	471.00		
			0.69	17.50	348	518.00		
			0.75	19.00	378	564.00		
			0.81	20.60	409	610.00		
			0.88	22.20	440	656.00		
			0.94	23.80	471	702.00		
			1.00	25.40	502	748.00		

Note : Other sizes and specifications / materials / grades are available upon request.

Stainless Steel Pipe Dimension as per ASTM & Weight-KG/M (ANSI B36.19)

Pipe Size		OD	Sch 5S		Sch 10S		Sch 40S	
DN	Inch	mm	WT mm	Weight (Kg/m)	WT mm	Weight (Kg/m)	WT mm	Weight (Kg/m)
10	3/8	17.1	1.24	0.490	1.65	0.63	2.31	0.845
15	½	21.3	1.65	0.800	2.11	1.00	2.77	1.27
20	¾	26.7	1.65	1.03	2.11	1.28	2.87	1.68
25	1	33.4	1.65	1.30	2.77	2.09	3.38	2.50
32	1 ¼	42.2	1.65	1.65	2.77	2.70	3.56	3.38
40	1 ½	48.3	1.65	1.91	2.77	3.11	3.68	4.05
50	2	60.3	1.65	2.40	2.77	3.93	3.91	5.44
65	2 ½	73.0	2.11	3.69	3.05	5.26	5.16	8.63
80	3	88.9	2.11	4.51	3.05	6.45	5.49	11.30
90	3 ½	101.6	2.11	5.26	3.05	7.53	5.74	13.78
100	4	114.3	2.11	5.84	3.05	8.36	6.02	16.07
125	5	141.3	2.77	9.47	3.40	11.56	6.55	21.80
150	6	168.3	2.77	11.32	3.50	13.84	7.11	28.30
200	8	219.1	2.77	14.79	3.76	19.96	8.18	42.60
250	10	273.1	3.40	22.63	4.19	27.78	9.27	60.50
300	12	323.9	3.96	31.25	4.57	36.00	9.52	73.88
350	14	355.6	3.96	34.36	4.78	41.30	11.13	94.59
400	16	406.4	4.19	41.56	4.78	47.29	12.7	123.30
450	18	457.2	4.19	46.80	4.78	53.42	14.27	155.80
500	20	508.0	4.78	59.25	5.54	68.71	15.09	183.42
600	24	609.6	5.54	82.47	6.35	94.45	17.48	255.41

Pipe Size		OD	Sch 80S		Sch 160S		Sch XXS	
DN	Inch	mm	WT mm	Weight (Kg/m)	WT mm	Weight (Kg/m)	WT mm	Weight (Kg/m)
10	3/8	17.1	3.20	1.10	-	-	-	-
15	½	21.3	3.75	1.62	4.75	1.94	7.47	2.55
20	¾	26.7	3.91	2.20	5.54	2.89	7.82	3.63
25	1	33.4	4.55	3.24	6.35	4.24	9.09	5.45
32	1 ¼	42.2	4.85	4.47	6.35	5.61	9.70	7.77
40	1 ½	48.3	5.08	5.41	7.14	7.25	10.16	9.54
50	2	60.3	5.54	7.48	8.74	11.10	11.07	13.44
65	2 ½	73.0	7.01	11.40	9.53	14.90	14.20	20.39
80	3	88.9	7.62	15.20	11.1	21.30	15.24	27.65
90	3 ½	101.6	8.08	18.92	-	-	-	-
100	4	114.3	8.56	22.30	13.49	33.54	17.12	41.03
125	5	141.3	9.53	31.97	15.88	49.11	19.05	57.43
150	6	168.3	10.97	42.70	18.20	67.56	21.95	79.22
200	8	219.1	12.7	64.60	23.00	111.20	22.23	107.80
250	10	273.1	12.7	96.0	28.60	172.40	25.40	155.15
300	12	323.9	12.7	132.0	33.32	238.76	25.40	186.97
350	14	355.6	19.05	158.08	35.71	281.70	-	-
400	16	406.4	21.41	203.33	40.46	365.11	-	-
450	18	457.2	23.8	254.36	45.71	466.40	-	-
500	20	508.0	26.19	311.20	49.99	564.68	-	-
600	24	609.6	30.96	442.08	59.54	808.22	-	-

Note : Other sizes and specifications / materials / grades are available upon request.

4. Oil Country Tubular Goods (OCTG)

General

Oil Country Tubular Goods (OCTG) refers to a family of seamless pipe and tube products used in petroleum industry, such as drill pipes and casing pipes which are subjected to loading conditions according to their specific application.

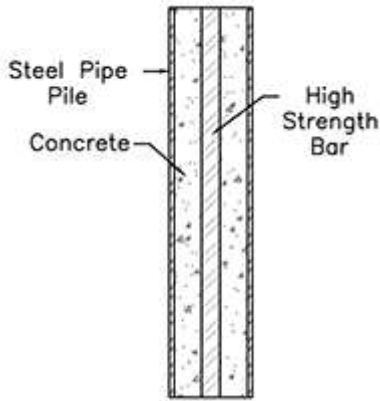
- Drill pipe is heavy seamless tube that rotates the drill bit and circulates drilling fluid. Pipe segments 30 ft (9m) long are coupled with tool joints. Drill pipe is simultaneously subjected to high torque by drilling, axial tension by its dead weight, and internal pressure by purging of drilling fluid. Additionally, alternating bending loads due to non-vertical or deflected drilling may be superimposed on these basic loading patterns.
- Casing pipe lines the borehole. It is subject to axial tension by its dead weight, internal pressure by fluid purging, and external pressure by surrounding rock formations. Casing is particularly exposed to axial tension and internal pressure by the pumped oil or gas emulsion.

Corrosion resistance under sour service conditions and high-strength through alloying content in combination with heat treatment such as quench and tempering are very important OCTG characteristics.

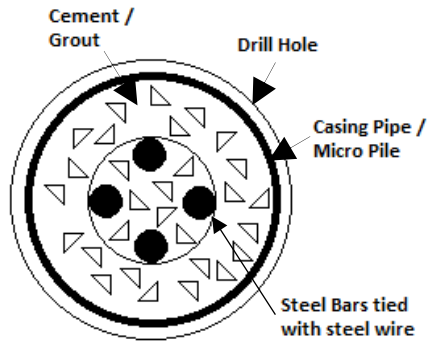
Casing Pipes as Micro Piles for High Tensile Loads

Micro piles are pile pipes installed in a subsurface environment that reinforce load transferring elements. Micro piles generally range from 4½ to 13½ inches in diameter. Though relatively small, micro piles are designed to carry high tensile loads.

Micro piles are an economical solution for reinforcement in structures where engineering challenges and usable space come into play. Since they can be installed in as little as 6 to 8 feet of workable spacing and exude minimal vibrations, micro piles are ideal for piling projects in close proximity to neighbouring structures. Micro piles are commonly used in older buildings and historical sites.



Micro Pile



**Typical Cross Section of
Micro Pile**

API casing pipes used together with high strength bars and under pressure grouting offer an economical solution for micro pile system designed to carry high tensile loads.

API casing pipes are supplied plain-end or with thread and coupling. API casing pipes can also be supplied at custom length and custom threaded according to Buyer's requirement.

Mechanical Properties

API has adopted an OCTG "grade" designation to define the strength of piping steels. This designation consists of a grade letter followed by a number, which designates the minimum yield strength of the steel in ksi (10^3 psi).

Casing Pipe : API Spec. 5CT

Grade	Yield Strength				Tensile Strength		Hardness
	Min		Max		Min		Max
	Psi	MPa	Psi	MPa	Psi	MPa	HRC
H40	40,000	276	80,000	552	60,000	414	
J55	55,000	379	80,000	552	75,000	517	
K55	55,000	379	80,000	552	95,000	655	
N80	80,000	552	110,000	758	100,000	689	
L80-1	80,000	552	95,000	655	95,000	655	23
C90	90,000	621	105,000	724	100,000	689	25.4
C95	95,000	655	110,000	758	105,000	724	25.4
T95	95,000	655	110,000	758	105,000	724	
P110	110,000	758	140,000	965	125,000	862	
Q125	125,000	860	150,000	1,035	135,000	930	

Drill Pipe Body : API Spec 5D

Grade	Yield Strength				Tensile Strength		Elongation (%)
	Min		Max		Min		
	Psi	MPa	Psi	MPa	Psi	MPa	
E75	75,000	517	105,000	724	100,000	689	17
X95	95,000	655	125,000	862	105,000	724	16.5
G105	105,000	724	135,000	931	115,000	793	15
S135	135,000	931	165,000	1,138	145,000	1,000	12.5

Chemical Composition

Casing Pipe : API Spec. 5CT

API 5CT Grade	Chemical Composition (% max)									
	C	Mn	Mo	Cr	Ni	Cu	P	S	Si	
H40							0.030	0.030		
J55							0.030	0.030		
K55							0.030	0.030		
N80							0.030	0.030		
L80-1	0.43	1.90			0.25	0.35	0.030	0.030	0.45	
C90-1	0.35	1.90	0.75	1.20	0.99		0.020	0.010		
C95	0.45	1.90			0.99		0.030	0.030	0.45	
T95-1	0.35	1.90	0.85	1.50			0.020	0.010		
T95-2	0.50	1.20			0.99		0.030	0.010		
P110	1.90						0.030	0.030		
Q125							0.020	0.010		

Drill Pipe Body : API Spec 5D

API 5D Grade	Chemical Composition (% max)	
	P	S
E75	0.030	0.030
X95	0.030	0.030
G105	0.030	0.030
S135	0.030	0.030

Dimensional Tolerances

Casing Pipe : API Spec. 5CT

Item	Tolerance
Outside Diameter	OD < 114.3mm, ± 0.79 mm OD ≥ 114.3 mm, + 1.0% D, - 0.5%D
Wall Thickness	- 12.5%
Weight - Single Length	+ 6.5%, - 3.5%

Drill Pipe Body : API Spec 5D

Item		Tolerance
Pipe Body	Outside Diameter	OD ≤ 114.3 mm, ± 0.79 mm OD ≥ 114.3 mm, +0.1%, -0.5%
	Wall Thickness	-12.5%
Weight	Single Length	+6.5%, -3.5%

Pipe Length

	Range 1	Range 2	Range 3
Casing Pipe	4.88 ~ 7.62 m	7.62 ~ 10.36 m	10.36 ~ 14.63 m
Drill Pipe	5.49 ~ 6.71 m	8.23 ~ 9.14 m	11.58 ~ 13.72 m

Note : Other length or fixed length available upon request by Buyer, and by agreement between Buyer and Seller.

Size of Casing Pipes (API Spec. 5CT)

Size	Weight lb/ft	Weight kg/m	OD mm	WT mm
4 1/2"	9.5	14.14	114.30	5.21
	10.50	15.63	114.30	5.69
	11.60	17.62	114.30	6.35
	13.50	20.09	114.30	7.37
	15.10	22.47	114.30	8.56
5"	11.50	17.11	127.00	5.59
	13.00	19.35	127.00	6.43
	15.00	22.32	127.00	7.52
	18.00	26.79	127.00	9.19
	21.40	31.85	127.00	11.10
	23.20	34.53	127.00	12.14
5 1/2 "	24.10	35.86	127.00	12.70
	14.00	20.83	139.70	6.20
	15.50	23.07	139.70	6.98
	17.00	25.30	139.70	7.72
	20.00	29.76	139.70	9.17
	23.00	34.23	139.70	10.54
	26.80	39.89	139.70	12.70
	29.70	44.21	139.70	14.27
	32.60	48.53	139.70	15.87
	35.30	52.54	139.70	17.45
	38.00	56.56	139.70	19.05
6 5/8"	40.50	60.29	139.70	20.62
	43.10	64.16	139.70	22.23
	20.00	29.76	168.28	7.32
	24.00	35.72	168.28	8.94
	28.00	41.67	168.28	10.59
7"	32.00	47.62	168.28	12.06
	17.00	25.30	177.80	5.87
	20.00	29.76	177.80	6.91
	23.00	34.23	177.80	8.05
	26.00	38.69	177.80	9.19
	29.00	43.16	177.80	10.36
	32.00	47.62	177.80	11.51
	35.00	52.09	177.80	12.65
	38.00	56.55	177.80	13.72
	42.70	63.56	177.80	15.87
	46.40	69.07	177.80	17.45
	50.10	74.58	177.80	19.05
	53.60	79.79	177.80	20.62
	57.10	85.00	177.80	22.23
7 5/8"	24.00	35.72	193.68	7.62
	26.40	39.29	193.68	8.33
	29.70	44.20	193.68	9.53
	33.70	50.15	193.68	10.92
	39.00	58.04	193.68	12.70

Size	Weight lb/ft	Weight kg/m	OD mm	WT mm
7 5/8"	42.80	63.69	193.68	14.27
	45.30	67.41	193.68	15.11
	47.10	70.09	193.68	15.88
	51.20	76.21	193.68	17.45
	55.30	82.32	193.68	19.05
7 3/4"	46.10	68.62	219.08	15.11
8 5/8"	24.00	35.72	219.08	6.71
	28.00	41.68	219.08	7.72
	32.00	47.62	219.08	8.94
	36.00	53.57	219.08	10.16
	40.00	59.53	219.08	11.43
	44.00	65.48	219.08	12.70
	49.00	72.92	244.48	14.15
9 5/8"	32.30	48.08	244.48	7.92
	36.00	53.57	244.48	8.94
	40.00	59.53	244.48	10.03
	43.50	64.74	244.48	11.05
	47.00	69.94	244.48	11.99
	53.50	79.62	244.48	13.84
	58.40	86.93	244.48	15.11
	59.40	88.42	244.48	15.47
	64.90	96.61	244.48	17.07
	70.30	104.65	244.48	18.64
	75.60	112.54	244.48	20.24
10 3/4"	32.75	48.75	273.05	7.09
	40.50	60.27	273.05	8.89
	45.50	67.71	273.05	10.16
	51.00	75.90	273.05	11.43
	55.50	82.59	273.05	12.57
	60.70	90.33	273.05	13.84
	65.70	97.77	273.05	15.11
	73.20	108.96	273.05	17.07
	79.20	117.90	273.05	18.64
	85.30	126.98	273.05	20.24
	42.00	62.52	298.45	8.46
11 3/4"	47.00	69.94	298.45	9.53
	54.00	80.36	298.45	11.05
	60.00	89.29	298.45	12.42
	65.00	96.76	298.45	13.56
	71.00	105.69	298.45	14.78
13 3/8"	48.00	71.45	339.73	8.38
	54.50	81.10	339.73	9.65
	61.00	90.78	339.73	10.92
	68.00	101.20	339.73	12.19
	72.00	107.18	339.73	13.08

Size of Casing, Seamless and Welded (ANSI)

Size	OD mm	WT mm	Sch.	Weight kg/m
4"	114.3	6.02	40	16.07
		8.56	80	22.32
		11.13	120	28.32
		13.49	160	33.54
5"	141.3	6.55	40	21.77
		9.53	80	30.97
		12.70	120	40.28
		15.88	160	49.11
6"	168.3	7.11	40	28.26
		10.97	80	42.56
		14.27	120	54.20
		18.26	160	67.56
8"	219.1	6.35	20	33.31
		7.04	30	36.81
		8.18	40	42.55
		10.31	60	53.08
		12.70	80	64.64
		15.09	100	75.92
		18.26	120	90.44
		23.01	160	111.27
10"	273.1	6.35	20	41.77
		7.80	30	51.03
		9.27	40	60.31
		12.70	60	81.55
		15.09	80	96.01
		18.26	100	114.75
		21.44	120	133.60
		28.58	160	172.33
12"	323.9	6.35	20	49.73
		8.38	30	65.20
		10.31	40	79.73
		14.27	60	108.96
		17.48	80	132.08
		21.44	100	159.91
		25.40	120	186.97
		33.32	160	238.76
14"	355.6	6.35	10	54.69
		7.92	20	67.90
		9.53	30	81.33
		11.13	40	94.55
		15.09	60	126.71
		19.05	80	158.10
		23.83	100	194.96
		27.79	120	224.65
		35.71	160	281.70

Size	OD mm	WT mm	Sch.	Weight kg/m
16"	406.4	6.35	10	62.64
		7.92	20	77.83
		9.53	30	93.27
		12.70	40	123.30
		16.66	60	160.12
		21.44	80	203.53
		26.19	100	245.56
		30.96	120	286.64
		40.49	160	365.35
18"	457.0	6.35	10	70.57
		7.92	20	87.71
		11.13	30	122.83
		14.27	40	155.80
		19.05	60	205.74
		23.83	80	254.55
		29.36	100	309.62
		34.93	120	363.56
20"	508.0	45.24	160	459.37
		6.35	10	78.55
		9.53	20	117.15
		12.70	30	155.12
		15.09	40	183.42
		20.62	60	247.83
		26.19	80	311.17
		32.54	100	381.53
		38.10	120	441.49
		50.01	160	564.81

Note : Other sizes (wall thickness) are available in casing dimension of 114.4mm (4") to 508.0mm (20") upon request

Size of Drill Pipe Body (API Spec. 5D)

Size Designation		Nominal Weight	Calculated Weight		Grade	Wall Thickness	
in.	mm		lb/ft	kg/m		in.	mm
2 3/8	60.3	6.65	6.26	9.32	E,X,G,S	0.280	7.11
2 7/8	73.0	10.40	9.72	14.48	E,X,G,S	0.362	9.19
3 ½	88.9	9.5	8.81	13.12	E	0.254	6.45
		13.30	12.31	18.34	E,X,G,S	0.368	9.35
		15.50	14.63	21.79	E	0.449	11.40
		15.50	14.63	21.79	X,G,S	0.449	11.40
4	101.6	14.00	12.93	19.26	E,X,G,S	0.330	8.38
4 ½	114.3	13.75	12.24	18.23	E	0.271	6.88
		16.60	14.98	22.31	E,X,G,S	0.337	8.56
		20.00	18.69	27.84	E,X,G,S	0.430	10.92
5	127.0	16.25	14.87	22.15	X,G,S	0.296	7.52
		19.50	17.93	26.71	E	0.362	9.19
		19.50	17.93	26.71	X,G,S	0.362	9.19
		25.60	24.03	35.79	E	0.500	12.70
		25.60	24.03	35.70	X,G,S	0.500	12.70
5 ½	139.7	21.90	19.81	29.51	E,X,G,S	0.361	9.17
		24.70	22.54	33.57	E,X,G,S	0.415	10.54

5. Pipe Fittings

General

A pipe 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 mitred 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 mitred bend has about six times the resistance of a smooth elbow. As such, pipe fittings are preferable for most piping systems where rate of flow, internal pressure and protection against a corrosive environment are primary design considerations. Pipe fittings are joined to the piping system either by threaded screw (THD), flanges or butt welded (BW).

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. 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, butt welded fittings form a continuous metal structure with the pipe, adding forged-in strength to any piping system.

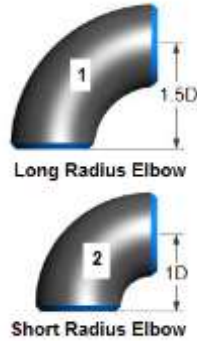
Pipe fittings are generally made by hot forming, e.g. elbows using a mandrel; hot induction, e.g. large diameter bends; or cold forming, e.g. caps and tees.

Types of pipe fittings :

1. Elbows

Elbows are the most commonly used fittings. Generally, their size designations are either long radius or short radius. The long radius elbow is usually adequate for standard service conditions. The centre-to-end dimension is always $1\frac{1}{2}$ times the nominal size of the elbow. Short radius elbows have a centre-to-end measurement equal to pipe diameter.

For service where the flow rate is critical and space is available, long radius elbows are usually used. This provides the least reduction in flow and pressure drop from internal frictional resistance and stream turbulence. When space is limited and the flow rate is non-critical, a short radius elbow is often selected. A long radius elbow generally costs less than a short radius fittings.



2. 180° Returns

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 in the space that is available determines whether a short or long radius return is used. All long and short radius 180° returns have centre-to-centre dimensions that are double those of matching 90° elbows.



3. Reducing Elbow

The 90° reducing elbow is designed to change direction as well as reduce the length of flow within a piping system. Using both a standard 90° elbow and reducer could essentially do the same. However, a 90° long radius-reducing elbow 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. These features prevent sizeable pressure drops in the line.



4. Tees

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 straight tee is manufactured with all three outlets, the run as well as the branch in the same size. A reducing tee is made with the branch outlet smaller than the run to accommodate the design flow rate.



Straight Tee



Reducing Tee

5. 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.



6. 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.

The eccentric reducer has a reducing outlet end off-centre. It will line up straight with one side of the inlet but not with the other outlet. One advantage over the concentric reducer is that it can be installed flush against a flat ceiling or wall. This lends greater support to the piping system and many times reduces the required space.

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



Eccentric Reducer



Concentric Reducer

7. Lap Joint Stub Ends

These fittings are used in lines that might require a quick disconnection. Normally, stub ends are installed in pairs and mated lap joint flanges. This allows easy 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. Lap joint stub ends are made with serrated gasket surfaces for improved sealing of the connection and prevention of leakage at the joint.



Standards and Specifications

Carbon steel butt-welding fittings are manufactured according to the following codes and standards :

No.	Reference Code / Standard	Revision / Year	Description of Code	Coverage
1.	ANSI B16.9	2007	Factory-made Wrought Steel Butt-welding Fittings	Dimension, tolerances, ratings, testing and markings
2.	ASTM A234	ASME Sec II 2007	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service	Material grade, chemical composition, mechanical properties and process.

Mechanical Properties

Standard	Grade	Mechanical Properties				
		Tensile Strength		Yield Strength	Elongation	Hardness
		MPa min	MPa max	MPa min	% min	HB max
ASTM A234	WPB	415	585	240	30	197
	WPC	485	655	275	30	197

Chemical Composition

Grade	Composition %									
	C	Mn	P	S	Si	Cr	Mo	Ni	Cu	Others
WPB	0.30	0.29 - 1.06	0.050	0.058	0.10	0.40	0.15	0.40	0.40	V 0.08
WPC	0.35	0.29 - 1.06	0.50	0.058	0.10	0.40	0.15	0.40	0.40	V 0.08

Reference Weight (Mass) Calculation

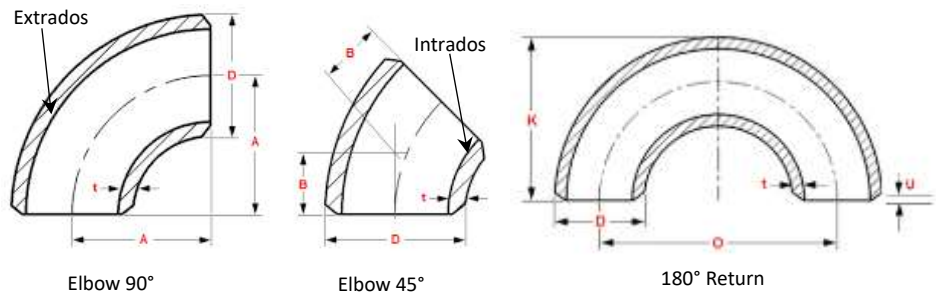
The following formula is used for calculation of reference weight (mass) of carbon steel fittings :

Length of elbow : $L = S \times R / 1000 \times 0.01746m$
where, S = angle of elbow in degrees; R = radius of elbow in mm

Weight of elbow : $W = L \times \text{weight per meter of pipe (kg/m)}$

Dimensional Tolerances

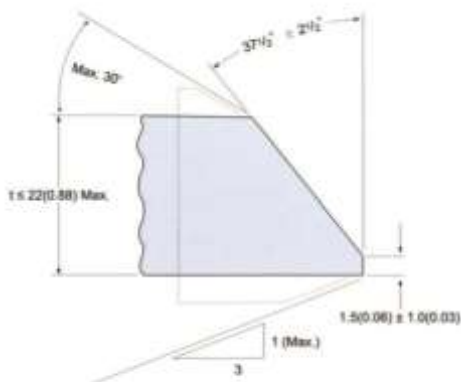
Dimensional tolerances for fittings are specified under ASME B16.9 and summarized as below :



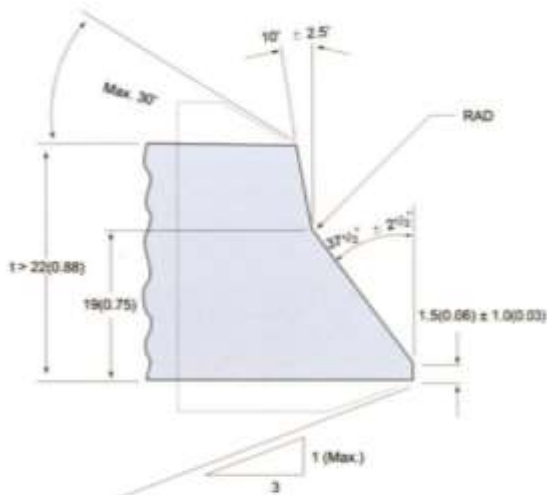
All Fittings				90° & 45° elbows	180° Return		
NPS	Outside OD at bevel	Inside ID at end	Wall Thickness t	Centre-to-end A, B	Centre-to-centre O	Back-to-Face K	Alignment of Ends U
½ - 2 ½	+ 0.06 - 0.03	± 0.03	Not less than 87.5% of nominal thickness	± 0.06	± 0.25	± 0.25	± 0.03
3 – 4	± 0.06	± 0.06					
5 – 8	+ 0.09 - 0.06						
10 – 18	+ 0.16 - 0.12	± 0.12		± 0.09	± 0.38		
20 – 24	+ 0.25 - 0.16	± 0.19					
26 – 30							
32 – 48							

Weld End Preparations

End preparations are made in accordance to ASME B16.9 as follows :



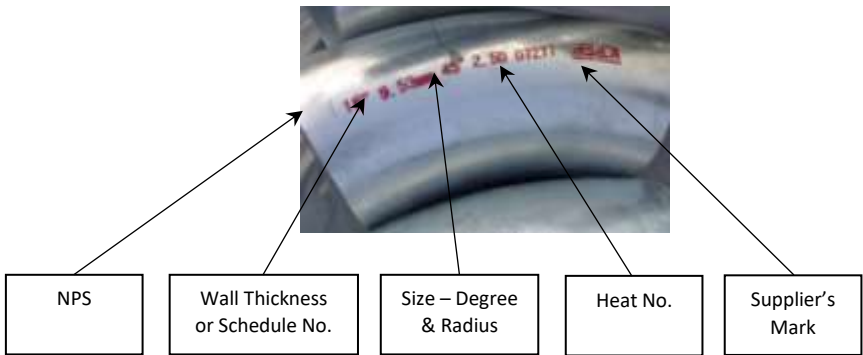
(a) Plain Bevel



(b) Compound Bevel

Marking

All fittings are clearly and permanently marked by stencil marking or stamping on the outside surface in accordance to ASTM A234 as follows :



Packing and Shipping

Fittings are supplied with temporary external coating for surface protection during shipping ie. standard mill varnish (black) unless otherwise specified by Buyer.

Fittings are protected with rubber bevel-end protectors (where necessary) and packed in standard export packaging ie. wrapped in plastic sheets and strapped in wooden boxes or pallets, for optimized protection during shipping.



Additional trade information

“Schedule” Pipe and Fittings

One of the most common ways to describe a pipe or fitting is by its “schedule”. Many buyers tend to ask for “schedule pipe” or “schedule fitting” when sending out price enquiries, without specifying pipe sizes.

Pipe schedule is the term used to describe the thickness of a pipe or fitting. For all pipe sizes the outside diameter (O.D.) remains relatively constant. The variations in wall thickness affects only the inside diameter (I.D.).

A schedule number indicates the approximate value of :

$$Sch. = 1000 (P/S)$$

where,

P = service pressure (psi)

S = allowable stress (psi)

The higher the schedule number is, the thicker the pipe is. Since the outside diameter of each pipe size is standardized, a particular nominal pipe size will have different inside pipe diameter depending on the schedule specified.

Pipe Schedule for Carbon Steel Pipe (According to ASME B36.10)

Pipe Schedule 10 Carbon Steel Pipe (According to ASME B36.10)			Nominal Wall Thickness													
Pipe Size	DN	OD	Sch 10	Sch 20	Sch 30	STD	Sch 40	Sch 60	XS	Sch 80	Sch 100	Sch 120	Sch 140	Sch 160	XXS	
½"	15	21.3				2.77	2.77		3.73	3.73					4.78	7.47
¾"	20	26.7				2.87	2.87		3.91	3.91					5.56	7.82
1"	25	33.4				3.38	3.38		4.55	4.55					6.35	9.09
1 ¼"	32	42.2				3.56	3.56		4.85	4.85					6.35	9.70
1 ½"	40	48.3				3.68	3.68		5.08	5.08					7.14	10.2
2"	50	60.3				3.91	3.91		5.54	5.54					8.74	11.1
2 ½"	65	73.0				5.16	5.16		7.01	7.01					9.53	14.0
3"	80	88.9				5.49	5.49		7.62	7.62					11.1	15.2
3 ½"	90	101.6				5.74	5.74		8.08	8.08						
4"	100	114.3				6.02	6.02		8.56	8.56		11.3			13.5	17.1
5"	125	141.3				6.55	6.55		9.53	9.53		12.7			15.9	19.0
6"	150	168.3				7.11	7.11		11.0	11.0		14.3			18.3	21.2
8"	200	219.1		6.35	7.04	8.18	8.18	10.3	12.7	12.7	15.1	18.3	20.6	23.0	22.2	
10"	250	273.1		6.35	7.80	9.27	9.27	12.7	12.7	15.1	18.3	21.4	25.4	28.6	25.4	
12"	300	323.9		6.35	8.38	9.53	10.3	14.3	12.7	17.5	21.1	25.4	28.6	33.3	25.4	
14"	350	355.6	6.35	7.92	9.53	9.53	11.1	15.1	12.7	19.1	23.8	27.8	31.8	35.7		
16"	400	406.4	6.35	7.92	9.53	9.53	12.7	16.7	12.7	21.4	26.2	31.0	36.5	40.5		
18"	450	457.2	6.35	7.92	11.1	9.53	14.3	19.1	12.7	23.8	29.4	34.9	39.7	45.2		
20"	500	508.0	6.35	9.53	12.7	9.53	15.1	20.6	12.7	26.2	32.5	38.1	44.4	50.0		
24"	600	610.0	6.35	9.53	14.3	9.53	17.5	22.2	12.7	28.6	34.9	46.0	52.4	59.5		
30"	750	762.0	7.92	12.7	15.9	9.53		24.6	12.7							
36"	900	914.0	7.92	12.7	15.9	9.53	19.1		12.7							

Note : STD – Standard

XS – Extra Strong

XXS – Double Extra Strong

Pipe Schedule for Stainless Steel Pipe (According to ASME B36.19)

Pipe Size	DN	OD	Nominal Wall Thickness			
			Sch 5S	Sch 10S	Sch 40S	Sch 80S
½"	15	21.3	1.65	2.11	2.77	3.73
¾"	20	26.7	1.65	2.11	2.87	3.91
1"	25	33.4	1.65	2.77	3.38	4.55
1 ¼"	32	42.2	1.65	2.77	3.56	4.85
1 ½"	40	48.3	1.65	2.77	3.68	5.08
2"	50	60.3	1.65	2.77	3.91	5.54
2 ½"	65	73.0	2.11	3.05	5.16	7.01
3"	80	88.9	2.11	3.05	5.49	7.62
3 ½"	90	101.6	2.11	3.05	5.74	8.08
4"	100	114.3	2.11	3.05	6.02	8.56
5"	125	141.3	2.77	3.40	6.55	9.53
6"	150	168.3	2.77	3.40	7.11	10.97
8"	200	219.1	2.77	3.76	8.18	12.70
10"	250	273.1	3.40	4.19	9.27	12.70
12"	300	323.9	3.96	4.57	9.53	12.70
14"	350	355.6	3.96	4.77		
16"	400	406.4	4.19	4.77		
18"	450	457.2	4.19	4.77		
20"	500	508.0	4.77	5.54		
24"	600	610.0	4.77	5.54		
30"	750	762.0	5.54	6.35		
36"	900	914.0	6.35	7.92		

Wall Thickness at the Extrados

One of the most important factors to consider when purchasing fittings is the wall thickness at the Extrados of the elbow ie. the outer curve. When manufacturing an elbow whether by mandrel, hot induction or cold forming, the Extrados will inevitably become thinner as it is "stretched", "bent" or "formed".

Some manufacturers will make an elbow from a pipe of the same size and nominal thickness and the same or equivalent material. While, the elbow will have minimal reduction in wall thickness at the ends, the wall thickness at extrados could reduce significantly depending on the radius of bending.

As a general rule, percentage wall thinning of extrados is as follows :

R/D	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	≥ 10.0
RE (%)	22.0	19.0	15.0	12.0	10.0	9.0	8.0	7.0	6.0	0.5

R = Radius D = Outside Diameter RE = Percentage reduction in extrados

Eg. Elbow 12" (323.9mm) Sch 40 (10.31mm) and radius = 900mm

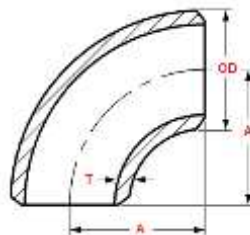
$$R/D = 2.78 \approx 3$$

$$RE = 15\%$$

WT (extrados) $\approx 8.76\text{mm}$ (if using pipe with same nominal wall thickness as starting material)

As a result, some of these elbows do not meet the tolerance for wall thickness in accordance to ASME B16.9 (ie. 87.5% of nominal wall thickness). In order for elbows to meet the minimal requirements, a thicker pipe will need to be used as starting material to manufacture the elbows. In general, for an elbow with $R = D$ the minimal wall thickness has to be at least 150% of the nominal wall thickness in order for the wall thickness at the extrados to be at least 90% of the nominal wall thickness.

ASME B16.9 - ELBOWS

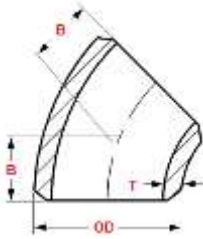


90° Long Radius $R = 1.5D$

90° Short Radius $R = 1D$

NPS	Outside Diameter OD	Centre-to-end			STD		Sch 40	
		Long		Short				
		A	B	A	T	ID	T	ID
½"	21.3	38	16		2.77	15.8	2.77	15.8
¾"	26.7	38	19		2.87	20.9	2.87	20.9
1"	33.4	38	22	25	3.38	26.6	3.38	26.6
1 ¼"	42.2	48	25	32	3.56	35.1	3.56	35.1
1 ½"	48.3	57	29	38	3.68	40.9	3.68	40.9
2"	60.3	76	35	51	3.91	52.5	3.91	52.5
2 ½"	73.0	95	44	64	5.16	62.7	5.16	62.7
3"	88.9	114	51	76	5.49	77.9	5.49	77.9
3 ½"	101.6	133	57	89	5.74	90.1	5.74	90.2
4"	114.3	152	64	102	6.02	102.3	6.02	102.3
5"	141.3	190	79	127	6.55	120.2	6.55	120.2
6"	168.3	229	95	152	7.11	154.1	7.11	154.1
8"	219.1	305	127	203	8.18	202.7	8.18	202.7
10"	273.0	381	159	254	9.27	254.5	9.27	254.5
12"	323.8	457	190	305	9.53	304.8	10.31	303.2
14"	355.6	533	222	356	9.53	336.6	11.13	333.3
16"	406.4	610	254	406	9.53	386.1	12.70	381.0
18"	457.0	686	286	457	9.53	437.9	14.27	428.5
20"	508.0	762	318	508	9.53	488.9	15.09	477.8
22"	559.0	838	343	559	9.53	539.9		
24"	610.0	914	381	610	9.53	590.9		
26"	660.0	991	406		9.53	640.9		
28"	711.0	1067	438		9.53	691.9		
30"	762.0	1143	470		9.53	742.9		
32"	813.0	1219	502		9.53	793.9		

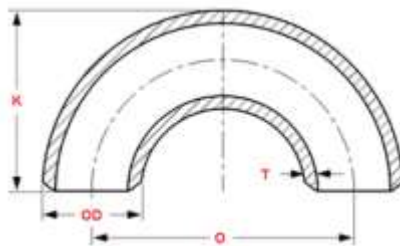
Note : Other sizes (NPS and wall thickness) and fitting types are available upon request



45° Long Radius R = 1.5D

XS		Sch 80		Sch 160		XXS		NPS
T	ID	T	ID	T	ID	T	ID	
3.73	13.9	3.73	13.9					½"
3.91	18.9	3.91	18.9					¾"
4.55	24.3	4.55	24.3	6.35	20.7	9.09	15.2	1"
4.85	32.5	4.85	32.5	6.35	29.5	9.7	22.8	1 ¼"
5.08	38.1	5.08	38.1	7.14	34.0	10.16	28.0	1 ½"
5.54	49.3	5.54	49.3	8.74	42.9	11.07	38.2	2"
7.01	59.0	7.01	59.0	9.53	54.0	14.02	15.0	2 ½"
7.62	73.7	7.62	73.7	11.13	66.7	15.24	58.4	3"
8.08	85.2	8.08	85.2					3 ½"
8.56	97.2	8.56	97.2	13.49	87.3	17.12	80.0	4"
9.53	122.3	9.53	122.3	15.88	109.6	19.05	103.2	5"
10.97	146.3	10.97	146.3	18.26	131.8	21.95	124.4	6"
12.7	193.7	12.7	193.7	23.01	173.1	22.23	174.6	8"
12.7	247.7	15.09	242.8	28.58	215.9	25.40	222.2	10"
12.7	298.5	17.48	288.8	33.53	257.2	25.40	273.0	12"
12.7	330.2	19.05	317.5	35.71	284.2			14"
12.7	381.0	21.44	363.5	40.49	325.4			16"
12.7	431.6	23.83	409.3					18"
12.7	482.6	26.19	455.6					20"
12.7	533.6	28.58	501.8					22"
12.7	584.6	30.96	548.1					24"
12.7	634.6							26"
12.7	685.6							28"
12.7	736.6							30"
12.7	787.6							32"

ASME B16.9 – 180° RETURN



180° Long Radius Return

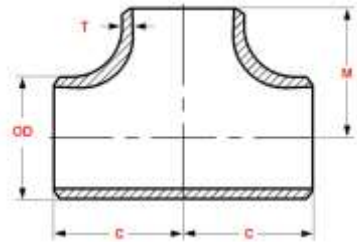
180° Short Radius Return

NPS	Outside Diameter OD	Long		Short		STD	
		O	K	O	K	T	ID
½"	21.3	76	48			2.77	15.8
¾"	26.7	76	51			2.87	20.9
1"	33.4	76	56	51	41	3.38	26.6
1 ¼"	42.2	95	70	64	52	3.56	35.1
1 ½"	48.3	114	83	76	62	3.68	40.9
2"	60.3	152	106	102	81	3.91	52.5
2 ½"	73.0	191	132	127	100	5.16	62.7
3"	88.9	229	159	152	121	5.49	77.9
3 ½"	101.6	267	184	178	140	5.74	90.1
4"	114.3	305	210	203	159	6.02	102.3
5"	141.3	381	262	254	197	6.55	120.2
6"	168.3	457	313	305	237	7.11	154.1
8"	219.1	610	414	406	313	8.18	202.7
10"	273.0	762	518	508	391	9.27	254.5
12"	323.8	914	619	610	467	9.53	304.8
14"	355.6	1067	711	711	533	9.53	336.6
16"	406.4	1219	813	813	610	9.53	386.1
18"	457.0	1372	914	914	686	9.53	437.9
20"	508.0	1524	1016	1016	762	9.53	488.9
22"	559.0	1676	1118			9.53	539.9
24"	610.0	1829	1219	1219	914	9.53	590.9

Note : Other sizes (NPS and wall thickness) and fitting types are available upon request

Sch 40		XS		Sch 80		Sch 160		XXS		NPS
T	ID	T	ID	T	ID	T	ID	T	ID	
2.77	15.8	3.73	13.9	3.73	13.9					½"
2.87	20.9	3.91	18.9	3.91	18.9					¾"
3.38	26.6	4.55	24.3	4.55	24.3	6.35	20.7	9.09	15.2	1"
3.56	35.1	4.85	32.5	4.85	32.5	6.35	29.5	9.7	22.8	1 ¼"
3.68	40.9	5.08	38.1	5.08	38.1	7.14	34.0	10.16	28.0	1 ½"
3.91	52.5	5.54	49.3	5.54	49.3	8.74	42.9	11.07	38.2	2"
5.16	62.7	7.01	59.0	7.01	59.0	9.53	54.0	14.02	15.0	2 ½"
5.49	77.9	7.62	73.7	7.62	73.7	11.13	66.7	15.24	58.4	3"
5.74	90.2	8.08	85.2	8.08	85.2					3 ½"
6.02	102.3	8.56	97.2	8.56	97.2	13.49	87.3	17.12	80.0	4"
6.55	120.2	9.53	122.3	9.53	122.3	15.88	109.6	19.05	103.2	5"
7.11	154.1	10.97	146.3	10.97	146.3	18.26	131.8	21.95	124.4	6"
8.18	202.7	12.7	193.7	12.7	193.7	23.01	173.1	22.23	174.6	8"
9.27	254.5	12.7	247.7	15.09	242.8	28.58	215.9	25.40	222.2	10"
10.31	303.2	12.7	298.5	17.48	288.8	33.53	257.2	25.40	273.0	12"
11.13	333.3	12.7	330.2	19.05	317.5	35.71	284.2			14"
12.70	381.0	12.7	381.0	21.44	363.5	40.49	325.4			16"
14.27	428.5	12.7	431.6	23.83	409.3	45.24	366.5			18"
15.09	477.8	12.7	482.6	26.19	455.6	50.01	408.0			20"
		12.7	533.6	28.58	501.8	53.98	451.0			22"
		12.7	584.6	30.96	548.1	59.54	490.9			24"

ASME B16.9 – STRAIGHT TEE / CROSSES

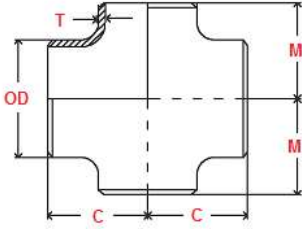


Straight Tee

NPS	Outside Diameter OD	Centre-to-end run C	Centre-to-end outlet M	STD		Sch 40	
				T	ID	T	ID
½"	21.3	25	2	2.77	15.8	2.77	15.8
¾"	26.7	29	29	2.87	20.9	2.87	20.9
1"	33.4	38	38	3.38	26.6	3.38	26.6
1 ¼"	42.2	48	48	3.56	35.1	3.56	35.1
1 ½"	48.3	57	57	3.68	40.9	3.68	40.9
2"	60.3	64	64	3.91	52.5	3.91	52.5
2 ½"	73.0	76	76	5.16	62.7	5.16	62.7
3"	88.9	86	86	5.49	77.9	5.49	77.9
3 ½"	101.6	95	95	5.74	90.1	5.74	90.2
4"	114.3	105	105	6.02	102.3	6.02	102.3
5"	141.3	124	124	6.55	120.2	6.55	120.2
6"	168.3	143	143	7.11	154.1	7.11	154.1
8"	219.1	178	178	8.18	202.7	8.18	202.7
10"	273.0	216	216	9.27	254.5	9.27	254.5
12"	323.8	254	254	9.53	304.8	10.31	303.2
14"	355.6	279	279	9.53	336.6	11.13	333.3
16"	406.4	305	305	9.53	386.1	12.70	381.0
18"	457.0	343	343	9.53	437.9	14.27	428.5
20"	508.0	381	381	9.53	488.9	15.09	477.8
22"	559.0	419	419	9.53	539.9		
24"	610.0	432	432	9.53	590.9	17.48	575.0
26"	660.0	495	495	9.53	640.9		
28"	711.0	521	521	9.53	691.9		
30"	762.0	559	559	9.53	742.9		
32"	813.0	597	597	9.53	793.9	17.48	778.0

Note : Other sizes (NPS and wall thickness) and fitting types are available upon request

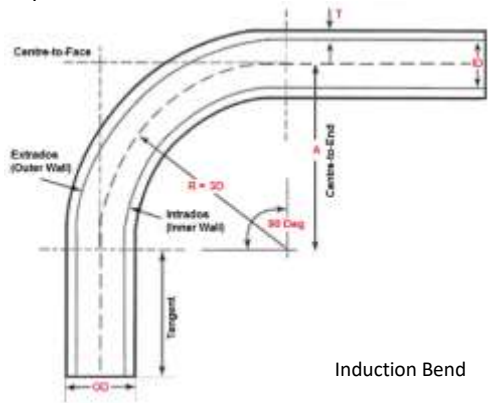
ASME B16.9 – STRAIGHT TEE / CROSSES



Straight Cross

XS		Sch 80		Sch 160		XXS		NPS
T	ID	T	ID	T	ID	T	ID	
3.73	13.9	3.73	13.9					½"
3.91	18.9	3.91	18.9					¾"
4.55	24.3	4.55	24.3	6.35	20.7	9.09	15.2	1"
4.85	32.5	4.85	32.5	6.35	29.5	9.7	22.8	1 ¼"
5.08	38.1	5.08	38.1	7.14	34.0	10.16	28.0	1 ½"
5.54	49.3	5.54	49.3	8.74	42.9	11.07	38.2	2"
7.01	59.0	7.01	59.0	9.53	54.0	14.02	15.0	2 ½"
7.62	73.7	7.62	73.7	11.13	66.7	15.24	58.4	3"
8.08	85.2	8.08	85.2					3 ½"
8.56	97.2	8.56	97.2	13.49	87.3	17.12	80.0	4"
9.53	122.3	9.53	122.3	15.88	109.6	19.05	103.2	5"
10.97	146.3	10.97	146.3	18.26	131.8	21.95	124.4	6"
12.7	193.7	12.7	193.7	23.01	173.1	22.23	174.6	8"
12.7	247.7	15.09	242.8	28.58	215.9	25.40	222.2	10"
12.7	298.5	17.48	288.8	33.53	257.2	25.40	273.0	12"
12.7	330.2	19.05	317.5	35.71	284.2			14"
12.7	381.0	21.44	363.5	40.49	325.4			16"
12.7	431.6	23.83	409.3	45.24	366.5			18"
12.7	482.6	26.19	455.6	50.01	408.0			20"
12.7	533.6	28.58	501.8	53.98	451.0			22"
12.7	584.6	30.96	548.1	59.54	490.9			24"
12.7	634.6							26"
12.7	685.6							28"
12.7	736.6							30"
12.7	787.6							32"

ASME B16.9 – BENDS (HOT INDUCTION)



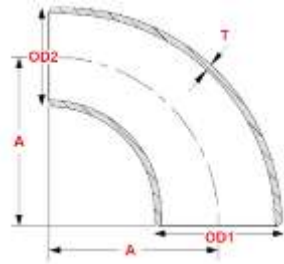
Induction Bend

NPS	Outside Diameter OD	Centre-to-end			STD		Sch 40	
		R=2.5D	R=3D	R=3.6D				
		A	A	A	T	ID	T	ID
2"	60.3	127	152	183	3.91	52.5	3.91	52.5
2 ½"	73.0	159	191	229	5.16	62.7	5.16	62.7
3"	88.9	191	229	274	5.49	77.9	5.49	77.9
4"	114.3	254	305	366	6.02	102.3	6.02	102.3
5"	141.3	318	381	457	6.55	120.2	6.55	120.2
6"	168.3	381	457	549	7.11	154.1	7.11	154.1
8"	219.1	508	610	732	8.18	202.7	8.18	202.7
10"	273.0	635	762	914	9.27	254.5	9.27	254.5
12"	323.8	762	914	1097	9.53	304.8	10.31	303.2
14"	355.6	889	1067	1280	9.53	336.6	11.13	333.3
16"	406.4	1016	1219	1463	9.53	386.1	12.70	381.0
18"	457.0	1143	1372	1645	9.53	437.9	14.27	428.5
20"	508.0	1270	1524	1829	9.53	488.9	15.09	477.8
22"	559.0	1398	1677	2012	9.53	539.9		
24"	610.0	1525	1829	2196	9.53	590.9		
26"	660.0	1650	1981	2376	9.53	640.9		
28"	711.0	1778	2134	2560	9.53	691.9		
30"	762.0	1905	2286	2743	9.53	742.9		
32"	813.0	2033	2438	2927	9.53	793.9		
36"	914.0	2285	2743	3290	9.53	894.9		
38"	965.0	2413	2896	3474	9.53	945.9		
40"	1016.0	2540	3048	3658	9.53	996.9		
42"	1067.0	2668	3200	3841	9.53	1047.9		
48"	1219.0	3048	3658	4388	9.53	1199.9		

ASME B16.9 – BENDS (HOT INDUCTION)

XS		Sch 80		Sch 160		XXS		NPS
T	ID	T	ID	T	ID	T	ID	
5.54	49.3	5.54	49.3	8.74	42.9	11.07	38.2	2"
7.01	59.0	7.01	59.0	9.53	54.0	14.02	15.0	2 ½"
7.62	73.7	7.62	73.7	11.13	66.7	15.24	58.4	3"
8.08	97.2	8.08	97.2	13.49	87.3	17.12	80.0	4"
9.53	122.3	9.53	122.3	15.88	109.6	19.05	103.2	5"
10.97	146.3	10.97	146.3	18.26	131.8	21.95	124.4	6"
12.7	193.7	12.7	193.7	23.01	173.1	22.23	174.6	8"
12.7	247.7	15.09	242.8	28.58	215.9	25.40	222.2	10"
12.7	298.5	17.48	288.8	33.53	257.2	25.40	273.0	12"
12.7	330.2	19.05	317.5	35.71	284.2			14"
12.7	381.0	21.44	363.5	40.49	325.4			16"
12.7	431.6	23.83	409.3					18"
12.7	482.6	26.19	455.6					20"
12.7	533.6	28.58	501.8					22"
12.7	584.6	30.96	548.1					24"
12.7	634.6							26"
12.7	685.6							28"
12.7	736.6							30"
12.7	787.6							32"
12.7	888.6							36"
12.7	939.6							38"
12.7	990.6							40"
12.7	1041.6							42"
12.7	1193.6							48"

ASME B16.9 – REDUCING ELBOWS

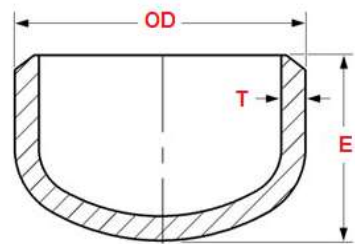


90° Long Radius Reducing Elbow

NPS1	NPS2	Outside Diameter		Centre-to-End A	STD	XS	Sch 160	XXS
		Large End OD1	Small End OD2		T	T	T	T
2"	1 ½"	60.3	48.3	76	3.91	5.54	8.74	10.16
2"	1 ¼"	60.3	42.2	76	3.91	5.54	8.74	10.16
2"	1"	60.3	33.4	76	3.91	5.54	8.74	10.16
2 ½"	2"	73.0	60.3	95	5.16	7.01	9.53	11.07
2 ½"	1 ½"	73.0	48.3	95	5.16	7.01	9.53	11.07
2 ½"	1 ¼"	73.0	42.2	95	5.16	7.01	9.53	11.07
3"	2 ½"	88.9	73.0	114	5.49	7.62	11.13	14.02
3"	2"	88.9	60.3	114	5.49	7.62	11.13	14.02
3"	1 ½"	88.9	48.3	114	5.49	7.62	11.13	14.02
3 ½"	3"	101.6	88.9	133	5.74	8.08		15.24
3 ½"	2 ½"	101.6	73.0	133	5.74	8.08		15.24
3 ½"	2"	101.6	60.3	133	5.74	8.08		15.24
4"	3 ½"	114.3	101.6	152	6.02	8.56	13.49	16.15
4"	3"	114.3	88.9	152	6.02	8.56	13.49	16.15
4"	2 ½"	114.3	73.0	152	6.02	8.56	13.49	16.15
4"	2"	114.3	60.3	152	6.02	8.56	13.49	16.15
5"	4"	141.3	114.3	190	6.55	9.53	15.88	17.12
5"	3 ½"	141.3	101.6	190	6.55	9.53	15.88	17.12
5"	3"	141.3	88.9	190	6.55	9.53	15.88	17.12
5"	2 ½"	141.3	73.0	190	6.55	9.53	15.88	17.12
6"	5"	168.3	141.3	229	7.11	10.97	18.26	19.05
6"	4"	168.3	114.3	229	7.11	10.97	18.26	19.05
6"	3 ½"	168.3	101.6	229	7.11	10.97	18.26	19.05
6"	3"	168.3	88.9	229	7.11	10.97	18.26	19.05
8"	6"	219.1	168.3	305	8.18	12.7	23.01	21.95
8"	5"	219.1	141.3	305	8.18	12.7	23.01	21.95
8"	4"	219.1	114.3	305	8.18	12.7	23.01	21.95

NPS1	NPS2	Outside Diameter		Centre-to-End A	STD	XS	Sch 160	XXS
		Large End OD1	Small End OD2		T	T	T	T
10"	8"	273.0	219.1	381	9.27	12.7	28.58	22.23
10"	6"	273.0	168.3	381	9.27	12.7	28.58	22.23
10"	5"	273.0	141.3	381	9.27	12.7	28.58	22.23
12"	10"	323.8	273.0	457	9.53	12.7	33.32	
12"	8"	323.8	219.1	457	9.53	12.7	33.32	
12"	6"	323.8	168.3	457	9.53	12.7	33.32	
14"	12"	355.6	323.8	533	9.53	12.7	35.71	
14"	10"	355.6	273.0	533	9.53	12.7	35.71	
14"	8"	355.6	219.1	533	9.53	12.7	35.71	
16"	14"	406.1	355.6	610	9.53	12.7	40.49	
16"	12"	406.1	323.8	610	9.53	12.7	40.49	
16"	10"	406.1	273.0	610	9.53	12.7	40.49	
18"	16"	457.0	406.1	686	9.53	12.7		
18"	14"	457.0	355.6	686	9.53	12.7		
18"	12"	457.0	323.8	686	9.53	12.7		
18"	10"	457.0	273.0	686	9.53	12.7		
20"	18"	508.0	457.0	762	9.53	12.7		
20"	16"	508.0	406.1	762	9.53	12.7		
20"	14"	508.0	355.6	762	9.53	12.7		
20"	12"	508.0	323.8	762	9.53	12.7		
20"	10"	508.0	273.0	762	9.53	12.7		
24"	22"	610.0	559.0	914	9.53	12.7		
24"	20"	610.0	508.0	914	9.53	12.7		
24"	18"	610.0	457.0	914	9.53	12.7		
24"	16"	610.0	406.1	914	9.53	12.7		
24"	14"	610.0	355.6	914	9.53	12.7		
24"	12"	610.0	323.8	914	9.53	12.7		

ASME B16.9 – CAP



NPS	Outside Diameter OD	Nominal Length E	Limiting Wall Thickness for E	Length E1	STD	
					T	ID
½"	21.3	25	4.57	25	2.77	15.8
¾"	26.7	25	3.81	25	2.87	20.9
1"	33.4	38	4.57	38	3.38	26.6
1 ¼"	42.2	38	4.83	38	3.56	35.1
1 ½"	48.3	38	5.08	38	3.68	40.9
2"	60.3	38	5.59	44	3.91	52.5
2 ½"	73.0	38	7.11	51	5.16	62.7
3"	88.9	51	7.62	64	5.49	77.9
3 ½"	101.6	64	8.13	76	5.74	90.1
4"	114.3	64	8.64	76	6.02	102.3
5"	141.3	76	9.65	89	6.55	120.2
6"	168.3	89	10.92	102	7.11	154.1
8"	219.1	102	12.70	127	8.18	202.7
10"	273.0	127	12.70	152	9.27	254.5
12"	323.8	152	12.70	178	9.53	304.8
14"	355.6	165	12.70	191	9.53	336.6
16"	406.4	178	12.70	203	9.53	386.1
18"	457.0	203	12.70	229	9.53	437.9
20"	508.0	229	12.70	254	9.53	488.9
22"	559.0	254	12.70	254	9.53	539.9
24"	610.0	267	12.70	305	9.53	590.9

Note : Other sizes (NPS, wall thickness) are available upon request.

Sch 40		XS		Sch 80		Sch 160		XXS		NPS
T	ID	T	ID	T	ID	T	ID	T	ID	
2.77	15.8	3.73	13.9	3.73	13.9					½"
2.87	20.9	3.91	18.9	3.91	18.9					¾"
3.38	26.6	4.55	24.3	4.55	24.3	6.35	20.7	9.09	15.2	1"
3.56	35.1	4.85	32.5	4.85	32.5	6.35	29.5	9.7	22.8	1 ¼"
3.68	40.9	5.08	38.1	5.08	38.1	7.14	34.0	10.16	28.0	1 ½"
3.91	52.5	5.54	49.3	5.54	49.3	8.74	42.9	11.07	38.2	2"
5.16	62.7	7.01	59.0	7.01	59.0	9.53	54.0	14.02	15.0	2 ½"
5.49	77.9	7.62	73.7	7.62	73.7	11.13	66.7	15.24	58.4	3"
5.74	90.2	8.08	85.2	8.08	85.2					3 ½"
6.02	102.3	8.56	97.2	8.56	97.2	13.49	87.3	17.12	80.0	4"
6.55	120.2	9.53	122.3	9.53	122.3	15.88	109.6	19.05	103.2	5"
7.11	154.1	10.97	146.3	10.97	146.3	18.26	131.8	21.95	124.4	6"
8.18	202.7	12.7	193.7	12.7	193.7	23.01	173.1	22.23	174.6	8"
9.27	254.5	12.7	247.7	15.09	242.8	28.58	215.9	25.40	222.2	10"
10.31	303.2	12.7	298.5	17.48	288.8	33.53	257.2	25.40	273.0	12"
11.13	333.3	12.7	330.2	19.05	317.5	35.71	284.2			14"
12.70	381.0	12.7	381.0	21.44	363.5	40.49	325.4			16"
14.27	428.5	12.7	431.6	23.83	409.3	45.24	366.5			18"
15.09	477.8	12.7	482.6	26.19	455.6	50.01	408.0			20"
		12.7	533.6	28.58	501.8	53.98	451.0			22"
		12.7	584.6	30.96	548.1	59.54	490.9			24"

6. Flanges

General

A flange is used to join pipes, valves, or a vessel within a system. It is normally in the form of a plate or ring to form a rim at the end of a pipe when fastened. A blind flange is a plate for covering or closing the end of a pipe. A flange joint is a connection of pipes, where the connecting pieces have flanges by which the parts are bolted together.

Flange designs are available as “weld neck”, “slip-on”, “lap joint”, “socket weld”, “threaded”, and also “blind”.

1. Welding Neck Flange

The welding neck flange is also referred to as "high hub" flange. It is designed to transfer stresses to the pipe, thus reducing high stress concentrations at the base of the flange. The welding neck flange is the best designed butt-welded flange because of its inherent structural value but is expensive. It is normally used for high pressure, cold or hot temperatures.



2. Slip-on flange

The 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 bored slightly larger than the OD of the matching pipe. They are preferred over welding neck flanges due to their lower initial cost.



3. Threaded Flange

The 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. It is normally used in low pressure services at ordinary atmospheric temperatures and in highly explosive areas where welding create a hazard.



4. Lap Joint Flange

The lap joint flange is practically identical to a slip-on flange except it has a radius at the intersection of the bore and flange race. This radius is necessary to accommodate a lap joint stub end. It is normally used in systems requiring frequent dismantling for inspections.



5. Socket Weld Flange

The socket welding flange is similar to a slip-on flange except it has a bore and a counter bore dimension. The counter bore is slightly larger than the OD of the matching pipe, allowing the pipe to be inserted. The diameter of the smaller bore is the same as the ID of the matching pipe. A restriction is built into the bottom of the bore which sets as a shoulder for the pipe to rest on. This eliminates any restriction in flow.



6. Blind Flanges

The blind flange is a flange without a bore. It is used to close off the ends of a piping system and/or a pressure vessel opening. It also permits easy access to the interior of a line or vessel once it has been sealed and must be reopened.



The flange faces are also typically “flat face”, “raised face”, “tongue and groove”, or “ring joint” styles, although other styles are possible upon request by Buyer.

1. Raised Face

Raised Face flange is the most common type and is easily to identify. Its gasket surface is raised above the bolting circle face. This face type allows the use of a wide combination of gasket designs, including flat ring sheet types, spiral wound and double jacketed types. The purpose of this flange is to concentrate more pressure on a smaller gasket area and thereby increase the pressure containment capability of the joint.



2. Flat face

Flat Face flange has a gasket surface in the same plane as the bolting circle face. Applications using flat face flanges are frequently those in which the mating flange or flanged fitting is made from a casting. This is to keep the thin, brittle cast iron flange from being sprung into the gap caused by the raised face of the carbon steel flange. Flat face flanges are never to be bolted to a raised face flange.



3. Tongue and groove

The Tongue and Groove faces of this flanges must be matched. One flange face has a raised ring (Tongue) machined onto the flange face while the mating flange has a matching depression (Groove) machined into its face. T&G joints are self-aligning.



4. Ring Joint

Ring Type Joint flanges are typically used in high pressure (Class 600 and higher rating) and/or high temperature services above 800°F (427°C). They have grooves cut into their faces which steel ring gaskets. The flanges seal when tightened bolts compress the gasket between the flanges into the grooves, deforming the gasket to make intimate contact inside the grooves, creating a metal to metal seal.



Standards and Specifications

There are many different flange standards to be found worldwide. To allow easy functionality and flexibility, these are designed to have standardised dimensions. Common world standards include API and ASA/ANSI/ASME (USA), PN/DIN (European), BS10 (British/Australian), and JIS/KS (Japanese/Korean).

In most cases, these standards are not interchangeable (e.g. an ANSI/ASME flange will not mate against a JIS flange). Further, many of the flanges in each standard are divided into "pressure classes", allowing flanges to be capable of taking different pressure ratings. Again these are not generally interchangeable (e.g. an ANSI/ASME 150 will not mate with an ANSI/ASME 300).

PN Flanges

PN flanges meet the requirements of EN 1092-1:2007 and DIN standards (e.g. DIN2633). PN and the number that follows e.g. PN16, indicates flange dimensions and mechanical properties – "nominal pressure". It is not a direct equivalent of permissible working pressure (which largely depends on flange material and temperature of the medium). For temperature +20°C, the nominal working pressure of PN16 flange is 16 bar.

PN-marked flanges are manufactured for the following PN values :

PN2,5	PN6	PN10	PN16	PN25	PN40	PN63	PN100	PN160	PN250	PN320	PN400
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Flange dimensions according to different PN are sometimes the same, e.g.:

DN	PN6	PN10	PN16	PN25	PN40
from 10 to 40	PN6	Same as PN40	Same as PN40	Same as PN40	PN40
from 50 to 150	PN6	Same as PN16	PN16	Same as PN40	PN40
above 150	PN6	PN10	PN16	PN25	PN40

ANSI Flanges

ANSI flanges (or also known as ASME or ASA flanges) are made to standards called out by ASME B16.5 or ASME B16.47. ASME B16.5 refers to nominal pipe sizes (NPS) from ½" to 24" while ASME B16.47 covers NPS from 26" to 60". Each specification further delineates flanges into pressure classes:

Standard	NPS	Nominal Pressure (psi) coverage							
B16.5	½"~24"		150	300	400	600	900	1500	2500
B16.47	26"~60"	75	150	300	400	600	900		

However these classes do not correspond to maximum pressures in psi. Instead, the maximum pressure depends on the material of the flange and the temperature. For example, the maximum pressure for a Class 150 flange is 285 psi, and for a Class 300 Flange it is 740 psi (both are for ASTM A105 Carbon Steel and temperatures below 100F).

API Flanges

The difference between ASME/ANSI and API flanges is the fabrication material and the higher rated API operating pressure. ASME/ANSI flanges are common in industrial process systems handling water, steam, air and gas.

API flanges are manufactured for high strength operating refinery systems with products such as oil and explosive gases. The flange standards API 6A and ASME/ANSI B16.5 are similar dimensionally but the API 6A flanges are rated for higher pressures.

ANSI/ASME B16.5 vs. API 6A				
Flange	Pressure Rating (psi)		Nominal Pipe Size (NPS)	
	ANSI/ASME B16.5	API 6A	ANSI/ASME B16.5	API 6A
Weld Neck	600	2000	$\frac{1}{2}'' \sim 24''$	$1 \frac{13}{16}'' \sim 11''$
	900	3000		
	1500	5000		
Blind and Threaded	600	2000		$1 \frac{13}{16}'' \sim 21 \frac{1}{4}''$
	900	3000		$1 \frac{13}{16}'' \sim 20 \frac{3}{4}''$
	1500	5000		$1 \frac{13}{16}'' \sim 11''$

API 6A and ANSI flanges cannot be inter-changed or inter-connected without affecting the overall working pressure rating. API 6A flanges are not commonly used outside of high-strength tubular goods for oil and gas industry use as they are relatively more expensive.

Flange Material

Flange material are specified according to steel groups as follow :

Material	Pipes	Fittings	Flanges
Carbon Steel	API 5L Grade B	ASTM A234 Gr. WPB	ASTM A105
	A106 Grade B		
	A53 Grade B		
Stainless Steel	ASTM A312 Gr. TP304	ASTM A403 Gr. WP304	ASTM A182 Gr. F304
	ASTM A312 Gr. TP316	ASTM A403 Gr. WP316	ASTM A182 Gr. F316
	ASTM A312 Gr. TP321	ASTM A403 Gr. WP321	ASTM A182 Gr. F321
	ASTM A312 Gr. TP347	ASTM A403 Gr. WP347	ASTM A182 Gr. F347
Alloy Steel High-Temp	ASTM A335 Gr. P1, P11	ASTM A234 Gr. P1, P11	ASTM A182 Gr. F1, F11
Alloy Steel Low-Temp	ASTM A333 Gr. 3, 6	ASTM A420 Gr. WPL3, WPL6	ASTM A350 Gr. LF3, LF2

Notes :

Pipes

API 5L - Carbon steel Line Pipe
ASTM A106 - Seamless carbon steel pipe for high-temperature service
ASTM A53 - Welded and seamless carbon steel pipe
ASTM A312 - Seamless & welded austenitic stainless steel pipe for high temperature and general corrosive service
ASTM A335 - Seamless ferritic alloy steel pipe for high temperature service
ASTM A333 - Seamless & welded carbon and alloy steel pipe for low temperature service

Fittings

ASTM A234 - Seamless and welded wrought carbon steel and alloy steel fittings
ASTM A403 - Wrought austenitic stainless steel piping fittings
ASTM A420 - Piping fittings of wrought carbon steel and alloy steel for low-temperature service

Flanges

ASTM A105 - Forged carbon steel flanges
ASTM A182 - Forged or rolled alloy and stainless steel pipe flanges
ASTM A350 - Carbon and low alloy steel forged or ring-rolled flanges for low temperature service

Mechanical Properties

The mechanical properties for selected flange material are as shown below:

Material Grade	Yield Strength min, MPa	Tensile Strength min, MPa	Elongation min, %	Hardness max, HB
ASTM A105	250	485	22	187
ASTM A182 Gr. F304	205	515	30	
ASTM A182 Gr. F316	205	515	30	
ASTM A182 Gr. F321	205	515	30	
ASTM A350 Gr. LF2	250	485 ~ 655	22	

Chemical Composition

The chemical composition for selected flange material are as shown below:

Material Grade	Chemical Composition (% max)							
	C	Mn	P	S	Si	Ni	Cr	Mo
ASTM A105	0.35	0.6~1.05	0.035	0.040	0.1~0.35	0.40	0.30	0.12
ASTM A182 Gr. F304	0.08	2.00	0.045	0.030	1.00	8.0~11.0	18.0~20.0	
ASTM A182 Gr. F316	0.08	2.00	0.045	0.030	1.00	10.0~14.0	16.0~18.0	3.00
ASTM A182 Gr. F321	0.08	2.00	0.045	0.030	1.00	9.0~12.0	17.0~19.0	
ASTM A350 Gr. LF2	0.30	0.6~1.35	0.035	0.040	0.30	0.40	0.30	0.12

Flange Marking

ANSI and EN standards require that each flange is clearly and permanently marked by stamping on the flange outer rim. The markings should include:

1. Manufacturer's /Supplier's trade name or mark
2. Standard
3. Material Designation / Grade
4. Nominal Pressure Rating
5. Nominal Pipe Size (NPS) – the outside diameter of pipe to be matched by the flange
6. Flange type or number (for PN flange)
7. Heat number



Flange Packing and Shipping

Flanges are supplied with temporary external coating for surface protection during shipping ie. standard mill varnish (gold/yellow) unless otherwise specified by Buyer.

Flanges are packed in standard export packaging ie. wrapped in plastic sheets and strapped in wooden boxes or pallets, for optimized protection during shipping.



Additional trade information

Forged vs Casted Flange

Forging is the application of thermal and mechanical energy to steel billets or ingots to cause the material to change shape while in a solid state. Casting, on the other hand, is the process where metal is heated until molten. While in the molten or liquid state it is poured into a mould or vessel to create a desired shape.

In producing flanges, casting has a much lower production cost as it entails a relatively more simple production and machining process. However, casted flange has some obvious disadvantages including casting defects such as gas porosity, hot cracking (from solidification) and impurity/inclusions, as well as poor seam-line inside.

By contrast, forged flanges have a higher production cost but offers a much higher quality product. Forging offers uniformity of composition and structure resulting in metallurgical recrystallization and grain refinement from the thermal cycle and deformation process. This strengthens the resulting steel product particularly in terms of impact and shear strength. Forged flange is generally stronger and more reliable than castings and plate steel due to the fact that the grain flows of the steel are altered, conforming to the shape of the part. Caution must be taken when purchasing flanges as some suppliers may offer casted flanges due to cheaper costs but with compromise on quality and performance.

Abbreviation

Flanges are commonly described by abbreviations or acronyms as follow :

Flange Type	Acronym
Welding Neck	WN
Slip-On	SO
Socket Welding	SW
Threaded	TH
Lap Joint	LJ
Blind	BL

Face Type	Acronym
Raised Face	RF
Flat Face	FF
Tongue and groove	TG
Ring Joint	RJ

Eg. Slip-on flange with raised face = SORF

DN ("Diameter Nominale")

DN stands for "Diameter Nominale" or nominal diameter. Put simply, it is a rough translation of mm from imperial sizes, assuming that an inch is 25mm. We refer to a 12" flange as DN300, when in fact it is 304.8mm.

½"	DN15
¾"	DN20
1"	DN25
1 ¼"	DN32
1 ½"	DN40
2"	DN50

2 ½"	DN65
3"	DN80
4"	DN100
5"	DN125
6"	DN150
8"	DN200

10"	DN250
12"	DN300
14"	DN350
16"	DN400
18"	DN450
20"	DN500

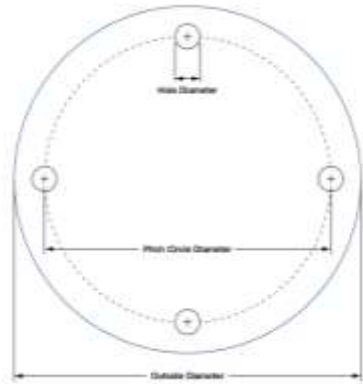
Pitch Circle Diameter (PCD)

The PCD of a flange is one of the most critical dimensions. PCD is also known as bolt circle diameter (BCD) in ANSI/ASME.

PCD is the diameter of a circle that goes through each of the bolt holes. PCD is very important in identifying the right size of flanges. Designers and engineers use the PCD of a flange to help determine the size of a particular flange or gasket in a flanged connection, or to find a match for an installed flange that needs replacement.

In order to measure the PCD of a flange installed in pipework, measure two adjacent holes (see photo) and calculate the PCD using the following formulae :

- 4 holes: multiply by 1.414
- 8 holes: multiply by 2.613
- 12 holes: multiply by 3.864
- 16 holes: multiply by 5.126

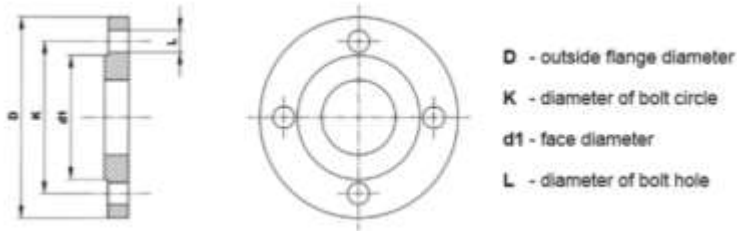


Example:

150mm flange has 8 holes and measures 90mm.

$$\text{PCD} = 90 \times 2.613 = 235\text{mm}$$

PN flange dimension – EN1092-1



Nominal Diameter		PN6					
mm	inch	D	K	d1	L	Bolt Nos.	Thread
15	½	80	55	40	11	4	M10
20	¾	90	65	50	11	4	M10
25	1	100	75	60	11	4	M10
32	1 ¼	120	90	70	14	4	M12
40	1 ½	130	100	80	14	4	M12
50	2	140	110	90	14	4	M12
65	2 ½	160	130	110	14	4	M12
80	3	190	150	128	18	4	M16
100	4	210	170	148	18	4	M16
125	5	240	200	178	18	8	M16
150	6	265	225	202	18	8	M16
200	8	320	280	258	18	8	M16
250	10	375	335	312	18	12	M16

Nominal Diameter		PN10 / 16					
mm	inch	D	K	d1	L	Bolt Nos.	Thread
15	½	95	65	45	14	4	M12
20	¾	105	75	58	14	4	M12
25	1	115	85	68	14	4	M16
32	1 ¼	140	100	78	18	4	M16
40	1 ½	150	110	88	18	4	M16
50	2	165	125	102	18	4	M16
65	2 ½	185	145	122	18	8	M16
80	3	200	160	138	18	8	M16
100	4	220	180	158	18	8	M16
125	5	250	210	188	18	8	M16
150	6	285	240	212	22	8	M20
200	8	340	295	268	22	8/12	M20
250	10	395/405	350/355	320	22/26	12	M20/M24

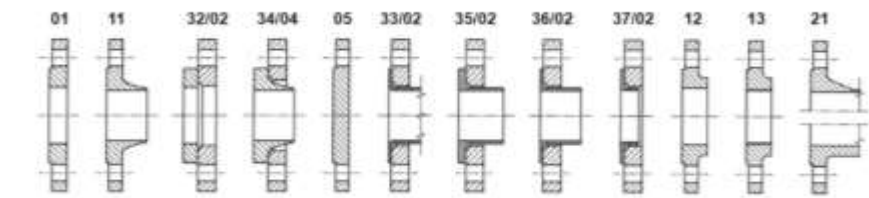
PN flange dimension – EN1092-1

Nominal Diameter		PN25					
mm	inch	D	K	d1	L	Bolt Nos.	Thread
15	½	95	65	45	14	4	M12
20	¾	105	75	58	14	4	M12
25	1	115	85	68	14	4	M12
32	1 ¼	140	100	78	18	4	M16
40	1 ½	150	110	88	18	4	M16
50	2	165	125	102	18	4	M16
65	2 ½	185	145	122	18	8	M16
80	3	200	160	138	18	8	M16
100	4	235	190	162	22	8	M20
125	5	270	220	188	26	8	M24
150	6	300	250	218	26	8	M24
200	8	360	310	278	26	12	M24
250	10	425	370	335	30	12	M27

Nominal Diameter		PN40					
mm	inch	D	K	d1	L	Bolt Nos.	Thread
15	½	95	65	45	14	4	M12
20	¾	105	75	58	14	4	M12
25	1	115	85	68	14	4	M12
32	1 ¼	140	100	78	18	4	M16
40	1 ½	150	110	88	18	4	M16
50	2	165	125	102	18	4	M16
65	2 ½	185	145	122	18	8	M16
80	3	200	160	138	18	8	M16
100	4	235	190	162	22	8	M20
125	5	270	220	188	26	8	M24
150	6	300	250	218	26	8	M24
200	8	375	320	285	30	12	M27
250	10	450	385	345	30	12	M30

Note : Other sizes (DN and nominal pressure) and flange types are available upon request

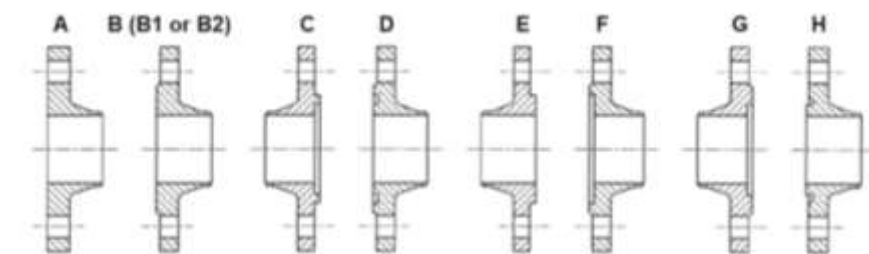
PN Flange Type (according to EN 1092-1)



01	Plate flange for welding
11	Weld-neck flange
02	Loose plate flange (swivel)
04	Loose plate flange (swivel)
05	Blank flange
32	Weld-on plate collar
34	Weld-neck collar

33	Lapped end pipe
35	Weld collar with long neck
36	Pressed collar with long neck
37	Pressed collar
12	Hubbed slip-on flange for welding
13	Hubbed threaded flange
21	Integral flange

Sealing Surface of PN flanges (according to EN 1092-1)

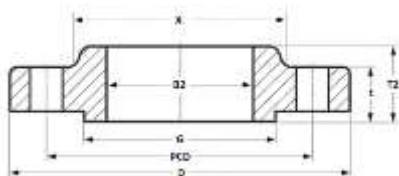


A	Flat
B	Raised face
C	Tongue
D	Groove

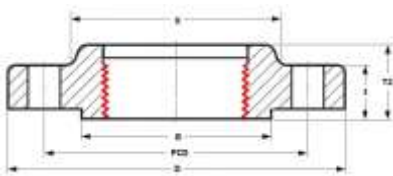
E	Spigot
F	Recess
G	O-ring spigot
H	O-ring groove

ANSI flange dimension – ANSI B16.5

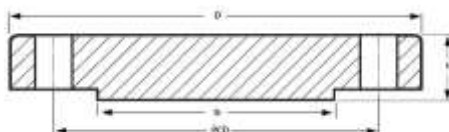
Slip-on Flange



Threaded Flange



Blind Flange



Class 150

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick- ness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Est. Weight (kg)
NPS	D	G	X	t	B2	T2				
½	89	35.1	30.2	11.2	22.4	15.7	60.5	4	½"	0.47
¾	99	42.9	38.1	12.7	27.7	15.7	69.9	4	½"	0.58
1	108	50.8	49.3	14.2	34.5	17.5	79.2	4	½"	0.86
1 ¼	117	63.5	58.7	15.7	43.2	20.6	88.9	4	½"	1.08
1 ½	127	73.2	65.0	17.5	49.5	22.4	98.6	4	½"	1.41
2	152	91.9	77.7	19.1	62.0	25.4	120.7	4	5/8"	22.6
2 ½	178	104.6	90.4	22.4	74.7	28.4	139.7	4	5/8"	3.43
3	191	127.0	108.0	23.9	90.7	30.2	15.4	4	5/8"	3.90
4	229	157.2	134.9	23.9	116.1	33.3	190.5	8	5/8"	5.75
5	254	185.7	163.6	23.9	143.8	36.6	215.9	8	¾"	6.22
6	279	215.9	192.0	25.4	170.7	39.6	241.3	8	¾"	7.41
8	343	269.7	246.1	28.4	221.5	44.5	298.5	8	¾"	12.36
10	406	323.9	304.8	30.2	276.4	49.3	362.0	12	7/8"	17.10
12	483	381.0	365.3	31.8	327.2	55.6	431.8	12	7/8"	27.68
14	533	412.8	400.1	35.1	359.2	57.2	476.3	12	1"	35.20
16	597	469.9	457.2	36.6	410.5	63.5	539.8	16	1"	45.03
18	635	533.4	505.0	39.6	461.8	68.3	577.9	16	1 1/8"	49.71
20	699	584.2	558.8	42.9	513.1	73.2	635.0	20	1 1/8"	65.50

Class 300

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	G	X	t	B2	T2				
½	95	35.1	38.1	14.2	22.4	22.4	66.5	4	½"	0.64
¾	117	42.9	47.8	15.7	27.7	25.4	82.6	4	5/8"	1.15
1	124	50.8	53.8	17.5	34.5	26.9	88.9	4	5/8"	1.39
1 ¼	133	63.5	63.5	19.1	43.2	26.9	98.6	4	5/8"	1.67
1 ½	155	73.2	69.9	20.6	49.5	30.2	114.3	4	5/8"	2.53
2	165	91.9	84.1	22.4	62.0	33.3	127.0	8	¾"	2.89
2 ½	191	104.6	100.1	25.4	74.7	38.1	149.4	8	¾"	4.35
3	210	127.0	117.3	28.4	90.7	42.9	168.1	8	¾"	5.84
4	254	157.2	146.1	31.8	116.1	47.8	200.2	8	¾"	10.13
5	279	185.7	177.8	35.1	143.8	50.8	235.0	8	¾"	12.58
6	318	215.9	206.2	36.6	170.7	52.3	269.7	12	¾"	16.04
8	381	269.7	260.4	41.1	221.5	62.0	330.2	12	7/8"	24.50
10	445	323.9	320.5	47.8	276.4	66.5	387.4	16	1"	34.16
12	521	381.0	374.7	50.8	327.2	73.2	450.9	16	1 1/8"	51.26
14	584	412.8	425.5	53.8	359.2	76.2	514.4	20	1 ¼"	72.12
16	648	469.9	482.6	57.2	410.5	82.6	571.5	20	1 ½"	90.40
18	711	533.4	533.4	60.5	461.8	88.9	628.7	24	1 ¾"	109.0
20	775	584.2	587.2	63.5	513.1	95.3	685.8	24	1 ¾"	136.0

Class 600

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	G	X	t	B2	T2				
½	95	35.1	38.1	14.2	22.4	22.4	66.5	4	½"	0.91
¾	117	42.9	47.8	15.7	27.7	25.4	82.6	4	5/8"	1.40
1	124	50.8	53.8	17.5	34.5	26.9	88.9	4	5/8"	1.70
1 ¼	133	63.5	63.5	20.6	43.2	28.4	98.6	4	5/8"	2.27
1 ½	155	73.2	69.9	22.4	49.5	31.8	114.3	4	¾"	3.10
2	165	91.9	84.1	25.4	62.0	36.6	127.0	8	¾"	3.63
2 ½	191	104.6	100.1	28.4	74.7	41.1	149.4	8	¾"	5.44
3	210	127.0	117.3	31.8	90.7	46.0	168.1	8	¾"	7.26
4	273	157.2	152.4	38.1	116.1	53.8	215.9	8	7/8"	14.97
5	330	185.7	189.0	44.5	143.8	60.5	266.7	8	1"	28.5
6	356	215.9	222.3	47.8	170.7	66.5	292.1	12	1"	36.32
8	419	269.7	273.1	55.6	221.5	76.2	349.3	12	1 1/8"	44.0
10	508	323.9	342.9	63.5	276.4	113.1	431.8	16	1 ¼"	76.2
12	559	381.0	400.1	66.5	327.2	117.3	489.0	20	1 ½"	97.52
14	603	412.8	431.8	69.9	359.2	127.0	527.1	20	1 3/8"	102.0
16	686	469.9	495.3	76.2	410.5	139.7	603.3	20	1 ½"	149.82
18	743	533.4	546.1	82.6	461.8	152.4	654.1	20	1 5/8"	180.1
20	813	584.2	609.6	88.9	513.1	165.1	723.9	24	1 5/8"	231.54

Class 900

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	G	X	t	B2	T2				
½	121	35.1	38.1	22.4	22.4	31.8	82.6	4	¾"	1.81
¾	130	42.9	44.5	25.4	27.7	35.1	88.9	4	¾"	2.4
1	149	50.8	52.3	28.4	34.5	41.1	101.6	4	7/8"	3.41
1 ¼	159	63.5	63.5	28.4	43.2	41.1	111.3	4	7/8"	4.1
1 ½	178	73.2	69.9	31.8	49.5	44.5	124.0	4	1"	5.45
2	216	91.9	104.6	38.1	62.0	57.2	165.1	8	7/8"	9.98
2 ½	244	104.6	124.0	41.1	74.7	63.5	190.5	8	1"	15.8
3	241	127.0	127.0	38.1	90.7	53.8	190.5	8	7/8"	11.8
4	292	157.2	158.8	44.5	116.1	69.9	235.0	8	1 1/8"	23.2
5	349	185.7	190.5	50.8	143.8	79.2	279.4	8	1 ¼"	37.65
6	381	215.9	235.0	55.6	170.7	85.9	317.5	12	1 1/8"	48.3
8	470	269.7	298.5	63.5	221.5	101.6	393.7	12	1 3/8"	75.0
10	546	323.9	368.3	69.9	276.4	108.0	469.9	16	1 3/8"	111.13
12	610	381.0	419.1	79.2	327.2	117.3	533.4	20	1 3/8"	146.0
14	641	412.8	450.9	85.9	359.2	130.0	558.8	20	1 ½"	172.36
16	705	469.9	508.0	88.9	410.5	133.4	616.0	20	1 5/8"	192.95
18	787	533.4	565.2	101.6	461.8	152.4	685.8	20	1 7/8"	272.4
20	857	584.3	622.3	108.0	513.1	158.8	749.3	20	2"	331.42
24	1041	692.2	749.3	139.7	616.0	203.2	901.7	20	2 ½"	632.0

Class 1500

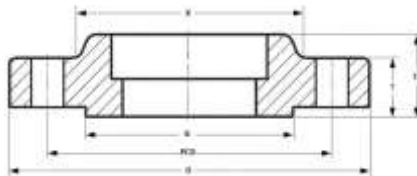
Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	G	X	t	B2	T2				
½	121	35.1	38.1	22.4	22.4	31.8	82.6	4	¾"	1.8
¾	130	42.9	44.5	25.4	27.7	35.1	88.9	4	¾"	2.33
1	149	50.8	52.3	28.4	34.5	41.1	101.6	4	7/8"	3.41
1 ¼	159	63.5	63.5	28.4	43.2	41.1	111.3	4	7/8"	4.1
1 ½	178	73.2	69.9	31.8	49.5	44.5	124.0	4	1"	5.45
2	216	91.9	104.6	38.1	62.0	57.2	165.1	8	7/8"	10.5
2 ½	244	104.6	124.0	41.1	74.7	63.5	190.5	8	1"	15.8
3	267	127.0	133.4	47.8	90.7	73.2	203.2	8	1 1/8"	21.77
4	311	157.2	162.1	53.8	116.1	90.4	241.3	8	1 ¼"	31.0
5	375	185.7	196.9	73.2	143.8	104.6	292.1	8	1 ½"	58.8
6	394	215.9	228.6	82.6	170.7	119.1	317.5	12	1 3/8"	74.0
8	483	269.7	292.1	91.9	221.5	142.7	393.7	12	1 5/8"	117.73
10	584	323.9	368.3	108.0	276.4	158.8	482.6	12	1 7/8"	197.49
12	673	381.0	450.9	124.0	327.2	180.0	571.5	16	2"	264.41
14	749	412.8	495.3	133.4	359.2	-	635.0	16	2 ¼"	-
16	826	469.9	552.5	146.1	410.5	-	704.9	16	2 ½"	-
18	914	533.4	596.9	162.1	461.8	-	774.7	16	2 ¾"	-
20	984	584.2	641.4	177.8	513.1	-	831.9	16	3"	-
24	1168	692.2	762.0	203.2	616.0	-	990.6	16	3 ½"	-

ANSI flange dimension – ANSI B16.5

Welding Neck Flange



Socket Weld Flange



Class 150

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thickness	Length thru Hub		PCD	Bolt Nos.	Bolt size	WN Weight (kg)
NPS	D	G	X	t	T1	T2				
½	89	35.1	30.2	11.2	47.8	15.7	60.5	4	½"	0.51
¾	99	42.9	38.1	12.7	52.3	15.7	69.9	4	½"	0.74
1	108	50.8	49.3	14.2	55.6	17.5	79.2	4	½"	1.07
1 ¼	117	63.5	58.7	15.7	57.2	20.6	88.9	4	½"	1.4
1 ½	127	73.2	65.0	17.5	62.0	22.4	98.6	4	½"	1.81
2	152	91.9	77.7	19.1	63.5	25.4	120.7	4	5/8"	2.64
2 ½	178	104.6	90.4	22.4	69.9	28.4	139.7	4	5/8"	4.28
3	191	127.0	108.0	23.9	69.9	30.2	154	4	5/8"	5.18
4	229	157.2	134.9	23.9	76.2	33.3	190.5	8	5/8"	7.32
5	254	185.7	163.6	23.9	88.9	36.6	215.9	8	¾"	8.95
6	279	215.9	192.0	25.4	88.9	39.6	241.3	8	¾"	11.26
8	343	269.7	246.1	28.4	101.6	44.5	298.5	8	¾"	18.2
10	406	323.9	304.8	30.2	101.6	49.3	362.0	12	7/8"	24.94
12	483	381.0	365.3	31.8	114.3	55.6	431.8	12	7/8"	38.98
14	533	412.8	400.1	35.1	127.0	57.2	476.3	12	1"	51.71
16	597	469.9	457.2	36.6	127.0	63.5	539.8	16	1"	64.41
18	635	533.4	505.0	39.6	139.7	68.3	577.9	16	1 1/8"	74.84
20	699	584.2	558.8	42.9	144.5	73.2	635.0	20	1 1/8"	89.36

Class 300

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Length thru Hub		PCD	Bolt Nos.	Bolt size	WN Weight (kg)
NPS	D	G	X	t	T1	T2				
½	95	35.1	38.1	14.2	52.3	22.4	66.5	4	½"	0.78
¾	117	42.9	47.8	15.7	57.2	25.4	82.6	4	⅝"	1.34
1	124	50.8	53.8	17.5	62.0	26.9	88.9	4	⅝"	1.64
1 ¼	133	63.5	63.5	19.1	65.0	26.9	98.6	4	⅝"	2.06
1 ½	155	73.2	69.9	20.6	68.3	30.2	114.3	4	⅝"	3.06
2	165	91.9	84.1	22.4	69.9	33.3	127.0	8	¾"	3.54
2 ½	191	104.6	100.1	25.4	76.2	38.1	149.4	8	¾"	5.38
3	210	127.0	117.3	28.4	79.2	42.9	168.1	8	¾"	7.32
4	254	157.2	146.1	31.8	85.9	47.8	200.2	8	¾"	11.62
5	279	185.7	177.8	35.1	98.6	50.8	235.0	8	¾"	15.55
6	318	215.9	206.2	36.6	98.6	52.3	269.7	12	¾"	19.95
8	381	269.7	260.4	41.1	111.3	62.0	330.2	12	7/8"	30.9
10	445	323.9	320.5	47.8	117.3	66.5	387.4	16	1"	44.7
12	521	381.0	374.7	50.8	130.0	73.2	450.9	16	1 1/8"	64.41
14	584	412.8	425.5	53.8	142.7	76.2	514.4	20	1 ¼"	88.92
16	648	469.9	482.6	57.2	146.1	82.6	571.5	20	1 ¼"	112.94
18	711	533.4	533.4	60.5	158.8	88.9	628.7	24	1 ¼"	138.34
20	775	584.2	587.2	63.5	162.1	95.3	685.8	24	1 ¼"	167.37

Class 600

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Length thru Hub		PCD	Bolt Nos.	Bolt size	WN Weight (kg)
NPS	D	G	X	t	T1	T2				
½	95	35.1	38.1	14.2	52.3	22.4	66.5	4	½"	0.90
¾	117	42.9	47.8	15.7	57.2	25.4	82.6	4	⅝"	1.59
1	124	50.8	53.8	17.5	62.0	26.9	88.9	4	⅝"	1.90
1 ¼	133	63.5	63.5	20.6	66.5	28.4	98.6	4	⅝"	2.49
1 ½	155	73.2	69.9	22.4	69.9	31.8	114.3	4	¾"	3.63
2	165	91.9	84.1	25.4	73.2	36.6	127.0	8	¾"	4.54
2 ½	191	104.6	100.1	28.4	79.2	41.1	149.4	8	¾"	6.40
3	210	127.0	117.3	31.8	82.6	46.0	168.1	8	¾"	8.5
4	273	157.2	152.4	38.1	101.6	53.8	215.9	8	7/8"	17.27
5	330	185.7	189.0	44.5	114.3	60.5	266.7	8	1"	30.87
6	356	215.9	222.3	47.8	117.3	66.5	292.1	12	1"	36.77
8	419	269.7	273.1	55.6	133.4	76.2	349.3	12	1 1/8"	52.57
10	508	323.9	342.9	63.5	152.4	85.9	431.8	16	1 ¼"	86.26
12	559	381.0	400.1	66.5	155.4	91.9	489.0	20	1 ¼"	102.95
14	603	412.8	431.8	69.9	165.1	93.7	527.1	20	1 3/8"	122.16
16	686	469.9	495.3	76.2	177.8	106.4	603.3	20	1 ½"	177.06
18	743	533.4	546.1	82.6	184.2	117.3	654.1	20	1 5/8"	215.65
20	813	584.2	609.6	88.9	190.5	127.0	723.9	24	1 5/8"	267.86

Class 900

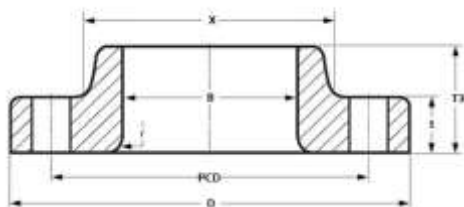
Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Length thru Hub		PCD	Bolt Nos.	Bolt size	WN Weight (kg)
NPS	D	G	X	t	T1	T2				
½	121	35.1	38.1	22.4	60.5	31.8	82.6	4	¾"	2.10
¾	130	42.9	44.5	25.4	69.9	35.1	88.9	4	¾"	2.72
1	149	50.8	52.3	28.4	73.2	41.1	101.6	4	7/8"	3.86
1 ¼	159	63.5	63.5	28.4	73.2	41.1	111.3	4	7/8"	4.54
1 ½	178	73.2	69.9	31.8	82.6	44.5	124.0	4	1"	5.97
2	216	91.9	104.6	38.1	101.6	57.2	165.1	8	7/8"	10.92
2 ½	244	104.6	124.0	41.1	104.6	63.5	190.5	8	1"	16.33
3	241	127.0	127.0	38.1	101.6	53.8	190.5	8	7/8"	15.00
4	292	157.2	158.8	44.5	114.3	69.9	235.0	8	1 1/8"	23.13
5	349	185.7	190.5	50.8	127.0	79.2	279.4	8	1 ¼"	38.50
6	381	215.9	235.0	55.6	139.7	85.9	317.5	12	1 1/8"	49.89
8	470	269.7	298.5	63.5	162.1	101.6	393.7	12	1 3/8"	80.63
10	546	323.9	368.3	69.9	184.2	108.0	469.9	16	1 3/8"	119.05
12	610	381.0	419.1	79.2	200.2	117.3	533.4	20	1 3/8"	157.97
14	641	412.8	450.9	85.9	212.9	130.0	558.8	20	1 ½"	181.60
16	705	469.9	508.0	88.9	215.9	133.4	616.0	20	1 5/8"	224.73
18	787	533.4	565.2	101.6	228.6	152.4	685.8	20	1 7/8"	308.72
20	857	584.3	622.3	108.0	247.7	158.8	749.3	24	2"	376.82
24	1041	692.2	749.3	139.7	292.1	203.2	901.7	24	2 ½"	685.00

Class 1500

Nominal Pipe Size	Outside Diam.	OD of Raised Face	Base of Hub	Thick-ness	Length thru Hub		PCD	Bolt Nos.	Bolt size	WN Weight (kg)
NPS	D	G	X	t	T1	T2				
½	121	35.1	38.1	22.4	60.5	31.8	82.6	4	¾"	2.10
¾	130	42.9	44.5	25.4	69.9	35.1	88.9	4	¾"	2.72
1	149	50.8	52.3	28.4	73.2	41.1	101.6	4	7/8"	3.86
1 ¼	159	63.5	63.5	28.4	73.2	41.1	111.3	4	7/8"	4.54
1 ½	178	73.2	69.9	31.8	82.6	44.5	124.0	4	1"	5.97
2	216	91.9	104.6	38.1	101.6	57.2	165.1	8	7/8"	10.92
2 ½	244	104.6	124.0	41.1	104.6	63.5	190.5	8	1"	16.34
3	267	127.0	133.4	47.8	117.3	73.2	203.2	8	1 1/8"	21.79
4	311	157.2	162.1	53.8	124.0	90.4	241.3	8	1 ¼"	31.30
5	375	185.7	196.9	73.2	155.4	104.6	292.1	8	1 ½"	59.02
6	394	215.9	228.6	82.6	171.5	119.1	317.5	12	1 3/8"	74.91
8	483	269.7	292.1	91.9	212.9	142.7	393.7	12	1 5/8"	123.83
10	584	323.9	368.3	108.0	254.0	158.8	482.6	12	1 7/8"	205.93
12	673	381.0	450.9	124.0	282.4	180.0	571.5	16	2"	306.00
14	749	412.8	495.3	133.4	298.5	-	635.0	16	2 ¼"	416.00
16	826	469.9	552.5	146.1	311.2	-	704.9	16	2 ½"	567.50
18	914	533.4	596.9	162.1	327.2	-	774.7	16	2 ¾"	736.00
20	984	584.2	641.4	177.8	355.6	-	831.9	16	3"	929.00
24	1168	692.2	762.0	203.2	406.4	-	990.6	16	3 ½"	1504.00

ANSI flange dimension – ANSI B16.5

Lap Joint Flange



Class 150

Nominal Pipe Size	Outside Diam.	Base of Hub	Thickness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	X	t	B	T3				
½	89	30.2	11.2	22.9	15.7	60.5	4	½"	0.51
¾	99	38.1	12.7	28.2	15.7	69.9	4	½"	0.64
1	108	49.3	14.2	35.1	17.5	79.2	4	½"	0.93
1 ¼	117	58.7	15.7	43.7	20.6	88.9	4	½"	1.16
1 ½	127	65.0	17.5	50.0	22.4	98.6	4	½"	1.51
2	152	77.7	19.1	62.5	25.4	120.7	4	⅝"	2.38
2 ½	178	90.4	22.4	75.4	28.4	139.7	4	⅝"	3.60
3	191	108.0	23.9	91.4	30.2	154.4	4	⅝"	4.06
4	229	134.9	23.9	116.8	33.3	190.5	8	⅝"	5.96
5	254	163.6	23.9	144.5	36.6	215.9	8	¾"	6.44
6	279	192.0	25.4	171.5	39.6	241.3	8	¾"	7.61
8	343	246.1	28.4	222.3	44.5	298.5	8	¾"	12.66
10	406	304.8	30.2	277.4	49.3	362.0	12	7/8"	16.78
12	483	365.3	31.8	328.2	55.6	431.8	12	7/8"	28.30
14	533	400.1	35.1	360.2	79.2	476.3	12	1"	41.50
16	597	457.2	36.6	411.2	87.4	539.8	16	1"	52.98
18	635	505.0	39.6	462.3	96.8	577.9	16	1 1/8"	59.00
20	699	558.8	42.9	514.4	103.1	635.0	20	1 1/8"	71.12

Class 300

Nominal Pipe Size	Outside Diam.	Base of Hub	Thickness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	X	t	B	T3				
½	95	38.1	14.2	22.9	22.4	66.5	4	½"	0.71
¾	117	47.8	15.7	28.2	25.4	82.6	4	⅝"	1.20
1	124	53.8	17.5	35.1	16.9	88.9	4	⅝"	1.47
1 ¼	133	63.5	19.1	43.7	26.9	98.6	4	⅝"	1.79
1 ½	155	69.9	20.6	50.0	30.2	114.3	4	⅝"	2.62
2	165	84.1	22.4	62.5	33.3	127.0	8	¾"	3.03
2 ½	191	100.1	25.4	75.4	38.1	149.4	8	¾"	4.54
3	210	117.3	28.4	91.4	42.9	168.1	8	¾"	6.04
4	254	146.1	31.8	116.8	47.8	200.2	8	¾"	10.07
5	279	177.8	35.1	144.5	50.8	235.0	8	¾"	12.52
6	318	206.2	36.6	171.5	52.3	269.7	12	¾"	16.15
8	381	260.4	41.1	222.3	62.0	330.2	12	⅞"	24.69
10	445	320.5	47.8	277.4	95.3	387.4	16	1"	39.92
12	521	374.7	50.8	328.2	101.6	450.9	16	1 ⅛"	58.70
14	584	425.5	53.8	360.2	111.3	514.4	20	1 ¼"	83.46
16	648	482.6	57.2	411.2	120.7	571.5	20	1 ½"	106.14
18	711	533.4	60.5	462.3	130.0	628.7	24	1 ½"	133.95
20	775	587.2	63.5	514.4	139.7	685.8	24	1 ½"	157.65

Class 600

Nominal Pipe Size	Outside Diam.	Base of Hub	Thickness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	X	t	B	T3				
½	95	38.1	14.2	22.9	22.4	66.5	4	½"	0.80
¾	117	47.8	15.7	28.2	25.4	82.6	4	⅝"	1.36
1	124	53.8	17.5	35.1	26.9	88.9	4	⅝"	1.59
1 ¼	133	63.5	20.6	43.7	28.4	98.6	4	⅝"	2.04
1 ½	155	69.9	22.4	50.0	31.8	114.3	4	¾"	2.95
2	165	84.1	25.4	62.5	36.6	127.0	8	¾"	3.63
2 ½	191	100.1	28.4	75.4	41.1	149.4	8	¾"	5.03
3	210	117.3	31.8	91.4	46.0	168.1	8	¾"	6.70
4	273	152.4	38.1	116.8	53.8	215.9	8	⅞"	14.06
5	330	189.0	44.5	144.5	60.5	266.7	8	1"	27.50
6	356	222.3	47.8	171.5	66.5	292.1	12	1"	35.38
8	419	273.1	55.6	222.3	76.2	349.3	12	1 ⅛"	50.80
10	508	342.9	63.5	277.4	111.3	431.8	16	1 ¼"	74.00
12	559	400.1	66.5	328.2	117.3	489.0	20	1 ½"	108.86
14	603	431.8	69.9	360.2	127.0	527.1	20	1 ¾"	111.0
16	686	495.3	76.2	411.2	139.7	603.3	20	1 ½"	165.71
18	743	546.1	82.6	462.0	152.4	654.1	20	1 ⅝"	194.00
20	813	609.6	88.9	514.4	165.1	723.9	24	1 ⅝"	258.78
24	940	717.6	101.6	616.0	184.2	838.2	24	1 ⅞"	362.00

Class 900

Nominal Pipe Size	Outside Diam.	Base of Hub	Thickness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	X	t	B	T3				
½	121	38.1	22.4	22.9	31.8	82.6	4	¾"	1.81
¾	130	44.5	25.4	28.2	35.1	88.9	4	¾"	2.30
1	149	52.3	28.4	35.1	41.1	101.6	4	7/8"	3.40
1 ¼	159	63.5	28.4	43.7	41.1	111.3	4	7/8"	4.09
1 ½	178	69.9	31.8	50.0	44.5	124.0	4	1"	5.40
2	216	104.6	38.1	62.5	57.2	165.1	8	7/8"	9.67
2 ½	244	124.0	41.1	75.4	63.5	190.5	8	1"	13.36
3	241	127.0	38.1	91.4	53.8	190.5	8	7/8"	11.34
4	292	158.8	44.5	116.8	69.9	235.0	8	1 1/8"	22.60
5	349	190.5	50.8	144.5	79.2	279.4	8	1 ¼"	36.74
6	381	235.0	55.6	171.5	85.9	317.5	12	1 1/8"	47.50
8	470	298.5	63.5	222.3	114.3	393.7	12	1 3/8"	86.00
10	546	368.3	69.9	277.4	127.0	469.9	16	1 3/8"	125.64
12	610	419.1	79.2	328.2	142.7	533.4	20	1 3/8"	167.00
14	641	450.9	85.9	360.2	155.4	558.8	20	1 ½"	180.07
16	705	508.0	88.9	411.2	165.1	616.0	20	1 5/8"	211.11
18	787	565.2	101.6	462.0	190.5	685.8	20	1 7/8"	295.10
20	857	622.3	108.0	514.4	209.6	749.3	20	2"	367.74
24	1041	749.3	139.7	616.0	266.7	901.7	20	2 ½"	700.00

Class 1500

Nominal Pipe Size	Outside Diam.	Base of Hub	Thickness	Bore	Length thru Hub	PCD	Bolt Nos.	Bolt size	Weight (kg)
NPS	D	X	t	B	T3				
½	121	38.1	22.4	22.9	31.8	82.6	4	¾"	1.80
¾	130	44.5	25.4	28.2	35.1	88.9	4	¾"	2.28
1	149	52.3	28.4	35.1	41.1	101.6	4	7/8"	3.40
1 ¼	159	63.5	28.4	43.7	41.1	111.3	4	7/8"	4.09
1 ½	178	69.9	31.8	50.0	44.5	124.0	4	1"	5.40
2	216	104.6	38.1	62.5	57.2	165.1	8	7/8"	9.67
2 ½	244	124.0	41.1	75.4	63.5	190.5	8	1"	13.36
3	267	133.4	47.8	91.4	73.2	203.2	8	1 1/8"	17.65
4	311	162.1	53.8	116.8	90.4	241.3	8	1 ¼"	29.00
5	375	196.9	73.2	144.5	104.6	292.1	8	1 ½"	54.00
6	394	228.6	82.6	171.5	119.1	317.5	12	1 3/8"	62.00
8	483	292.1	91.9	222.3	142.7	393.7	12	1 5/8"	129.73
10	584	368.3	108.0	277.4	177.8	482.6	12	1 7/8"	220.19
12	673	450.9	124.0	328.2	218.9	571.5	16	2"	286.02
14	749	495.3	133.4	360.2	241.3	635.0	16	2 ¼"	404.06
16	826	552.5	146.1	411.2	260.4	704.9	16	2 ½"	552.10
18	914	596.9	162.1	462.0	276.4	774.7	16	2 ¾"	669.65
20	984	641.4	177.8	514.4	292.1	831.9	16	3"	805.85
24	1168	762.0	203.2	616.0	330.2	990.6	16	3 ½"	1285.55

7. Piping Technical Information

Pipe Alignment

Proper alignment is one of the most important tasks performed by the pipe fitter. 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 properly.

Many devices 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 handbook are popular with many pipe fitters and will enable you to quickly obtain good alignment.

Pipe-to-Pipe

Move pipe lengths together until bevels are nearly abutted, allowing a space for welding root gap. Centre squares on top of both pipes and move pipe up and down until squares are aligned. Tack weld top and bottom. Repeat procedure by placing squares on side of pipe. Correct alignment by moving pipe left or right. Tack weld each side



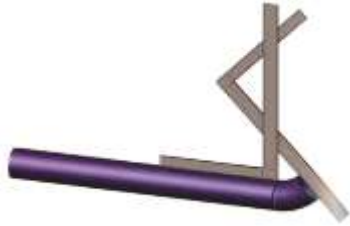
90° Elbow-to-Pipe

Place fitting bevel in line with bevel of pipe, allowing for welding root gap. Tack weld on top. Centre square on top of pipe. Centre the 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. Centre spirit level pipe. Next, centre 45° spirit level on face of elbow and move elbow until 45° bubble is centred.



Tee-to-Pipe

Abut bevels, allowing for welding root gap. Tack weld on top. Centre square on top pipe. Place the second square on centre 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. Centre 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 centred. Make one tack weld on top.



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



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

Welding 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 4' long. Use $\frac{1}{8}$ " X $1\frac{1}{2}$ " for pipe sizes $1\frac{1}{4}$ " thru 3"; $\frac{1}{8}$ " X $\frac{3}{4}$ " for sizes 1" or smaller.

STEP 1. Mark 90° notch on side of channel iron about 2' from end. Make equal notch on other side.



STEP 2. Cut out notches with hack saw.



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



STEP 4. Bend channel iron to 90° angle.



STEP 5. Weld sides of channel iron.



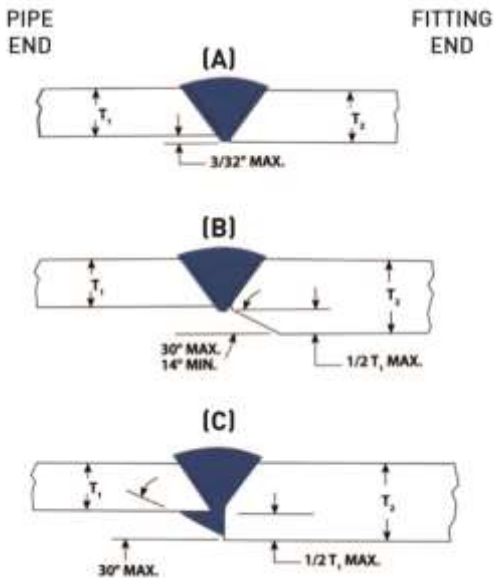
STEP 6. Place 90° Long Radius Elbow in jig. Saw half thru both sides of channel iron as shown in illustration. Repeat with other size elbows so jig may be used for several sizes.



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



Joining Buttwelding Fittings To Pipe

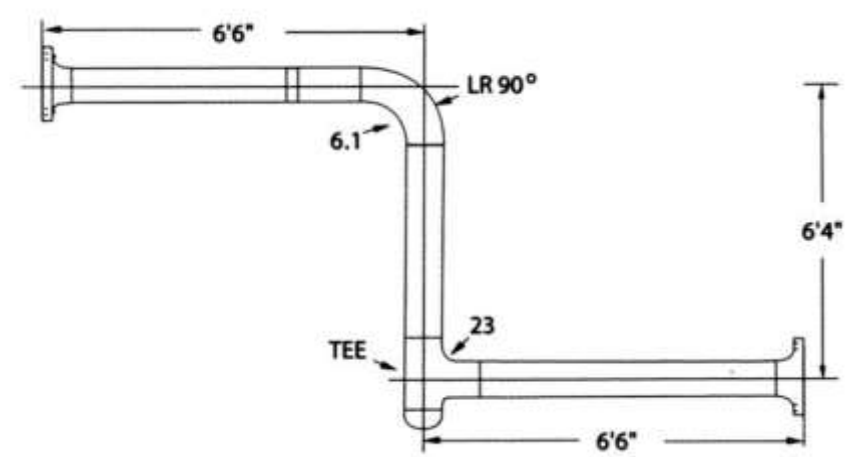


Note :

1. Butt welding 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 $37 \frac{1}{2}^\circ$ or 30° bevels and where the wall thickness of the thicker end to be joined does not exceed $1 \frac{1}{2}$ times the thinner (pipe) end.
3. The nominal thickness of pipe (T_1) and fitting (T_2) shall comply with the design requirements of the applicable section of the ASME B31.1 Code for Pressure Piping.
4. Where the total nominal offset ($T_2 - T_1$) does 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 strengths (or unequal allowable stress), the deposited weld metal shall have mechanical properties at least equal to those of the higher strength (pipe) end.
7. For treatments of ends with unequal external diameters and/or where T_2 is thicker than $1 \frac{1}{2}$ times of T_1 , refer to the applicable section of the ASME Code B31.4 or B31.8 or B16.9.

Flow Resistance : Equivalent Length Of Welded Elbows And Tees

NPS	Long Radius	Short Radius	Tees
1"	1.1	1.4	3.9
1 ¼"	1.4	1.8	5.2
1 ½"	1.6	2.1	6.0
2"	2.1	2.8	7.8
2 ½"	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 information given in the chart above illustrates the resistance of fittings to 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 for the curvature of elbows, so that the resistance values should be added to the total centre-to end dimensions of the piping configuration.

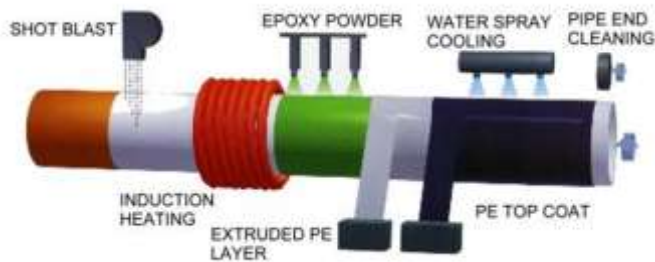
Example : Using 6” pipe

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

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

Pipeline Protection – 3LPE

Three Layer Polyethylene (3LPE) is an anti-corrosion system providing excellent pipeline protection for small and large diameter pipelines with moderately high operating temperatures. 3LPE is a multilayer coating composed of three functional components: a high performance fusion bonded epoxy (FBE), followed by a copolymer adhesive and an outer layer of polyethylene (PE) which provides tough, durable protection. In addition, 3LPE systems offer an excellent resistance to cathodic disbondment, reducing lifecycle cost of cathodic protection.



The FBE component provides excellent adhesion to steel, providing superior long term corrosion resistance and protection of pipelines operating at moderate temperatures. The tough outer PE layer protects pipelines during transportation and installation thereby reducing costly repairs while also providing added in-ground protection against shear forces, chemicals and abrasive soil conditions.

By increasing the thickness of the PE outer layer, the 3LPE System can provide a high level of mechanical protection across a variety of difficulty environments without requiring the use of costly backfill.



3LPE systems are conformed to DIN 30670 as follows :-

Property / Specification	Requirements
Coating thickness :	Min. thickness
i. $D < 114.3$	1.8 mm
ii. $114.3 < D < 273$	2.0 mm
iii. $273 < D < 508$	2.2 mm
iv. $508 < D < 762$	2.5 mm
v. $D < 762$	3.0 mm
Continuity	Free from holidays @ test voltage 25kV
Peeling Resistance	$> 35N / 10mm$
Impact Resistance	$> 10 NM$
Indentation Resistance	$< 0.3mm$
Elongation	$\geq 200\%$
Resistance to cathodic disbondment	10mm max
Cutback	$150 mm \pm 20mm @ 30^\circ$ max

Packing, Loading and Unloading Of Container

Line-pipes shall be protected during loading, transit and storage in order to preclude any damage and contamination by oil, salt water or other chemicals, which could adversely affect the pipes.

A. Standard Packing for Export

1.	For all pipes - bevel protected with steel ring	
2.	For 3LPE pipes - wrapped with fabric tarp and jute ropes are tied around pipe diameter at 4 intermittent points along pipe length	
3.	For small diameter pipes - bundled with steel strapping	

B. Container Lining

1.	Sides and floor of containers to be lined with treated wood planks to prevent damage to pipes during loading, unloading and shipping.	
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C. Loading and Un-loading of Container

1.	The loading and un-loading of pipes into container are done using a purpose built pipe handling attachment for forklift. For handling of 11.8m long pipes, 18-ton and above forklifts are used to ensure sufficient lifting capacity and counter-balance.	
2.	Using the attachment, pipes are carefully lifted and inserted / drawn out of the container. Pipes are lifted / hoisted using slings to ensure that there is no damage to the pipes.	

3. Wood dunnage are used to prevent damage from hard protrusions and to secure the pipes in the container. Where necessary, strappings are used to prevent movement during transport and shipping.



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