TTE TRAINING LIMITED

Phase 1 Fabrication

Carousel 1

PIPELINE DESIGN INSTALLATION & MAINTENANCE

PIPEWORK

INTRODUCTION

Pipe is hollow cylinder used to conduct or transfer fluids (liquids and gases) from one place to other place

A Piping System is a network of Pipes by using Pipe Fittings and other special components to perform the required mode of transferring fluids (Liquids/ Gas/ Slurry) safely from one location to another location. It is the effective method for transferring fluids without losses in properties, quality or quantity of fluid.

Millions of miles of pipework are in use everyday throughout all industries, transporting chemicals and products around the plants. So vast is the range of products, temperatures and pressures transferred through these pipes that no single type of material can be used in their fabrication. Therefore, great care must be taken in the selection of materials for pipework, to ensure that it meets the requirements of the plant.

PIPE-LINE DESIGN

Piping systems are designed to perform a definite function. Piping system designing and construction of any Plant or services are time consuming, complex, and expensive effort. Designing of piping systems are governed by Industrial/International Codes and Standards. The integrity of a piping system depends on the considerations and principles used in design, construction and maintenance of the system. All codes and standards define and set forth the engineering requirements which holds essential for proper design and construction of piping installations. Piping codes defines the requirements of design, fabrication, use of materials, tests and inspection of pipes and piping systems and which has a limited jurisdiction defined by the code.

Process piping and power piping are typically checked by Pipe Stress Engineers to verify that the routing, nozzle loads, hangers, and supports are properly placed and selected such that allowable pipe stress is not exceeded under different situations such as sustained, operating, pressure testing etc., as per the ASME B31, EN 13480 or any other applicable codes and standards.

It is necessary to evaluate the mechanical behaviour of the piping under regular loads (internal pressure and thermal stresses) as well under occasional and intermittent loading cases such as earthquake, high wind or special vibration, and water hammer.

Two major factors for consideration when selecting and designing pipework are:-

a) **SAFETY**

We must ensure the completed pipework will be able to withstand the temperature and pressure, which it will be subjected to.

Also the pipework must be suitable for the nature of the product it will handle.

b) **COST**

Although it is imperative that the pipework should operate safely, cost is also a very important factor. To be competitive the business needs to run efficiently and cost effectively, this means buying the right materials at the right price.

If we used one common metal, for example TITANIUM, to fabricate every pipe on a plant then this would not be cost effective. For although TITANIUM would be suitable for a large range of products, it is also extremely expensive and would be over specified for a large range of products such as water, caustic and ammonia etc.

When we design pipework, we need to specify the correct material for the job. This is true whether we are designing pipework for a new plant or just extending or repairing existing plant systems.

The information needed for pipe design, erection and maintenance has been compiled into the company **pipe specification and standards**, and can usually be found in the design office, Plant Engineers office or the maintenance foreman's office. These standards must always be consulted when any pipework is to be fabricated.

PIPE-LINE REFERENCES AND SPECIFICATIONS

All process pipelines will have a means of identification by being designated a reference code or number. This is cross referenced to the specification sheets.

This reference will be stated on the pipeline design and installation drawings, flow sheets and line diagrams

A complete pipeline specification consists of two sheets. The first sheet lists the fluid constituents, design and limiting conditions, heat treatment test pressures, recommended valves, inline items, joints and other variables.

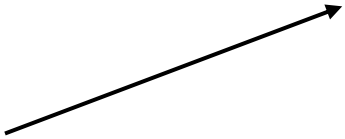
The second sheet specifies materials of construction and fabrication details including radiography. There are no variables on this second sheet and it can be common to a number of fluids. Any second sheet can be paired with appropriate first sheet of form a complete pipeline specification for any fluid.

PIPELINE SPECIFICATION SHEET EXAMPLE– see Fig. 1

The complete line reference code for any fluid is shown in heavy print right hand side of the index

The example being used is for Steam & Condensate HP .

Fluid Description	Main Pipe Material	Pressure Bar.G	Temperature	SPEC Reference
Air Compressed	C.S	10	50	AMA 004 A
Air Instrument	C.S	10	80	AGB 001 A
Air Instrument	ST.ST. 304L	10	80	SGB 003 A
Air Instrument	ST.ST. 316	10	80	SGD 003 A
Air Mask (Upto Receiver)	C.S	10	80	AMA 025 A
Air Mask (After Receiver)	ST.ST. 304L	7	60	SGB 017 A
Air Mask (After Receiver)	ST.ST. 316	7	60	SGD 017 A
Brine Refrigerated	CS	13.8	+150 -20	AGU 164 A
Dry Risers	CS	7	80	AMA 084 A
Natural Gas	C.S.	10	186	AMA 006 A
Nitrogen	C.S.	10	80	AGB 001 A
Steam Tracing for Wrapping Valves and Fittings	Small Bore Copper (Comp Fittings)	10	186	CZA 001 A
Steam Tracing Direct Clip On	CS	10	186	AMS 001 A
Steam Tracing Spacer	CS	10	186	AMS 002 A
Steam & Condensate L.P. (ANSI 150 Class 3)	CS	10	186	AMA 007 A
Steam & Condensate I.P. (ANSI 300 Class 2)	CS			AHB 007 A
Steam & Condensate H.P. (ANSI 600)	CS			ACB 002 A



PIPELINE REFERENCE NUMBER

This would be located on site drawings (construction drawings, Line diagrams) Stencilled or tabbed on the pipeline

Fig 1

Pipeline specifications (continued)

If we look at sheet 1 (previous page..**Fig 1**) we see a more detailed index giving more information of the pipe system eg: material code, flange rating, gasket type.

On the following sheet (sheet 2 **Fig 2**) we are presented with more detailed information with regards to material specification, wall thickness, types of fittings. Also mentioned is the fabrication class, heat treatment requirements.

On sheet 3 (**Fig 3**)are recommended valves, gasket types and bolting fasteners which are shown on the left hand side of the sheet.

If the project design group has good cause, perhaps for environmental or technical reasons, to change the recommended fittings, then these are listed on the right hand side of the sheet. This then forms a project orientated specification.

When constructing, modifying, maintaining, inspecting or testing a piping system, if there are any uncertainties whatsoever then the pipe specification should be referred to.

Any modifications or changes to the system are carried out, then the specification must be updated, recorded and all holders of the documents be provided with the current updates. (All previous and outdated copies must be returned to the design section or be destroyed)

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Engineering	Piping Systems Specification Index Sheet 1 of 4	Project No. T10009 Project Title. Standards Pipe Issue Note No. 3117	Issue A

See Record Of Modifications Sheet Index For Details Of Any Changes To Index

Spec. Ref.	Duty	Fluid Ref.	Main Piping Material.	Pipe.	Flange.	Gaskets.	Shop Test.	Radiography.	Heat Treatment.	Galvanising.	Tracing.	Jacketing.	Insulation.	Painting.
ACB002 A	Steam and Condensate H.P. Up To 400° C		CS	A106 GR.B	ANSI 600	SP. WND.		100%					Yes	
AGB001 A	Air - Instrument		CS	API5L GR.B	ANSI 150	CAF		10%						Yes
	Nitrogen													
AGU164 A	Brine - Refrigerated		CS	API5L GR.B	ANSI 150	CAF		10%	See Fab. Spec.				Yes	Yes
AHB007 A	Steam and Condensate I.P.		CS	API5L GR.B	ANSI 300	CAF		10%					Yes	Yes
	Water - Hot - High Pressure													
AMA004 A	Air - Compressed		CS	API5L GR.B	ANSI 150	CAF								Yes
AMA005 A	Water: General Works After Break Tank - Non Potable		CS	API5L GR.B	ANSI 150	CAF							Yes	Yes
AMA006 A	Natural Gas		CS	API5L GR.B	ANSI 150	CAF								Yes
AMA007 A	Steam and Condensate L.P.		CS	API5L GR.B	ANSI 150	CAF							Yes	Yes
AMA025 A	Air Mask - Up To Receiver		CS	API5L GR.B	ANSI 150	Rub--ber								Yes

Issue	A								
Date	3 Sept 1990								

Engineering	Piping System Specification	Project No.	10009	Project Title	Standards	Spec. Ref.	ACB002	Page 3 of 3

Material / Lining	Carbon Steel /	**Limitations Of Components** ***On This Page Only***	1/2" NS - 4" NS ANSI Class 600 Flange Rating 6" NS - 24" NS Limited By Pipe Wall Thickness				Remarks: For Other Fabrication Details See Page 2 Of This Specification
Fabrication Spec	Spec. EDS.PIP.51.01	**Fabrication Class**	Class 1 Piping System	**Inspection And N.D.T.**	Spec. EDS.PIP.51.01	**Heat Treatment**	None

	N.S. Range (in) Min	Max	Description	Standard Number	PCR (Item Code)
Pipe	1/2	4	Pipe, Seamless, Dimensions to ANSI B36. 10 Material Carbon Steel ASTM A106 Grade B, Sched.80 THK.		PAM80
	6	24	Pipe, Seamless, Dimensions to ANSI B36. 10 Material Carbon Steel ASTM A106 Grade B, Sched.80 THK.		*PAM
Flanges / Pipe Joints / Caps	1/2	24	**Pipe Joints / Caps** Cap, Butt Welding, Dimensions To ANSI B16.9 Material - Carbon Steel ASTM A234 Grade WPB, As Per THK.	04 4085	*KAM
	1/2	24	Butt Weld Type 'A'. ICI Spec. EDS.PIP.51.01		WBA51.01
	1/2	24	**Flanges** Flange, Blank, Dimensions To ANSI B16.5, Class 600, Material: Carbon Steel ASTM A105.	04 2082	*FAM600B
	1/2	24	Flange, Welding Neck, Dimensions To ANSI - - B16.5, Class 600, Material: Carbon Steel ASTM A105, As Pipe THK	04 2218	*FAM600WN
			ASSEMBLY	04 2619	
Reducers	3/4	24	Reducer, Butt Welding, Eccentric Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB. Large End As Pipe, Small End As Pipe THK.	04 4094	*RAME

	N.S. Range (in) Min	Max	Description	Standard Number	PCR (Item Code)
BENDS	1/2	4	FIRST CHOICE Cold Formed Bends With 5D Bend Radius		B-5D
	6	24	Elbow, Butt Welding, 45 Deg. Long Radius, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB, As Pipe THK	04 4093	*EAM45L
	6	24	Elbow, Butt Welding, 90 Deg. Long Radius, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB, As Pipe THK	04 4093	*EAM90L
	1/2	4	SECOND CHOICE Elbow, Butt Welding, 45 Deg. Long Radius, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB, SCHED.80 THK	04 4093	EAM45L80
	1/2	4	Elbow, Butt Welding, 90 Deg. Long Radius, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB, SCHED.80 THK	04 4093	EAM90L80
BRANCHES	1/2	24	Equal Tee, Butt Welding, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB, As Pipe THK.	04 4092	*TAME
	3/4	24	Reducing Tee, Butt Welding, Dimensions To ANSI B16. 9, Material: Carbon Steel ASTM A234 Grade WPB. Run As Pipe, Branch As Pipe THK.	04 4095	*TAMR
	1/2	24	REINFORCED BRANCH CONNECTIONS Nipolet, Plain End. Class 3000 Rating. Material: Carbon Steel ASTM A105.		*LAN3N
	1/2	24	ELBOLET, Butt Welding. Carbon Steel ASTM A105		*LANE
	1/2	24	LATROLET, Butt Welding. Carbon Steel ASTM A105		*LANL
	1/2	24	WELDOLET, Material: Carbon Steel ASTM A105		*LANW

Prelim Issue No.						Approved Issue No.						Date STD Copied
Date.						Date.						21-6-90

Note: For Items Outside The Scope of This Specification Consult Piping Section

*PCR = Short Code

Engineering	Piping System Specification		
Design Code	ANSI B31.3 Spec. EDS. PIP. 50.01	Thermal Insulation	Spec. M5000 STD. 18 1620
Fab / Erect Specification	Spec. EDS. PIP. 51.01	Tracing	Nil
Cleaning & Protection Internal	Spec. EDS. PIP. 51.01	Testing Shop	Nil
Cleaning & Protection External	Spec. EDS. PIP. 57.01	Testing Site	Spec. EDS. PIP. 64.01 Hydrostatic

	N.S. Range (in) Min	N.S. Range (in) Max	Description	Standard Number	PCR (Item Code)
Valves			Situation - A		
	1/2	1. 1/2	Parallel Slide Valve, Outside Screw, Rising Stem, Flanged Ends, Class ANSI 600, Handwheel Operated, Forged Steel Body.		VS087
	3	12	Parallel Slide Valve, Rising Stem, Flanged Ends, Class ANSI 600, Handwheel Operated, Cast Steel (Hytemp) Body		VS047
			Situation B+C		
	3/4	2	Parallel Slide Valve, Rising Stem, Flanged Ends, Class ANSI 600, Handwheel Operated, Forged Steel Body.		VS059
	3	3	Parallel Slide Valve, Rising Stem, Flanged Ends, Class ANSI 600, Handwheel Operated, Cast Steel (Hytemp) Body.		VS047
	4	12	Parallel Slide Valve, Rising Stem, Flanged Ends, Class ANSI 600, Handwheel Operated, Cast Steel Body.		VS048
	1/2	2	Check Valve, Ball Type, B.Cover,Horiz., To BS5352, Flanged Ends, Class ANSI 600, Carbon Steel Body.		VC218
	3/4	1. 1/2	Uniflow Slide Valve, Flanged Ends, Class ANSI 600, Wrench Operated, Carbon Steel Body.		VS043
	3	24	Check Valve, Swing Type, Bolted Cover, To BS1868, Flanged Ends, Class ANSI 600, Cast Carbon Steel Body. Note:- Use VS043 For Drain Purposes Only.		VC156
Gaskets	1/2	24	Gasket, Spiral Wound, Inside Bolt Circle To BS3381, Class 600, S/Steel 321 Strip, CAF Filler, Stainless Steel Inner Guide Ring, Carbon Steel Outer Guide Ring.		GSGSAC600R
Bolts	1/2	24	Stud Bolt BS4882 Inch With Nuts, Material 1% Cro. Mo. Steel Grade B7 Bolt, Grade 2H Nut.	08 0589	*BBAS

PROCUREMENT OF PIPING MATERIALS FOR FABRICATION (CARBON STEEL)

A “bulk stock” is held of all commonly used tubing and flanges, together with some butt weld fittings. These stock levels are based on the estimated requirements of customer usage and can be drawn out at short notice to meet customer demand quickly.

METALLIC MATERIALS OTHER THAN CARBON STEEL

Because these specified materials are usually very expensive such as MONEL/INCONEL and TITANIUM, they are not usually kept as a stockable item. The required lengths of tubing are usually obtained direct from the supplier as and when required.

MATERIALS OF CONSTRUCTION

As previously stated, the materials of construction are dictated by the temperatures, pressures and the products flowing through them.

Some materials which are in use:

METALS

MILD STEEL
CAST IRON
STAINLESS STEEL
TITANIUM
MONEL
INCONEL

NON-METALLIC MATERIALS

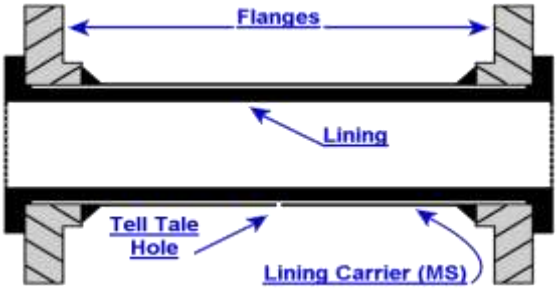
PLASTIC
GLASS
GRP (Glassfibre reinforced plastic)

LINED PIPEWORK

In some cases, to avoid using expensive materials such as MONEL, etc, carbon steel piping can be used if we coat the inside of the pipe with a chemical or abrasion resistant substance. This is called lined pipe and the lining should extend over the face of the flange.

EXAMPLES OF LINING MATERIALS

RUBBER (ie. BUTYL, NEOPRENE)
P.T.F.E
P.V.D.F
ALKATHENE
LEAD
GLASS
CERAMICS



Care must be taken not to damage the lining during transportation and installation, as any cracks or tears in the lining wall allow the product to make contact with the steel pipe wall causing corrosion. Extreme care should be taken in the glass lining, as any knocks or shocks would damage the glass.

PIPE SCHEDULES

Pipe schedule refers to the thickness of the wall or a piece of pipe, the thicker the wall, the stronger the pipe and the higher the pressure it will withstand. The schedule is important in relation to the two main points in the pipe selection:-

a) SAFETY
b) COST

a) **SAFETY:** We need the pipe to be able to withstand the maximum pressure it is likely to experience, therefore we select the appropriate schedule accordingly. The higher the pressure the greater the schedule.

b) **COST:** It is important when ordering pipe not to over specify by ordering thick wall high pressure pipe, for low pressure duties. This would mean paying more for a standard pipe which is not necessary.

So to cover both criteria we need to order a pipe which is not specified too high or too low for the duty intended. Schedule numbers increase with wall thickness, ie. 20. 40. 80. 160.

NOMINAL BORE

When we increase or decrease the wall thickness of a pipe we will alter the size of either the outside diameter, or the bore of the pipe because we need to fasten pipes together with either fittings (welded or screwed) or flanges (welded or screwed) which fir over the outside of the pipe.

Then we need the outside diameter to remain constant for each size of the pipe, therefore the bore of the pipe will either increase or decrease with the alternation of the pipe schedule. For this reason we refer to the bore of a pipe as “the nominal bore”.

An example of this can be seen in Fig. 3.

Wall thickness of nominal 1” NB pipe

To save us having to remember all the different pipe schedules, they also have been complied into standard tables. Examples can be seen in Fig.4 and Fig.5.

FIG. 4 (page13)

This table outlines the pipe schedules for carbon steel pipes showing the nominal bore, schedule number, wall thickness etc.

FIG. 5 (page 14)

This table lists the similar information as Fig. 4 except that it is for stainless steel pipe, which is shown by the “s” after the schedule number.

SMALL DIAMETER M.S PIPE

Small bore pipes are only made in a few thicknesses, because pressure alone does not determine the thickness; if it did some pipes would only need a few though thick. Other considerations are:

a) Minimum thickness needed to take a thread
b) Freedom from damage by denting etc
c) Ease of bending (thick pipes bend more uniformly)

Also the stress caused by pressure is often much less than that due to any of the following:

i) Thermal expansion (due to temperature changes)
ii) Loose or missing pipe supports
iii) Poorly fitted piping (if the flanges fail to align, report this to your supervisor)

LARGE DIAMETER PIPES

The large bore pipes are made in a wide range of thicknesses, because the savings on cost, by using a pipe no thicker than it need be, are increased. With these larger pipes, the actual bore of two similar nominal bore pipes can vary as much as 1 inch, and because of this, pipes larger than 12 inches. N.B. are referred to be outside diameter, which becomes an exact size in hole inches, 14”, 16”, 18” etc and does not involve any fractions as with smaller pipes.

Pipe and Tube (The difference)

The main difference between pipe and tube is the critical dimension used to describe the pipe size or the tube size.

For pipe, internal diameter (ID) roughly corresponds to the nominal pipe size for standard wall thickness.

For tube, the outer diameter (OD) closely corresponds to the tube size. In current European standards pipes and tubes are nowadays described as outside diameter by wall thickness

CARBON STEEL PIPE FOR PIPEWORK SYSTEMS

MAXIMUM WORKING TEMPERATURE 400OC

04 | ??? | **1646**

Page 1 of 2

No Issue No. 5 Date August

A Div Issue No 5 Date August

Specification: American Petroleum Institute API ???? Grade 8)

to date

Nom Size In	00 mm	Identification				Code or Ref. No.		
		Schedule No.	Designation	Wall ??? mm	Weight KG ??	API 5L Grade 8 Seamless or electronic ?	API 5L Grade 8 Seamless or ??????	Hyd. ? pressure bar
	21.3	80	Extra Strong	3.73	1.62	561.108.06		59
	26.7	80	Extra Strong	3.91	2.19	561.109.06		59
	33.4	80	Extra Strong	4.55	3.23	561.110.06		59
	48.3	80	Extra Strong	5.08	5.4	561.112.06		131
2	60.3	40	Std. Wall	3.91	5.43	561.114.04		172
		80	Extra Strong	5.54	7.47	561.114.06		173
2 ½	75	40	Std. Wall	5.16	8.62	561.116.04		173
3	88.9	40	Std. Wall	5.49	11.20	561.117.04		173
		80	Extra Strong	7.62	15.25	561.117.06		173
4	114.3	40	Std. Wall	6.02	16.06	561.119.04		152
		80	Extra Strong	8.56	22.3	561.119.06		193
6	168.3	40	Std. Wall	7.11	28.23	561.121.04		125
8	219.1	30	-	7.04	36.76	561.123.02		93
		40	Std. Wall	6.16	42.49	561.123.06		108
10	273	30	-	7.8	50.96	561.125.02		82
		40	Std. Wall	9.27	60.24	561.125.04		99
12	323.9	30	-	8.38	65.14	561.126.02		76
		40	-	10.31	79.71	561.126.04		92
14	355.6	30	Std. Wall	9.52	81.21	561.127.02		77
		40	-	11.13	34.31	561.127.04		90
16	406.4	30	Std. Wall	9.52	33.13	561.129.02		68
		40	Extra Strong	12.7	125.16	561.129.04		90
18	457.2	-	Std. Wall	9.52	105.05	561.130.03		61
		40	-	14.27	155.9	561.130.04		90
20	508	20	Std. Wall	9.52	116.97		561.131.01	55
		40	-	15.09	183.14		561.131.04	86
24	609.6	20	Std. Wall	9.52	140.81		561.133.01	45
		40	-	17.46	254.74		561.133.04	82

Pipe to ASTM A106 Grade B Seamless is an acceptable alternative for ? sizes ½ in, ?? in, ? in and ? in
For use on 1 ½ in norm size jacketed pipework only.
Standard mill inspection test pressures are listed. See 04 1609 for explanation.
Important See notes on page 2

AUSTENITIC STAINLESS STEEL PIPE

04	REFERENCE 4260
PAGE 1 OF 2	
ISSUE NO 1 DATE MAR 1979	
DIV ISSUE NO DATE	

GENERAL REFERENCES
DESIGN INFORMATION 04 4240

SPECIFICATION
LONGITUDINALLY-WELDED AUSTENITIC STAINLESS STEEL PIPE
TO ANSI/ASTM A312
SEE ORDERING INSTRUCTIONS ON PAGE 2

THE OUTSIDE DIAMETERS AND WALL THICKNESS ARE IN ACCORDANCE WITH BS 1600: PART 2 AND ANSI B36.19

NOM SIZE 1n	OD mm	SCHEDULE NUMBER	WALL THK's mm	WEIGHT Kg/m	*MILL HYDRAULIC TEST PRESSUE bar	
					TP 304L & TP 316L	TP 316 & TP 321
½	21.3	40S	2.77	1.26	172	172
¾	26.7	40S	2.87	1.68	172	172
1	33.4	10S	2.77	2.08	145	172
		40S	3.38	2.5	172	172
1 ½	48.3	10S	2.77	3.11	97	117
		40S	3.68	4.05	131	159
2	60.3	10S	2.77	3.93	76	97
		40S	3.91	5.43	110	131
3	88.9	10S	3.05	6.44	59	69
		40S	5.49	11.28	103	131
4	114.3	10S	3.05	8.35	45	55
		40S	6.02	16.06	90	110
6	168.3	10S	3.4	13.83	34	41
		40S	7.11	28.23	76	90
8	219.1	10S	3.76	19.94	31	34
		40S	8.18	42.49	66	76
10	273	10S	4.19	27.83	28	31
		40S	9.27	60.24	59	69
12	323.9	10S	4.57	36.01	24	28
		40S	9.52	73.76	52	62
14	355.6	10S	4.78	41.27	24	28
16	406.4	10S	4.78	47.25	21	24
18	457.2	10S	4.78	53.23	17	21
20	508	10S	5.54	68.55	17	24
24	609.6	10S	6.35	94.37	17	21

*STANDARD MILL INSPECTION TEST PRESSURES. SEE 04 4240 FOR EXPLANATION

FIG. 5

FLANGES

What is the purpose pipe flanges?

It is one of the most used methods for connecting pipes, valves, pumps and other equipment in order to form a pipework system.

Flanges are devices used to connect sections or lengths of pipe together.

For ease of installation pipe is normally supplied in 6mtr lengths, but many pipe configurations require many variations in length.

They allow items such as valves, pumps, filters etc to be fitted into the system and also provide easy access for cleaning, inspection or modification.

Flanges, like pipes, operate under varying conditions of temperature and pressure.
Standard maximum operating pressure and temperature ratings have been established for flanges and are expressed in pounds per square inch.

FLANGE STANDARDS

There are three main flange standards:-

BS 10
BS 1560
BS 4504

BS10

This is the old British Standards and no longer in common use, although they can still be found on older types of equipment, so stock is still held.

These flanges are classified as tables D, E, H, J and S. The safe working pressure increases as the letter of the alphabet increases, ie. a table “S” flange would rate higher than a table “E” flange.

BS1560

This is a fairly new standard, based on the AMERICAN ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE) or ASA (AMERICAN AUTHORITY). These flanges are classified by the pressure ratings, such as class 150 or class 300, where the number represents the pressure ratings in P.S.I.

The class, ie. 300 and nominal bore, ie. 2” for which the flanges is suited can be found stamped on the side of the flange. These flanges are common use on all plants replacing the BS 10 system.

BS 4504

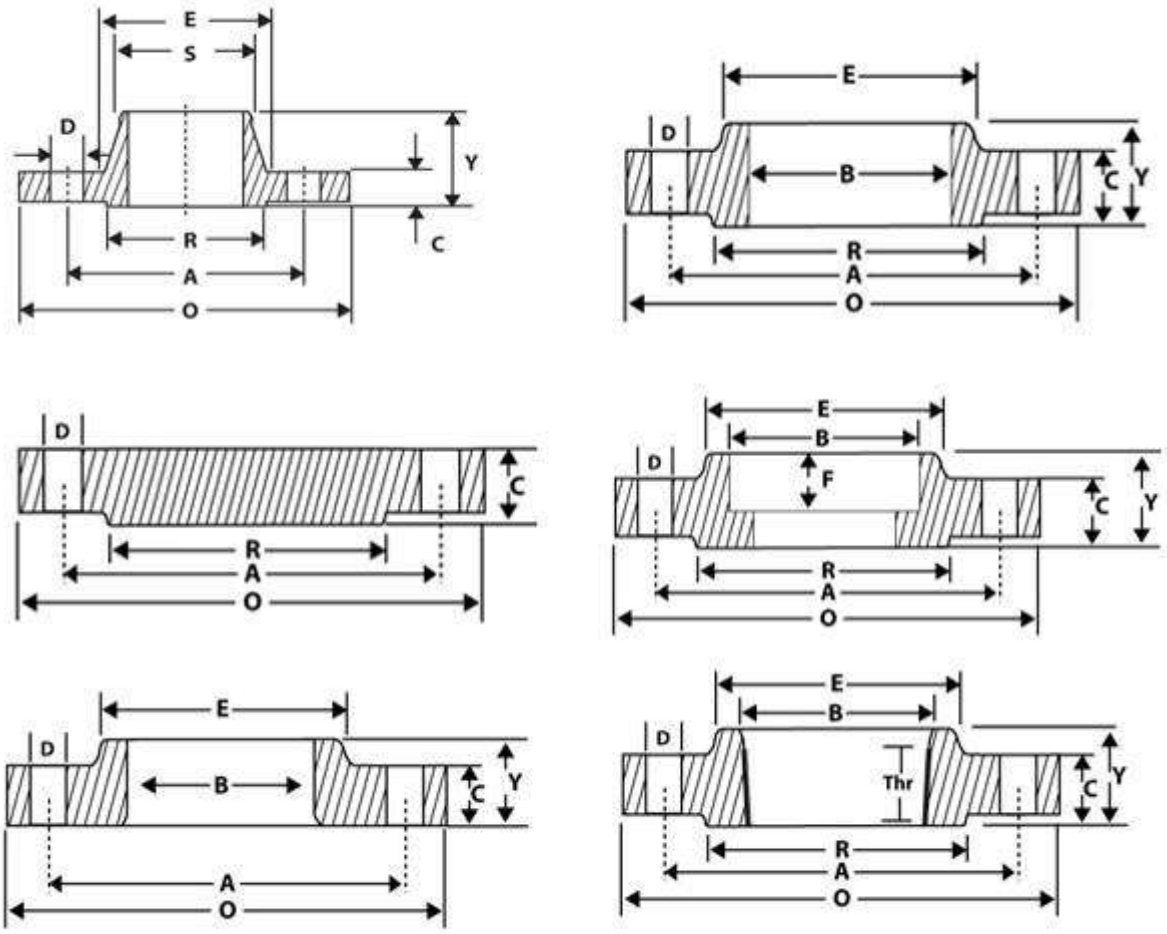
This is the British Metric Flange System and is not a common as the ASA system, being found mainly on metric equipment. This is known as the PN series because they are classified in ratings such as PN 10 and PN 16 (where the PN stands for nominal pressure and the number is the pressure rating in bars).

FLANGE TYPES

Temperature (°F)	ANSI Pressure Class *(lb)*						
	150	300	400	600	900	1500	2500
	Hydrostatic Test Pressure *(psig)*						
	450	1125	1500	2225	3350	5575	9275
-20 to 100	285	740	990	1480	2220	3705	6170
200	260	675	900	1350	2025	3375	5625
300	230	655	875	1315	1970	3280	5470
400	200	635	845	1270	1900	3170	5280
500	170	600	800	1200	1795	2995	4990
600	140	550	730	1095	1640	2735	4560
650	125	535	715	1075	1610	2685	4475
700	110	535	710	1065	1600	2665	4440
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

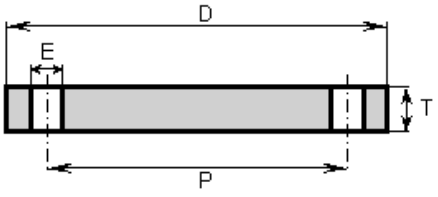
Pipe Flange dimensions

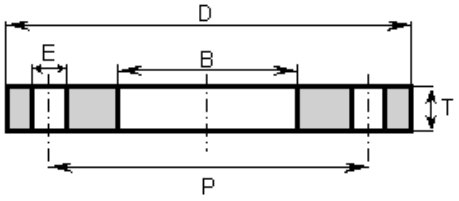
When measuring a flange to determine its size and rating, dimensions are taken from the type of flange and reference made to the accompanying dimension tables



Flange types

Flange dimension table for class 150 flanges



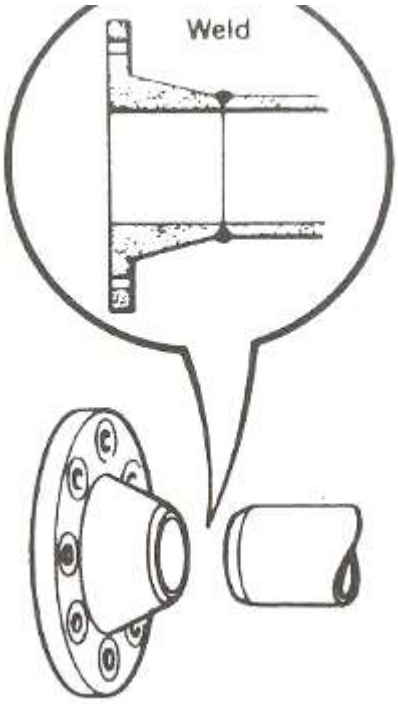


N.B. Size	Table	D	B	T	P	E	No. of Holes
½"	D	95	22	5	67	14	4
	E	95	22	6	67	14	4
	F	95	22	10	67	14	4
	H	114	22	13	83	18	4
¾"	D	102	28	5	73	14	4
	E	102	28	6	73	14	4
	F	102	28	10	73	14	4
	H	114	28	13	83	18	4
1"	D	114	35	5	83	14	4
	E	114	35	7	83	14	4
	F	121	35	10	87	18	4
	H	121	35	14	87	18	4
1 ¼"	D	121	43	6	87	14	4
	E	121	43	8	87	14	4
	F	133	43	13	99	18	4
	H	133	43	18	99	18	4
1 ½"	D	133	50	6	99	14	4
	E	133	50	9	99	14	4
	F	140	50	13	105	18	4
	H	140	50	18	105	18	4
2"	D	152	62	8	114	18	4
	E	152	62	10	114	18	4
	F	165	62	16	127	18	4
	H	165	62	19	127	18	4

N.B. Size	Table	D	B	T	P	E	No. of Holes
2 ½"	D	165	75	8	127	18	4
	E	165	75	10	127	18	4
	F	184	75	16	146	18	8
	H	184	75	19	146	18	8
3"	D	184	91	10	146	18	4
	E	184	91	11	146	18	4
	F	203	91	16	165	18	8
	H	203	91	22	165	18	8
3 ½"	D	203	103	10	165	18	4
	E	203	103	12	165	18	8
	F	216	103	19	178	18	8
	H	216	103	22	178	18	8
4"	D	216	116	10	178	18	4
	E	216	116	13	178	18	8
	F	229	116	19	191	18	8
	H	229	116	25	191	18	8
5"	D	254	144	13	210	18	8
	E	254	144	14	210	18	8
	F	279	144	22	235	22	8
	H	279	144	29	235	22	8
6	D	279	171	13	235	18	8
	E	279	171	18	235	22	8
	F	305	171	22	260	22	12
	H	305	171	29	260	22	12

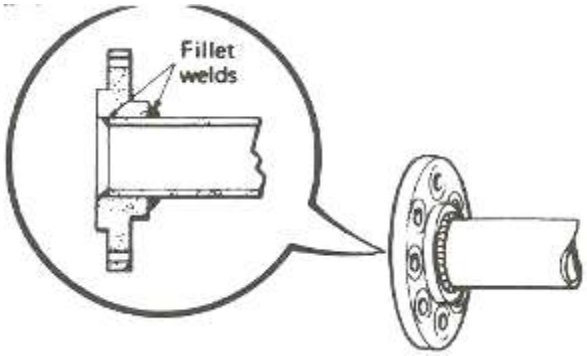
FLANGES

Flanges, like pipes, operate under varying conditions of temperature and pressure. Standard maximum operating pressure and temperature ratings have been established for flanges and are expressed in pounds per square inch.

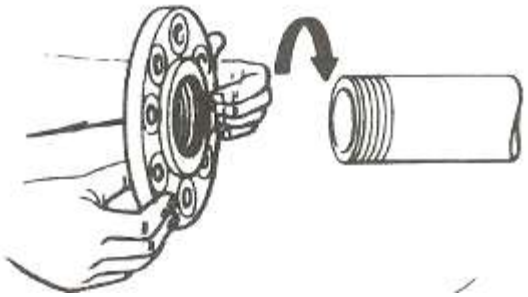


Welding neck flanges are identified by their tapered hubs which connect the flange to the pipe.

Slip on flanges fit onto the end of the pipe and are fillet welding in position, back and front.

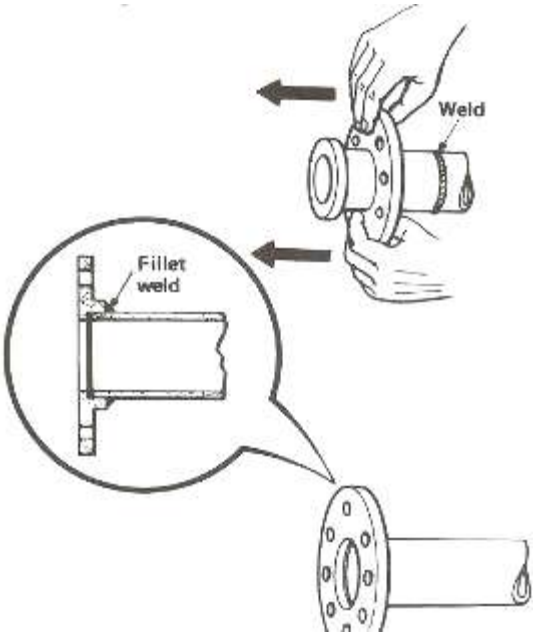


Screwed or threaded flanges are screwed on to the end of the pipe.
Used for low pressure duty.
Self aligning .

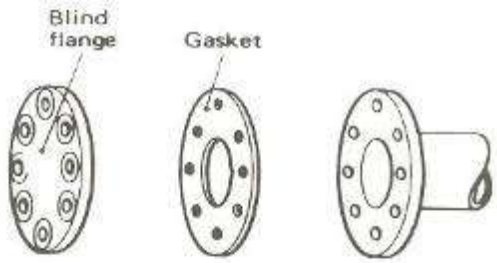


Backing flanges are used with lap joints stubs where frequent dismantling for inspection and cleaning is necessary.

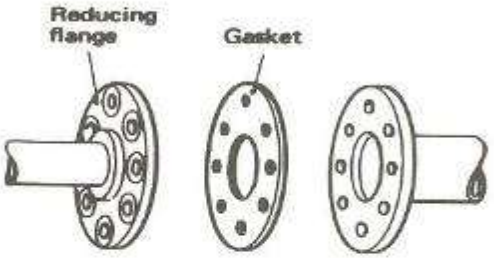
Socket weld flanges are slipped onto the ends of pipes and fillet welded in position. This type of flange is used for pipework below 38mm (1 ½ in.) diameter.



Blind flanges are used to blank off the ends of piping, valves and pressure vessel openings.



Reducing flanges are used where a reduction in the diameter of pipe is required at the flange.

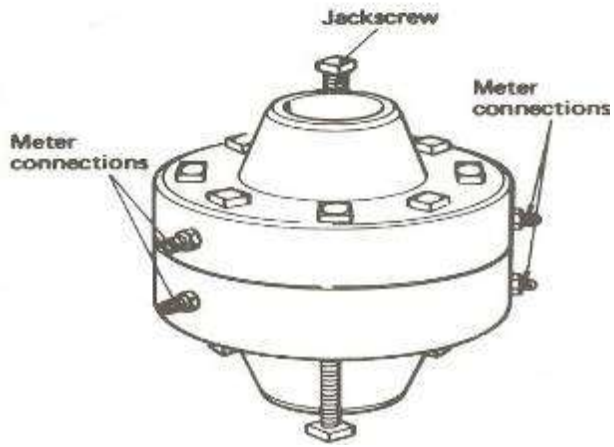


Different types of *orifice flanges* are manufactured, ie. weld-neck, slip-on and screwed types;. They are always supplied in pairs.

These flanges are used in conjunction with an orifice meter to measure the rate of flow of liquids in a pipework system.

Two holes in each flange serve as meter connections.

Additional bolts act as jackscrews to push the flanges for installation or maintenance.



Blinds and Spacers

When it is necessary to blind-off a line for lengthy periods, a blind is fitted in the line between pipe flanges.

To make allowances for the blind, a spacer is fitted between the flanges on original construction. This is removed when the blind is fitted.

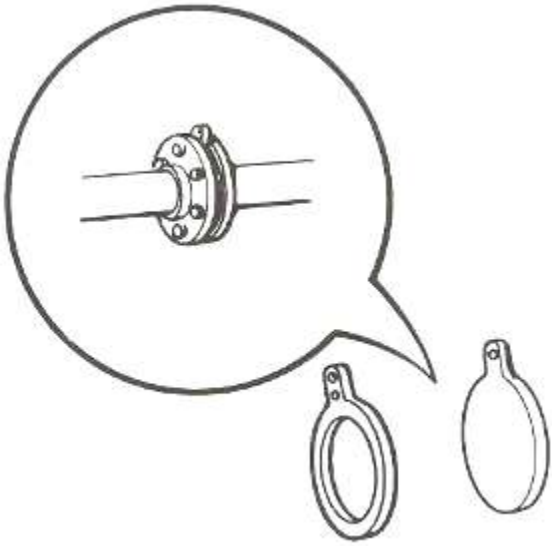
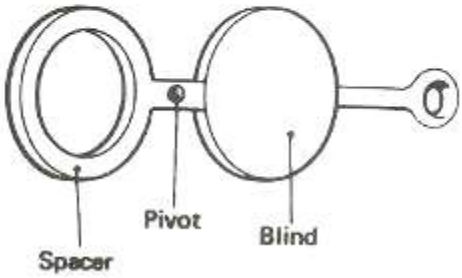


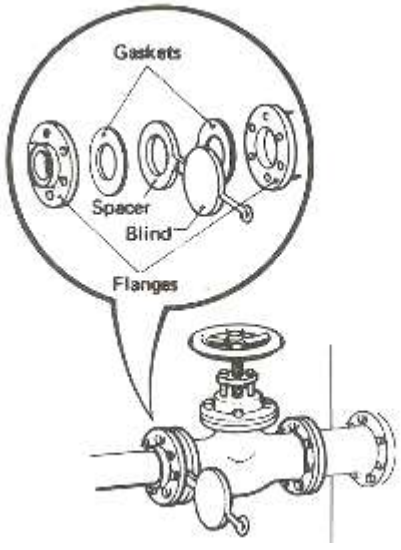
Figure of 8, Spectacle blinds and spacers

The figure 8 blind may be fitted between the flanges of a pipe and a valve connected to a vessel, tank or tower.

When maintenance is necessary and the line is to be closed down without emptying the vessel or tank, the blind side of figure 8 is swung between the pipe and the valve.

After maintenance, all pipe lines must be pressure tested. The figure 8 blind is used to blank off the valve to prevent it being pressurised and possibly damaged.



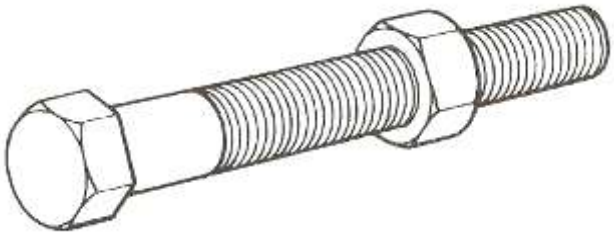


FIXINGS

Bolts

Bolts and nuts are made from mild steel and have limited qualities of strength and durability.

The use of bolts is therefore limited to low pressure lines.

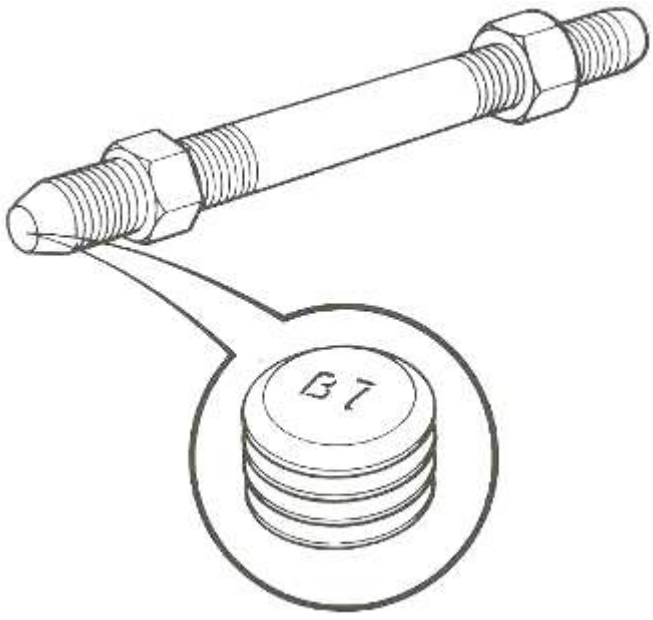


Stud Bolts

These are made from higher quality steel than machined bolts and used at higher pressures.

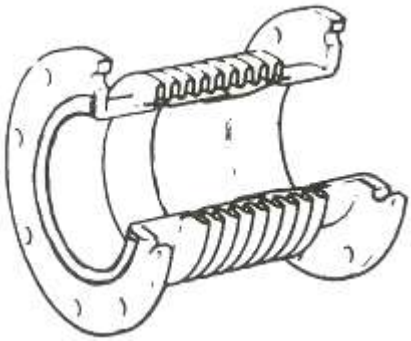
Stud bolts are used on high pressure lines, eg. Up to ASA series 1500 flanges.

At one end of the stud bolt is a coded marking which indicates the maximum operating temperature for which the bolt is suitable.



In some cases, pipelines can experience a considerable amount of movement or vibration when on line. This can be caused by a number of reasons. Thermal expansion and contraction or by machinery moving naturally when working, are the two common reasons. Normal pipework connected in this situation would not have the flexibility to cope and would soon experience metal fatigue and fracture. To accommodate this movement in the pipework a bellows unit can be fitted.

BELLOWS

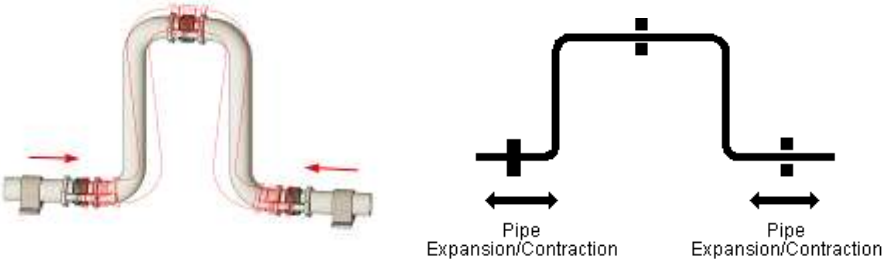


Or an all metal design, suitable for high temperatures and pressures, with the materials of construction compatible with the product.

The inclusion of a bellows expansion unit into any pipework needs careful consideration from design teams as there are very stringent standards and specification surrounding these units. All information required can be found in the ENGINEERING PROCEDURES AND INSTRUCTIONS.

EXPANSION BENDS

Another method of allowing for the expansion of the pipe is by use of an expansion bend, usually found in the steam systems.



This pipe connects the top of the still column to the condenser, and was designed and fitted to replace the expansion bellows which could not cope with the amount of expansion and contraction which took place, like all pipeworkk and ancillary equipment, expansion bends must conform to specification and standards.

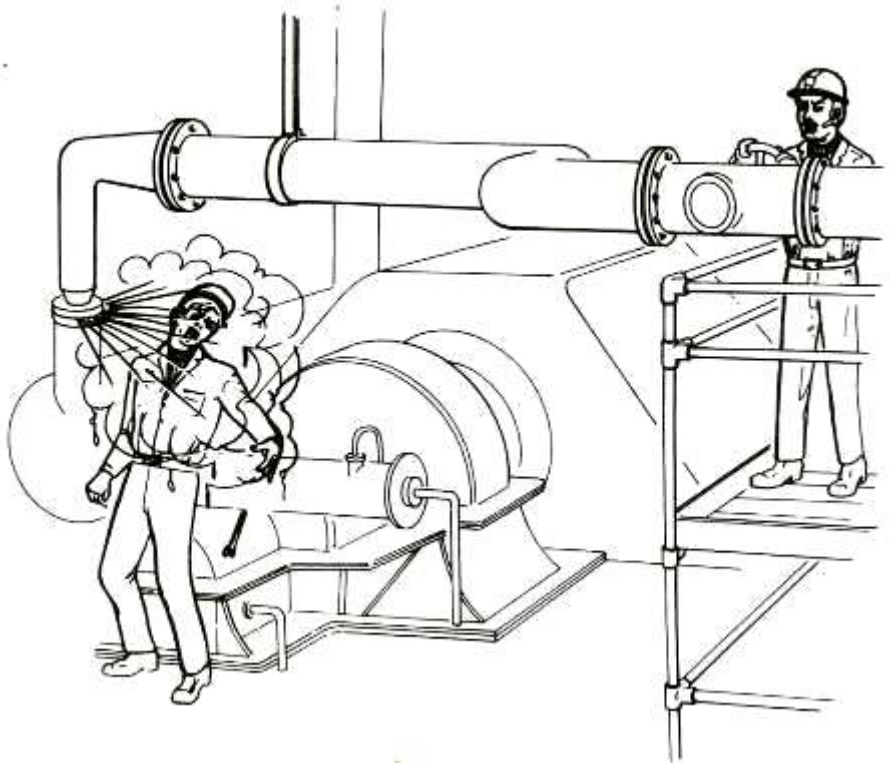
PIPES & FITTINGS

Pipework systems are designed to meet varying operating conditions. To avoid a failure in a system it is important that only the materials and components specified are used.

Codes to identify materials and parts have been developed by organisations such as British Standards Institution, American National Standards Institute and American Society of Tube Manufacturers. These codes are widely used by designers to specify their requirements. In some cases companies have developed their own codes.

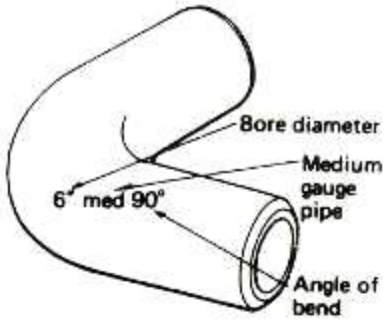
Manufacturers usually mark materials and components to help ensure correct selection and fitting.

Whenever there is doubt concerning the identification of a pipe, pipe fitting, gasket, valve or flange, the technician should consult the supervisor. The use of the wrong materials in a pipe work system may result in a serious accident or incident.



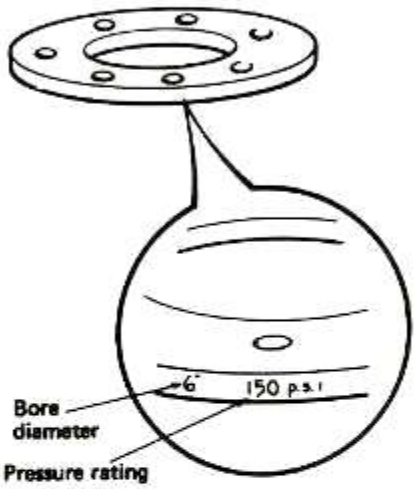
IDENTIFICATION OF FLANGES, FITTINGS AND VALVES

Pipe Fittings
Pipes and pipe fittings are marked with the same details. Frequently other information is included, eg. On an elbow, the angle of the elbow is shown.



Flanges
The rims of flanges are marked to show:

Nominal Size
Design working pressure in lbs per sq in.
Material type number
Weight



Valves
Valve bodies carry the following information:

Name of manufacturer
Nominal size
Design working pressure in lbs per sq in.

A metal disc with the company specification number attached to the valve.

On the disc are the details of the materials used for the trim of the valve.

'Trim' is the term used for certain working parts of a valve including the stem, seat disc and disc facings.

Screwed and socket weld fittings
These fittings are marked with the same information as valves, ie.

Name of manufacturer
Nominal size (bore)
Design pressure (lbs per sq in.)

RECOGNITION OF PIPE FITTING

Butt-welding fittings

Fittings of this type have bevelled ends for butt welding onto pipes and flanges.

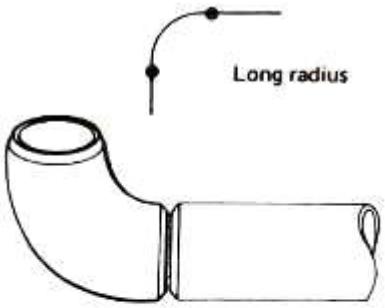
Elbows and bends provide deviations of 90^{o} or 45^{o} in pipework systems.

Note:

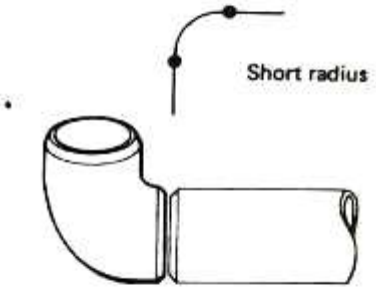
The symbol close to the illustrations which follow are those used in drawings to specify the fittings to be used*:*

Elbows

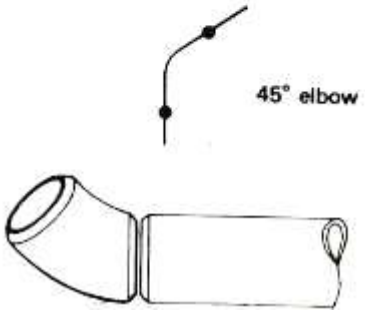
Long radius elbows have a radius equal to 1 ½ times the bore of the pipe.



Short radius elbows have a radius equal to the bore of the pipe.



45^{o} elbows allow a pipe deviation of that amount.

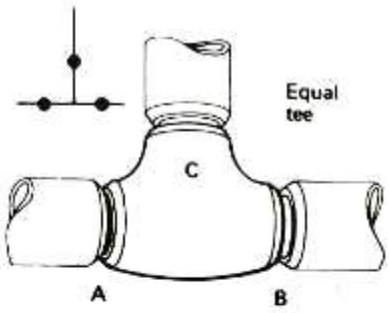


Tee Branch

A tee branches the pipe line at 90^{o}. The branches may be equal in diameter or there may be one reducing branch.

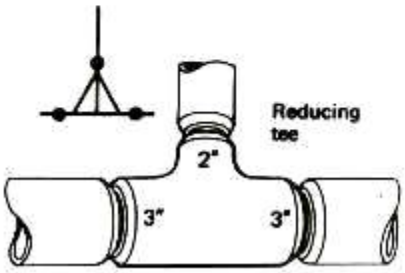
The dimensions of a branch are always quoted as:

AxBxC



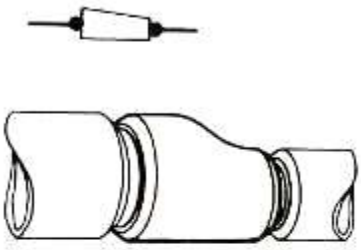
Reducing Tee Branch

Reducers are fitted where a change in pipe diameter is required.



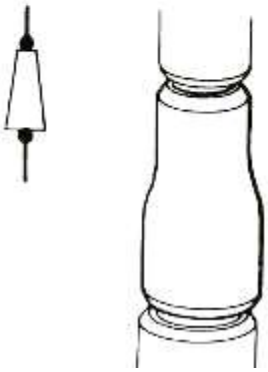
Eccentric reducer

Used mainly in the horizontal position.



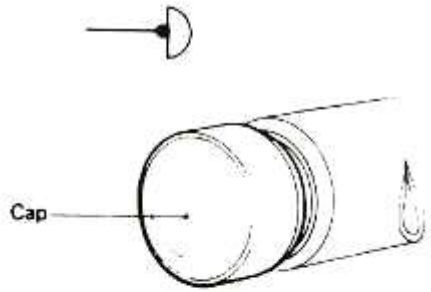
Concentric reducer

Used mainly in the vertical position.



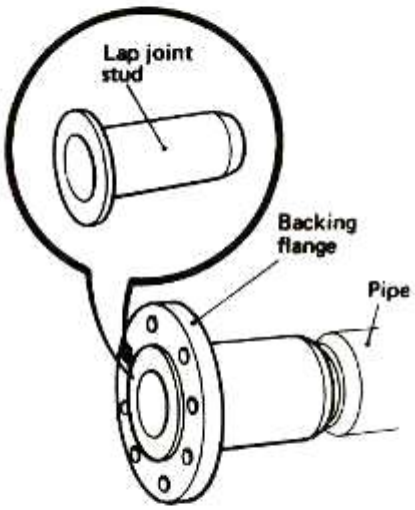
Caps

Caps are used for permanently blanking off the end of a pipe.



Lap-joint stubs

Lap-joint stubs and backing flanges are used for connections in low pressure pipelines.

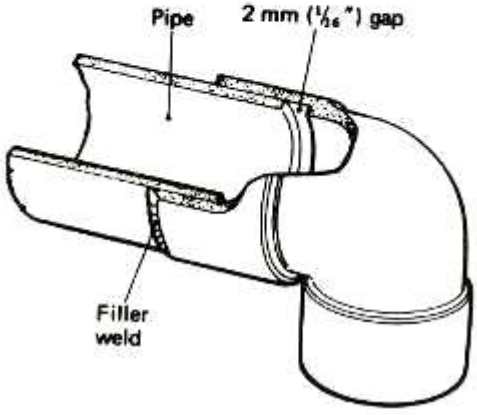


Socket-weld fittings

The use of socket weld fittings is generally restricted to pipework of 38m (1 ½ in.) diameter and smaller.

This type of fittings is particularly useful when pipe bending facilities are not available and when required dimensions of a pipe make bending impractical.

The pipe slips unto the socket of the fitting leaving a 1.6mm (1/16 in.) gap to allow for expansion when the pipe and fitting are welding

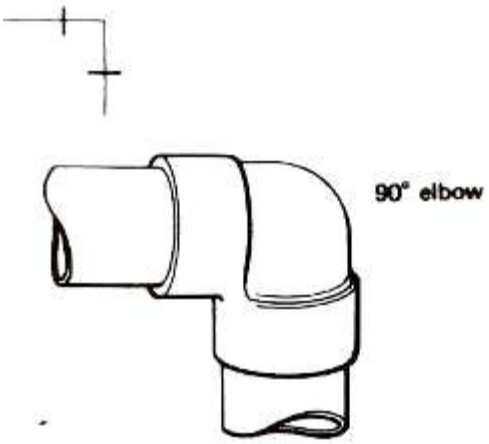


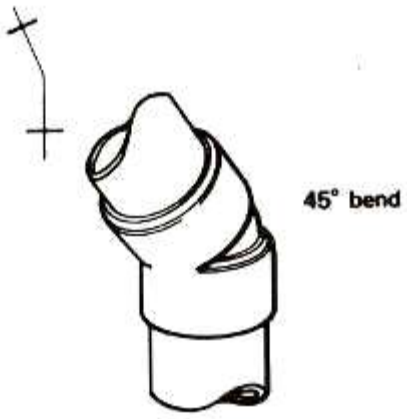
Socket weld fittings are rated from 2000 to 3000lb.

2000 lb rated socket weld fittings are used with schedule 40 pipe.

3000lb rated socket weld fittings are used with schedule 80 pipe.

Elbows are available in 90^{o} and 45^{o} bends

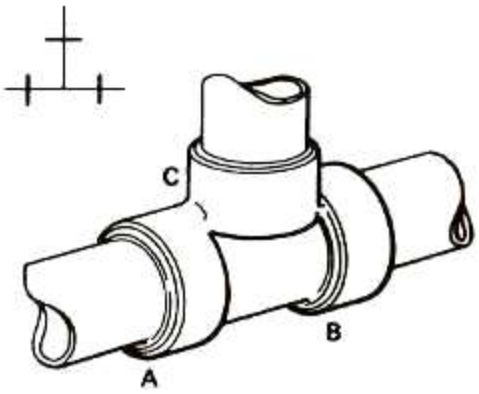




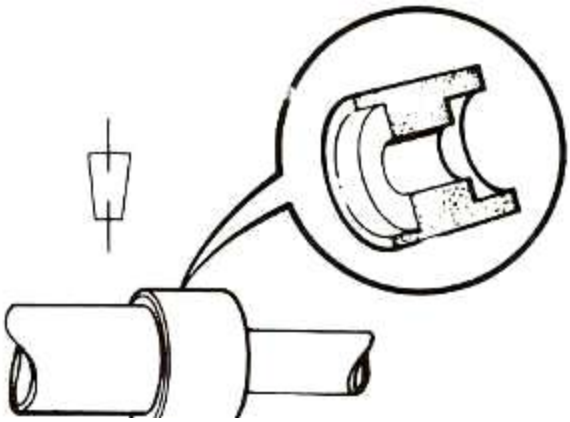
Tees are available with equal branches or with reducing branch.

Remember the branch dimensions are always quoted in a particular sequence:

AxBxC

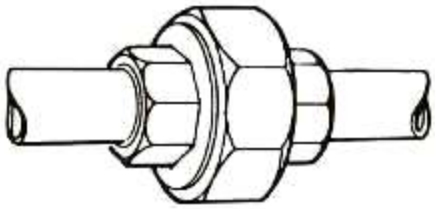


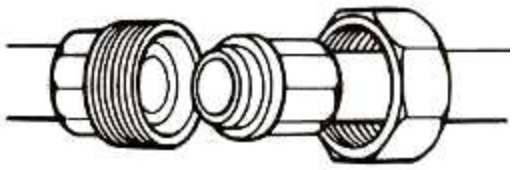
A reducer coupling is used where change in pipe diameter is required.



SCREWED FITTINGS

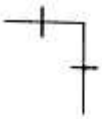
Unions are inserted in a pipeline where a break in the line is required.

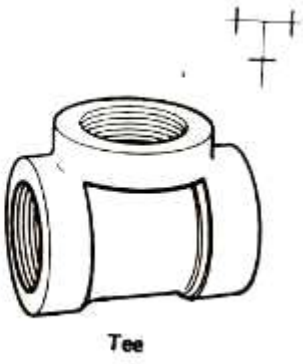




In general, the use of screwed fittings is restricted to the smaller pipe sizes 38mm (1 ½ in. and below) because other joining methods are more practical and economical.

American Petroleum Institute standards for screw threads on pipework are adopted for all screwed connections.





GASKETS

Gaskets

A gasket of softer material is fitted between two flanges to ensure a tight joint. It is placed between the joint surfaces and forms a seal when the joint is tightened.

Different types of gaskets, and materials from which gaskets may be made, are available to suit specified joint requirements.

Depending on the application, the main requirement of a gasket may be any or all of the following:

- hardness and compressibility
- resistance to heat
- resistance to pressure
- resistance to corrosive action

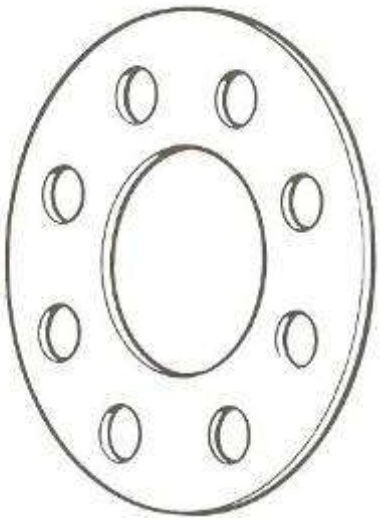
It is important that only the gasket specified on the drawing is fitted otherwise the joint may fail after tightening.

Full-face gaskets

The full-face gasket is used will full-face flanges.

The connecting bolts pass through holes in the flanges and gasket.

Full-face gaskets are made from compressed fibre, or compressed fibre on wire mesh or synthetic rubber.



Inside-bolt gaskets

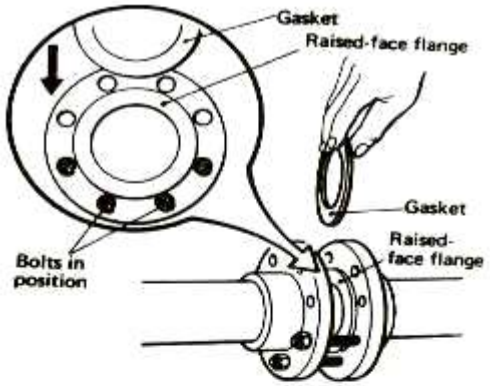
Inside-bolt gaskets are used with raised-face flanges.

These gaskets fit inside the ring of connecting bolts and against the raised faces of the flanges.

There are two main types of inside-bolt-circle gaskets.

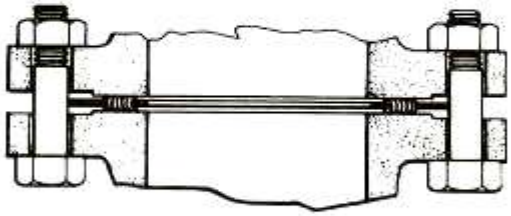
(i) *Raised-face plain gaskets*

These gaskets are made from compressed asbestos fibre or compressed asbestos fibre on wire mesh.



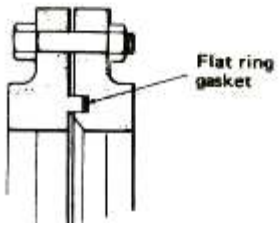
(ii) *Spiral-wound gaskets*

These gaskets are made from spiral-wound metal and fibre tapes which are supported in a metal frame.



Flat ring gaskets

This type of gasket is used with tongue and groove flanges. The gasket is made of aluminium, copper or soft steel depending upon its application.



JOINTING MATERIALS AND WHERE TO USE THEM

INTRODUCTION

All types of jointing are designed for specific duties; some resist acids, others heat, and so on, so it is important to select the correct material for the particular fluid being handled.

Often there are several suitable jointings from which to choose; either similar ones made by different manufacturers, or different grades made by the same manufacturer. The table below lists those jointings which should be used, and takes into consideration both the suitability and cost.

Temperature / Pressure Guidelines for Common Gasket Materials

Service	Flange Design Conditions			
	Pressure Class	Temp. °C	Flange Facing	Gasket Selection
General Hydrocarbon	150 300	-196/500*	RF	Tanged Graphite Sheet or Spiral Wound with Flexible Graphite or Spiral Wound with Non Graphite Filler
Steam/Condensate, Boiler Feed Water		-196/+500 -196/350		
General Utilities		-40/+250	RF	Nitrile Rubber Based Reinforced Sheet
General Hydrocarbon, Steam/ Condensate, Boiler Feed Water	600 900	-196/+500	RF	Spiral Wound with Flexible Graphite
General Hydrocarbon, Steam, Boiler Feed Water	1500 2500	As per flange material	RTJ	Metal Joint Ring
Hydrogen	150 300 600	-196/+500	RF	Spiral Wound with Flexible Graphite
	900 1500 2500	As per flange material	RTJ	Metal Joint Ring
Chemical Oxidisers/ HF Acid	150	-40/+200	RF	PTFE (reinforced or envelope)
	150 300 600	-40/+200	RF	Spiral Wound PTFE Filler

Apart from the jointing materials listed in the table, there are many others also suitable, but where these are not kept in stock normally, they have been excluded from the list; also the table only covers the most common applications and for other chemicals etc., one's supervisor should be consulted for the correct joining.

COMPOUNDS (For threads, joints, etc.)

A large range of products are available under the term "compounds", and set out below are those which are in common use and which are for use with pipe joints, etc.

JOINTING COMPOUNDS

NAME	APPLICATION	RESISTANCE TO:	REMARKS
"HERMETITE"	Flange gaskets, especially copper gaskets	Most fluids, etc.	Sets hard
"HYLOMAR" Universal Jointing Compound	Flange gaskets and screwed connections	Water, steam, acids, alkalis, gases, etc. High temperature	Sets hard on contact with air
FOLIAC"	Flange gaskets and screwed connections	Water, steam, acids, alkalis, gases, etc.	Allows joints to be easily re-broken. Also used as anti-seize compound on bolt threads
"LION" Liquid Jointing	Flange gaskets and face to face joints	Water, steam, oil, compressed air, gases etc. High temperatures up to 700^{o}F	Sets hard. Allows joints to be easily re-broken
"STAG" A (Red) Jointing Paste	Flange gaskets and screwed connections	Water, steam, oil, petrol, some acids, gases, etc.	Remains semi-plastic
"WHITE LEAD"	Screwed connections	Most fluids, etc.	

METTALIC GASKETS

APPLICATIONS

Standard “Metaflex” or spiral wound gaskets, which are 18/8/Ti with a Universal fibre filler are suitable for use with the highest temperatures and pressures encountered with steam, oil and water. However, special “Metaflex” gaskets may be used with acids, alkalis and high temperature gases by using a wide range of alternative materials. These are available from as follows:

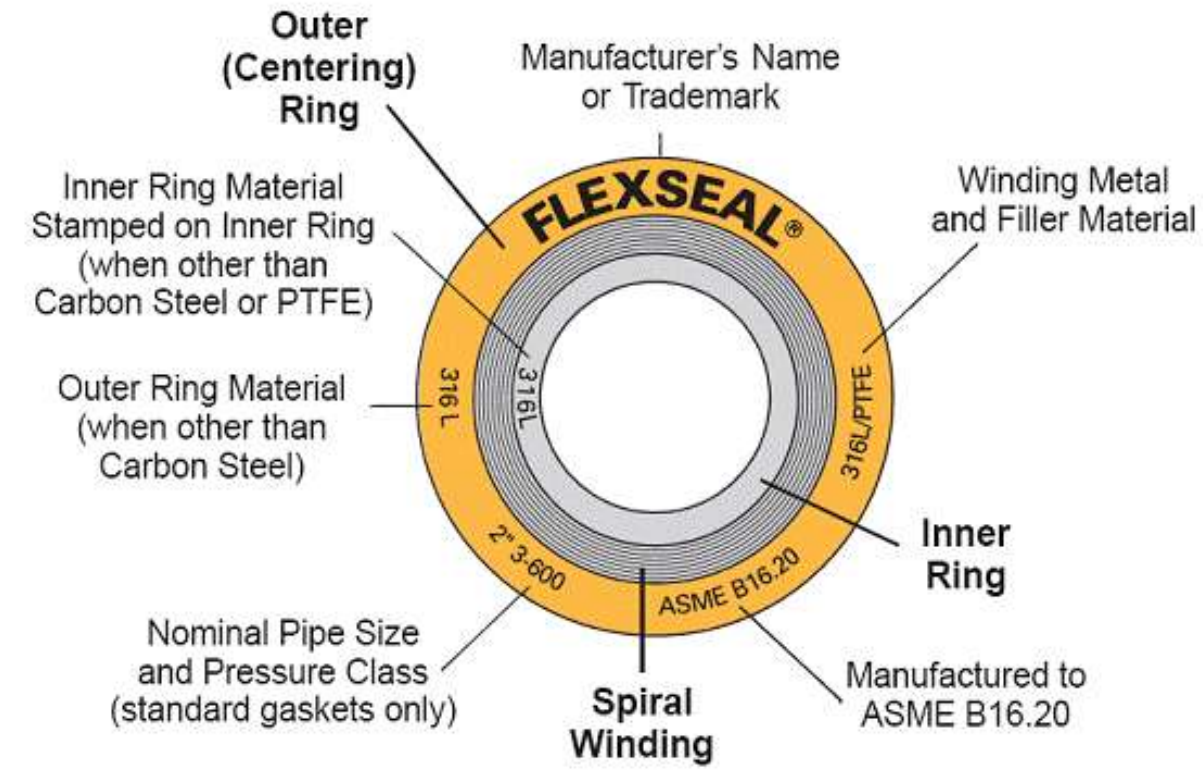
Metal strip	*Filler materials*
18/8 Titanium Stainless Steel	Standard fibre
18/8 Molybdenum Stainless Steel	PTFE
18% Chromium, 10% Nickel	Grafitoil
2% Molybdenum Steel	Nitresto
Monel Metal	Selfesto
Pure Nickel	Fluon
Galvanised Mild Steel	Aluminium
	Oilit
	Acidit
	Neoprone Rubber

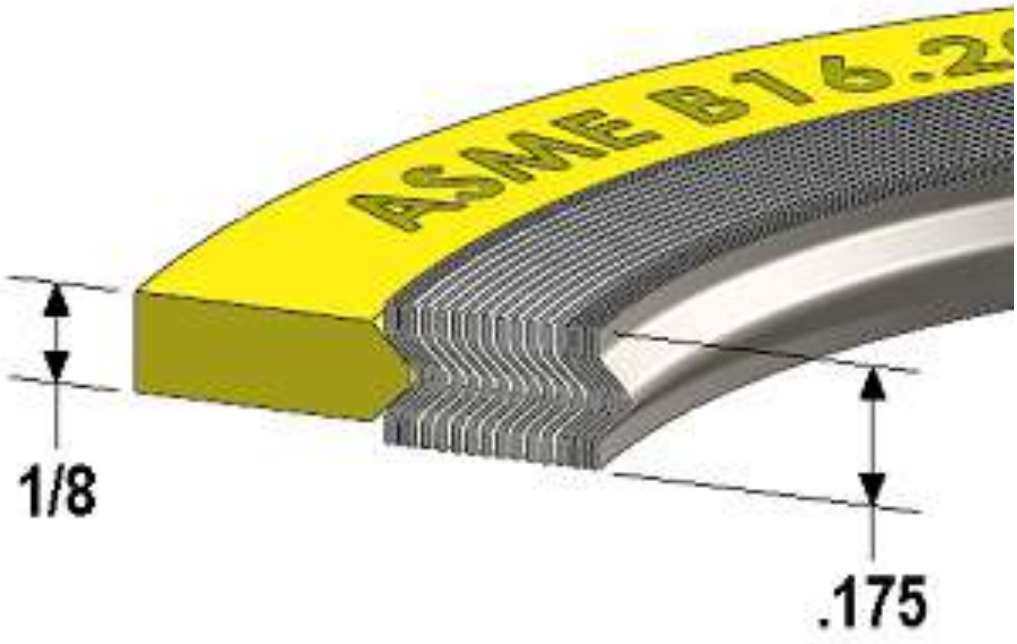
Experience has shown that the use of “Metaflex” gaskets in IP steam means containing a small amount of condensate is not to be recommended.

SPIRAL WOUND GASKETS

Spiral wound gaskets Style CG with a filler material in its sealing element and a solid 304 Stainless steel outer guide ring. The guide ring accurately centres the gasket on the flange face, provides additional radial support to prevent gasket blow-out and acts as a compression stop. General purpose gaskets suitable for use with flat face and raised face ASME B16.5 flanges.

Graphite, (98% pure) filler is for applications with temperatures ranging from -400° to +850° F.
PTFE filler for corrosion resistant applications. Temperature range from -450° to +450° F.


Outer (Centering) Ring
Manufacturer's Name or Trademark
Inner Ring Material Stamped on Inner Ring (when other than Carbon Steel or PTFE)
Winding Metal and Filler Material
Outer Ring Material (when other than Carbon Steel)
FLEXSEAL®
316L
316L
316L/PTFE
2" 3-600
ASME B16.20
Inner Ring
Nominal Pipe Size and Pressure Class (standard gaskets only)
Spiral Winding
Manufactured to ASME B16.20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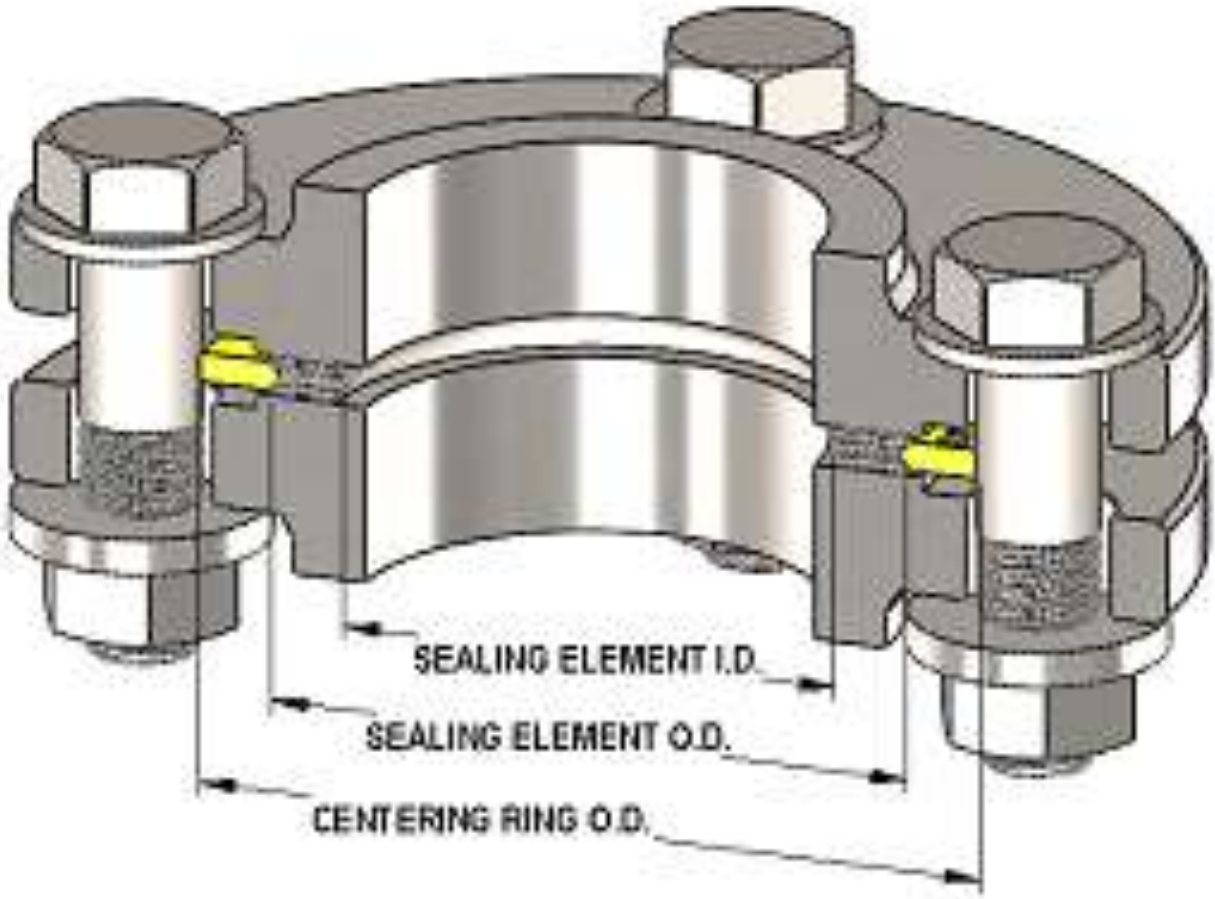
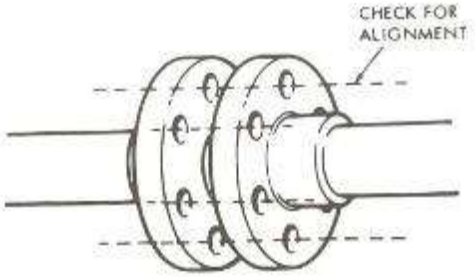

SEALING ELEMENT I.D.
SEALING ELEMENT O.D.
CENTERING RING O.D.

INSTALLATION OF PIPING

Making the Joint

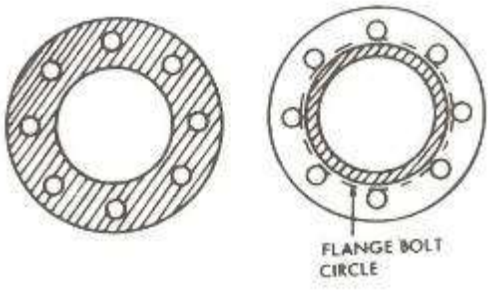


Using a Joint Ring

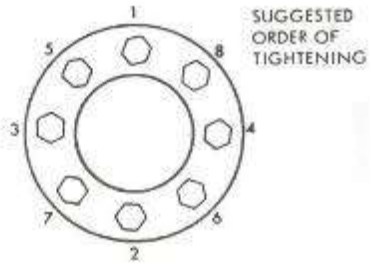
a) Select the correct type of joint ring.

b) Ensure that the flange faces are smooth and clean.

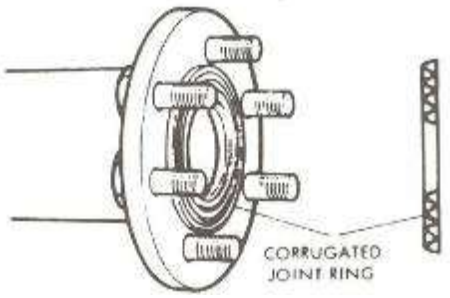
c) Check for correct alignment of the flange faces and securing bolt holes.



d) Insert a joint ring in position between the flange faces and fit the correct size and type of securing bolts, washers and nuts. The joint ring may be cut to cover the whole face of the flange, or it can be cut so that its greatest diameter is slightly smaller than the inside diameter of the flange bolt circle.



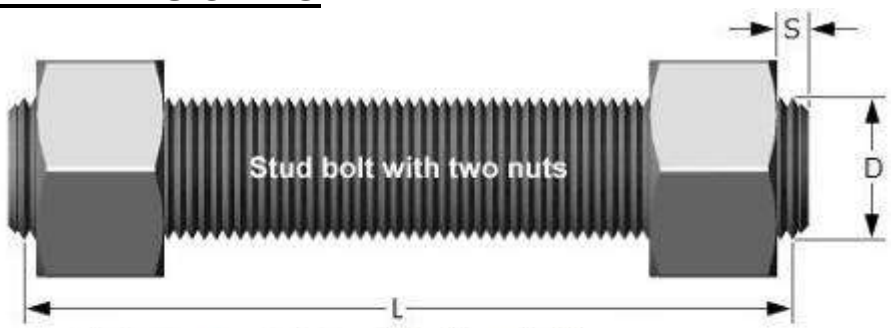
e) Tighten down evenly on the securing nuts and bolts.



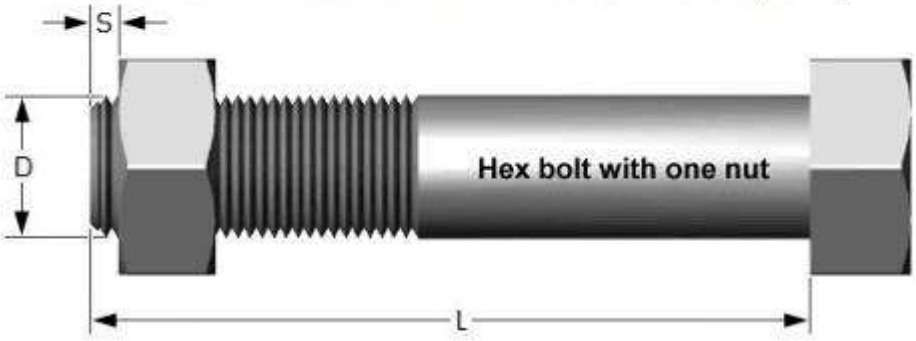
Note

It may be necessary to use jointing compound with some joint rings.

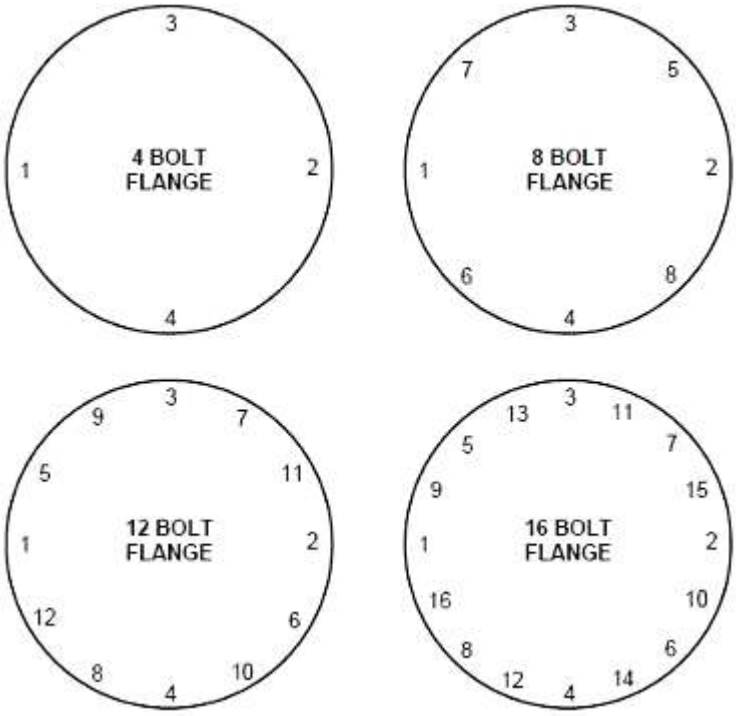
BOLTING AND TENSIONING



Studs are measured parallel to the axis (L)
from the first to the thread without the chamfers (points).



Hex bolts are measured from under the head
to the tip of the bolt.



COLD BENDING OF PIPES

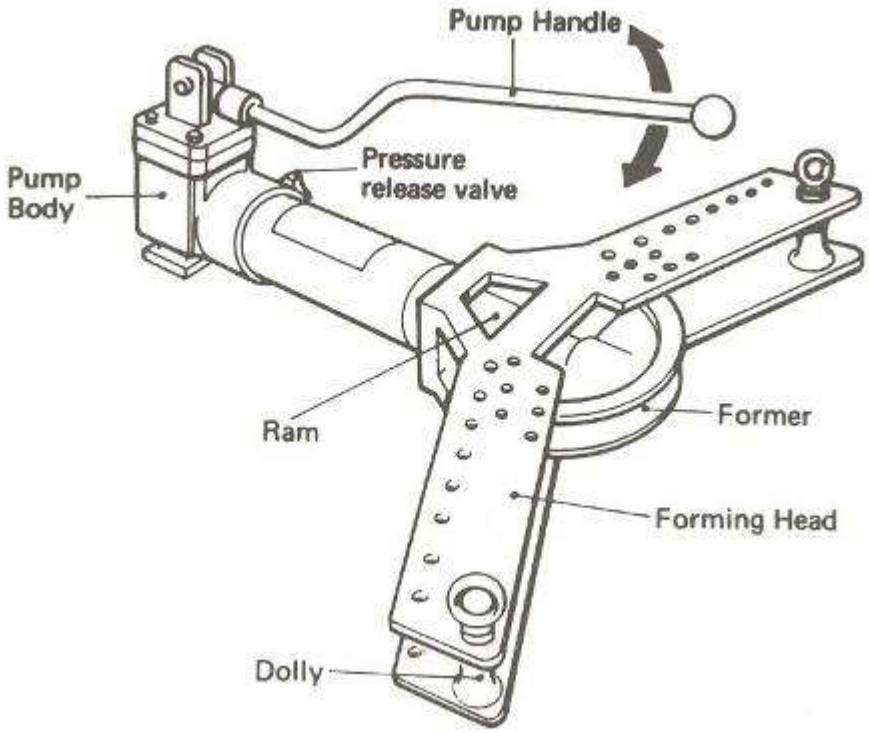
Pipes are cold bent to minimise the need for expensive connectors and so to reduce the cost of installing pipe systems. Bending may be done by hand or machine. The machines may be hand or power operated.

Cold bending

Various machines are available for cold bending. The methods and equipment described in this training element have been selected to cover pipes up to 50mm bore with minimum bend radius of 3 ½ times the bore of the pipe.

Manually operated
Hydraulic Bending Machine

This machine uses hydraulic pressure to bend carbon steel pipes of 12mm (½ in.) to 50mm (2 in.) bore.



PIPE FITTING

Because no pipeline can possibly travel for ever in a straight line, it becomes inevitable that we will have to bend the pipe around obstacles. The machine we use is a “pipe! Bender. A similar machine is to be found in most workshops. This is a machine which has a hydraulically operated ram and a set of formers to bend each size of pipe to a specific radius. Consider 90^o plain bend. If we take a piece of paper and bend it 90^o, because it has almost no thickness we can obtain a good sharp corner. For instance, a 24” long piece of paper bent in the centre to 90^o will give two “legs” of 12”. However, now consider our N.B pipe. A pipe has thickness, and it has a bore, this means we must bend it not to a sharp corner, but to a radius, or it will collapse, rendering the bend useless. On a “staffa” bender this radius is 3 ½ x diameter of pipe. Being as our pipe cannot be bent sharply this means it, in effect, “cuts the corners”, giving us a “leg” one each side which is longer than the 12” which our piece of paper gave us. Obviously, to make pipework which fits we must allow for this by subtracting a length of pipe from that which we measure. Thus there is a formula.

On the next few pages are various ways of calculating single and multiple bends. The basic information needed to calculate a bend is listed below.

1) ANGLES OF BEND

2) NOMINAL BORES (this will be decided by the fitter or design)

3) OUTSIDE DIAMETER (this can be measured)

PIPE BENDING CALCULATIONS

METHOD NO. 1

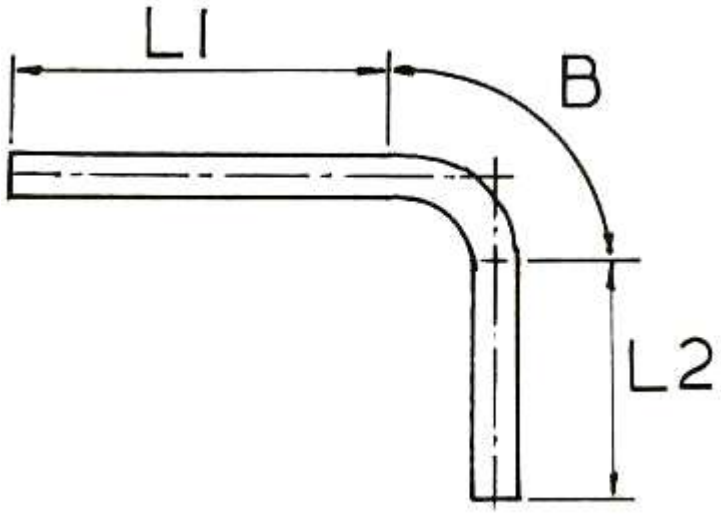
90^o BEND

A 90^o bend can be split into three sections

a) The straight length before the bend starts (L1)

b) The straight length after the bend finishes (L2)

c) The length of the bend itself (B)



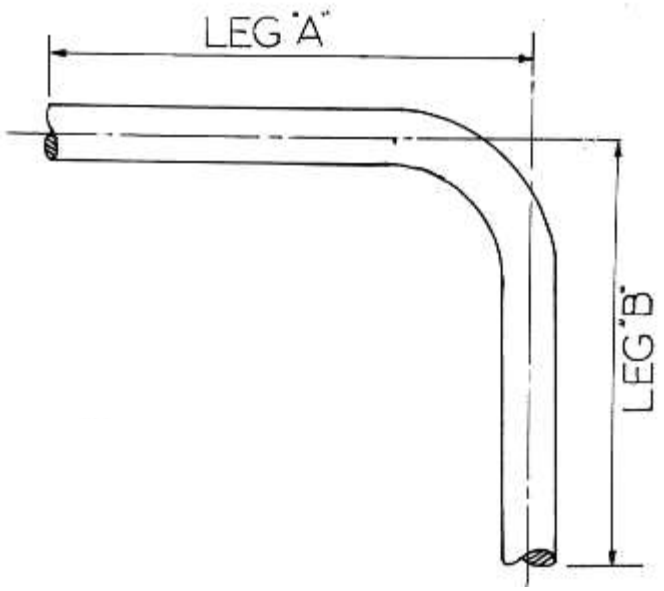
If we add “L, “, “L_2 “ and B” together, this will give us the length of pipe needed to fabricate the 90^o bend shown in Fig. 1.

It should be noted that all measurements used in pipe bending calculations are taken along the centre line of the pipe. In theory, at this point the length of the pipe neither increases nor decreases during the bending operation.**METHOD NO. 2**

WORKSHOP METHOD

For calculating pipe lengths when bending through 90^o.

For all 90^o bends take NB of pipe from each leg to accommodate for loss of pipe length required in bending.



N.B = 25mm
“A” = 800mm
“B” = 650mm

LENGTH OF PIPE =

A + B – 2 N.B
800 + 650 – 2 X 25 =

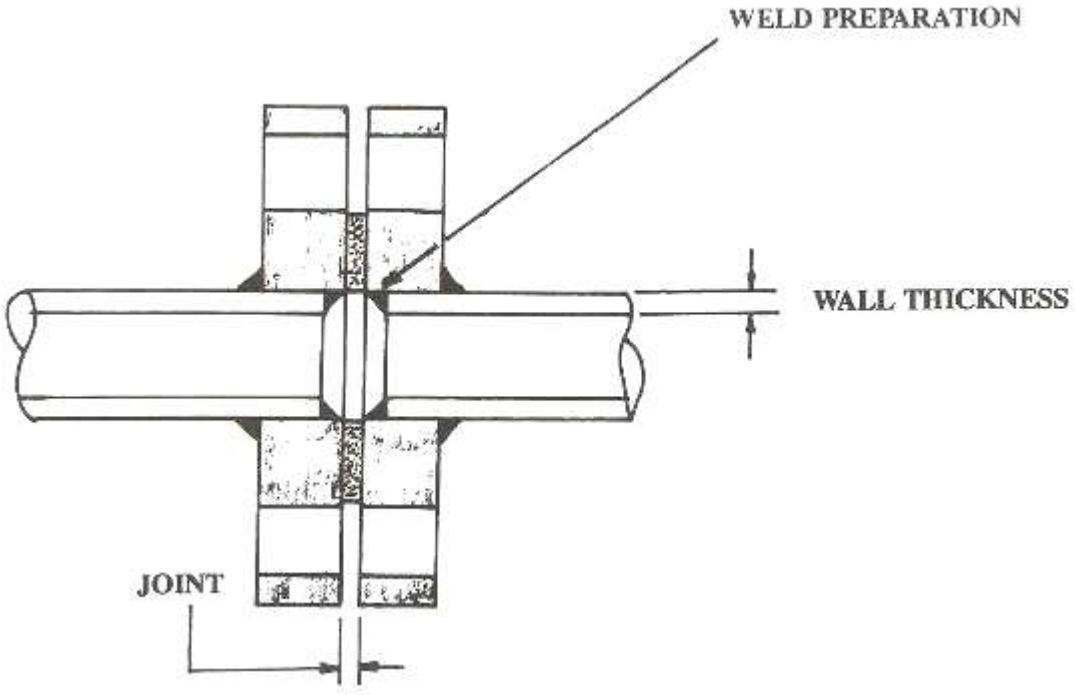
1450 – 50

LENGTH OF PIPE = 1400mm

BEND CENTRE = A – N.B
= 800 – 25

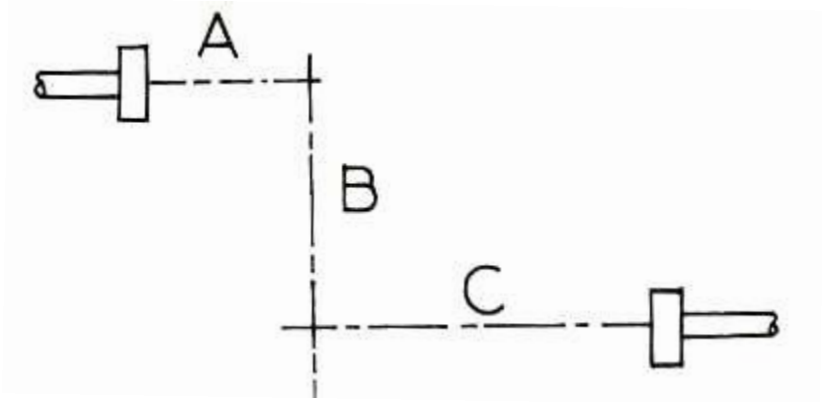
BEND CENTRE = 775mm

Because we need to fasten pipes together with leakproof joints for plant requirements, other factors have to be taken into consideration. If we look at the bolted flange we can see there is a gap between the two pipe ends. The factors which produce this gap must be taken into account when calculating the bend.

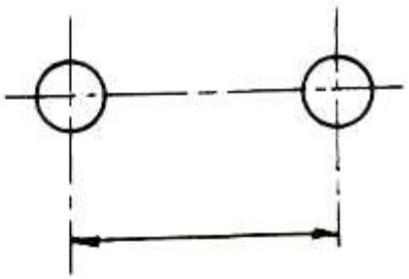


As the bolted flange needs a joint, then this joint will create a gap of the same thickness. Also, if welded flanges war used, as above, then the pipe needs setting back in the flanges to allow for the run of the weld. This is called the weld preparation and is usually the same as the pipe wall thickness. Therefore when calculating pipe lengths and bends we must allow for joint thickness and weld preparation.

TO MAKE A DOG LEG OR SET

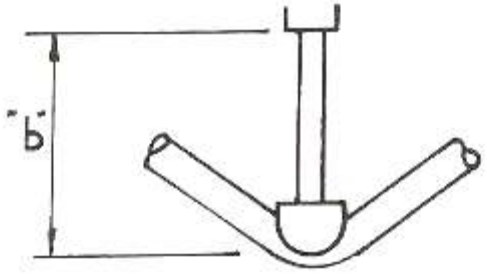


1. Measure distance between centre of two pipes.



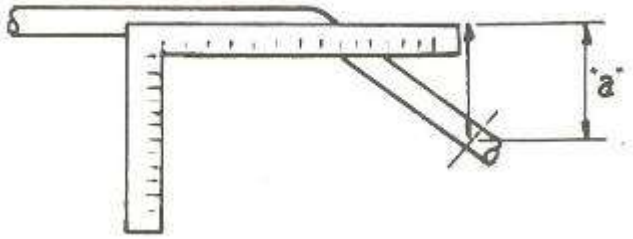
" a" Distance between pipe centres

2. Make first bend to approx. 45 and measure length of Ram from a fixed point on the bending machine.



"B" = Ram travel from fixed point

3. With square of straight edge on pipe centre line, measure across set until length "a" is obtained. Mark pipe at this spot.



4. Replace in bender on new chalk mark and set level. Make second bend in opposite direction first. Bring out Ram until length "b" is reached.

5. The set should not be correct and parallel and the pipe can be cut to length.

The setting up and operation of a manually operated Hydraulic Bending Machine

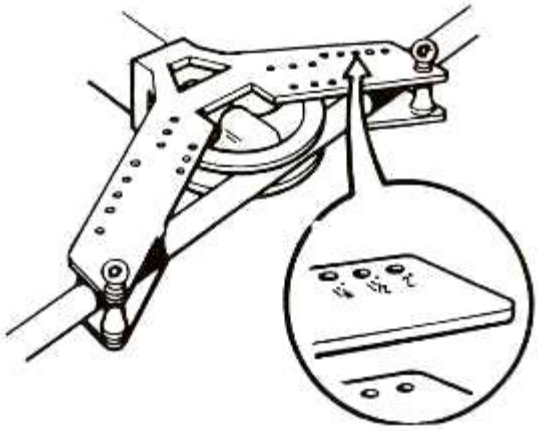
Screw the forming head onto the hydraulic cylinder.

Select the correct former to fit the outside diameter of the pipe. Formers are available for standard sizes of pipe from 12mm (1/2 in.) to 50mm (2 in.) bore.

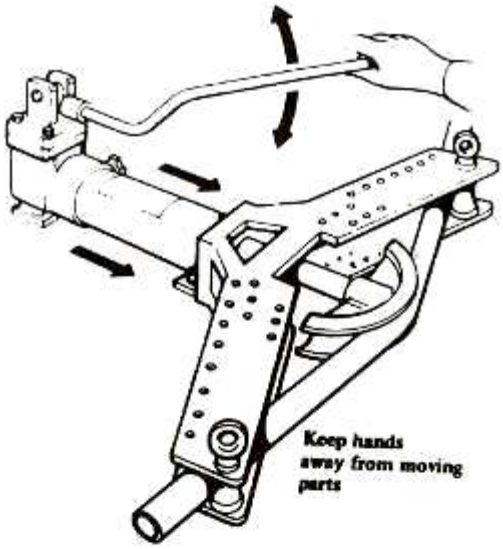
Place the machine on the ground.

Note:

Holes are drilled in the forming head. These are usually marked to show the nominal bore sizes of pipes.

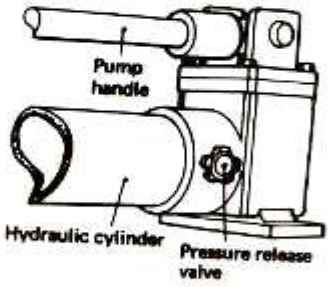


Close the pressure release valve on the pump body then start pumping to push the former against the pipe

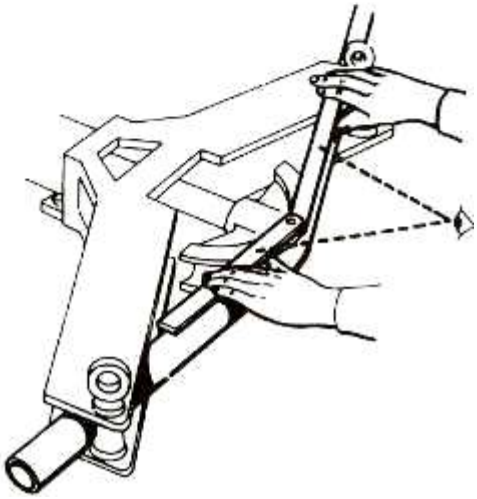


Stop pumping when the desired bend has been achieved.

Turn the pressure release valve anticlockwise to release the pressure in the hydraulic cylinder. When the ram has moved back about 6mm (1/4 in.) to 10mm (3/8 in.) close the pressure release valve to hold the ram steady.

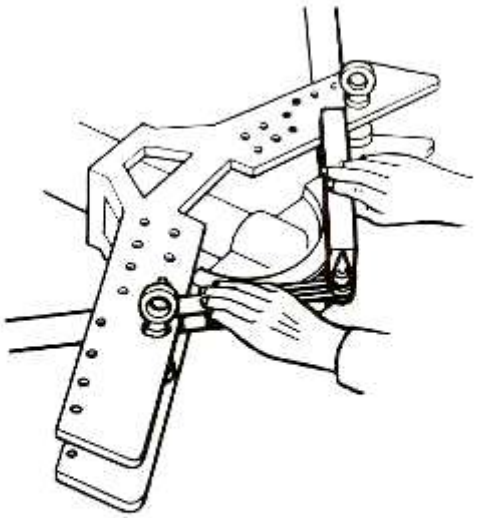


Check the accuracy of the bend with a bevel stick.



Open the pressure release valve and allow the ram to return to the start position. Remove the dollies and bent pipe from the machine.

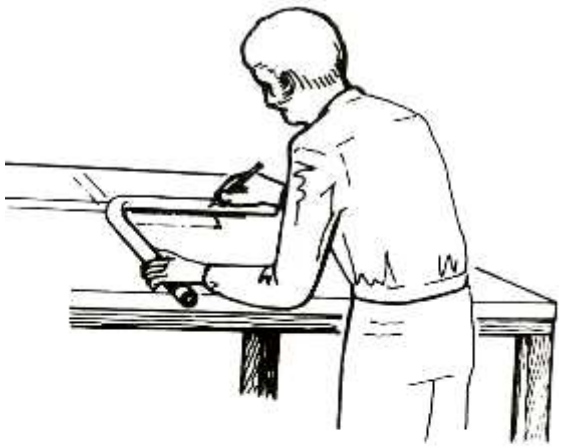
Measure from the front centre of the forming head to a chalk or other position on the pump body. Make a note of the measurement then open the pressure release valve and allow the ram to retract about 6mm (1/4 in.). Close the valve.



Note:
When released from the bending pressure, the pipe will spring back slightly, altering the degree of bend. By trial and error the trainee will learn how much the pipe should be over-bent to obtain a specified angle.

Re-check the bend by placing the bevel stick on the pipe and sighting it edges against the edge of the pipe.

Note:
The pipe can be bent further by more pumping. Ensure that the centre of the bend of the pipe remains in line with the centre line of the former. Before increasing the bend, pump until the distance between the former and the mark on the pump body agree with the measurement taken and recorded earlier.



Open the pressure release valve to slacken off the ram, remove the dollies and take the pipe put of the machine.

Keep a firm grip on the pipe to stop it falling when the pins and the dollies are removed.

Check the bend for accuracy by placing it in the full scale chalk drawing.

Place the pipe on the drawing and mark required cutting length.

Cut to size.

Note:
The procedure for bending any angle using this type of machine is similar to that described above.

CHECK LIST

PIPELINE – MAINTENANCE

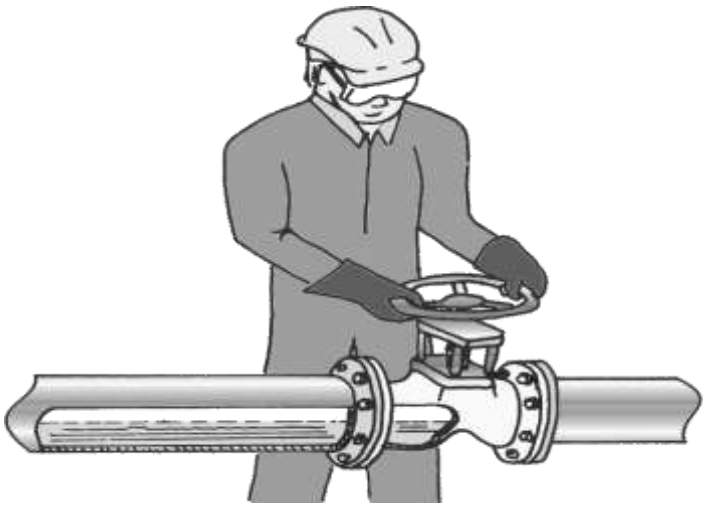
1. **Make sure you know what a pipeline contains before starting work on it.**
2. **Ascertain the direction of flow in the pipe.**
3. **Check where the pipe is coming from and where it is going to.**
4. **See all pipelines are safely anchored.**
5. **Be sure you can identify all pipelines and their contents.**
6. **Learn to recognise dangerous leakages, and:**
7. **How to act in an emergency.**
8. **Note where all the stop valves are.**
9. **Get to know the supervisors responsible for the various pipelines.**
10. **Arrange for the regular emptying of drip-trays under leaks.**
11. **Avoid tripping hazards – never leave loose pipes on the floor.**
12. **Make full use of the Permit to Work system.**

PIPELINE HAZARDS ARE NOT ALWAYS OBVIOUS

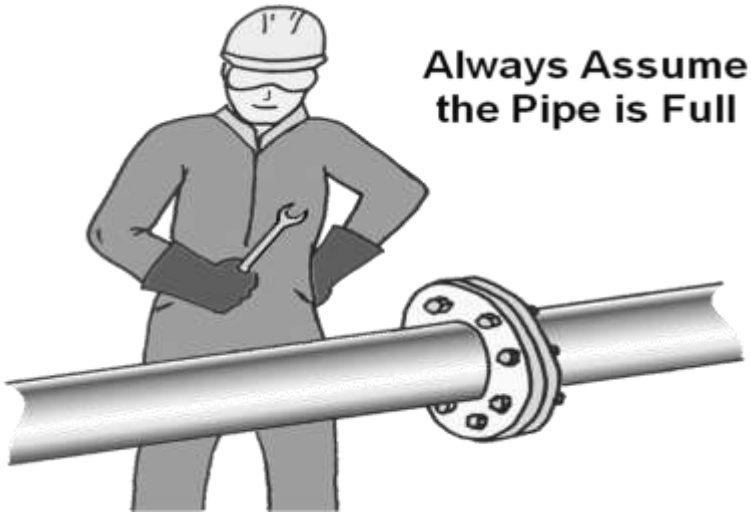
Before any work can commence, any or all of the following may be required:

- Permit to work
- Clearance certificate
- Isolation documents
- Entry permit
- Hot work permit
- Scheme of work
- Method statement
- PPE requirements
- Breathing apparatus
- Access request (scaffold)
- Barriers or guards
- Lifting equipment
- Lagging / trace heating removal
- Cleaning

Follow these simple precautions

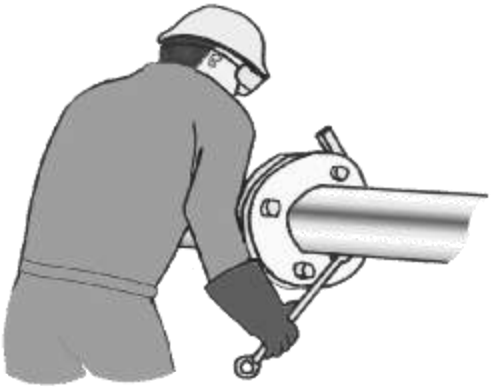


Check that the line is completely drained

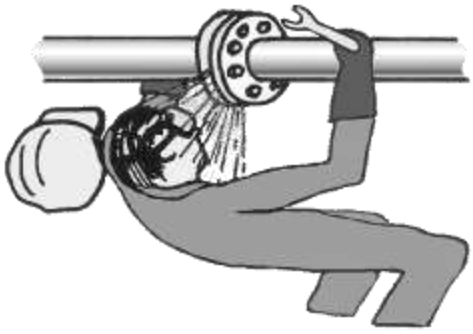


The Bolt furthest away from you should be slackened FIRST.

The last bolt should not be slackened until the fox-wedge has been used to open the joint.



Work from above, never below



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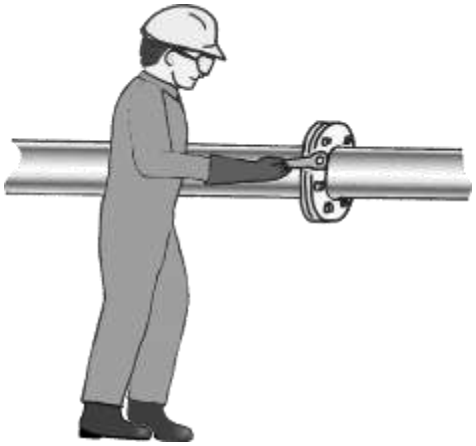
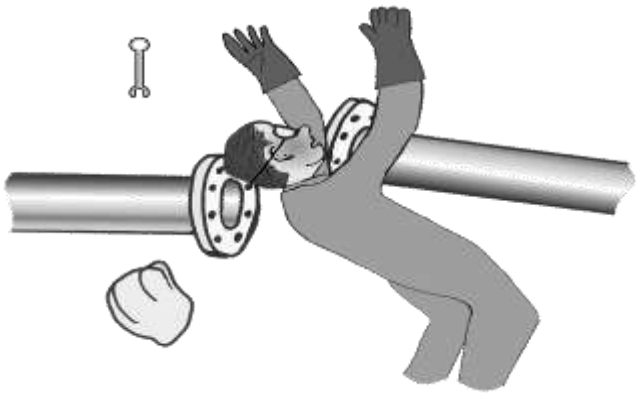
BEFORE THE JOINT IS BROKEN

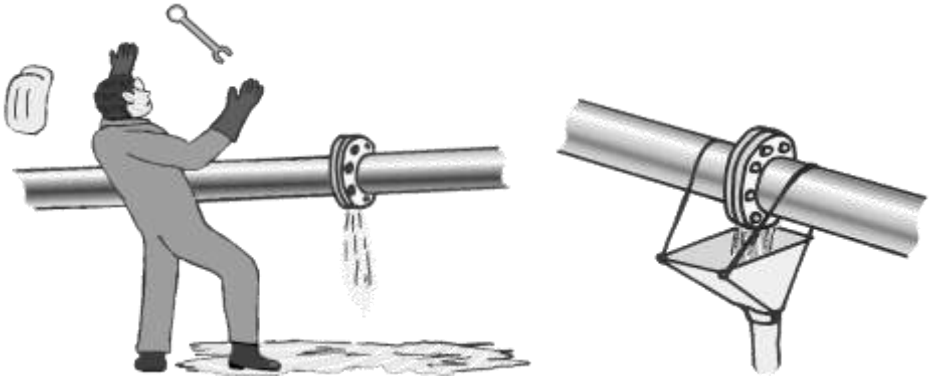
If The Bolts Are 'Bad' or Corroded

Renew them one at a time. In the correct sequence.

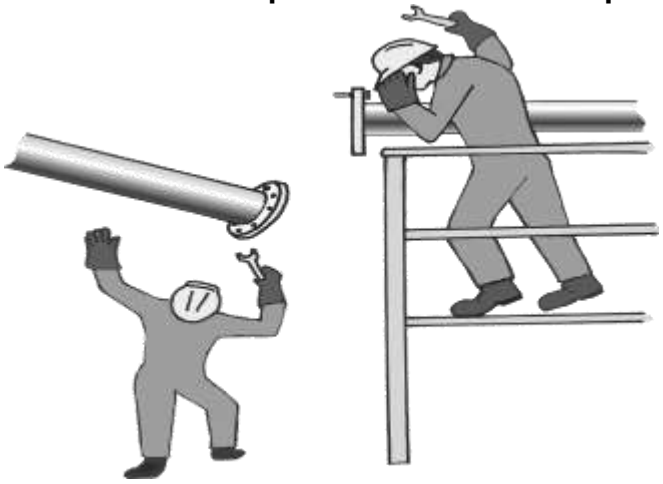




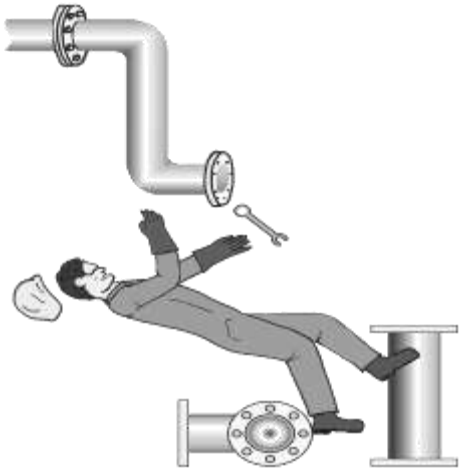
Watch Out For Pipe-Spring 'It Happens' When You Least Expect It..



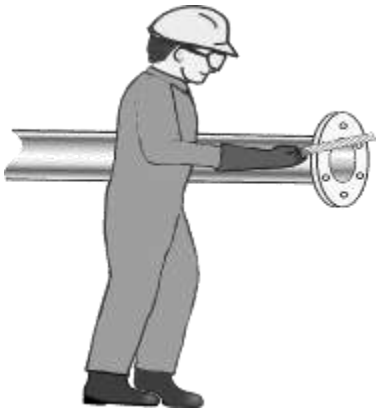
Keep Floors Clear of Corrosive Liquids You Could Get Splashed



Always Make Sure The Pipe-Line is Adequately Supported



When Dismantling Pipes Do Not Leave Them Under Your Feet



<u>Before Re-making A Joint</u>. Clean The Faces Properly
"If You Don't It Will Almost Certainly Leak"