Process Pipework Design & Fabrication

Website: www.ttetraining.ltd.uk

Aims

At the end of this session the student will have an understanding of the various considerations involved in the design and construction of pipelines.

Areas you need to think about will include

- Materials
- Pipe specifications
- Handling of Pipework
- Flanges (Types & Classifications)
- Gaskets
- Bolts & Studs
- Pipework Erection
- Testing
- Safe Dismantling

Pipework

Introduction

Domestic pipes are made from copper, plastic etc for clean products.

Pipework on chemical plants is used to transport large amounts of chemicals safely from one point to point.

To accommodate a wide variety of conditions and chemicals pipework is made from different materials to different standards of specifications, for example

(a) Safety - to withstand pressures, temperatures and to be compatible with the various chemicals passing through them.

(b) Cost - i.e.. Chromium alloys (expensive) carbon steel may be adequate.

Materials of Manufacture:

- Mild Steel
- Stainless Steel
- Cast Iron
- Copper
- Titanium
- Monel
- Inconel

Pipe sizing

Pipe work is sized or identified by its Nominal Bore And wall thickness

Common NB sizes:

1/4” NB
3/8” NB
1/2” NB
3/4” NB
1” NB
1.1/2” NB
2” NB
3” NB
4” NB
5” NB
6” NB
8” NB
10” NB

Pipework Schedules

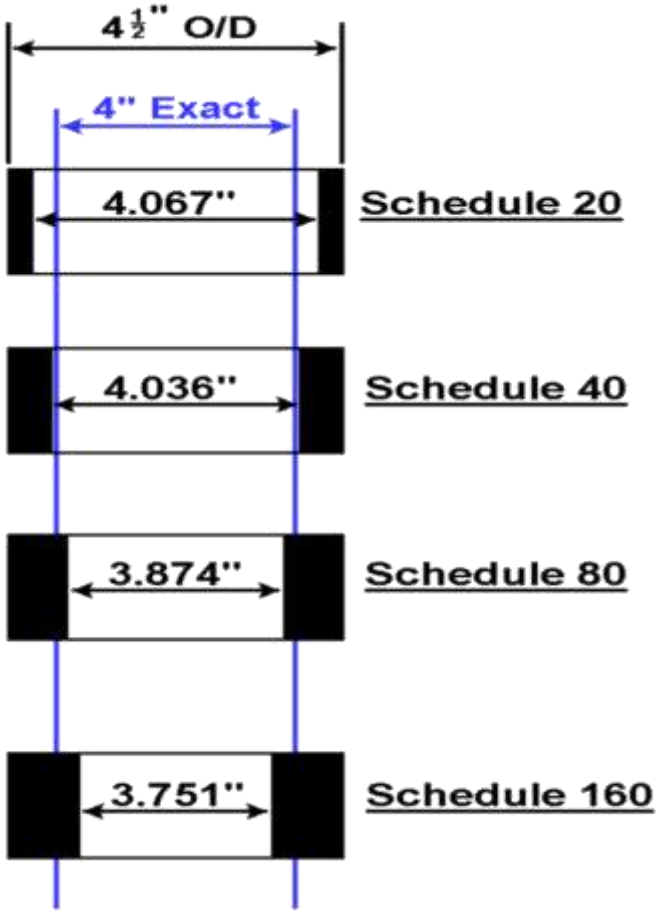
Refer to the wall thickness of schedule 20, 40, 80 and 160 pipe, as the number increases so does the wall thickness.

<u>The outside diameter remains constant, the bore diameter changes as the thickness increases.</u>

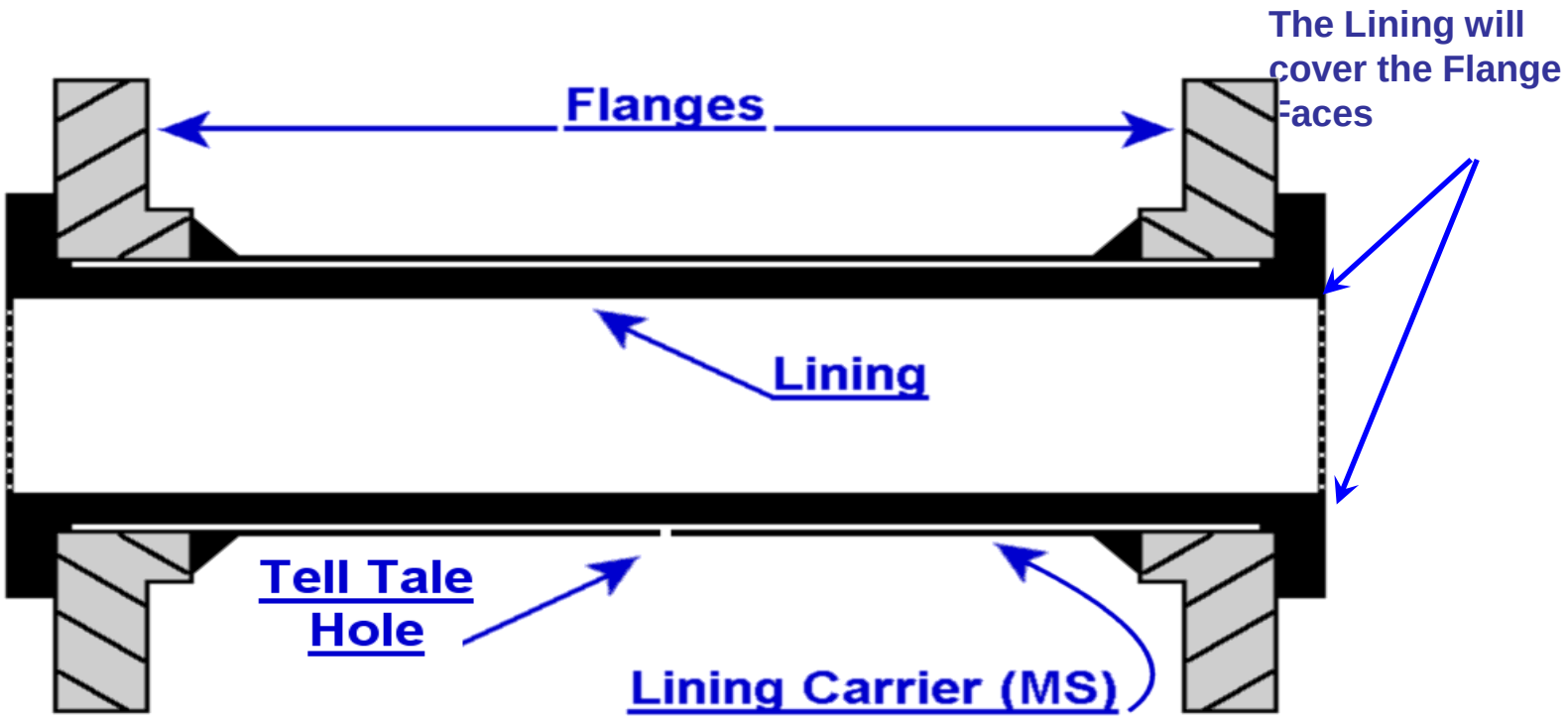
Q. Why does the bore change and not the outside diameter?

A. To enable standard fittings to be used.

Pipe Schedules



Lined Pipework



Why Are Pipes Lined?

It may be cheaper or more practical to produce a lined pipe than a complete pipe made from more expensive materials for particular applications.

e.g. Brittle materials like glass or resins cannot withstand high pressure or shock.

Types of Linings

- Rubber
- PTFE
- PVDF
- Alkathene
- Bitumen
- Lead
- Glass

Effects on Pipework

Pipework systems need to have flexibility to overcome:

- **Water Hammer**
- **Temperature Changes**
- **Vibration From Machines**

How Is This Achieved?

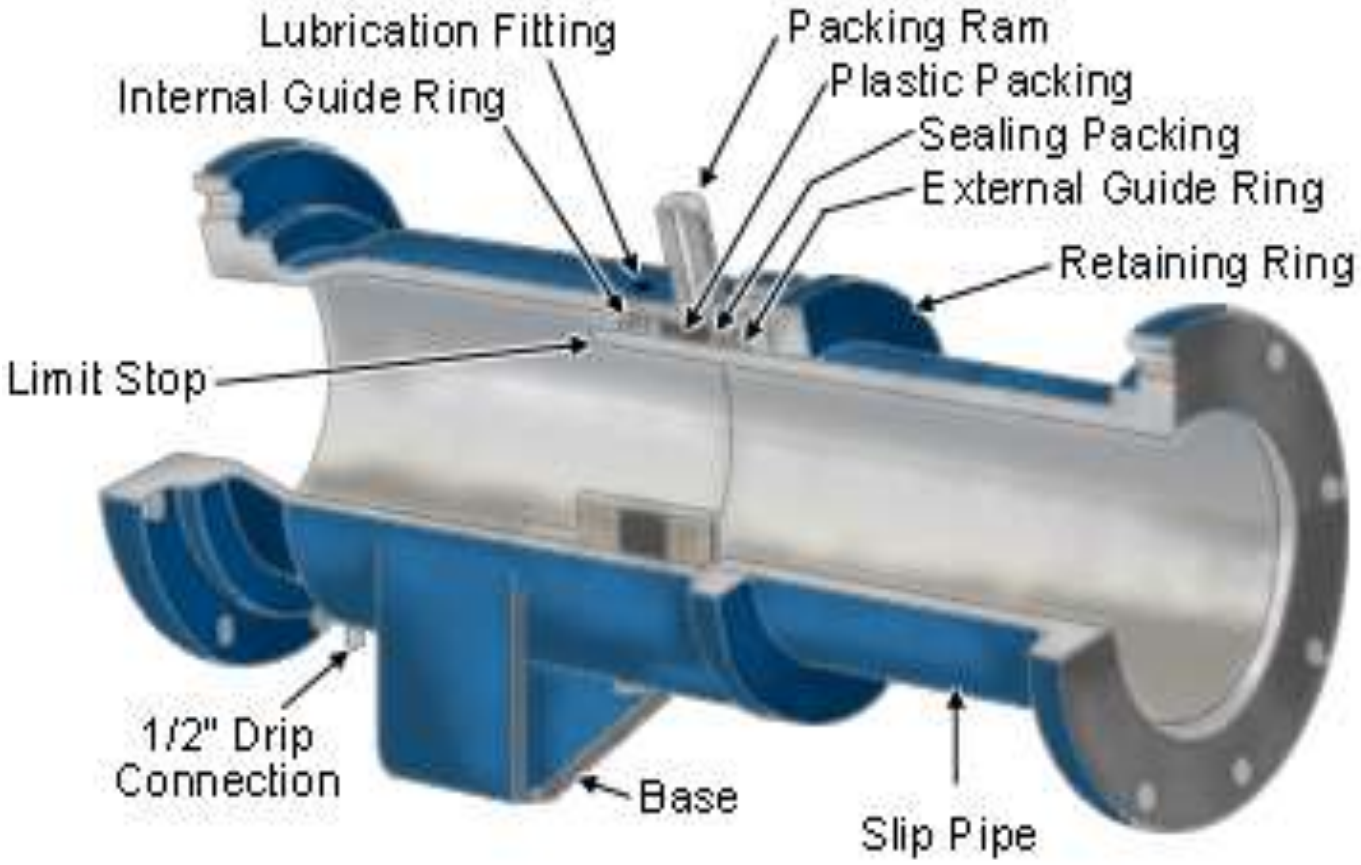
Bellows

- Expand and contract to overcome the movement of the pipework.

Expansion Loop

- The loop takes up any movement along the pipeline by increasing or decreasing its diameter.

Bellows

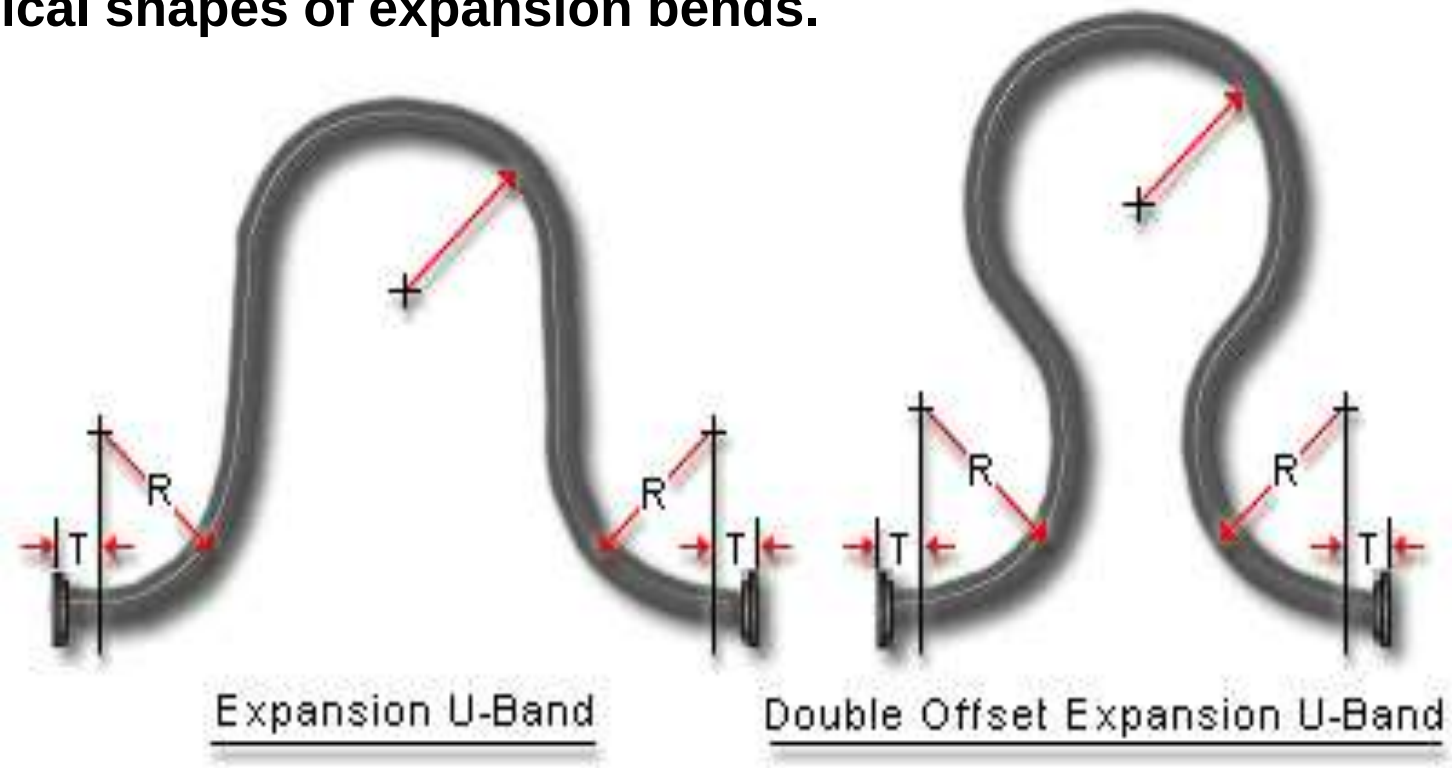


Slip Expansion Joint (CutawayView

A corrugated expansion joint consists of a flexible corrugated section which is able to absorb a certain amount of endwise movement of the pipe

Expansion bands make use of pipe fabricated with special bends.

The increase in the length of pipe due to expansion is taken up by flexing or springing of the bends. Below are some typical shapes of expansion bends.



Piping Supports

Piping must be supported in such a way as to prevent its weight from being carried by the equipment to which it is attached.

The supports used must prevent excessive sagging of the pipe and at the same time must allow free movement of the pipe due to expansion or contraction.

The supporting arrangement must be designed to carry the weight of the pipe, valves, fittings and insulation plus the weight of the fluid contained within the pipe.

Why use Pipe Supports

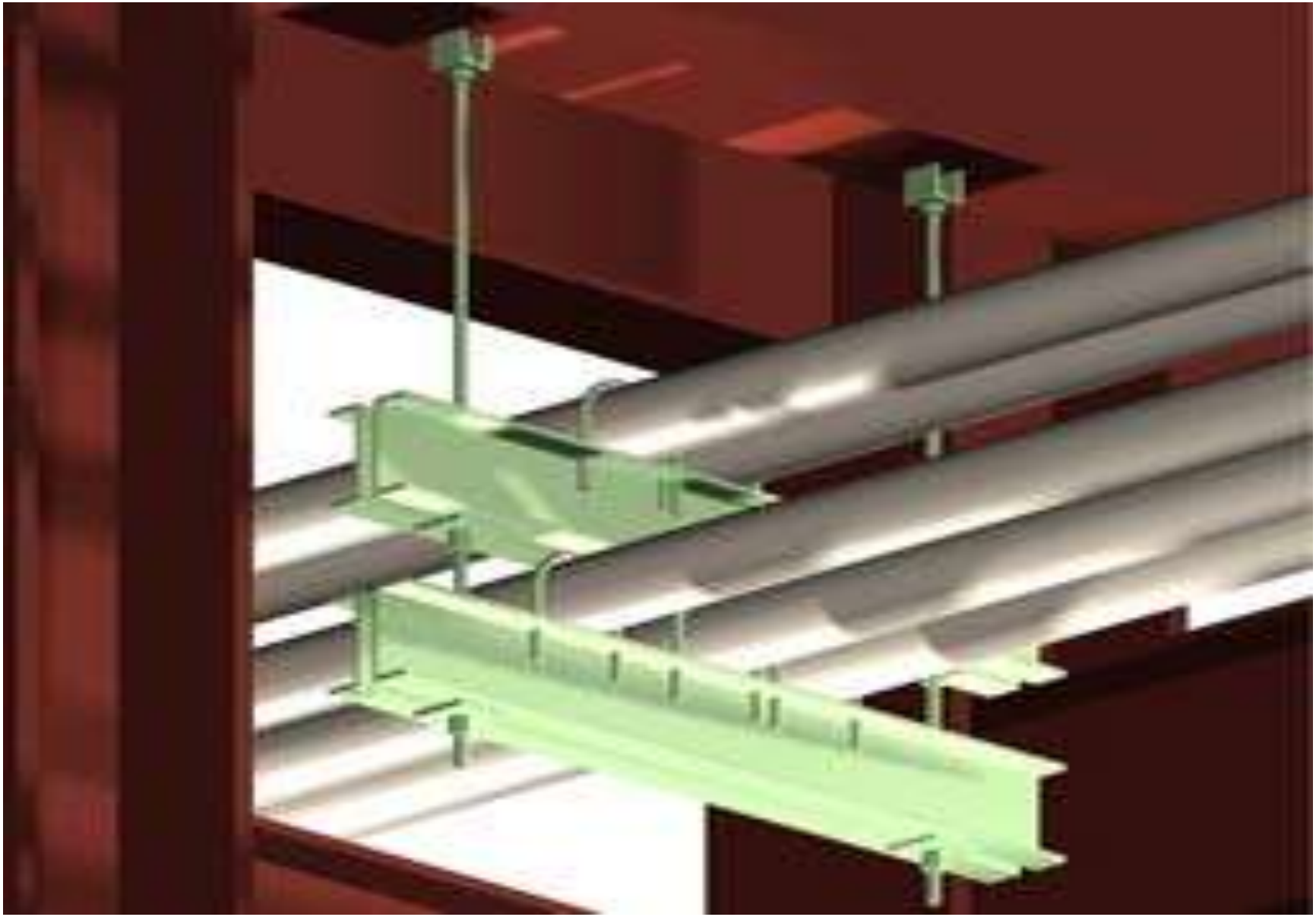
All pipe work has weight based on the diameter of pipe, materials of construction valves, fittings and insulation plus the weight of the fluid contained within the pipe.

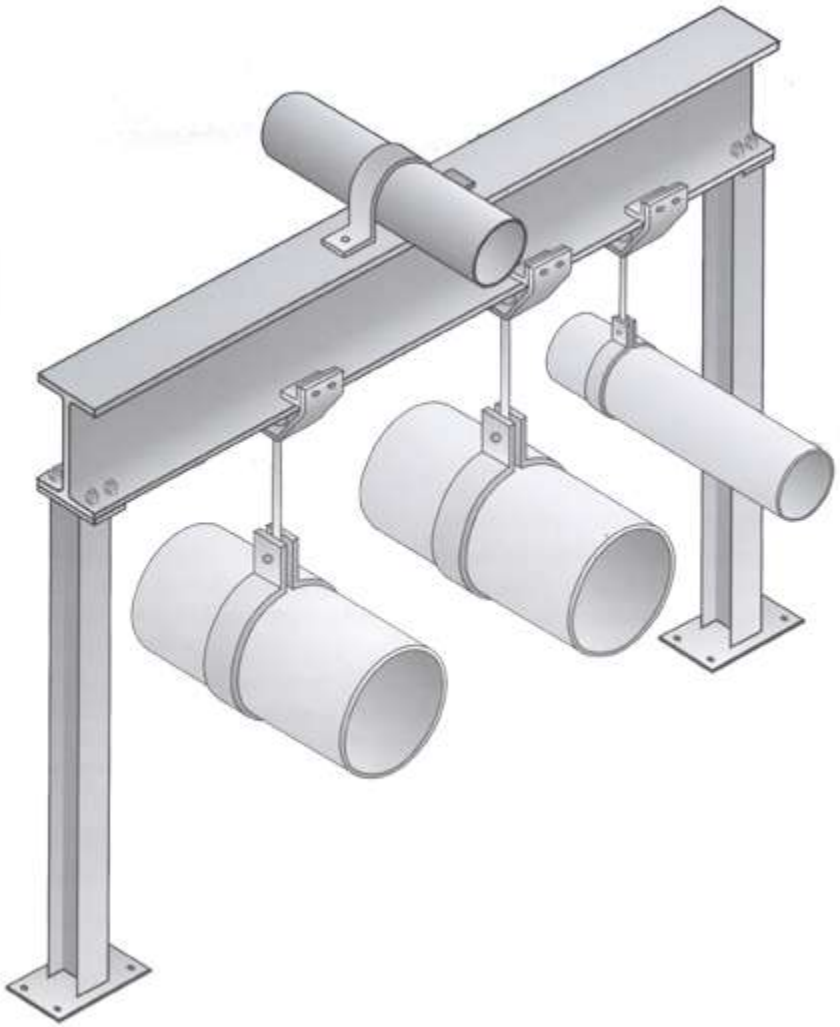
Pipelines have to be supported by external means at regular intervals to prevent them from sagging.

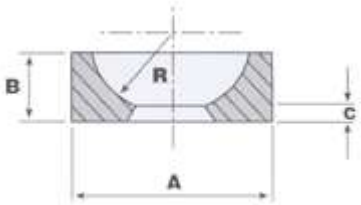
Normally pipes are placed on Pipe Racks or supported either from the bottom or hung from the supporting structure depending on layout & availability of supports.

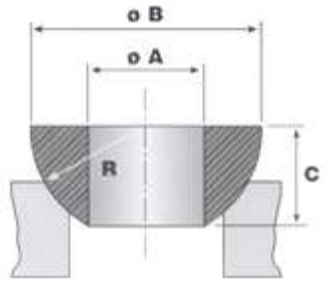
Pipe supports , pipe hangers etc are normally used to support pipe lines by suspending them from structural members or supporting pipe lines from the bottom where ever feasible.

Therefore it is essential to have a well designed pipe layout and pipe supports/hangers for trouble free service in the plant.






B
R
C
A


ø B
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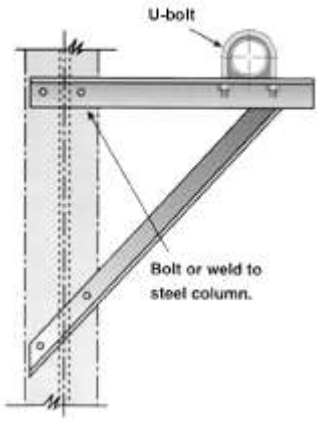
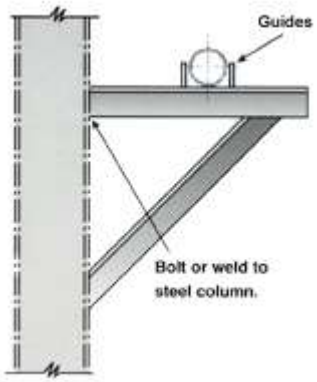
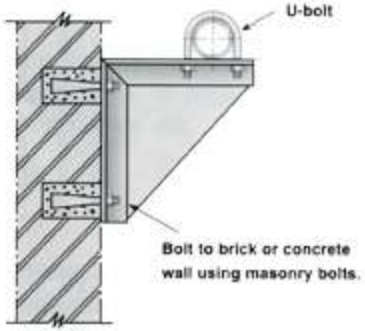
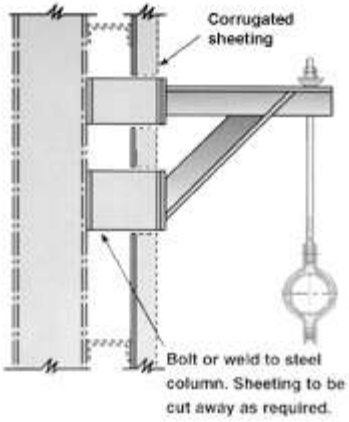
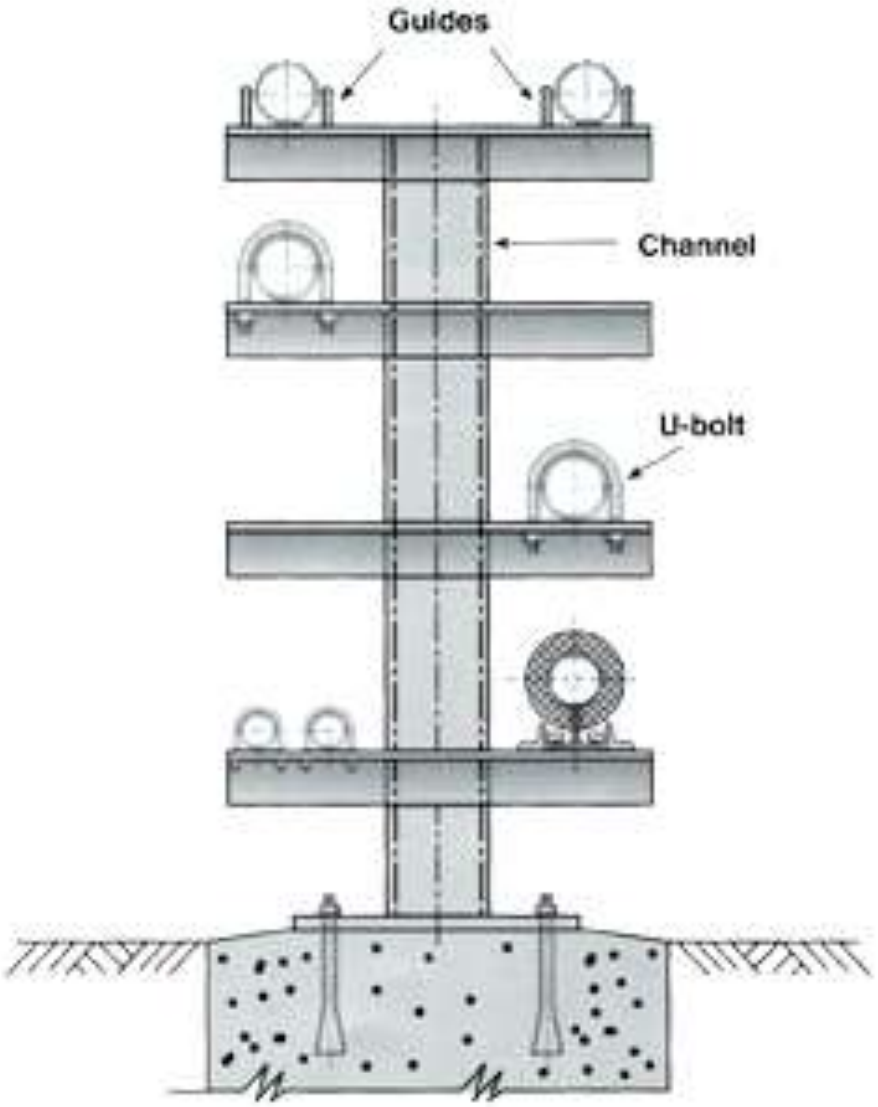
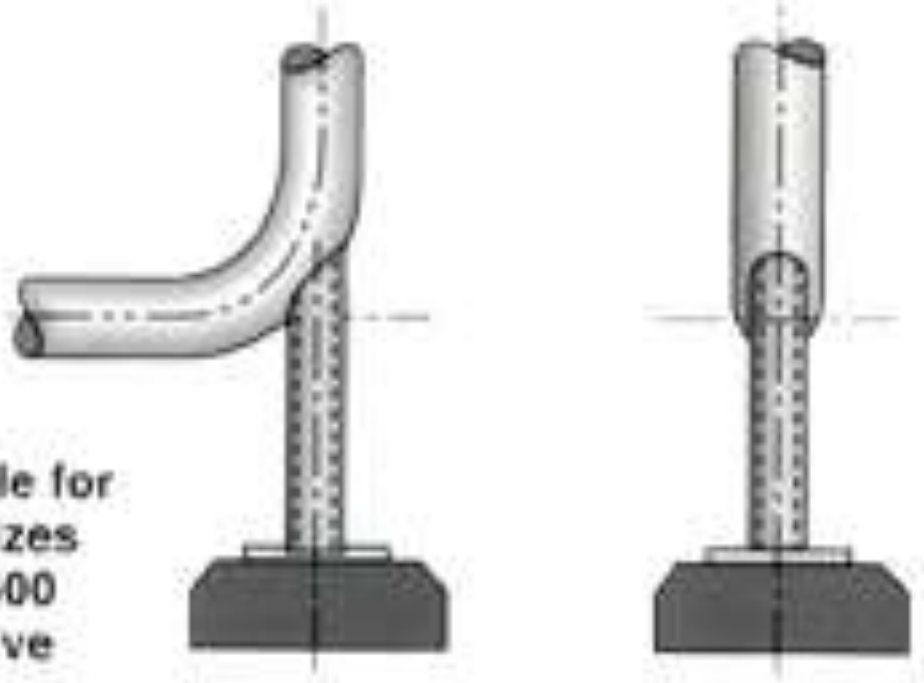




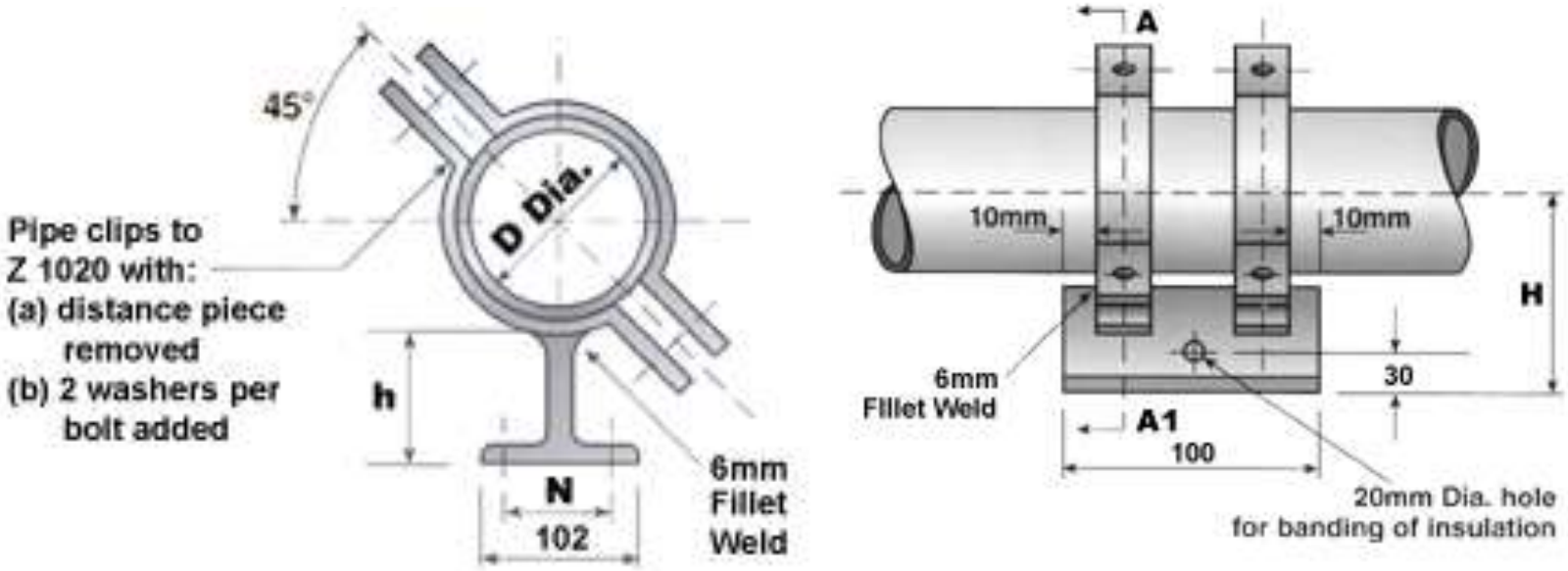




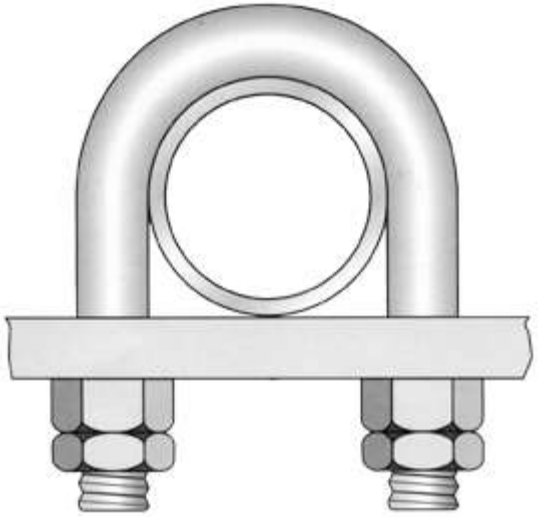

Guides
Channel
U-bolt



Suitable for pipe sizes 50 to 600 inclusive


45°
D Dia.
Pipe clips to
Z 1020 with:
(a) distance piece
removed
(b) 2 washers per
bolt added
h
N
102
6mm
Fillet
Weld
A
10mm
10mm
H
6mm
Fillet Weld
30
A1
100
20mm Dia. hole
for banding of insulation

Illustrated are various types of pipe supports and hangers.



Dynamic Pipe Supports

Spring supports have a lot of stored energy in them and are usually gagged to enable them to be installed, When the gags compressing the spring are released, the weight of the pipe work is supported.

Note if the supports are ever removed the gags must be replaced because of the stored energy. Spring supports must always be disposed off in a controlled safe manner.

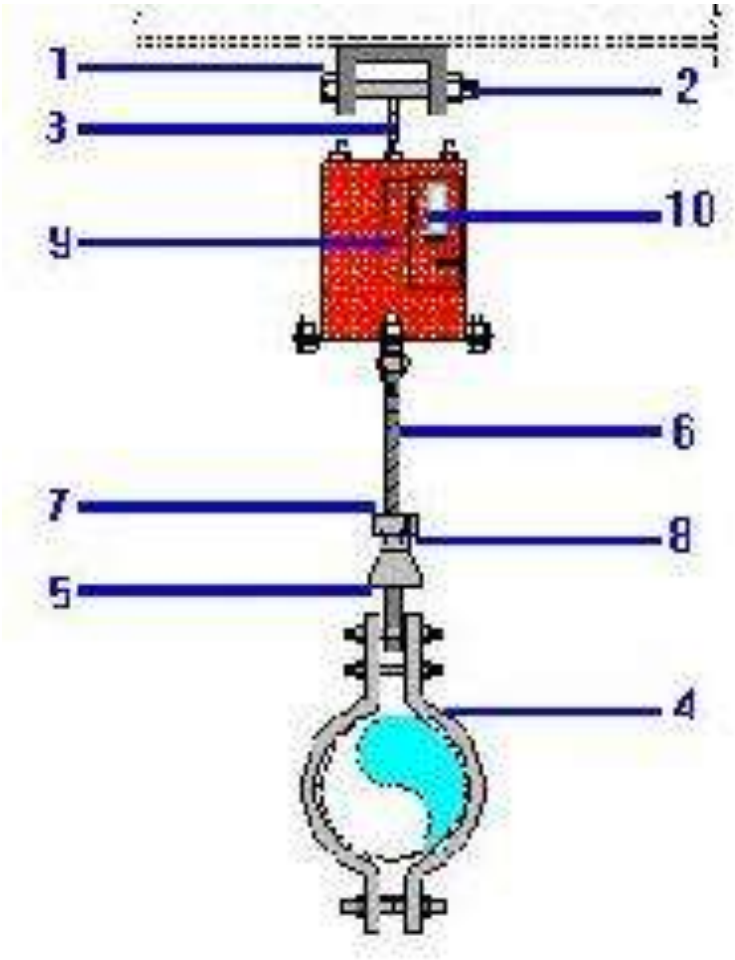
Typical Spring Hanger Supports

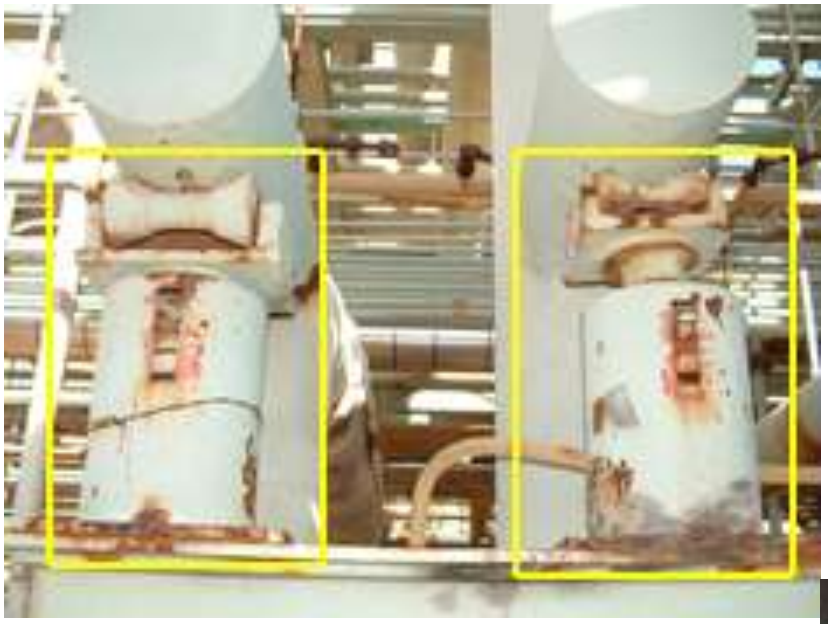
Wide load and movement range.
Robust and compact design: installed heights designed to a minimum.
Infinitely variable preset and locking device.

Travel indicator to allow movement to be monitored.
Lever rotation indicator, to demonstrate at a glance that the support is taking load correctly.
Low hysteresis, to ensure minimum load deviation.
Infinitely variable locking/balancing device.
Variable position load pin carrier.

Checks for Inspection of Hanger Assembly

Check the *beam attachment (1), pin (2)* and the *spring hanger attachment (3)* for any cracks, fractures, or signs of corrosion.
Check the *pipe clamp attachment (4), the weldless eye (5)* and *threaded rod (6)* for integrity.
Test the *turnbuckle (7), locknuts (8)*, and other threaded items to be sure they will turn.
Check the *spring coil (9)* for any sign of corrosion.
Mark the *position of the coil (10)* and compare it to design position and the





Pipe Flanges

**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.

**Also to allow items such as valves, pumps, filters etc
to be fitted into the system.**

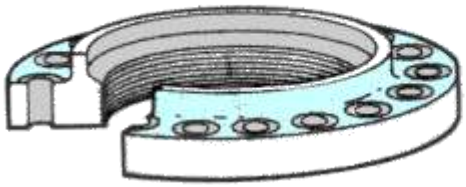
All Flanges Are Selected By Meeting Two Criteria:

Safety

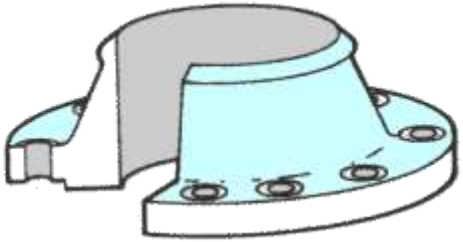
(Pipe material, size, process product, temperature, pressure)

Cost

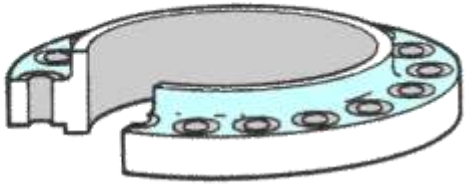
Types of Flange



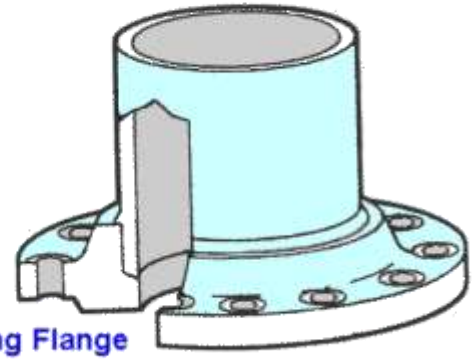
A. Threaded Flange



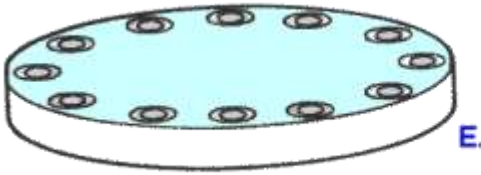
B. Welding Neck Flange



C. Slip-on Welding Flange



D. Socket Welding Flange



E. Blind Flange

Flanges

Flanges, like pipes, operate under varying conditions of temperature and pressure.

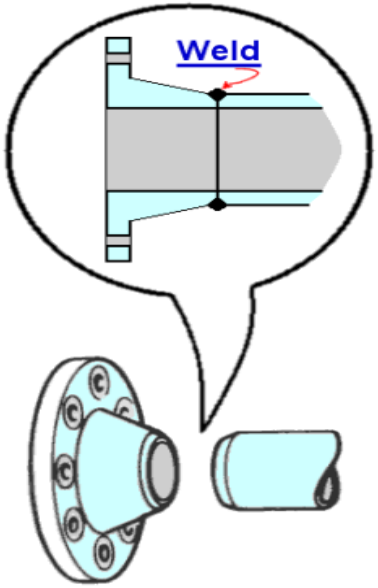
Standard maximum operating pressure and temperature ratings have been established for flanges and are expressed in pounds per square inch.

See the ASME B16.5 Flange Table Handout for Sizes

Welding neck flanges

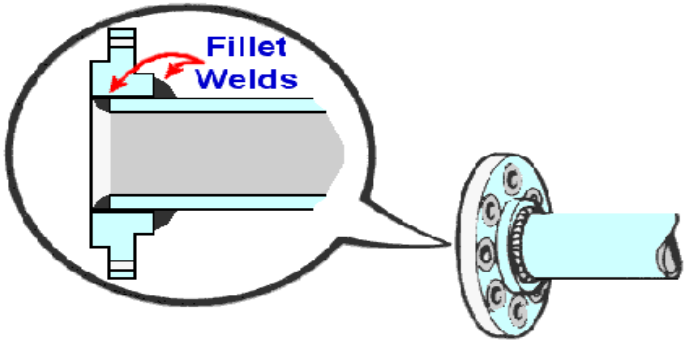
Are identified by their tapered hubs which connect the flange to the pipe.

Usually used on high pressure installations



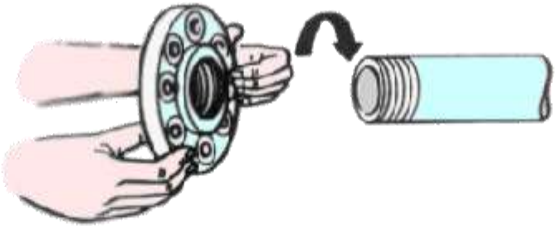
Slip on flanges

Fit onto the end of the pipe and are Fillet Welded into position, back and front.



Screwed or Threaded Flanges

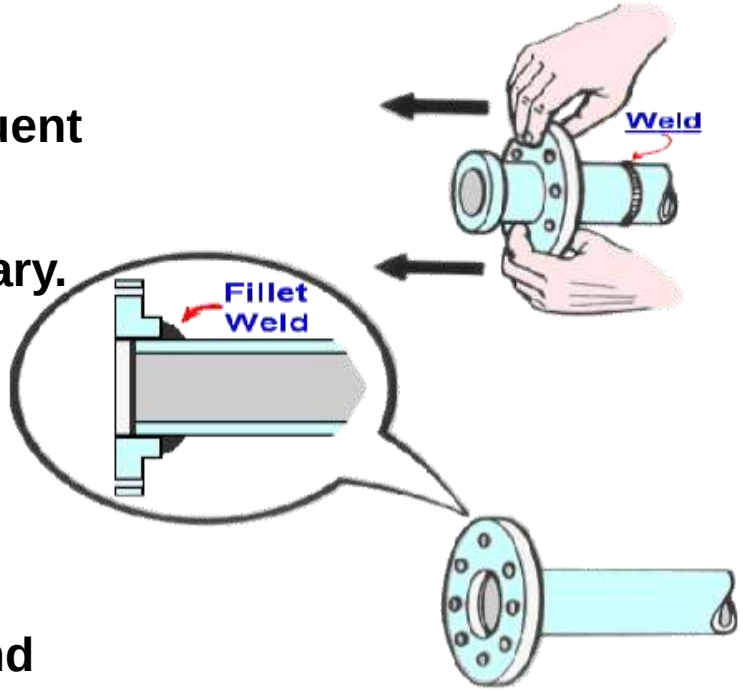
Screwed onto the end of the pipe.



Backing Flanges

Used with lap joints stubs where frequent dismantling

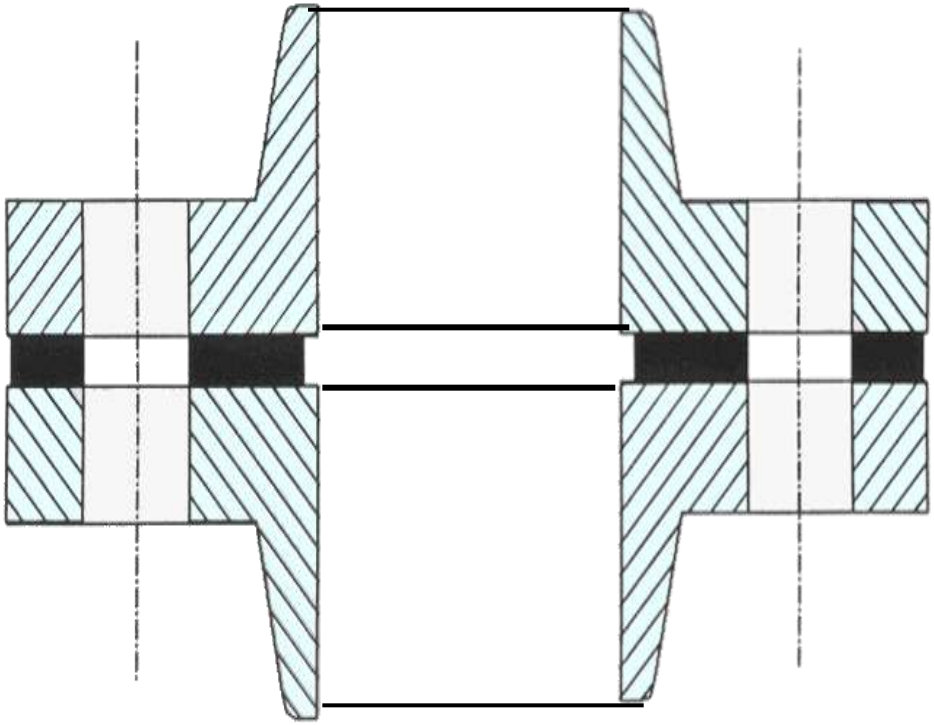
for inspection and cleaning is necessary.



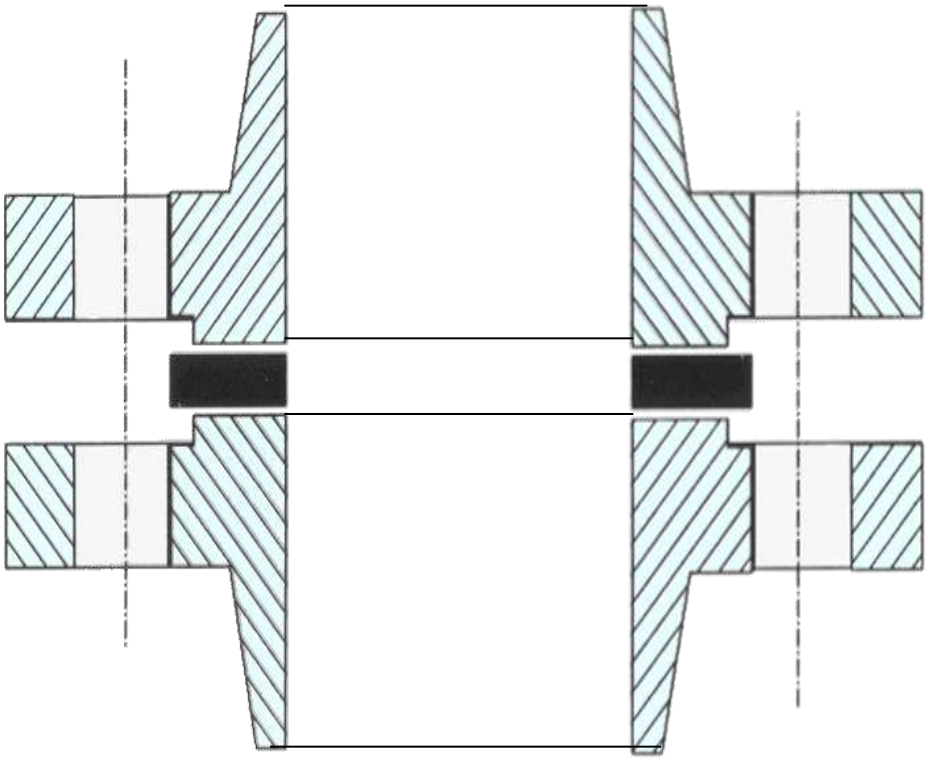
Socket Weld Flanges

Are slipped onto the ends of pipes and Fillet Welded in position.

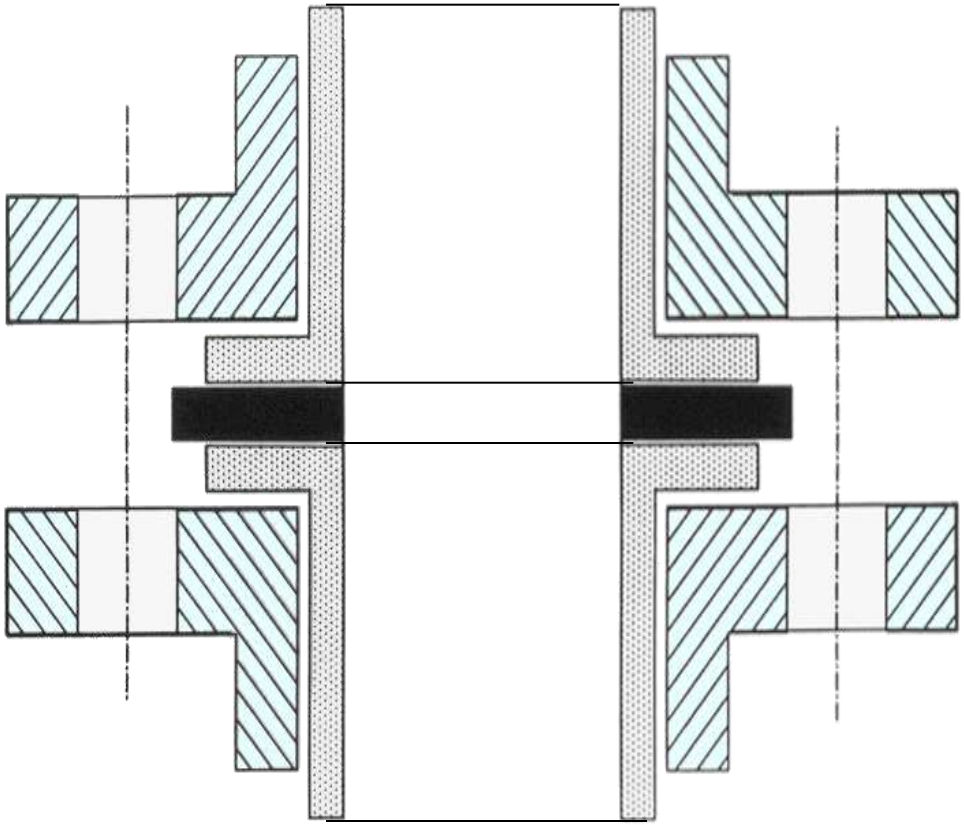
Flat Face



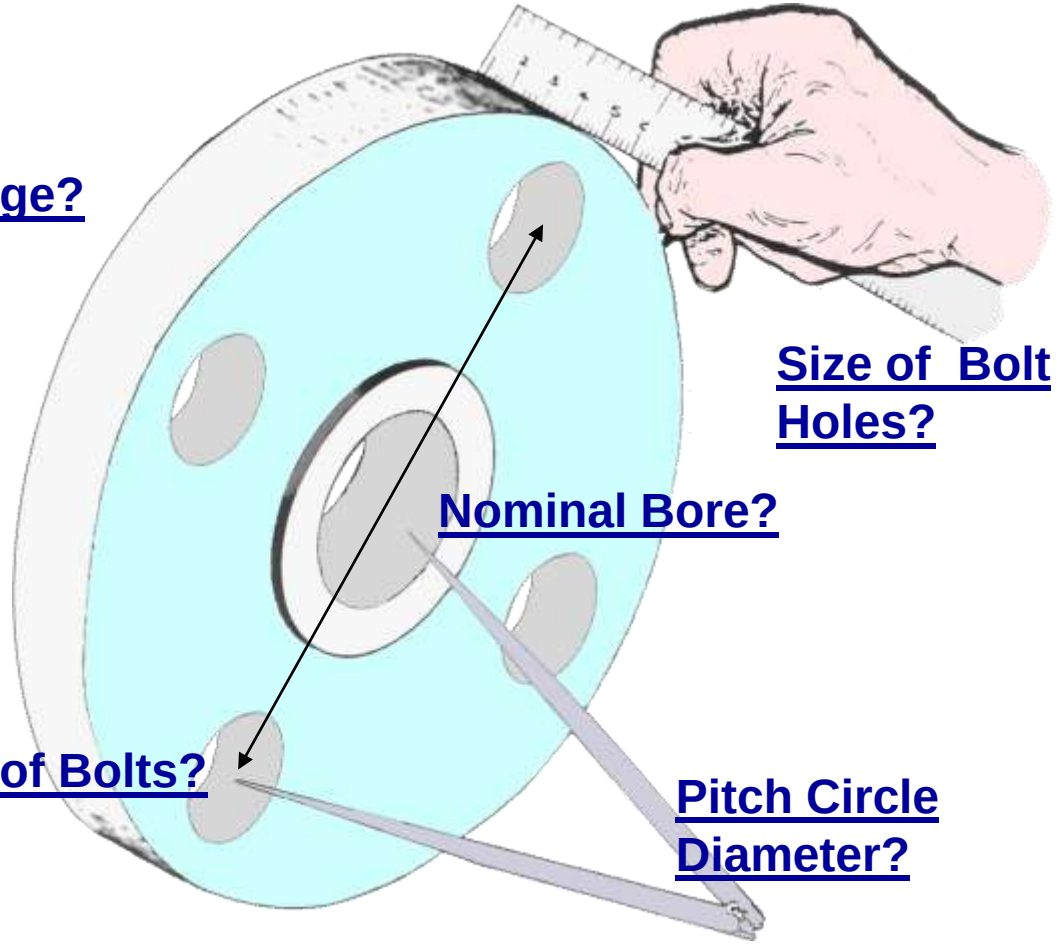
Raised Face



Lapped



Flange Measurements



Diameter of Flange?

Size of Bolt Holes?

Nominal Bore?

Number of Bolts?

Pitch Circle Diameter?

Joint Making Procedure

Ensure joint faces are clean, flat and have the correct surface finish.

Ensure that joint faces are aligned within specified limits.

External pressures should not be applied to align faces prior to bolting and joint face gap should be within specified limits.

Always use the specified jointing material.

Joint Making Procedure

Only use specified jointing compound and bolt lubrication.

Bolts should be of the correct specification and fitted in the correct sequence / procedure.

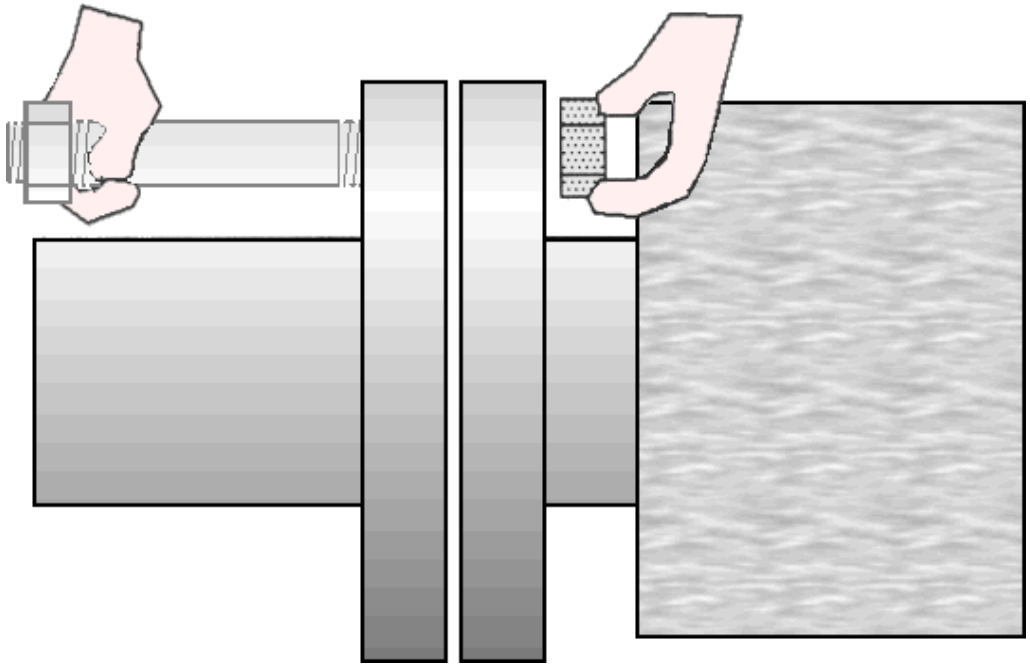
Bolt tension should be applied as specified.

Bolts should be the correct length.

One to one & half threads protruding.

Anti - Seize

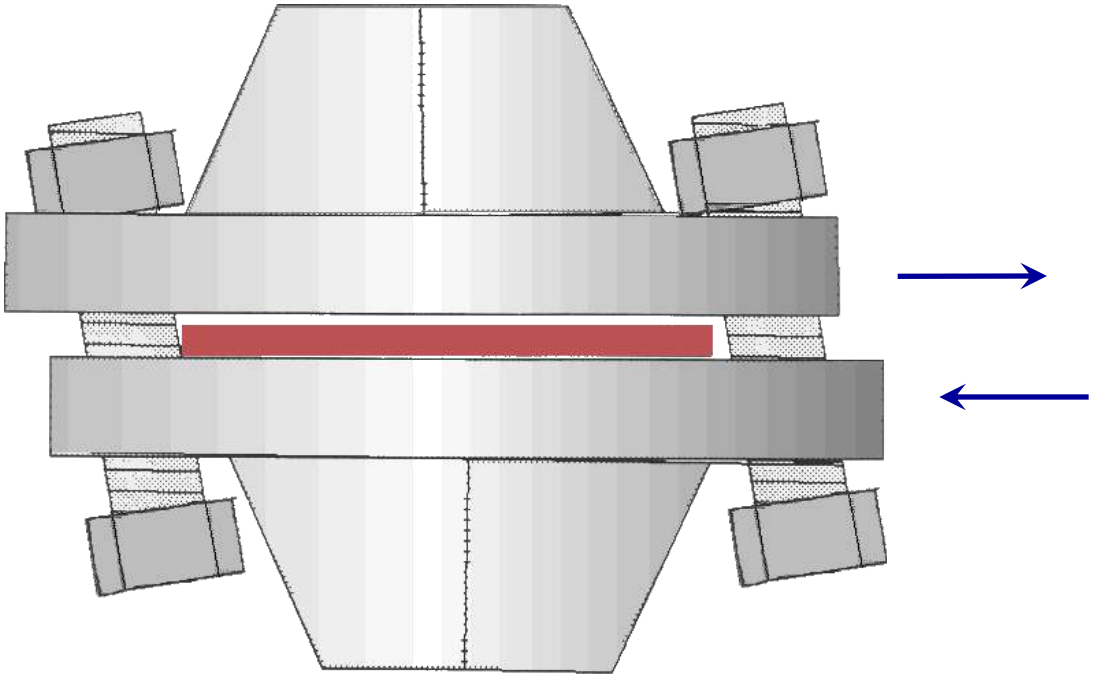
Always use anti-seize it saves time in the long run. It is recommended that you only put anti-seize on one side of the bolt. The reason for this is, when the bolt is undone next time, only one nut will come off and this will save you time and effort.



Because of the lagging put the anti-seized part of the bolt next to the obstruction.

Alignment of Flanges

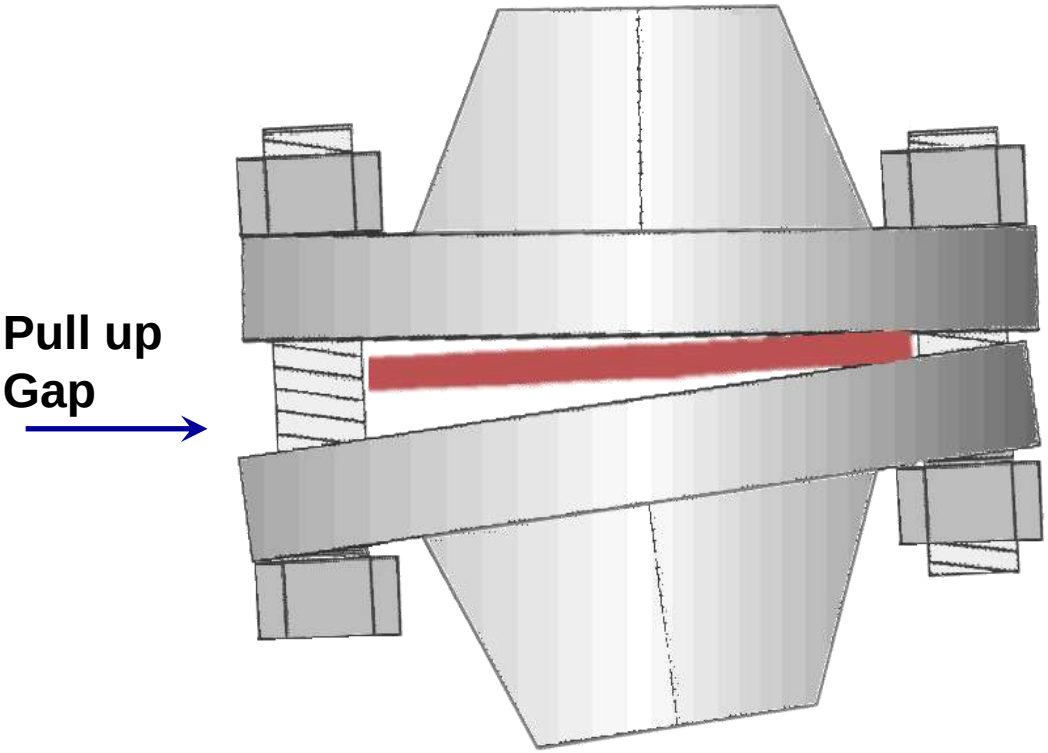
It is important to align the flanges with each other. If they are not, all of the gasket surface will not be used.



It is most critical that the male and female type of flanges are aligned so that they locate.

Pulling Up The Flange

The gasket must be compressed all the way round. It is important that the flange is pulled up squarely.



Alternative Joint Making Procedure

The Nominal Pipe Size is never the actual measurement of either the OD (Outside diameter) or ID (Inside Diameter) of the threaded male or female fitting.

Tapered Pipe Thread are found on ends of pipe (male), Nipples, Fittings (i.e. unions, couplings, elbows, tees, etc.) Thread sealant or tape is typically required to complete the seal.

Straight Pipe Threads - Found on straight through adapters, used to facilitate lock nuts, they all need gaskets or o-rings to seal.

Identifying Pipe Thread Forms:

Define thread

- Threads are called out according to the type of thread
- They usually follow a standard pattern and this is how they are identified

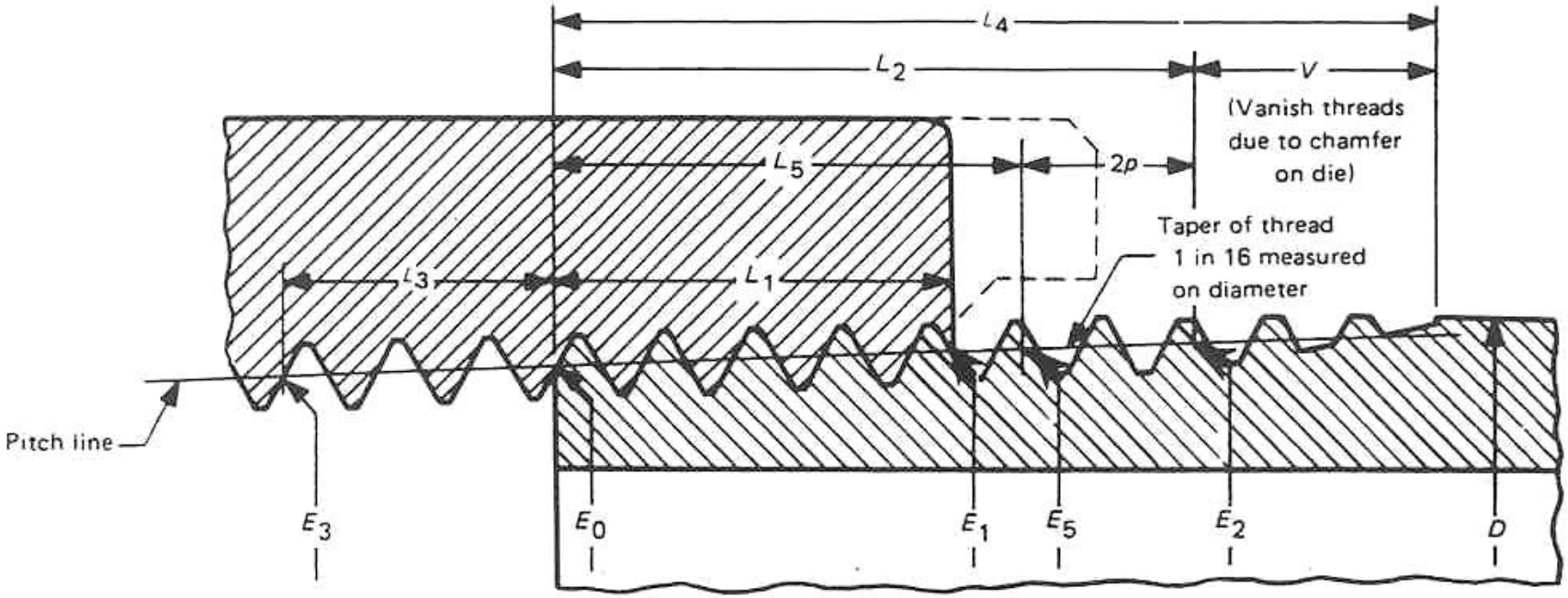
Define thread

- **NPT/NPTF** - American Pipe Thread
- Example: 1/4-18 NPT

  - 1/4 = nominal size
  - 18 = pitch (threads per inch)
  - NPT or NPTF usually specified or NPT/NPTF where it does not matter if it is either one

AN AMERICAN NATIONAL STANDARD
PIPE THREADS, GENERAL PURPOSE (INCH)

ANSI/ASME B1.20.1-1983



Define thread

- **UN/UNF** - Unified (SAE Straight Thread)
- Example: 9/16-18 UNF

  - 9/16 = actual size
  - 18 = pitch (threads per inch)
  - UN or UNF usually specified or UN/UNF where it does not matter
  - UNF is usually used for thread pitch above 12 TPI

Define thread

- **BSPT** - British Standard Pipe, Tapered
- Example: R3/8

  - R signifies tapered
  - 3/8 = nominal size
  - The pitch is usually assumed based on known standard

Define thread

- **BSPP** - British Standard Pipe, Parallel
- Example: G3/4

  - G signifies parallel
  - 3/4 = nominal size
  - The pitch is usually assumed based on known standard

Define thread

- **Metric Parallel**
- Example: M22X1.5

  - M signifies metric
  - 22 = actual size in mm
  - 1.5 = pitch (distance between threads in mm)

Define thread

- **Metric Tapered**
- Example: M10X1 keg (or tapered)

  - M signifies metric
  - 10 = actual size in mm
  - 1 = pitch (distance between threads in mm)
  - keg is the abbreviation for the German word meaning tapered and if the thread is tapered, it will be specified

Pipeline Specifications

On site there are many pipeline systems and they may look the same, so how do we identify them.

For example, a car has a registration plate, from that, reference to it's Make, Model, Year of manufacture, engine type etc can be Obtained.

Likewise with pipelines we need reference to identify its duty, situation, material spec, test and working pressures etc.

Each pipeline is given its own unique reference (number or letters)
This is called a PIPELINE SPECIFICATION

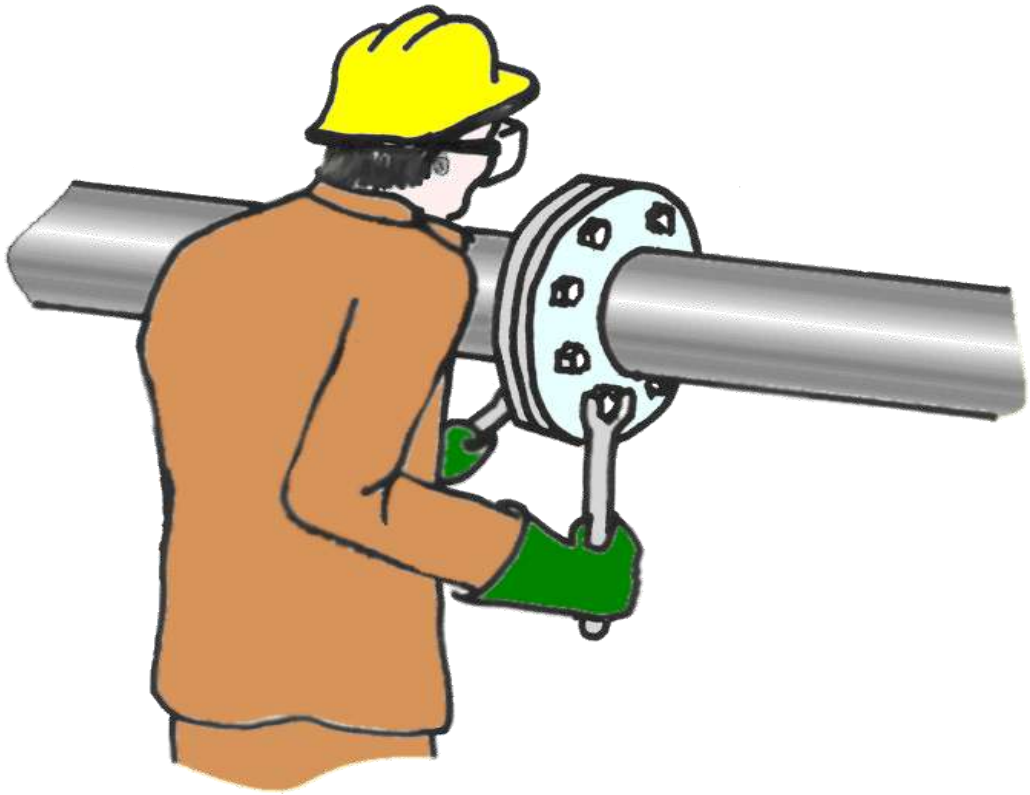
Pipeline Hazards Are Not Always Obvious

Check List

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 that 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.

Pipework

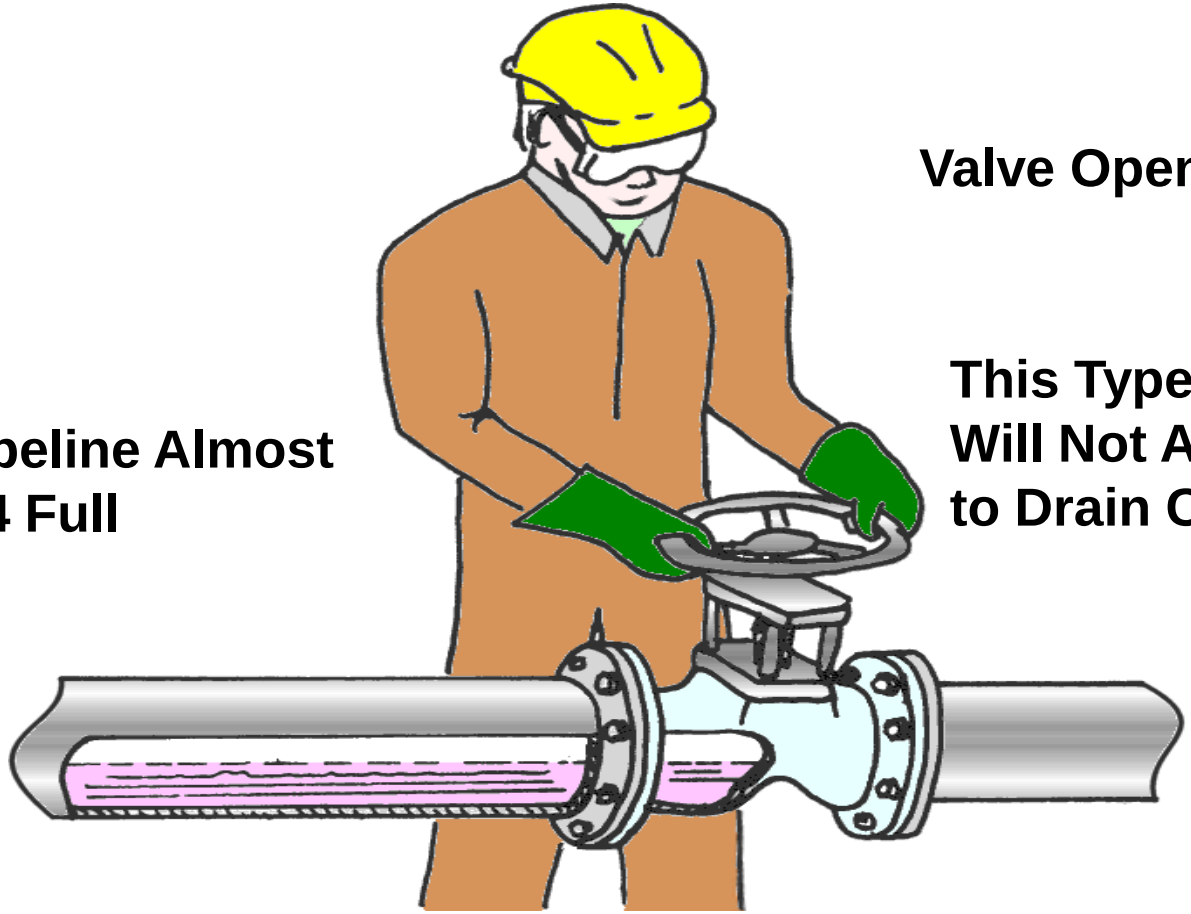


Follow these simple precautions

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

Before Breaking A Joint



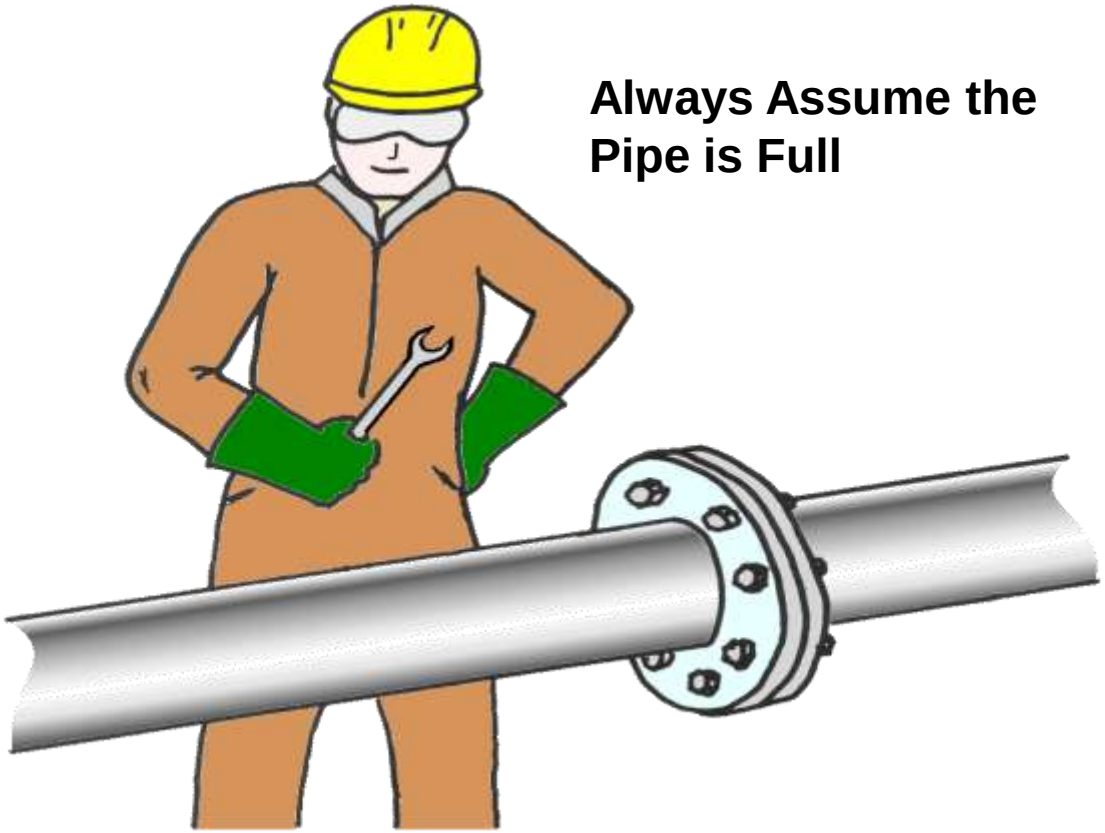
Valve Open

This Type of Valve Will Not Allow Line to Drain Completely

Pipeline Almost 3/4 Full

Check that the line is completely drained

When Breaking a Pipe-Joint

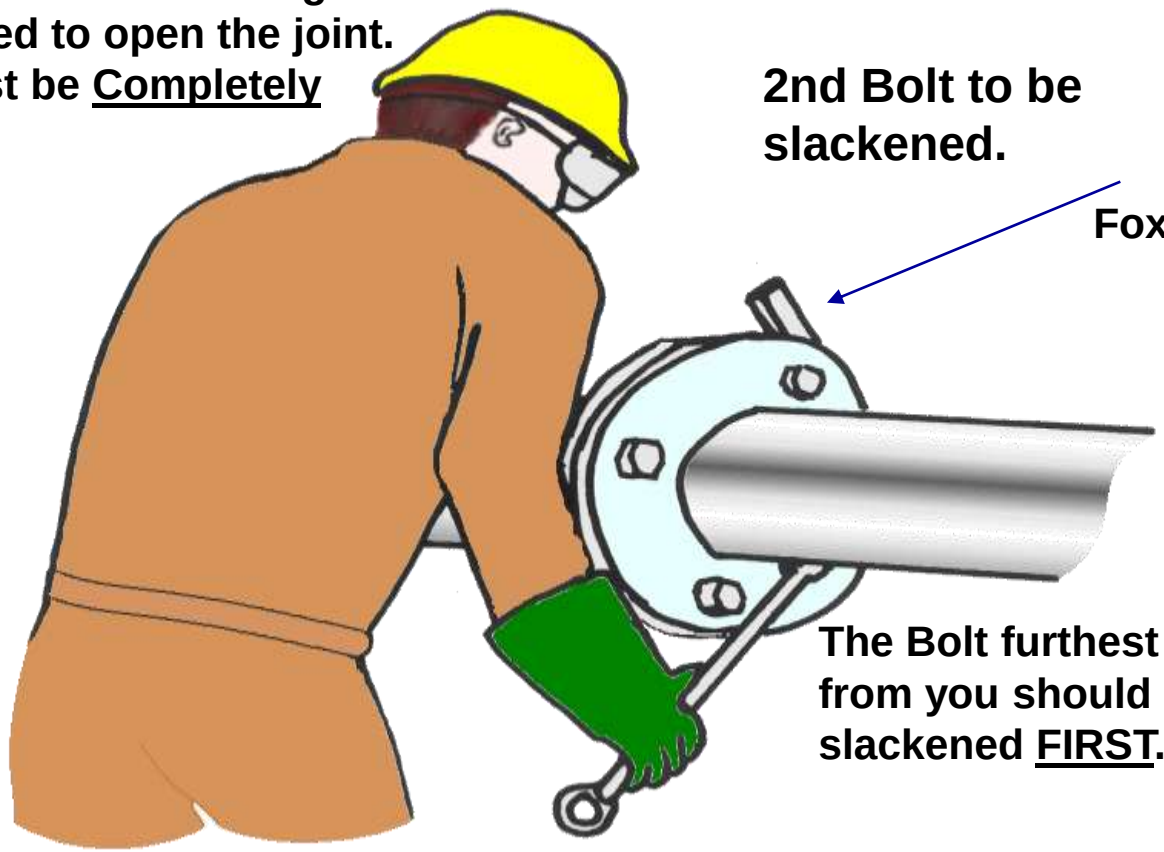


Always Assume the Pipe is Full

Proceed with the Utmost Caution

When Breaking a Joint

The last bolt should not be slackened until the fox-wedge has been used to open the joint. The line must be <u>Completely Drained.</u>



2nd Bolt to be slackened.

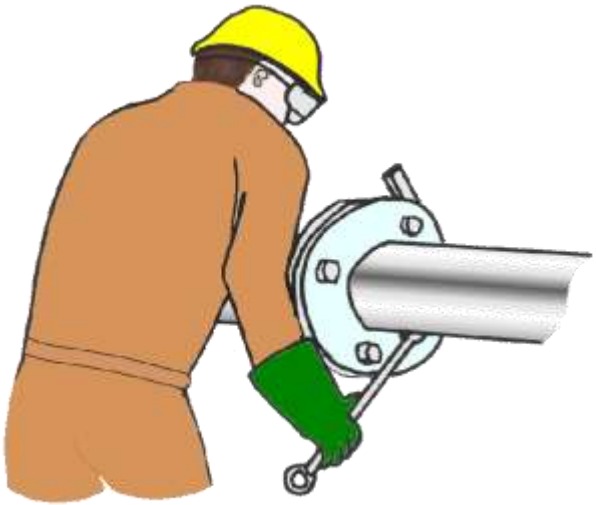
Fox-Wedge

3rd Bolt to be slackened.

The Bolt furthest away from you should be slackened <u>FIRST</u>.

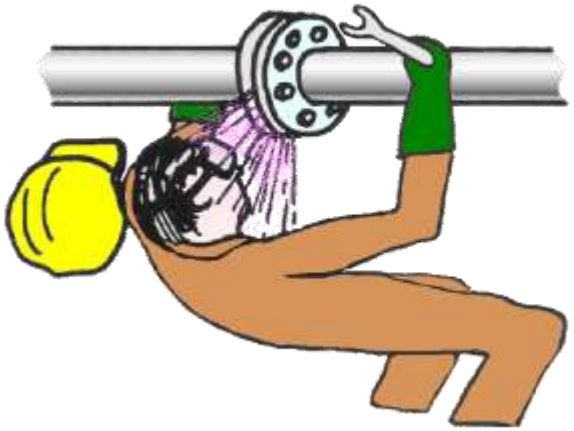
DO IT THE SAFE WAY

When Breaking a Joint

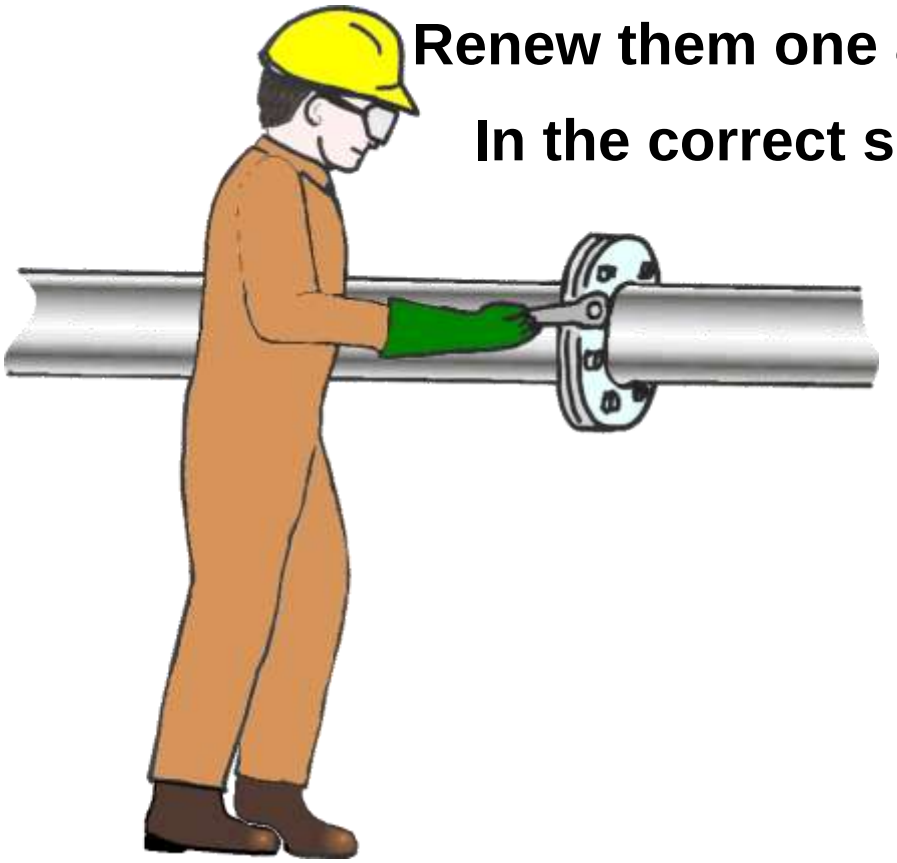


Work From <u>Above</u>

Never
<u>Below</u>



If The Bolts Are ‘Bad’

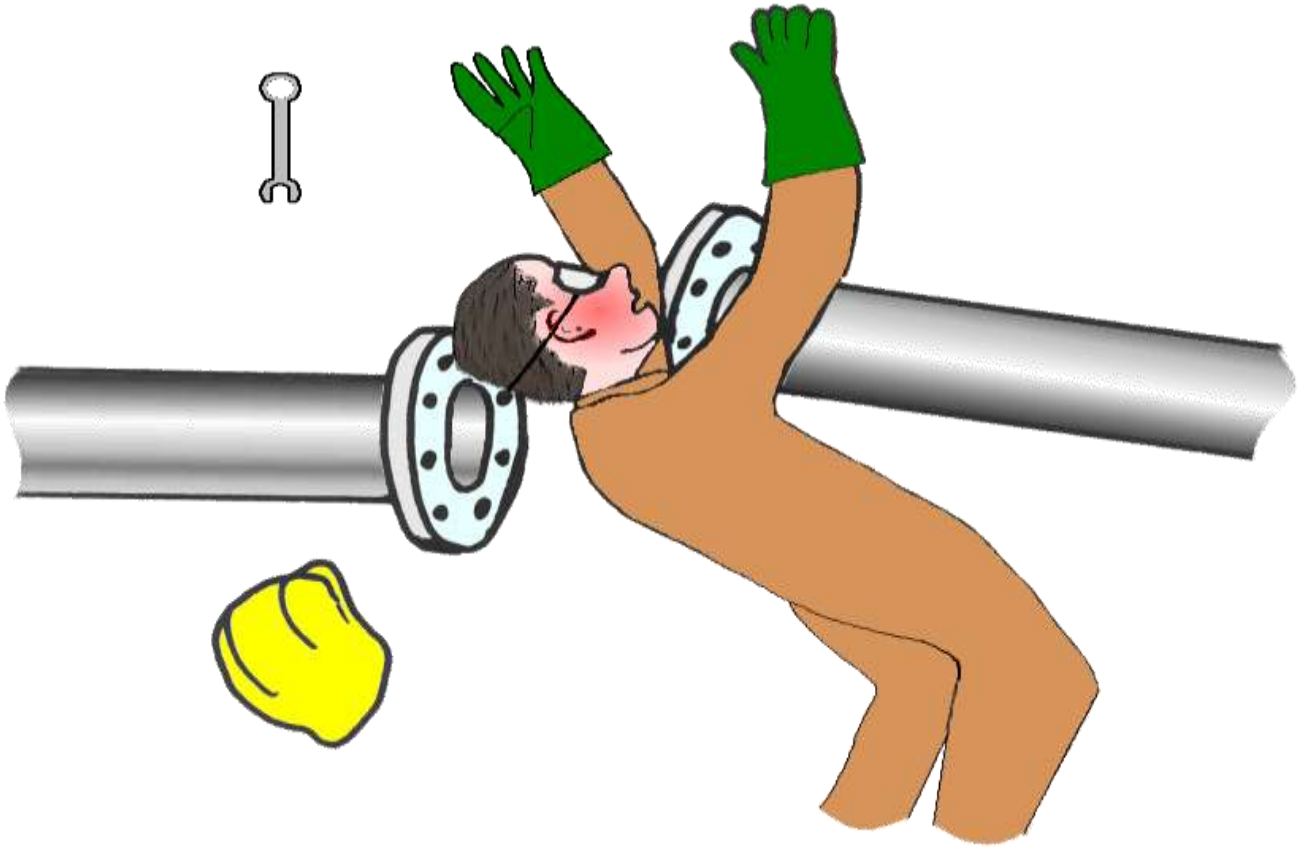


Renew them one at a time.

In the correct sequence.

BEFORE THE JOINT IS BROKEN

When Breaking a Joint



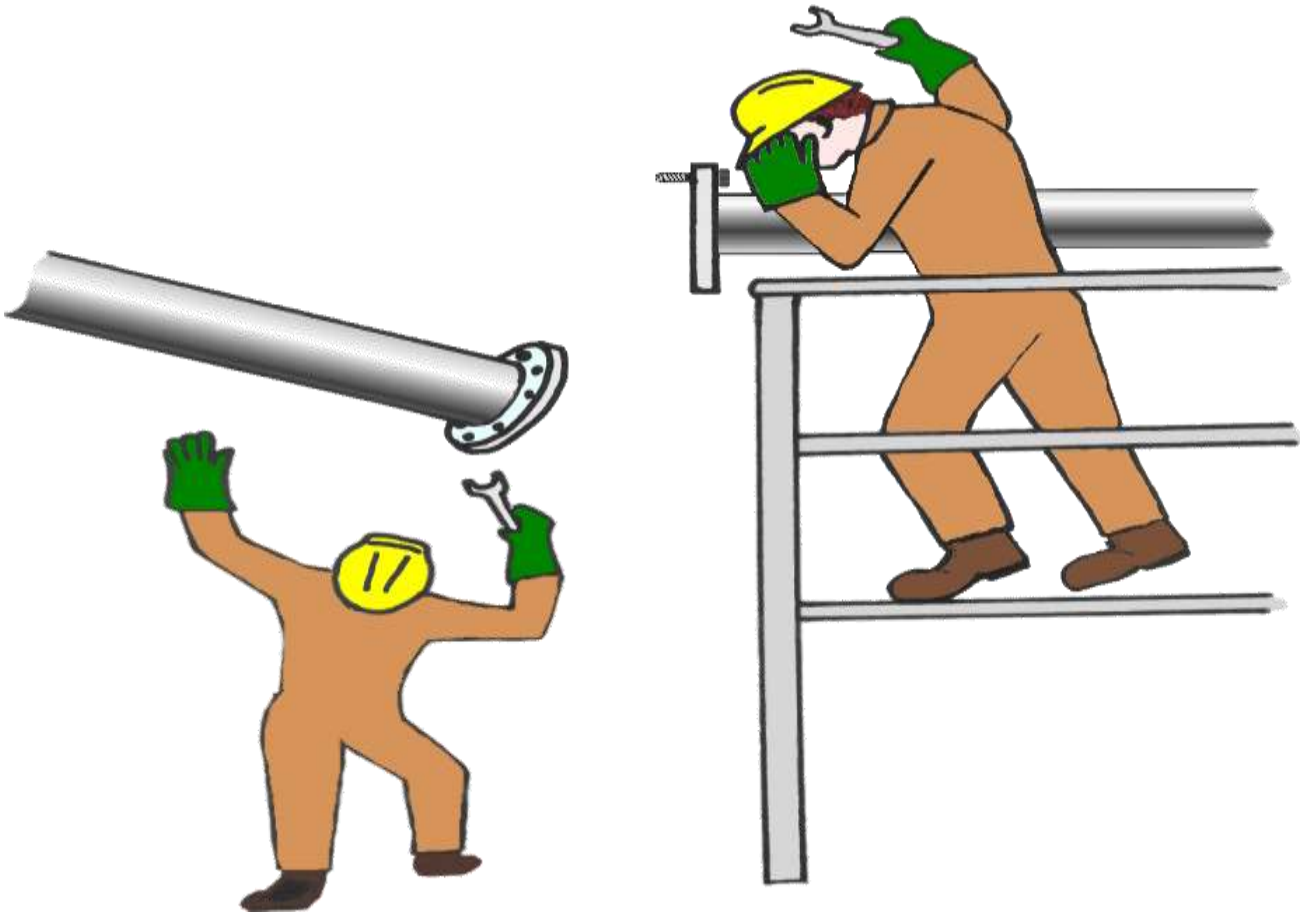
Watch Out For Pipe-Spring ‘It Happens’
When You Least Expect It..

When breaking joints on liquid lines

Always Use a Tundish to Drain Away Residue

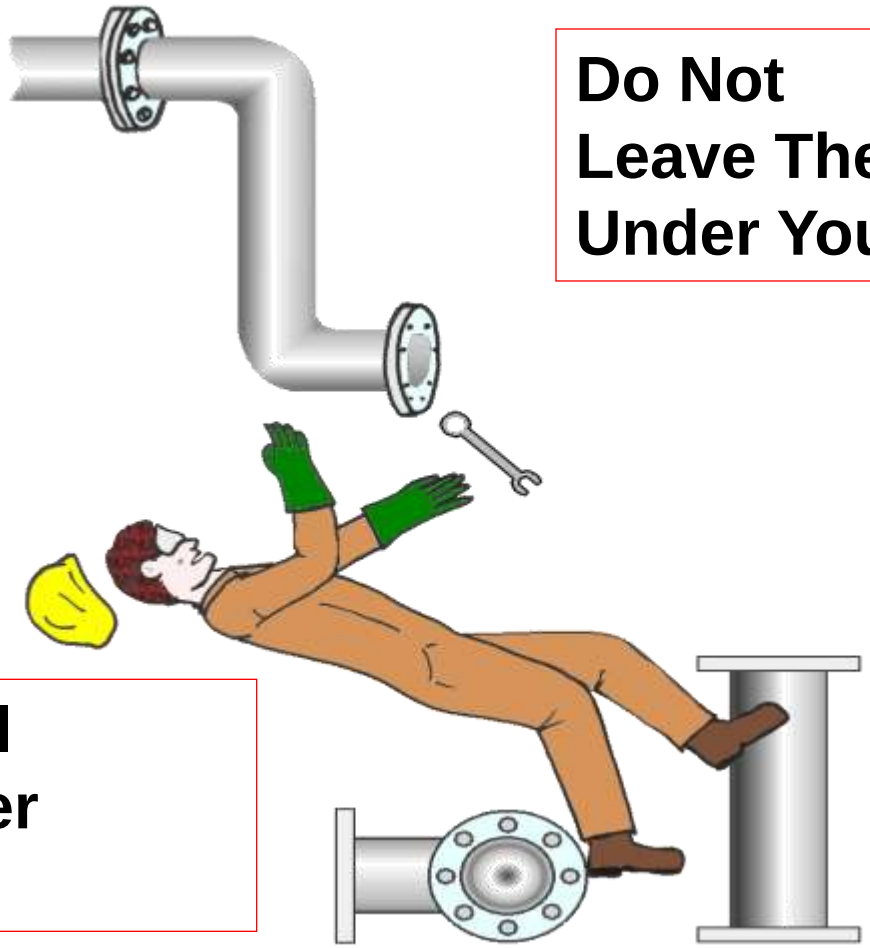
Keep Floors Clear of Corrosive Liquids You Could Get Splashed

Before Breaking a Joint



Always Make Sure The Pipe-Line is Adequately Supported

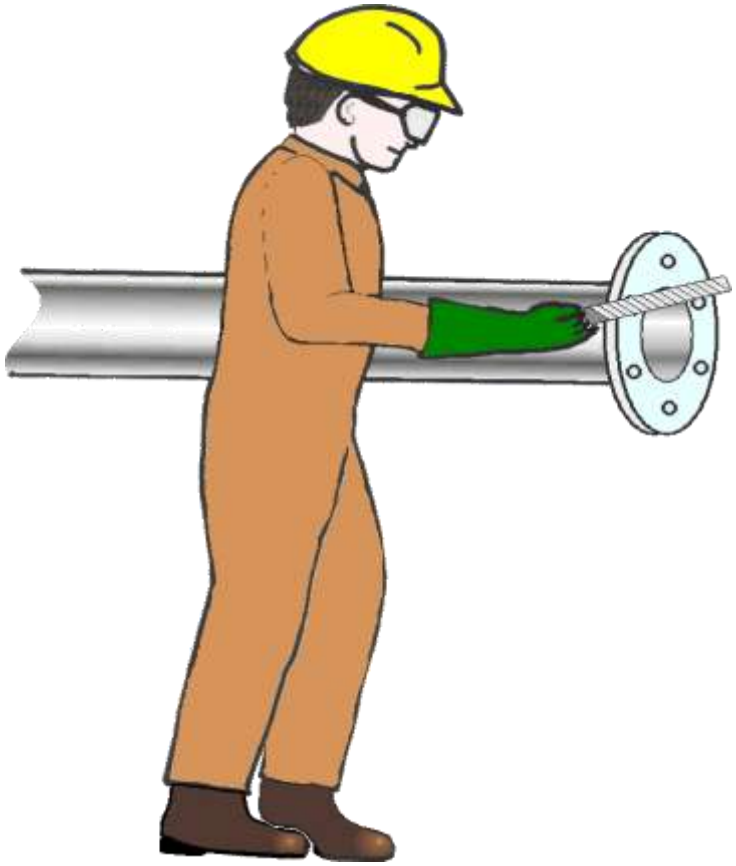
When Dismantling Pipes



Do Not
Leave Them
Under Your Feet

You Will
Fall Over
Them.

Before Re-making A Joint



Clean The Faces Properly
“If You Don’t It Will Almost Certainly Leak”

The End
Any Questions?