Piping Training Course

OVERVIEW OF PROCESS PLANT PIPING SYSTEM

Piping components: summary

- Definition
- Piping component
- Piping drawing
- Design
- Pipe work
- Codes & Standards

Definition

Definition:

- *piping:*

  assemblies of piping components used…[for] fluid flows. Piping also includes pipe supporting elements, but does not include support structures…or equipment…

- *piping system:*

  interconnected piping subject to the same design conditions

Definition:

- ***piping components:***

 mechanical elements suitable for joining or assembly into pressure tight fluid-containing piping systems include

Piping component

- *piping components includes:*
  - ✓ Pipe & tube
  - ✓ Fittings (e.g. elbows, reducers, branch, connections, flanges, etc.)
  - ✓ gaskets, bolting
  - ✓ valves
  - ✓ Pipe support
  - ✓ Special items such as expansion joints…

Pipe & Tube

- **Seamless** Show

- **Welded:**
  - Longitudinal seam
    - Single seam
    - Double seam (NPS ≥ 36”)
  - Helical (spiral) seam Show
    - NPS ≥ 4 ½”
    - 0.8 OD ≤ Skelp width ≤ 3.0 OD
    - Submerged arc welding

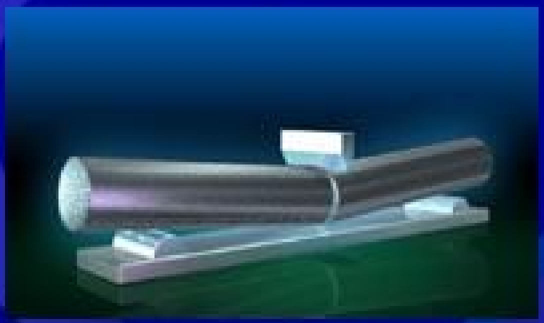
- **Welding process:**
  - Without filler metal
    - Electric welding — Show
    - Continuous welding — Show
  - With filler metal
    - Sub-merged arc welding
    - Gas metal arc welding

Piping components: Pipe & tube manufacturing : Seamless pipe

1

Billet preparing
visual control

2



Billet chopping

3

Billet heating
in annular furnace

4

Rough tube
piercing

5

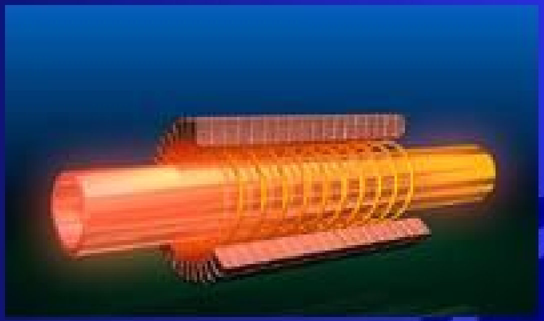
Tube rolling in
continuous mandrel mill

6

Mandrel removing

Piping components: Pipe & tube manufacturing : Seamless pipe

7

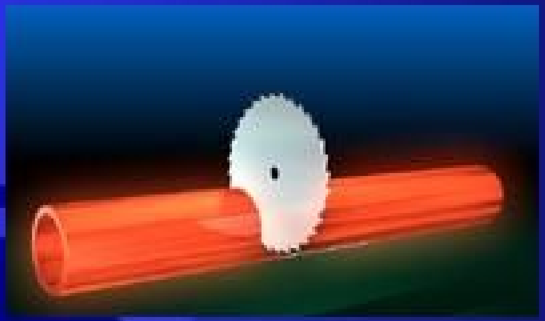


Tube heating in
cell induction furnace

8

Sizing and reduction

9



Stalk ends cutting,
tubes cutting with flying shears

10

Tubes cooling

11

Tubes leveling

12

Tubes cutting in ready
sizes, tubes facing

Piping components: Pipe & tube manufacturing : Seamless pipe

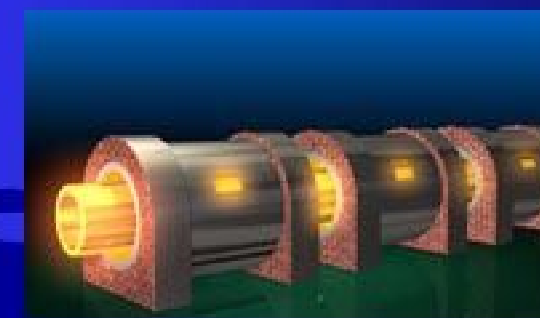
13

Geometry measuring,
mechanical tests,
chemical composition control

14

Tube ends sizing
(by OD and ID)

15

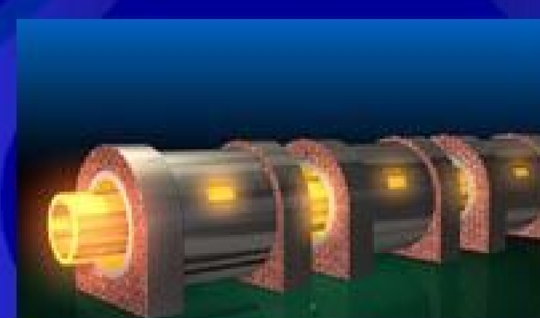


Heating for quenching

16

Quenching in sprayer

17



Tempering

18

Tubes cooling

Piping components: Pipe & tube manufacturing : Seamless pipe

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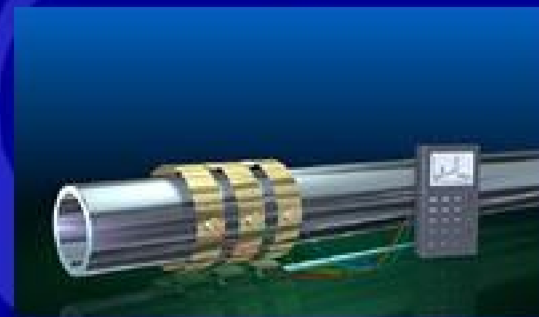
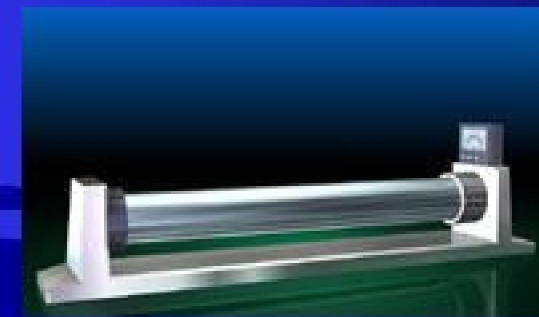
Tubes etching

20



Ultrasonic or electromagnetic test

21



Hydraulic test

22

Sweeping-up (if required), visual control

23

Preservative coating

25

Weighing, marking, packing, storing

Piping components: Pipe & tube manufacturing : Seamless pipe (threaded)

20 21

Tube end upset

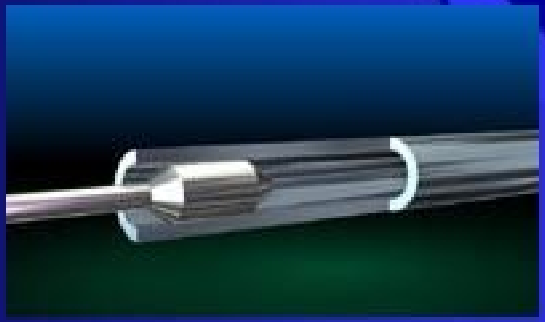
22

Thermal treatment

23

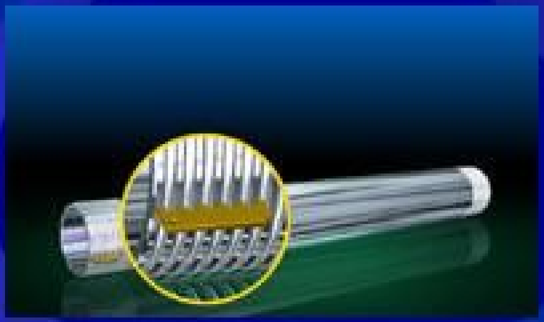
Leveling

24



Sweeping-up and grading by length

25



Threading, thread quality monitoring

26

Couplings screwing-on

Piping components: Pipe & tube manufacturing : Seamless pipe (threaded)

27

Hydraulic test

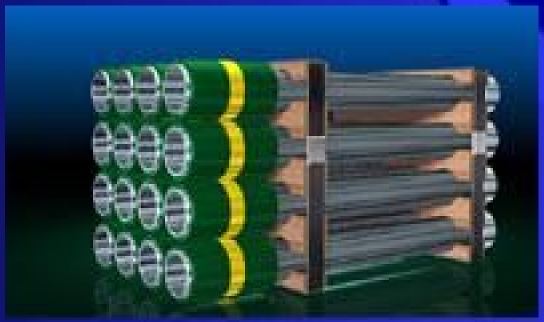
28

Tubes inspection, rings and nipple screwing-on, marking

29

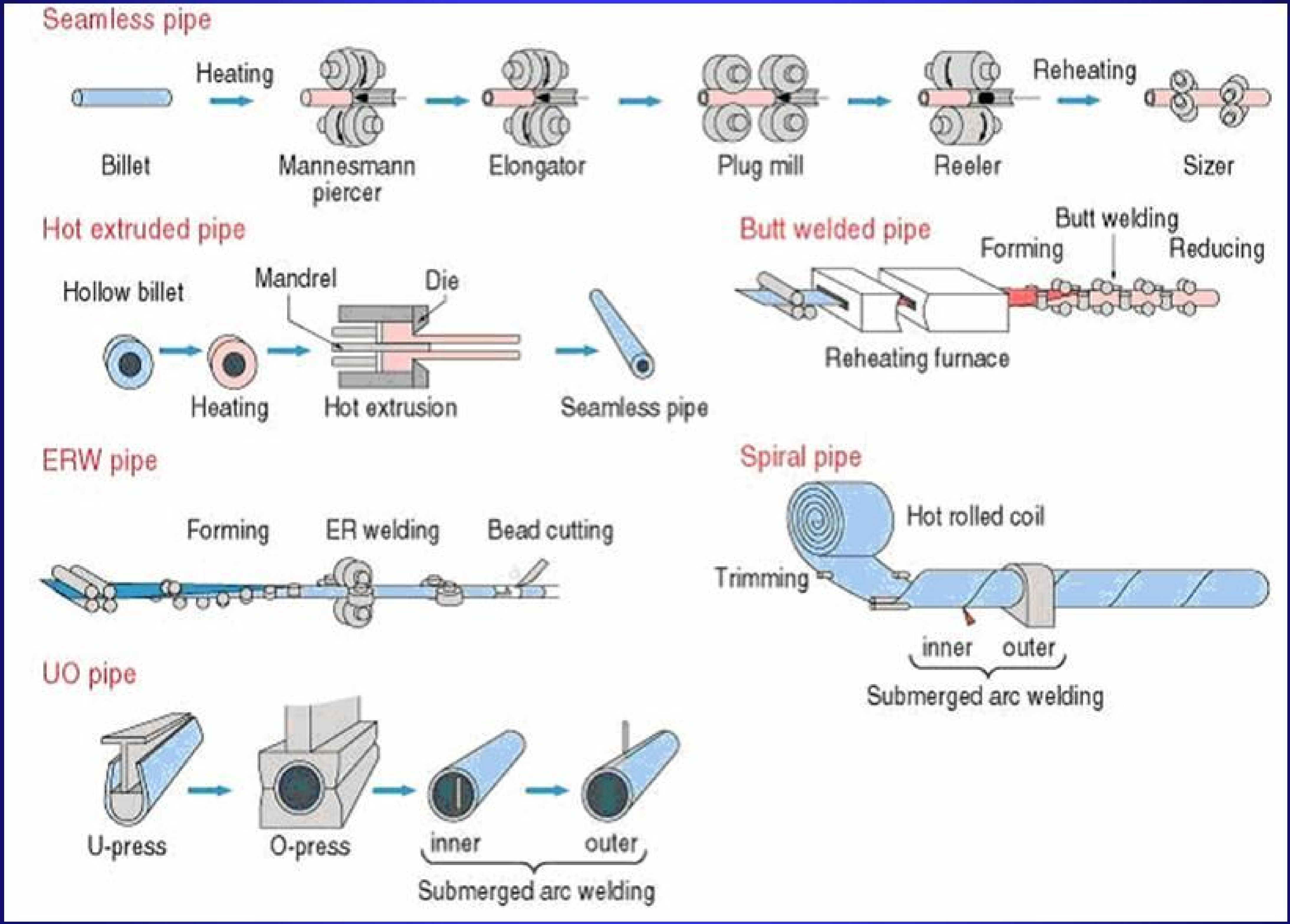
Painting (if required))

30



Packing, storing

Piping components: Pipe & tube manufacturing : other pipe



Piping components: pipe & tube classification

- Pipe classification:
  - Iron pipe size (approximate internal dia.)
  - Manufacturers' weight: NPS +
    - STD
    - XS
    - XXS
  - Schedule number: NPS +
    - 5, 5s, 10, 10s, 20, 20s, 30, 40, 40s, 60, 80, 80s, 100, 120, 140, 160 Show
    - SCH ≈ 1000 P/S
    - NPS ≤ 12, OD ≥ NPS
    - NPS ≥ 14, OD = NPS
    - NPS ≤ 10, SCH 40 = STD
    - NPS ≤ 8, SCH 80 = XS
    - Light wall = light gage = 5, 5s, 10, 10s
  - API designation
    - A25, A, B, X42, X46, X52, X60, X65, X70
    - X(AA), AA = Allowable stress
  - Pressure-Temperature Ratings
    - 150, 300, 400, 600, 900, 1500, 2500

Piping components: pipe & tube classification

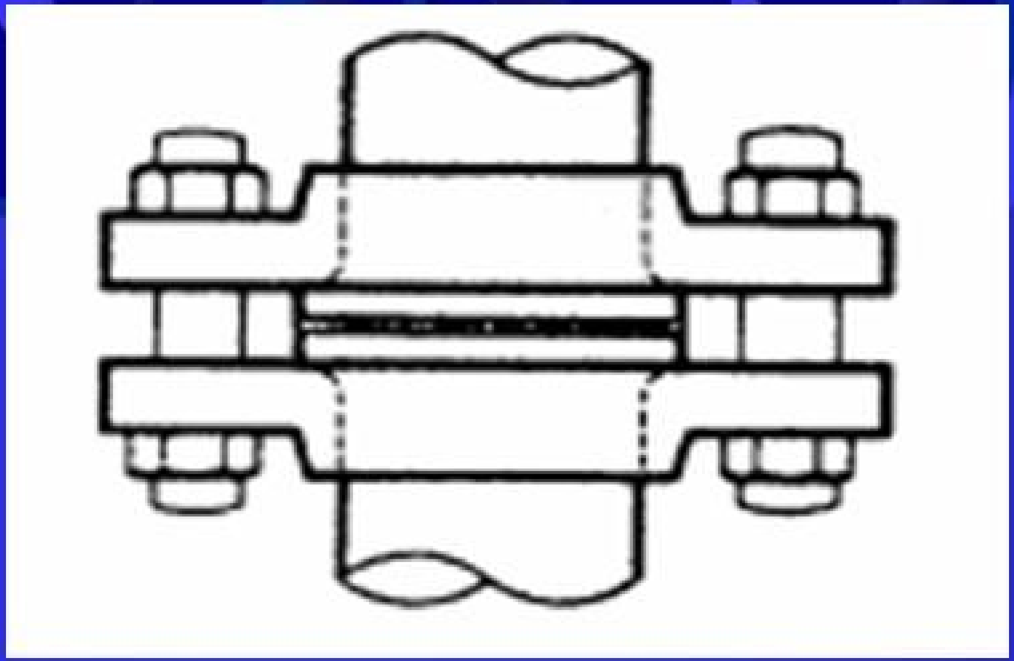
- **Pipe:**
  - NPS:
    1/8", ¼", 3/8", ½", ¾", 1", 1 ½", 2", 3", 4", 6", 8", 10", 12", 14", 16", 18", 20", 24", 28", 30", 32", 36", 40", 44", 48" 52", 56", 60"
  - NPS 1 ¼", 2 ½", 3 ½", 5" not used
  - Pipe is supplied in
    - Random length (17 to 25 ft)
    - Double random length (38 to 48 ft)
  - Pipe end:
    - BE (bevel end)
    - PE (plain end)
    - T& C (treaded and coupled, rating of coupling shall be specified

Piping components: pipe & tube classification

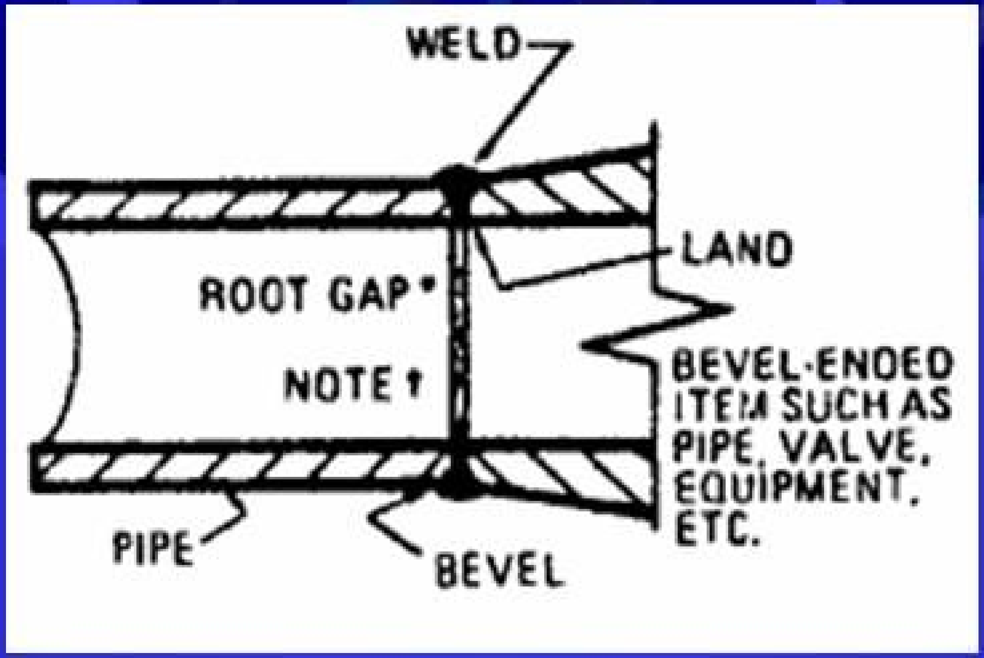
- **Tube:**
  - Specify by two of
    - Outside diameter
    - Inside diameter
    - Wall thickness:
      - Thousandths of inch
      - Gauge number
        - American wire gauge
        - Steel wire gauge
        - Birmingham wire gauge
        - …
  - When gauge numbers are given without reference to a system (BWG) is implied

- ASTM A53 – Steel Pipe
- ASTM A312 – Stainless Steel Pipe
- AWWA C151 – Ductile Iron Pipe
- API 5L – Line pipes
- ISO 11960, API 5CT – tubing
- ASTM A 53/A 53M Electric-weldedand seamless steel pipes, black or hot-dip galvanized
- ASTM A 106 Seamless carbon steel pipes for high temperature performance

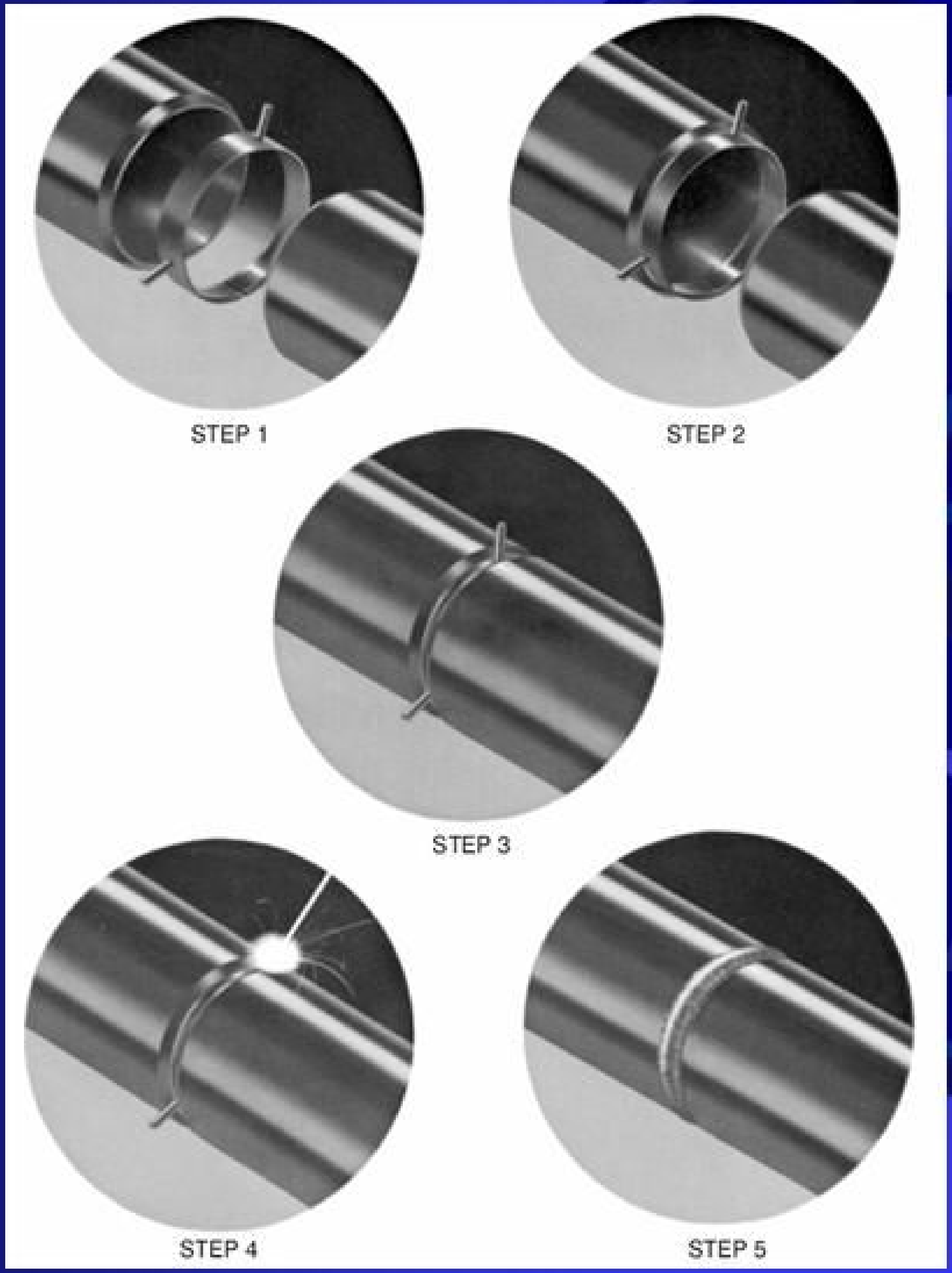
- Method of joining pipe:
  - Butt weld
  - Socket weld
  - Threaded
  - Quick coupling
  - Flange
  - Special item

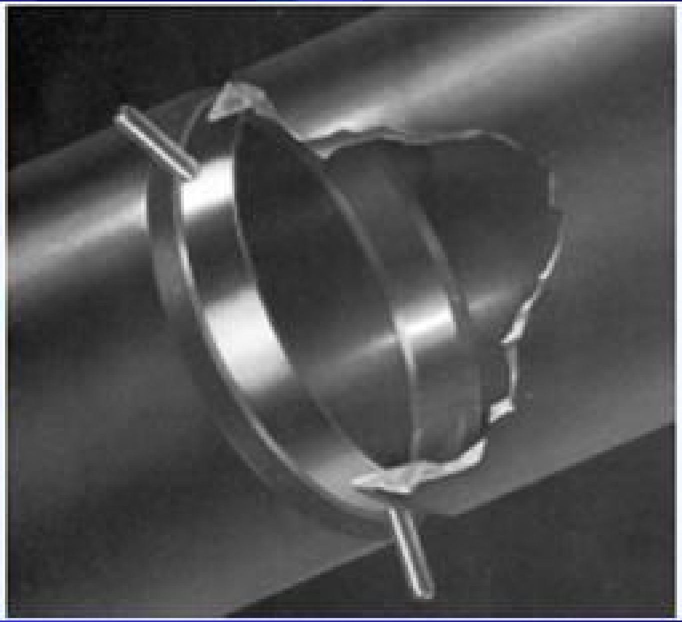


- ASME B16.9
- Used in most piping systems *NPS ≥ 2”*
- Use generally not restricted
- Difficult in small sizes, especially for thin wall

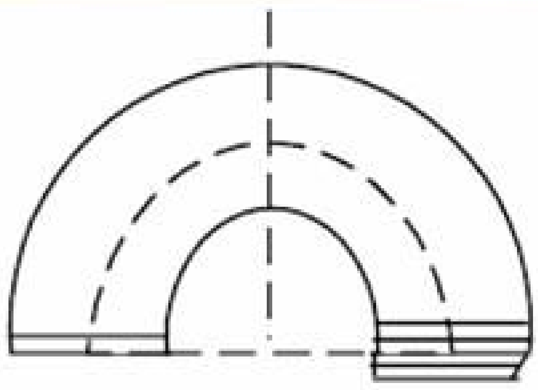


Backing ring



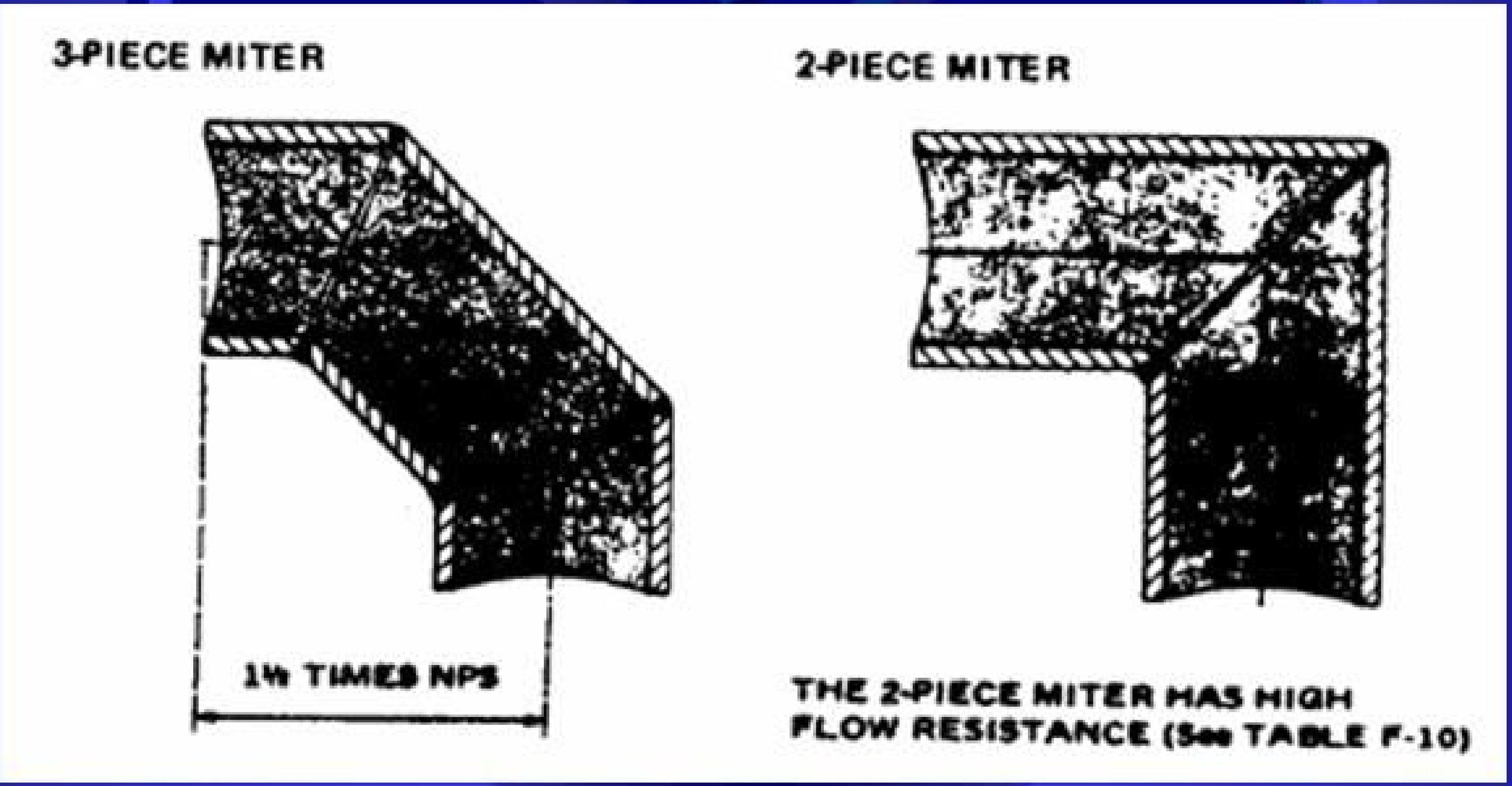


- Return:
  - Curvature = 1 ½ NPS
  - Uses in:
    - Vent on tanks

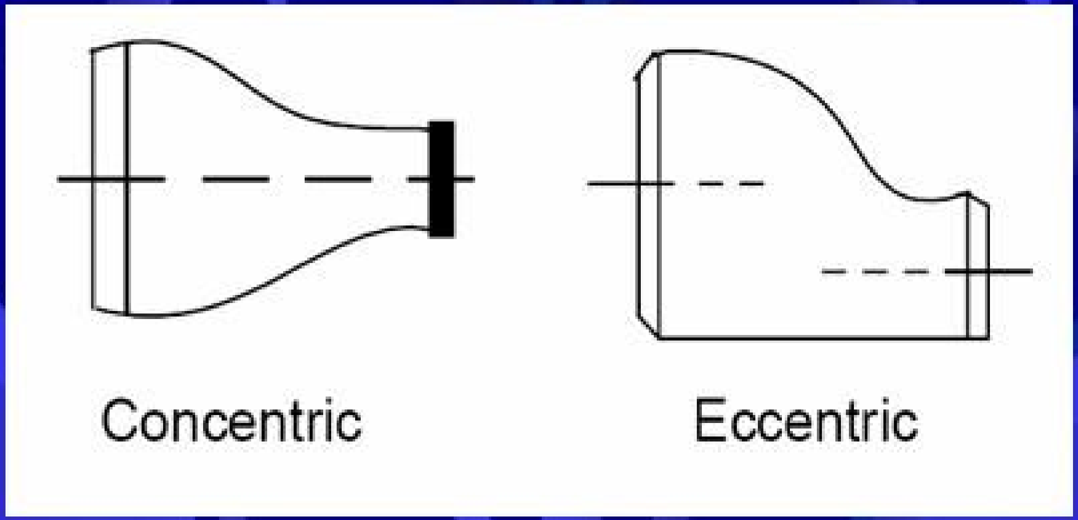

180° Return

- Bend:
  - Curvature = 4 - 6 NPS
  - Made from seamless and ERW straight pipe
  - Two methods used to making bend
    - Hot
    - Cold

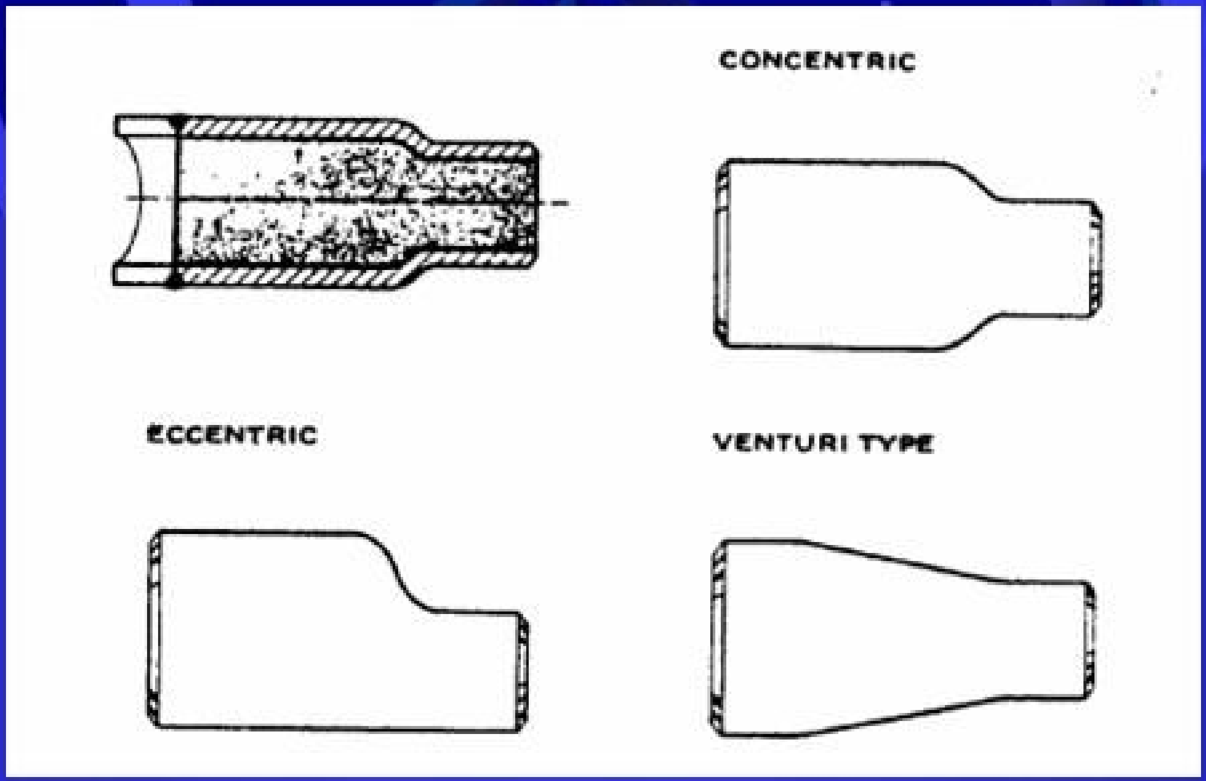
- Miter
  - 2 piece (pressure drop ≈ 4-6 LR elbow)
  - 3 piece (pressure drop ≈ 2 LR elbow)
  - Low pressure line, NPS > 10" & pressure drop not important
  - 90



- Reducer
  - Eccentric
    - Suction & discharge of pump
    - support
  - concentric



- Sewage :
  - connect butt-welded piping to smaller socket-weld or screwed
  - Abrupt change of line size in butt-weld Type:
    - Eccentric
    - Concentric
    - Venturi: Allows smoother flow

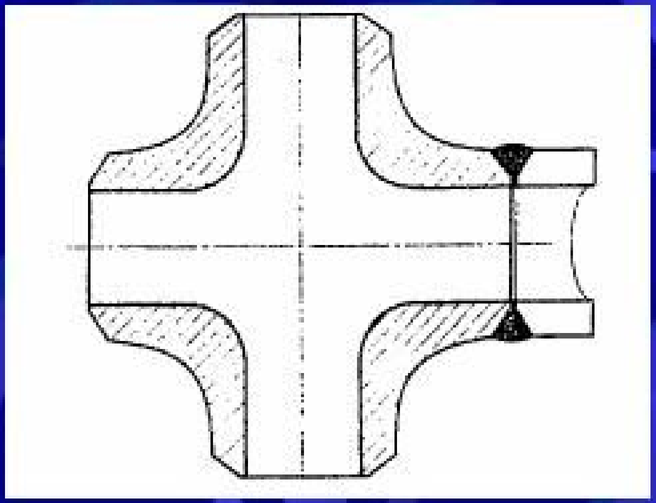


- Tee
  - Straight (branch to the same size as the run)
  - Reducing
    - Branch smaller than the run
  - Bullhead tee have branch larger than run & seldom used and made to special order

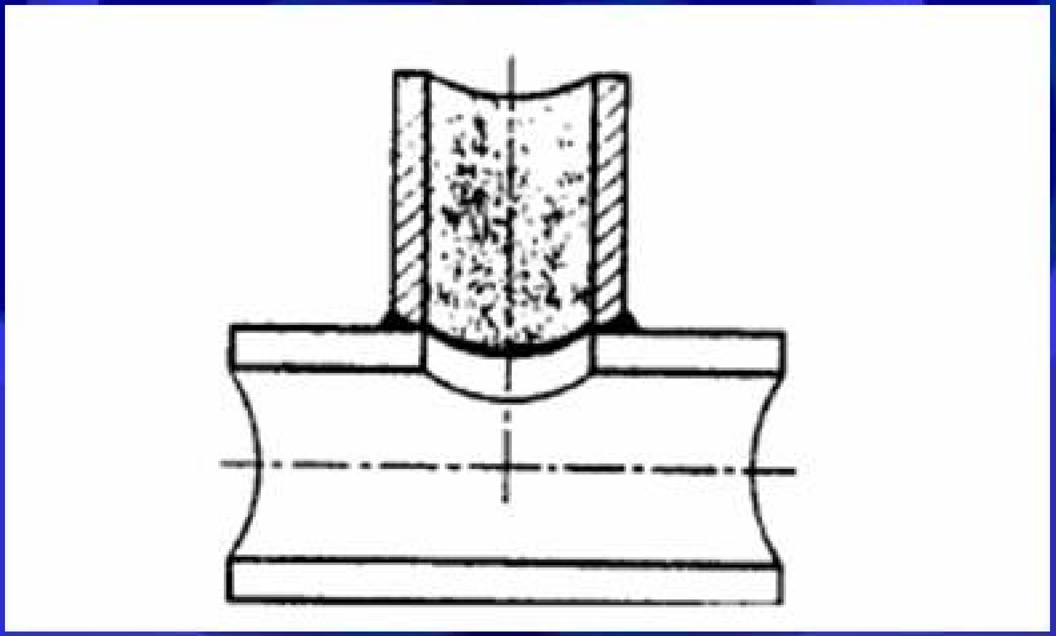
Specifying Size of Butt-Welding Reducing Tee

How to specify TEE	Run Inlet	Run Outlet	Branch	Example
Reducing on Branch	6”	6”	4”	Red Tee 6 x 6 x 4”

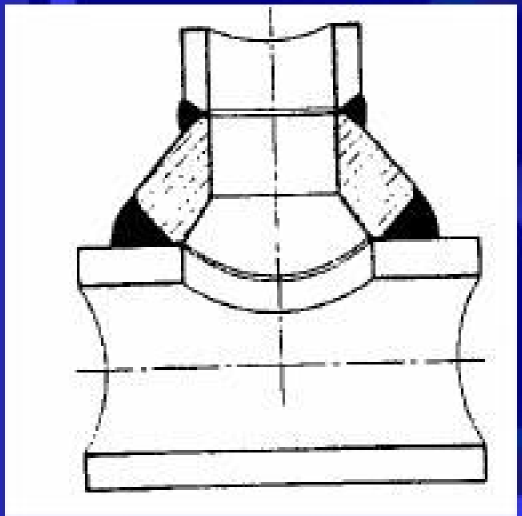
- Cross
  - Straight (branch to the same size as the run)
  - Reducing (rarely used)



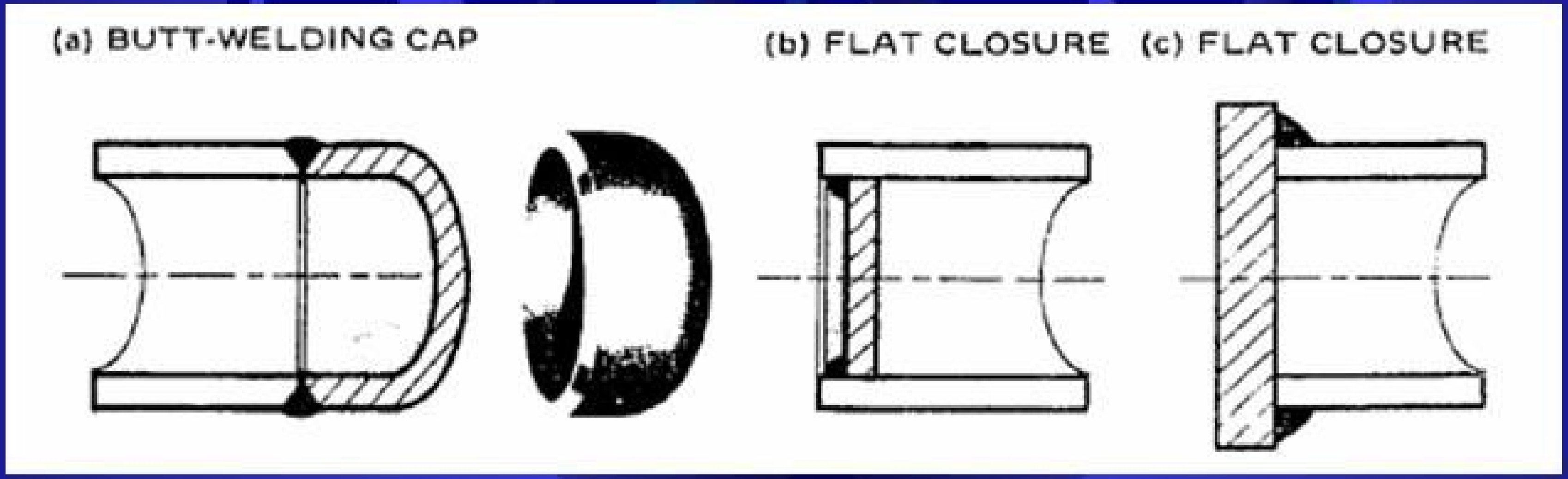
- Stub-in
  - Welded directly in the side of the main pipe run
  - Least expensive
  - NPS ≥ 2”
  - Cab be reinforced



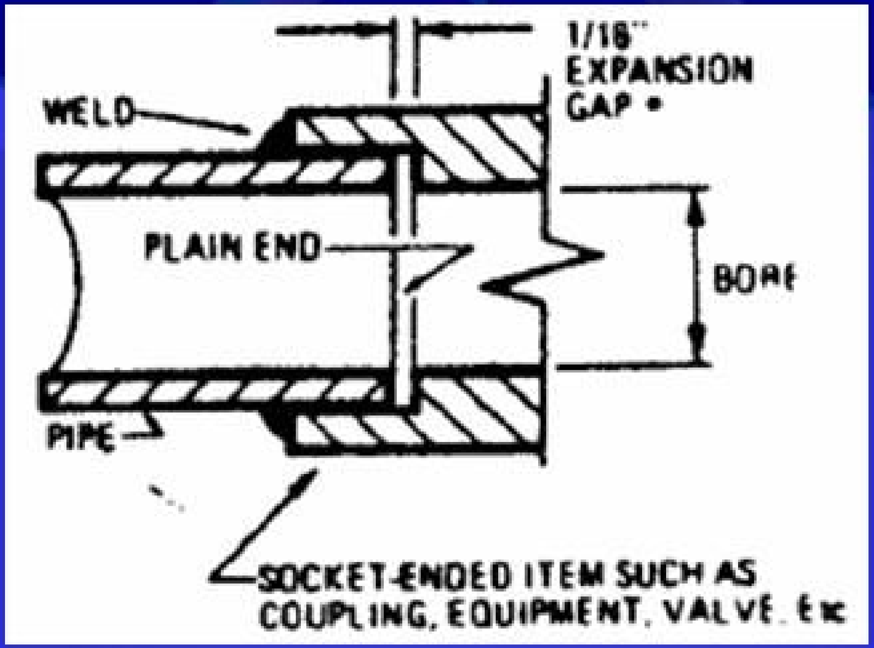
- Weldolet
  - Make a closer manifold that Tee
  - Full size
  - Reducing
  - Flat
    - Are available for connecting to pipe caps and pressure vessel



- Closure
  - Cap
  - Flat closure

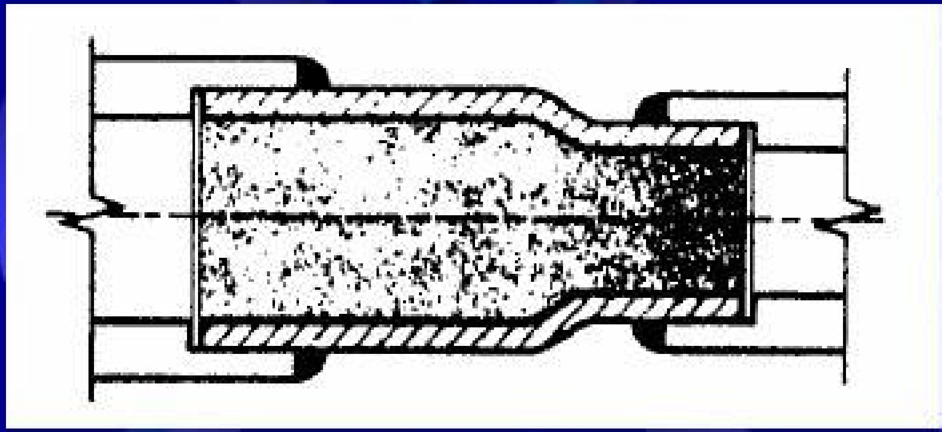


- Size frequently limited to *NPS*≤ *1 ½"* (*ASME* B16.11)
- Not used in "severe cyclic conditions" and in services where corrosion is accelerated in crevices
- No weld metal can enter bore, easier alignment on small line than butt-weld
- Tack is unnecessary
- Have not any leakage

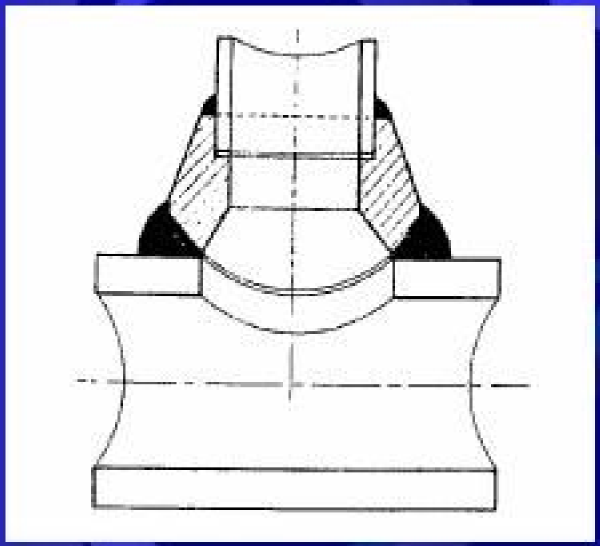


- Return:

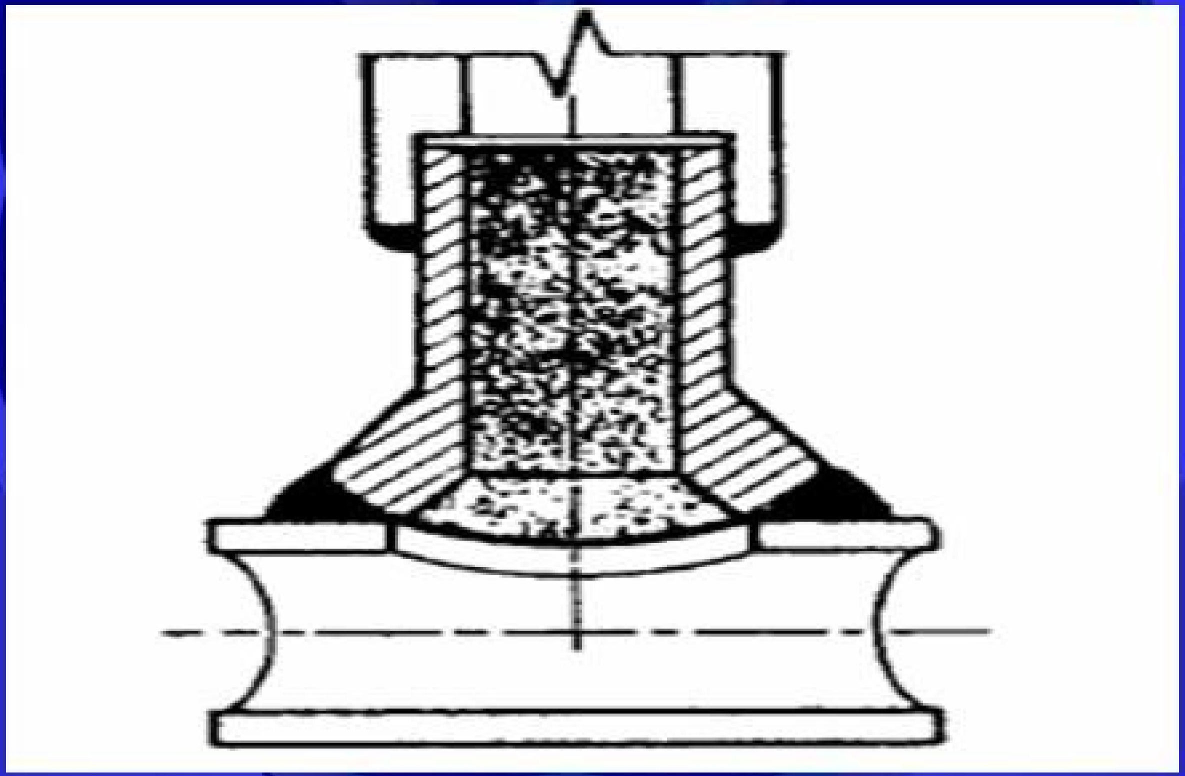
- Sewage :
  - Abrupt change of line size in butt-weld



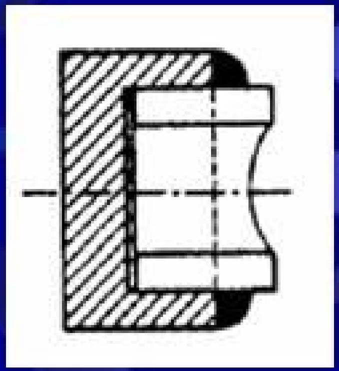
- Sockolet



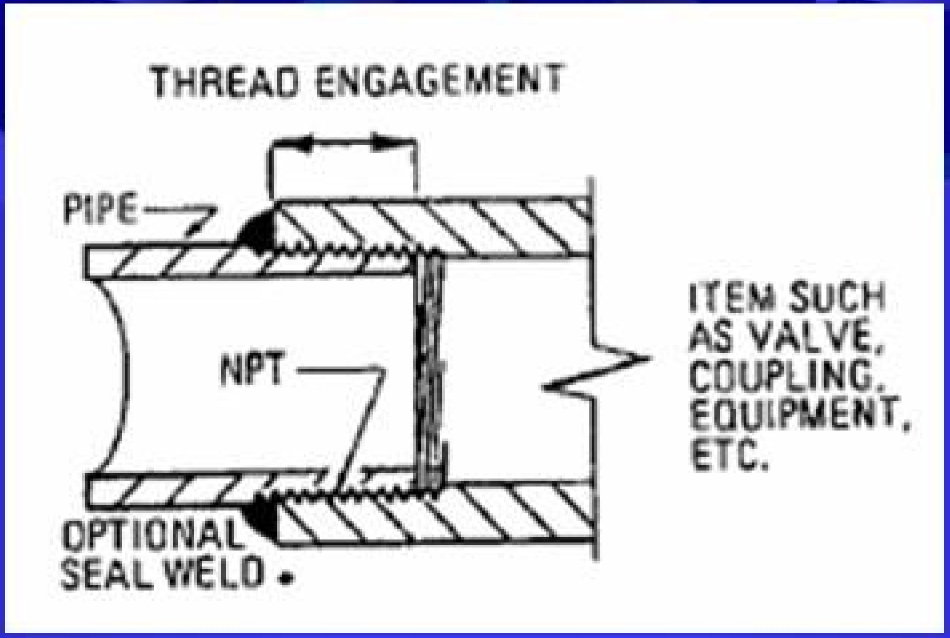
- Socket welding Elbolet
- Socket welding latrolet
- Nippolet



- Cap



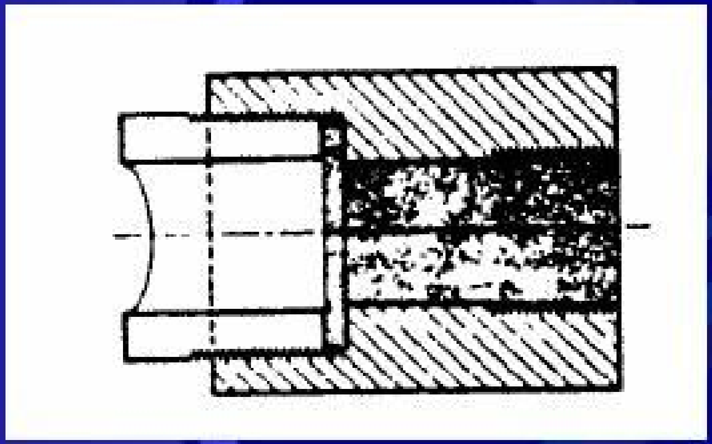
- **Common materials**
  - Gray iron (ASME B16.4)
  - Malleable iron (ASME B16.3)
  - Steel (ASME B16.11)
- ***Non-toxic, non-flammable,* Generally not used where leaks cannot be tolerated**
- ***NPS ≤ 1 ½" , pressure rating < 600, temperature < 625***



Piping components: Fitting (thread)

- Elbow (90, 45)
- Reducing elbow

- Reducer
- Reducer insert



- Tee

Specifying Size of Butt-Welding Reducing Tee

How to specify TEE	Run Inlet	Run Outlet	Branch	Example
Reducing on Branch	6”	6”	4”	Red Tee 6 x 6 x 4”

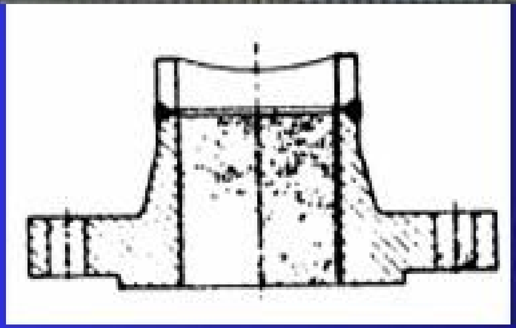
- Closure
  - Cap
  - plug



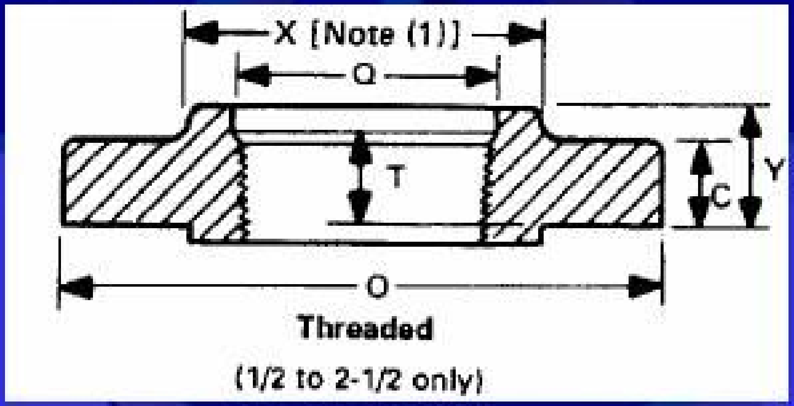
Piping components: Fitting (flange)

- Welding neck flange
  - Regular
  - Long (used for vessel & equipment nozzle, rarely for pipe
- Suitable where
  - Extreme temperature
  - Shear
  - Impact and vibration

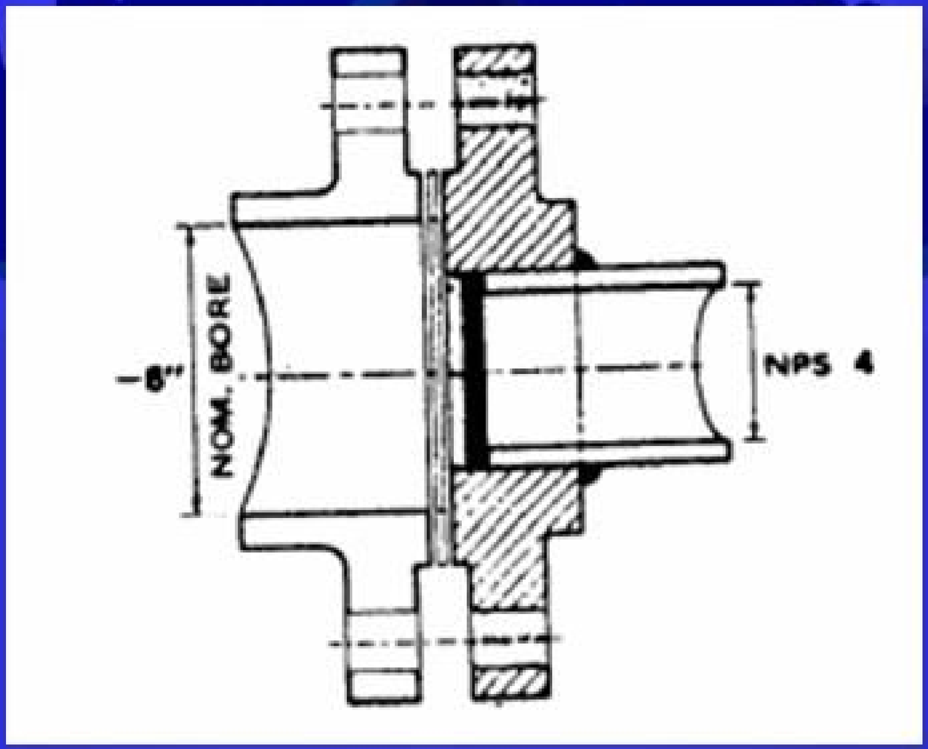
  Stress apply



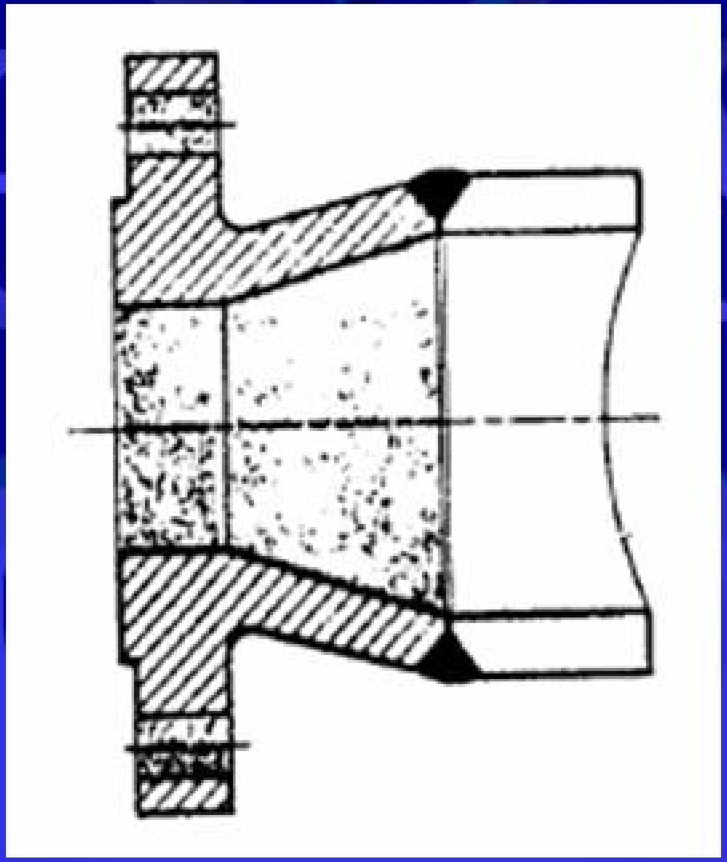
- Threaded flange



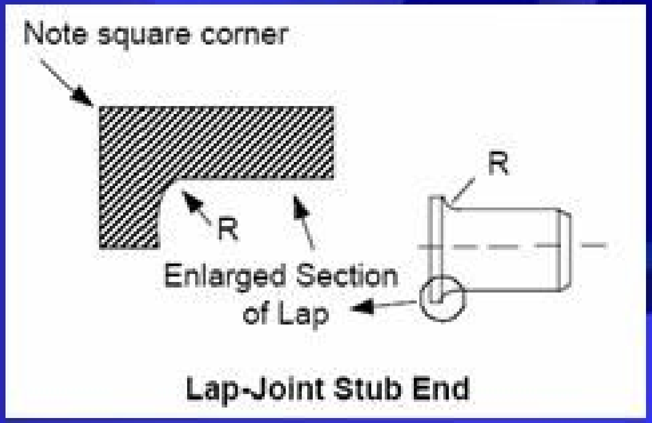
- Reducing flange
  - Specify by size of smaller pipe and outside diameter of flange to be mate
    - Ex/ RED FLG 4” × 11”
  - Should not be used if abrupt transition would create undesirable turbulence as at pump

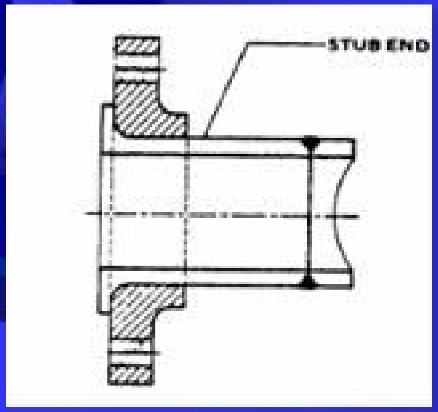


- Expander flange
  - Reducer + welding neck flange
  - Increase pipe size to first or second large size



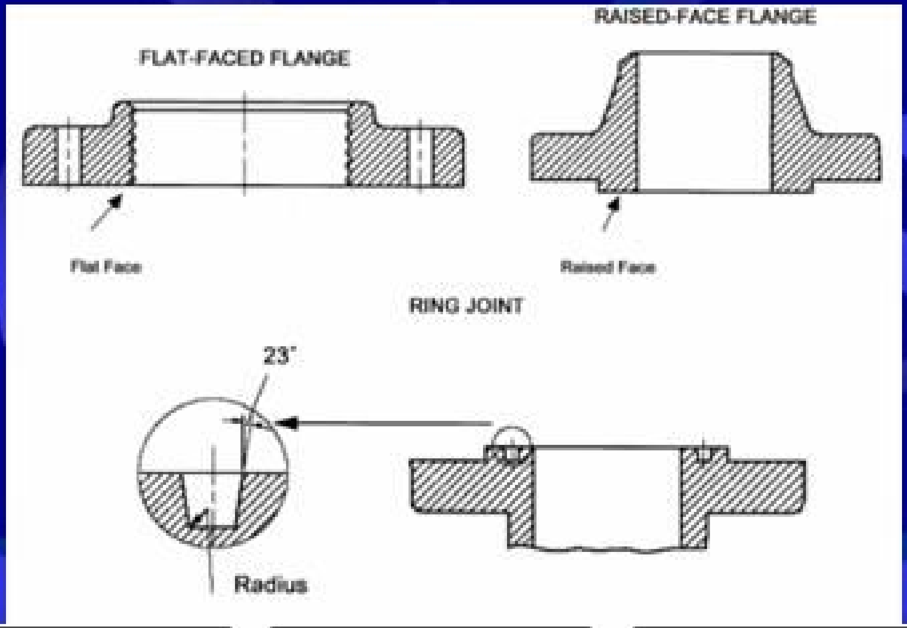
- Lap joint (van stone) flange
  - If stub and flange are of the same material they will be more expensive than a welding neck flange
  - Economical for different material of stub and flange

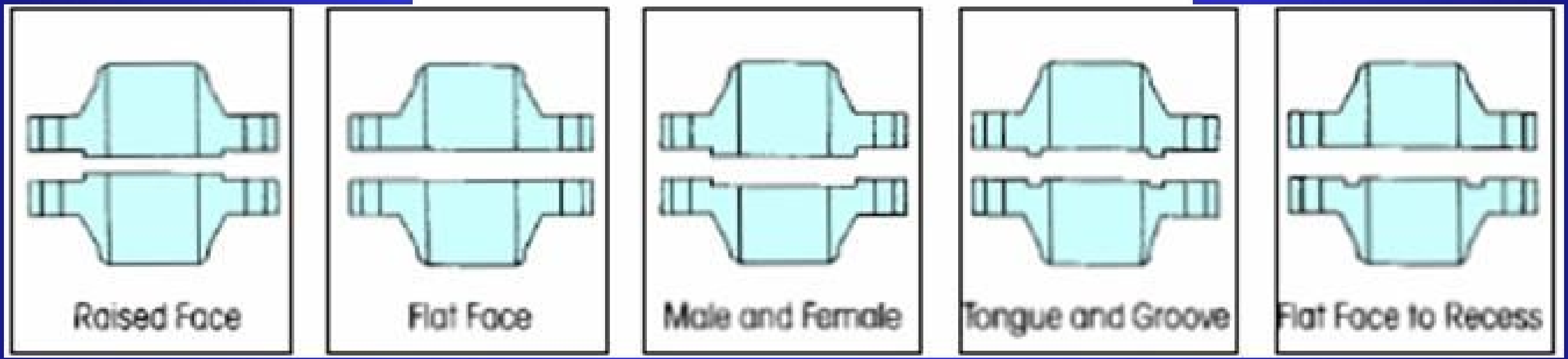




- Flageolet

- Flange Facing Types
  - Flat Faced
  - Raised Face
  - Ring Joint





Flange Rating Class:

- pressure/temperature combinations
- Seven classes (150, 300, 400, 600, 900, 1,500, 2,500)
- Flange strength increases with class number
- The material specifications are grouped within Material Group Numbers.

Material Specification List

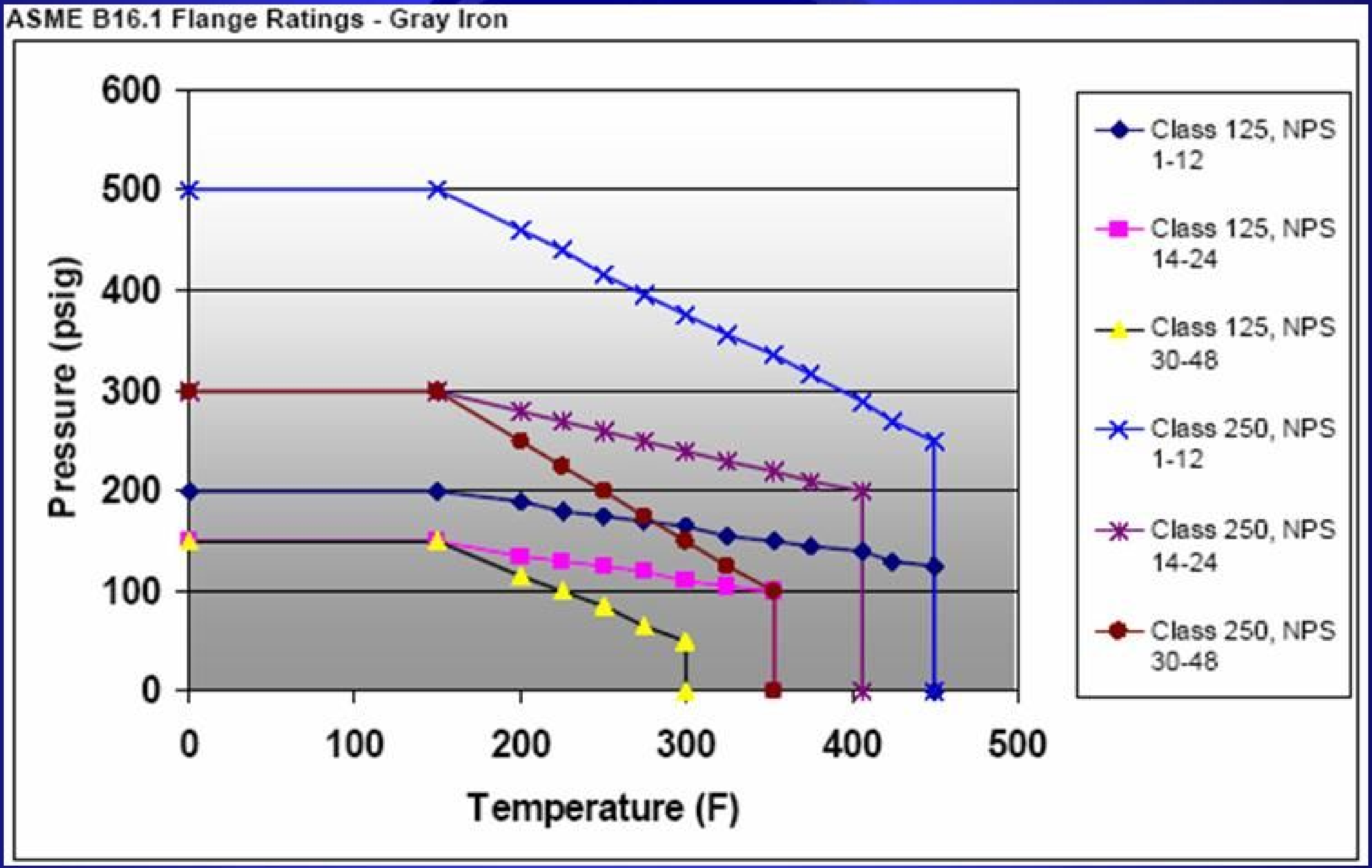
Material Groups		Product Forms					
Material Group Number	Nominal Designation Steel	Forgings		Castings		Plates	
		Spec. No.	Grade	Spec. No.	Grade	Spec. No.	Grade
1.1	Carbon	A105	--	A216	WCB	A515	70
		A350	LF2	--	--	A516	70
	C-Mn-Si	--	--	--	--	A537	Cl.1
1.2	Carbon	--	--	A216	WCC	--	--
		--	--	A352	LCC	--	--
	2½ Ni 3½ Ni	-- A350	-- LF3	A352 A352	LC2 LC3	A203 A203	B E
1.9	1Cr – ½Mo	A182	F12	--	--	--	--
	1¼ Cr – ½Mo	--	--	A217	WC6	--	--
	1¼ Cr – ½Mo - Si	A182	F11	--	--	A387	11
1.10	2¼ Cr – 1Mo	A182	F22	A217	WC9	A387	22

Pressure - Temperature Ratings

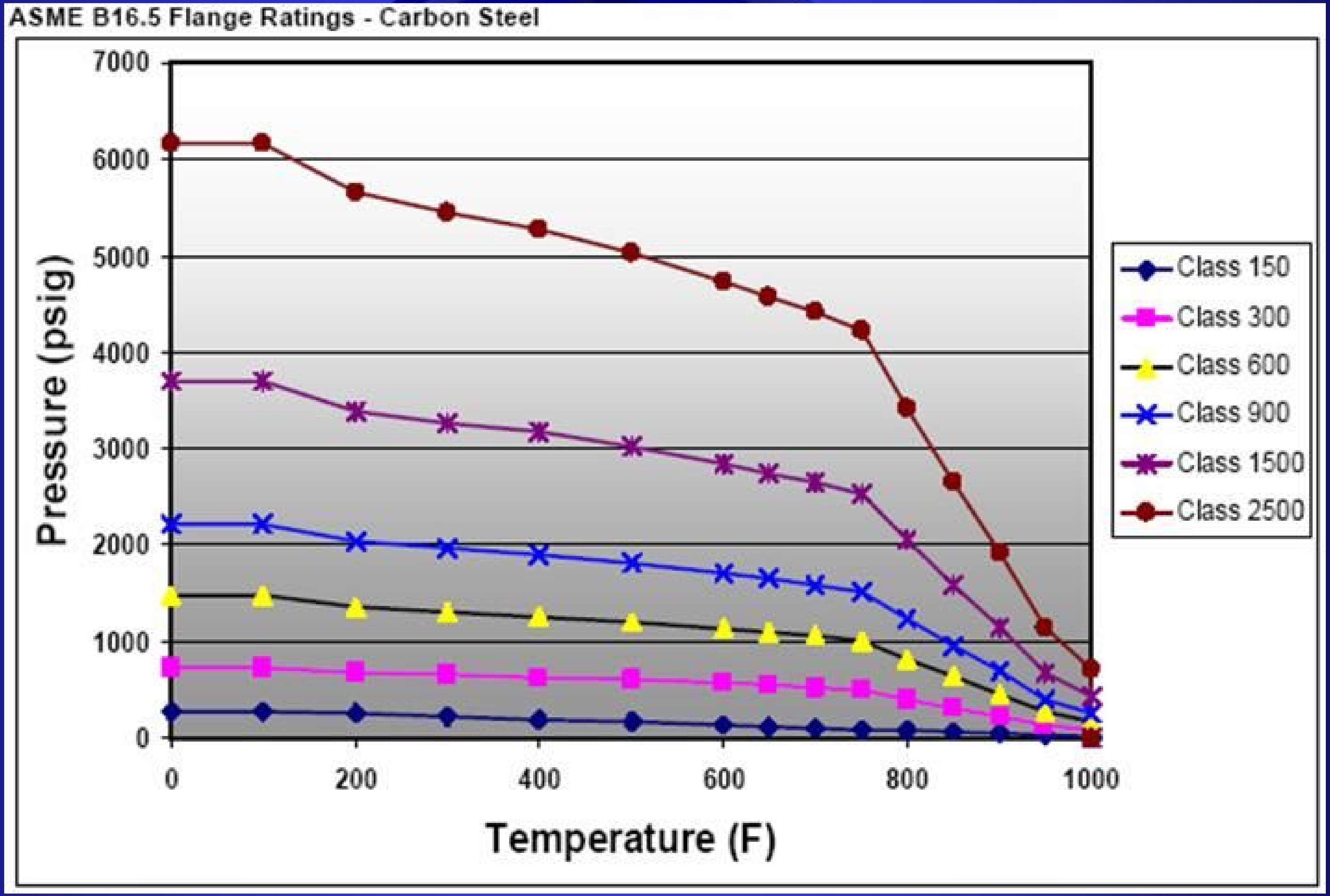
Material Group No.	1.8			1.9			1.10		
Classes	150	300	400	150	300	400	150	300	400
Temp., °F									
-20 to 100	235	620	825	290	750	1000	290	750	1000
200	220	570	765	260	750	1000	260	750	1000
300	215	555	745	230	720	965	230	730	970
400	200	555	740	200	695	885	200	705	940
500	170	555	740	170	695	805	170	665	885
600	140	555	740	140	605	785	140	605	805
650	125	555	740	125	590	785	125	590	785
700	110	545	725	110	570	710	110	570	755
750	95	515	685	95	530	675	95	530	710
800	80	510	675	80	510	650	80	510	675
850	65	485	650	65	485	600	65	485	650
900	50	450	600	50	450	425	50	450	600
950	35	320	425	35	320	290	35	375	505
1000	20	215	290	20	215	190	20	260	345

- Material and design temperature combinations that do not have a pressure indicated are not acceptable.

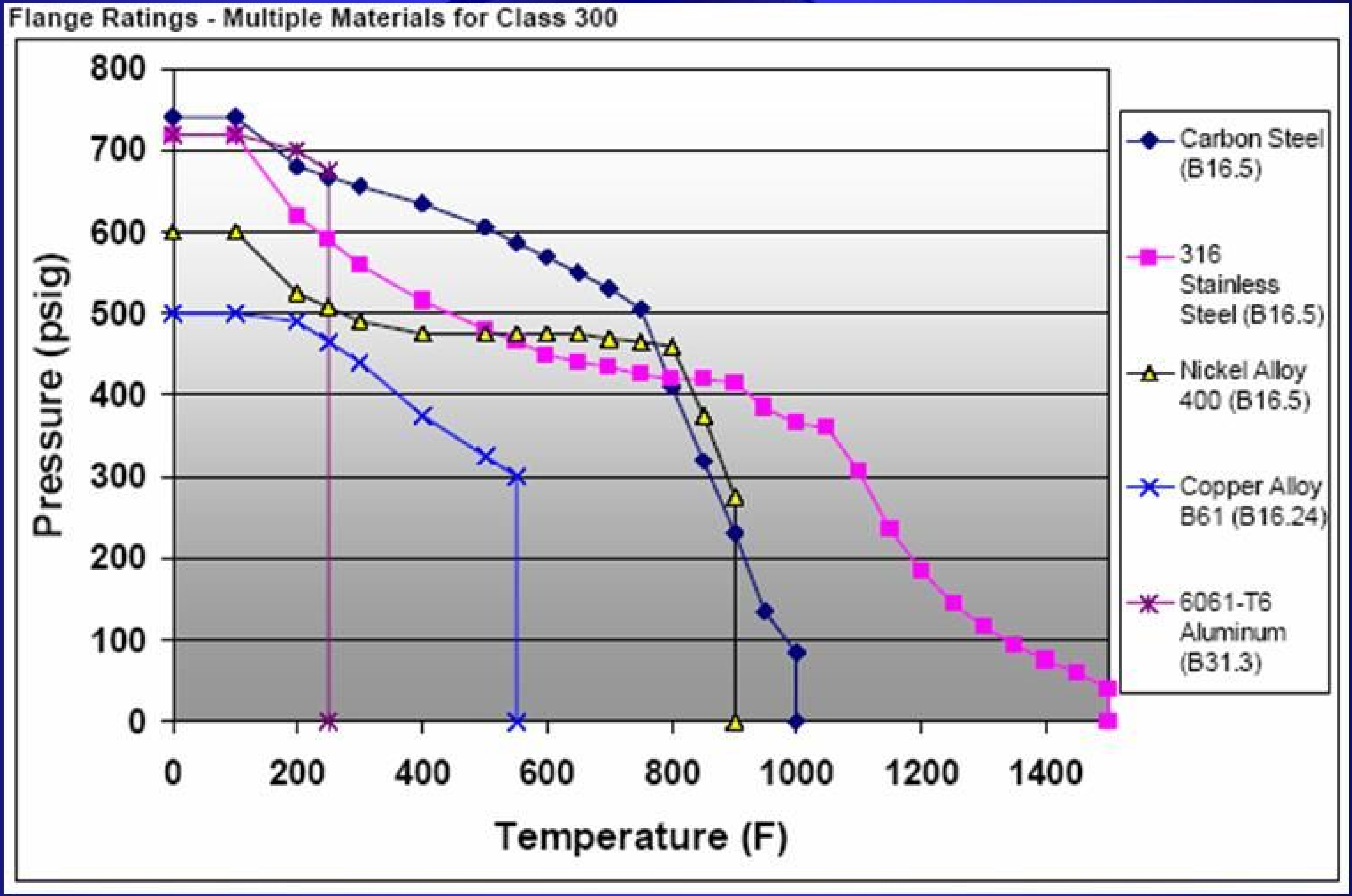
Flange Rating Class



Flange Rating Class



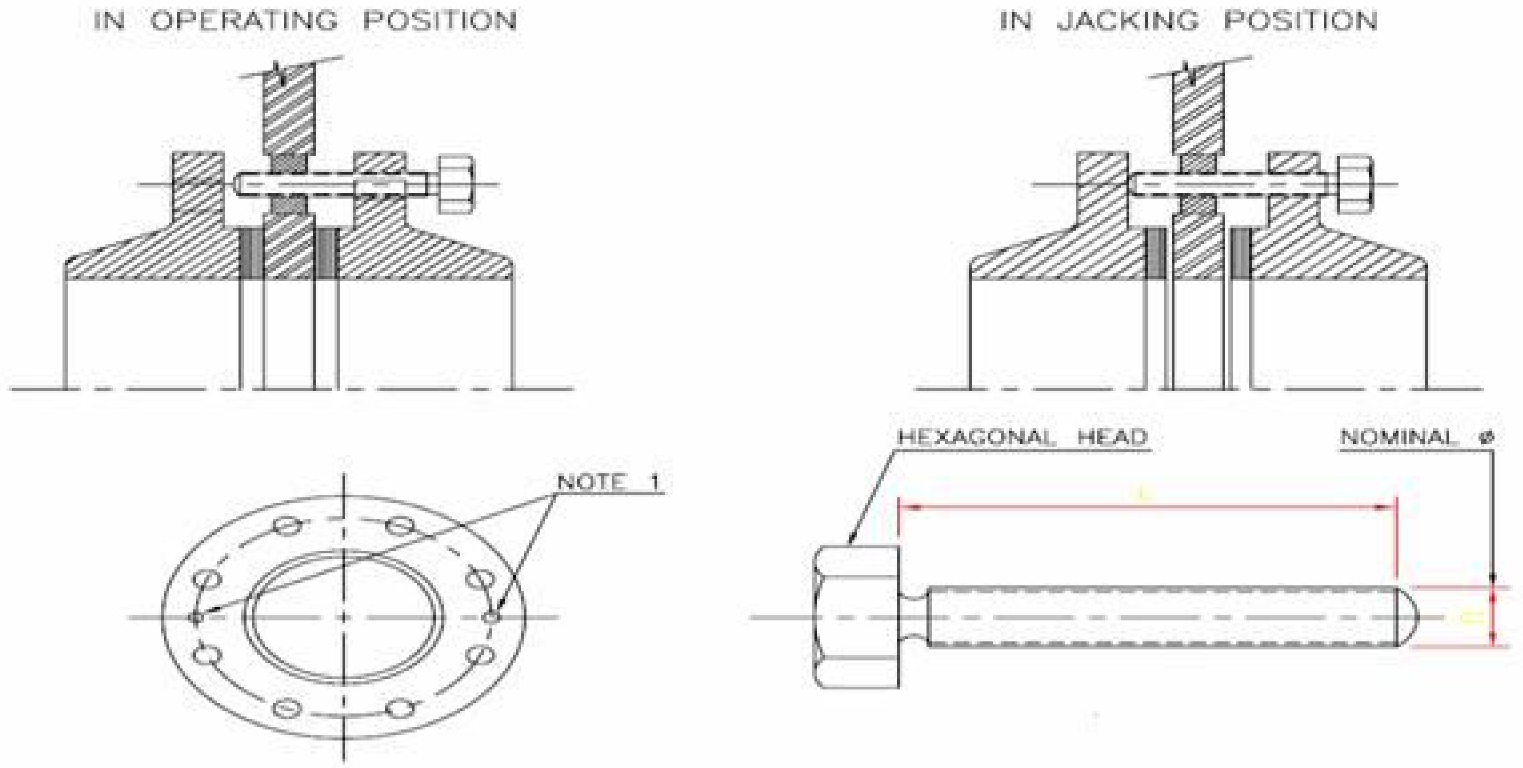
Flange Rating Class



Equipment Nozzle Load standards and Parameters

Equipment Item	Industry Standard	Parameters Used To Determine Acceptable Loads
Centrifugal Pumps	API 610	Nozzle size
Centrifugal Compressors	API 617, 1.85 times NEMA SM-23 allowable	Nozzle size, material
Air-Cooled Heat Exchangers	API 661	Nozzle size
Pressure Vessels, Shell-and-Tube Heat Exchanger Nozzles	ASME Code Section VIII, WRC 107, WRC 297	Nozzle size, thickness, reinforcement details, vessel/exchanger diameter, and wall thickness. Stress analysis required.
Tank Nozzles	API 650	Nozzle size, tank diameter, height, shell thickness, nozzle elevation.
Steam Turbines	NEMA SM-23	Nozzle size

Flange with jack screw



NOM. ø	150# RF		300# RF		600# RF	
	L	D	L	D	L	D
3"	NOT REQ'D				100	20
4"					110	20
6"	80	20	100	20	120	20
8"	90	20	110	20	140	20
10"	90	20	120	20	150	20
12"	100	20	130	20	160	20
14"	110	20	140	20	170	20
16"	110	20	160	20	190	20
18"	120	20	160	20	200	20
20"	120	20	170	20	210	20
24"	140	20	180	20	240	20
26"	140	20	180	20	250	20
28"	140	20	190	20	250	20
30"	160	20	200	20	270	20

Piping components: Fitting (piping specification)

PIPING SPECIFICATION

SHEET 2 OF 23

AISI 304 SS	ANSI 150 # CLASS	CLASS 304-1

TEMPERATURE RANGE
from -29°C to 427°C

<table>
<tr><th colspan="3">Nominal Pipe Size (in)</th><th>½</th><th>¾</th><th>1</th><th>1½</th><th>2</th><th>2½</th><th>3</th><th>4</th><th>6</th><th>8</th><th>10</th><th>12</th><th>14</th><th>16</th><th>18</th><th>20</th><th>24</th><th>28</th><th>32</th><th>36</th></tr>
<tr><td rowspan="4">PIPE (8)</td><td colspan="2">THK.</td><td colspan="4">Sch. 40S, P.E.</td><td colspan="8">Sch. 10S, B.E.</td><td colspan="5">6.3 mm , B.E.</td><td colspan="3"></td></tr>
<tr><td colspan="2">TYPE</td><td colspan="17">EFW</td><td colspan="3"></td></tr>
<tr><td colspan="2">STANDARD</td><td colspan="17">ANSI B36.19 / ANSI B1.20.1</td><td colspan="3"></td></tr>
<tr><td colspan="2">MATERIAL</td><td colspan="12">ASTM A312-TP304</td><td colspan="5">ASTM A358, C1.2, 304</td><td colspan="3"></td></tr>
<tr><td rowspan="11">FLANGES</td><td rowspan="4">LINES</td><td>TYPE</td><td colspan="17">WELD NECK</td><td colspan="3"></td></tr>
<tr><td>CLASS</td><td colspan="17">ANSI 150#, RF</td><td colspan="3"></td></tr>
<tr><td>MATERIAL</td><td colspan="17">A182 F304</td><td colspan="3"></td></tr>
<tr><td>SIZE</td><td colspan="17">ANSI B16.5</td><td colspan="3"></td></tr>
<tr><td rowspan="3">BLINDS</td><td>CLASS</td><td colspan="17">ANSI 150#, RF</td><td colspan="3"></td></tr>
<tr><td>MATERIAL</td><td colspan="17">ASTM A182-F304</td><td colspan="3"></td></tr>
<tr><td>SIZE</td><td colspan="17">ANSI B16.5</td><td colspan="3"></td></tr>
<tr><td rowspan="4">ORIFICE</td><td>TYPE</td><td colspan="4"></td><td colspan="13">Welding Neck</td><td colspan="3"></td></tr>
<tr><td>CLASS</td><td colspan="4"></td><td colspan="13">ANSI 300RF</td><td colspan="3"></td></tr>
<tr><td>MATERIAL</td><td colspan="4"></td><td colspan="13">ASTM A182-F304</td><td colspan="3"></td></tr>
<tr><td>BORE</td><td colspan="4"></td><td colspan="13">Same I.D. of attached pipe</td><td colspan="3"></td></tr>
<tr><td>IGS</td><td colspan="2">TYPE</td><td colspan="4">Socket Weld, Seamless</td><td colspan="13">Buttweld, Seamless</td><td colspan="3"></td></tr>
</table>

Piping components: Fitting (gasket)

FITTIN		CLASS	Cl. 3000	Thk. not less than pipe	
FITTIN		MATERIAL	ASTM A182-F304	ASTM A403-WP304	
COUPL		TYPE	Socket Weld C1.3000		
COUPL		MATERIAL	ASTM A182-F304		
PIPE BENDS (6)			ASTM A182-F304 Seamless	ASTM A403-WP304, Seamless	Welded ASTM A358 C1.1 304
BOLTING			Alloy Studs ASTM A-193-B7; semifinished, heavy series hex nuts, ASTM A194-2H		
GASKETS			See Note (4) (8)		
VALVES	GATE & GLOBE	TYPE	Socket weld	Flanged	
VALVES	GATE & GLOBE	CLASS	800#	ANSI 150# RF	
VALVES	GATE & GLOBE	MATERIAL	A182F 304	ASTM A351-CF8	
VALVES	BALL (7)	TYPE	Socket weld	ANSI 150#	
VALVES	BALL (7)	CLASS	800#	150 #	
VALVES	BALL (7)	MATERIAL	A182F 304	ASTM A351-CF8	
VALVES	CHECK	TYPE	Socket weld (Swing)	Flanged (Swing)	
VALVES	CHECK	CLASS	800#	ANSI 150 RF	
VALVES	CHECK	MATERIAL	A182F 304	ASTM A351-CF8	
VALVES	PLUG	TYPE	Flanged (Sleeved)		
VALVES	PLUG	CLASS	ANSI 150# RF		
VALVES	PLUG	MATERIAL	ASTM A351-CF8 (3)		
VALVES	FLUSH ANGLE	TYPE	Flanged		
VALVES	FLUSH ANGLE	CLASS	ANSI 150# RF		
VALVES	FLUSH ANGLE	MATERIAL	ASTM A351-CF8 (3)		

Piping components: Fitting (branch connection chart)

PIPING CLASSES

CLASS Nr : D1A

BRANCH CONNECTION CHART

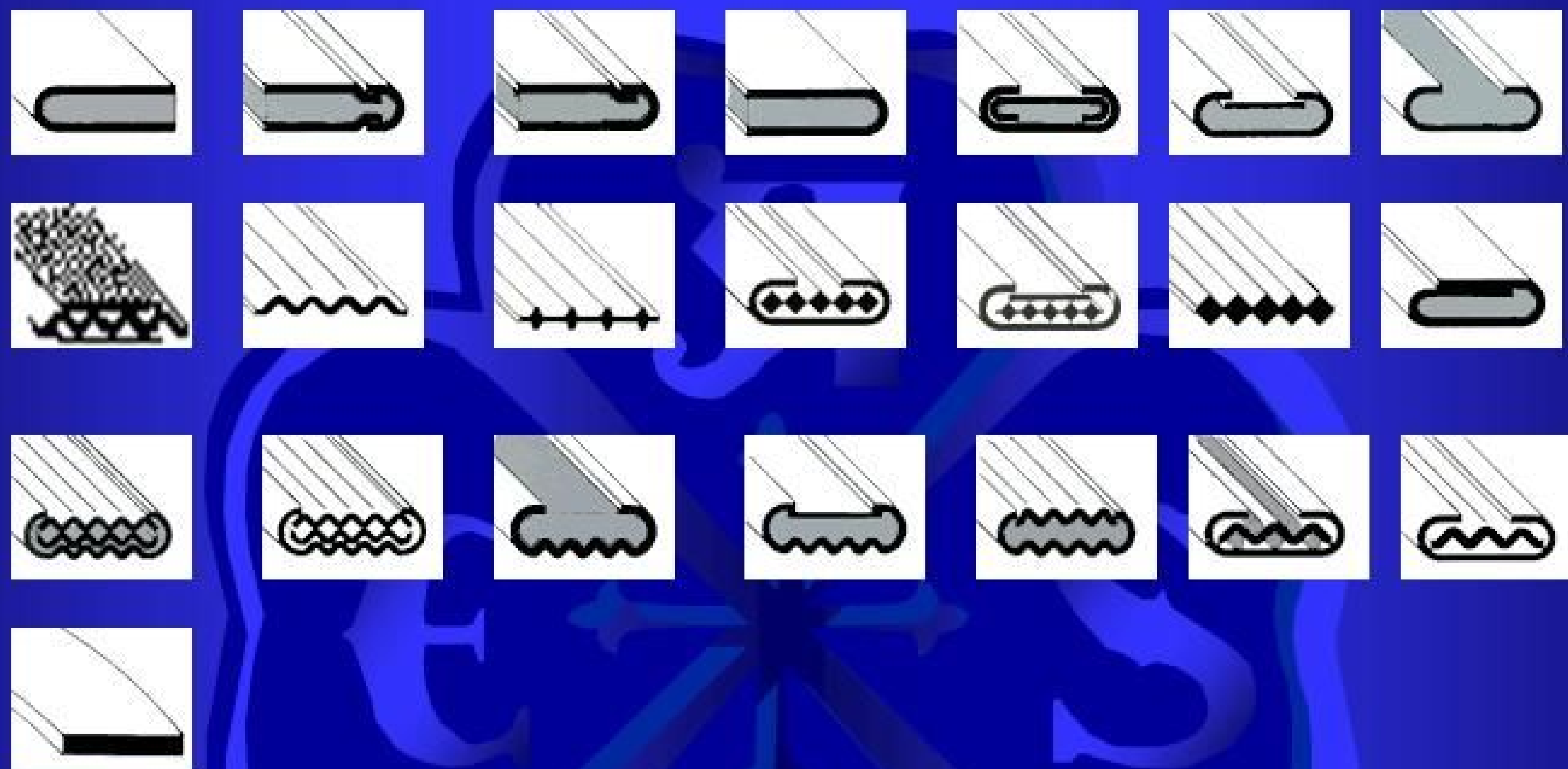
BRANCH SIZE	HEADER SIZE 4"	3"	2"	1½"	1"	¾"	½"
½"	TH	TH	TH	SRT	SRT	SRT	SET
¾"	TH	TH	TH	SRT	SRT	SET	
1"	TH	TH	TH	SRT	SET		
1½"	TH	TH	TH	SET			
2"	RT	RT	ET				
3"	RT	ET					
4"	ET						

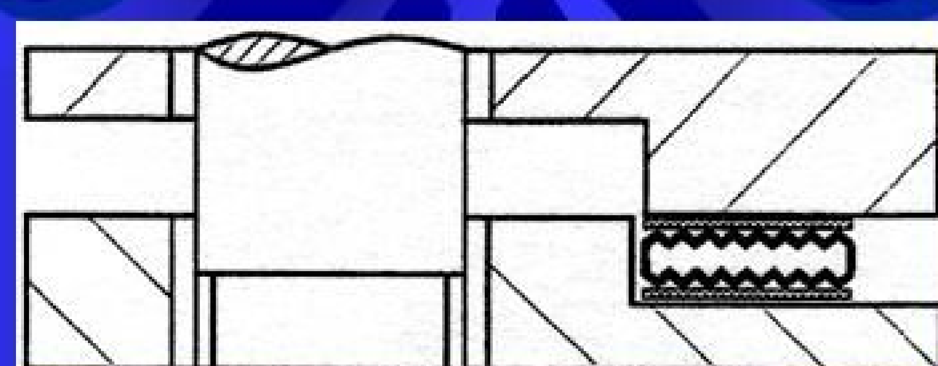
SET = SCREWED EQUAL TEE
ET = B.W. EQUAL TEE
SRT = SCREWED REDUCING TEE
TH = THREADOLET OR NIPOLET OR FLANGOLET (AS APPLICABLE)
RT = REDUCED B.W. TEE

- Gasket:
  - Resilient material
  - Inserted between flanges
  - Compressed by bolts to create seal
  - Commonly used types
    - Sheet
    - Spiral wound
    - Solid metal ring
    - Insulation gasket

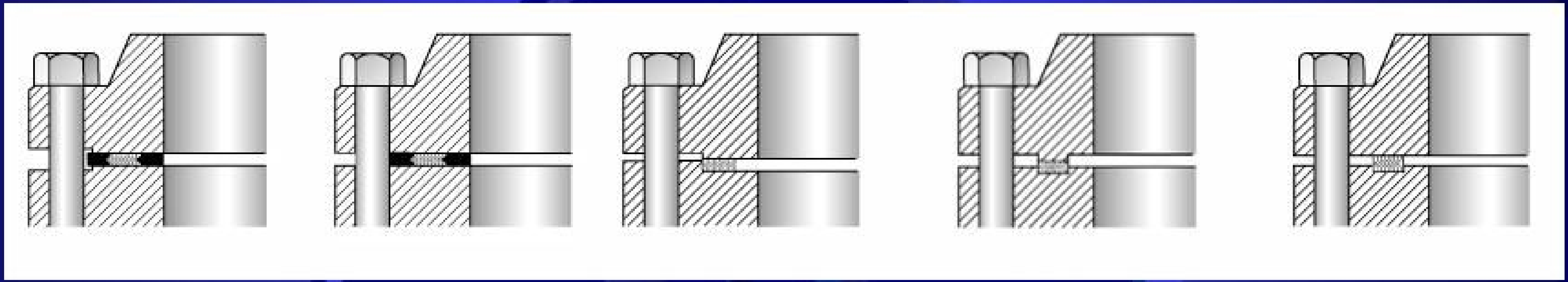
Piping components: Fitting (gasket)

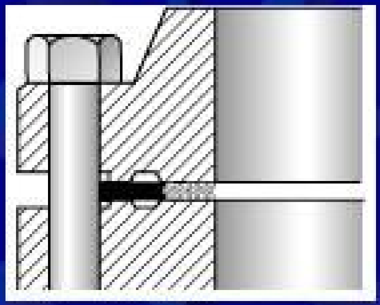
- Sheet

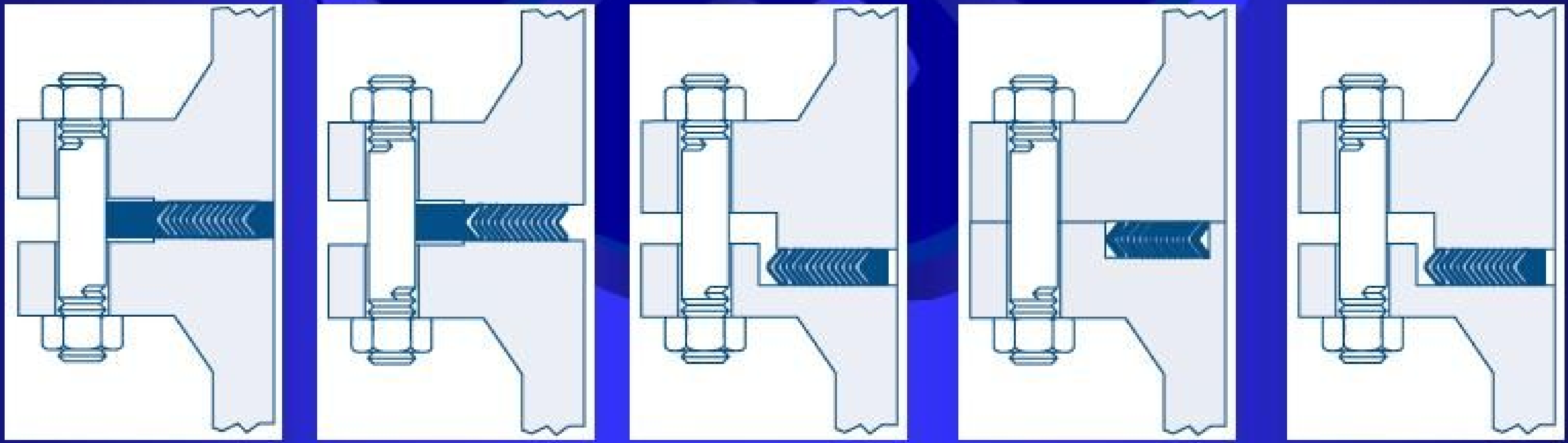




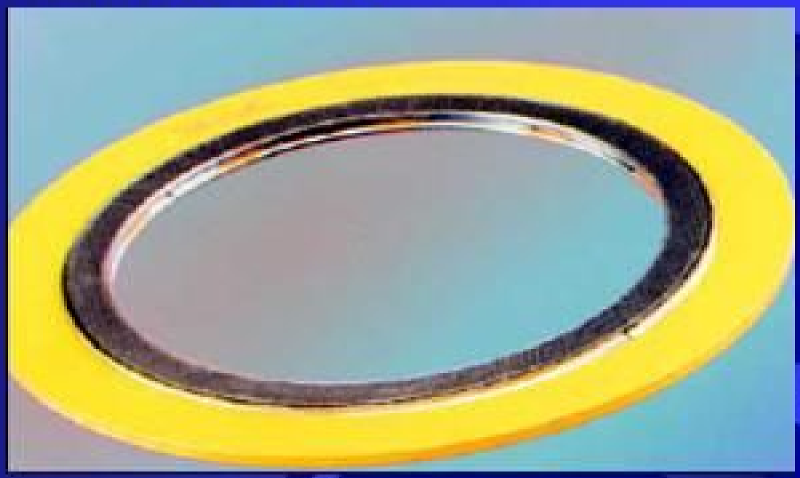
- Sheet

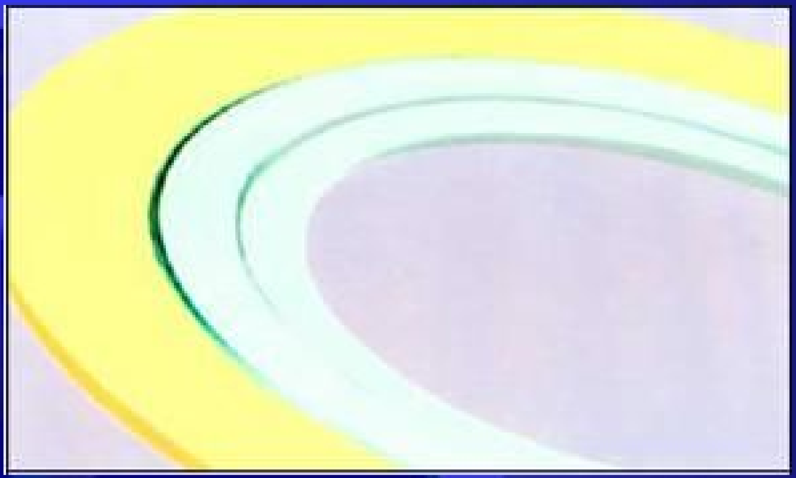


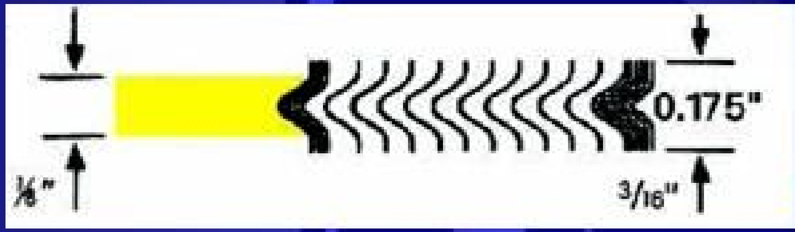


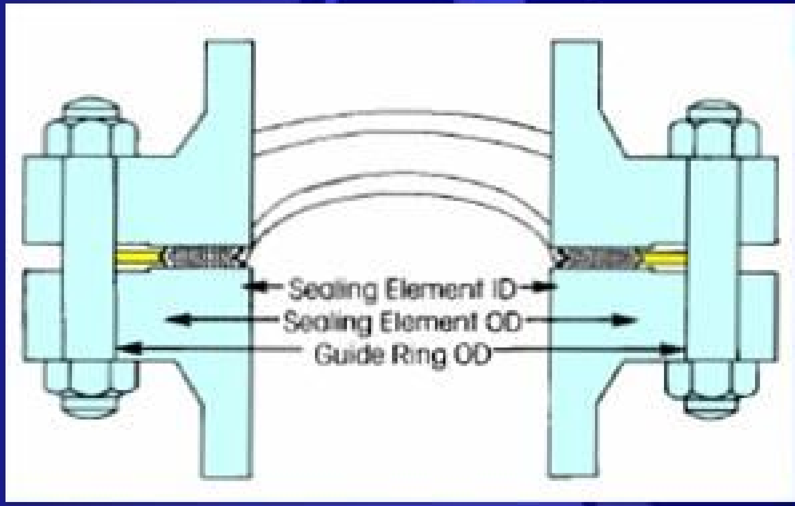


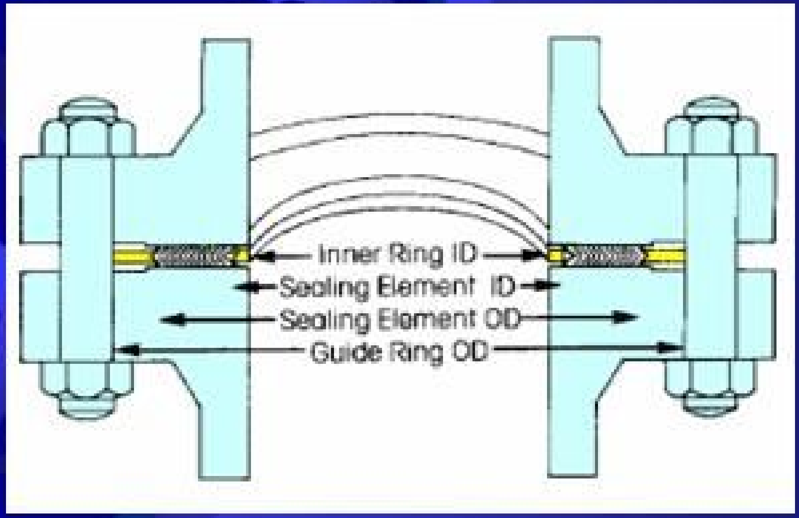
- Spiral wound

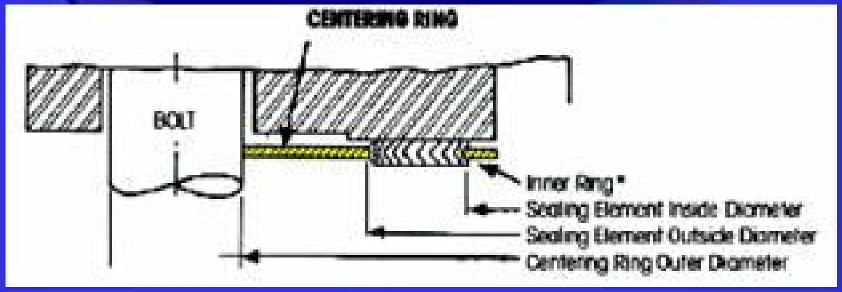






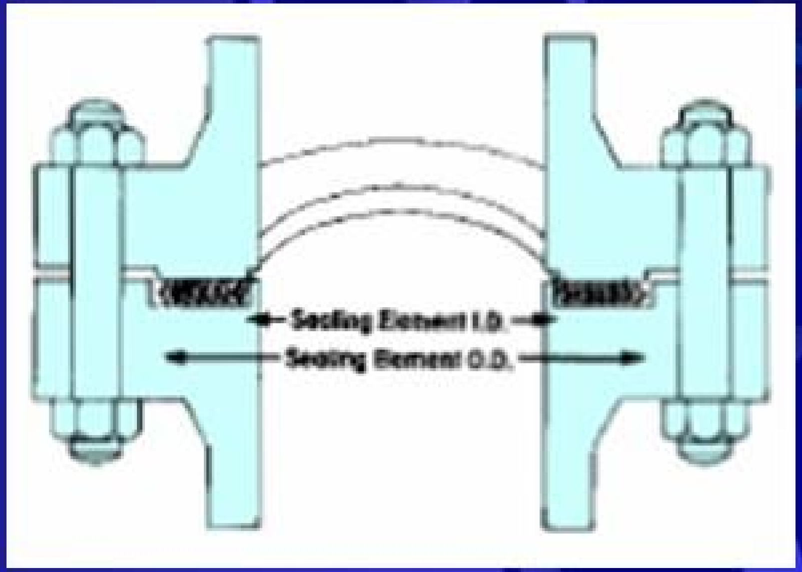


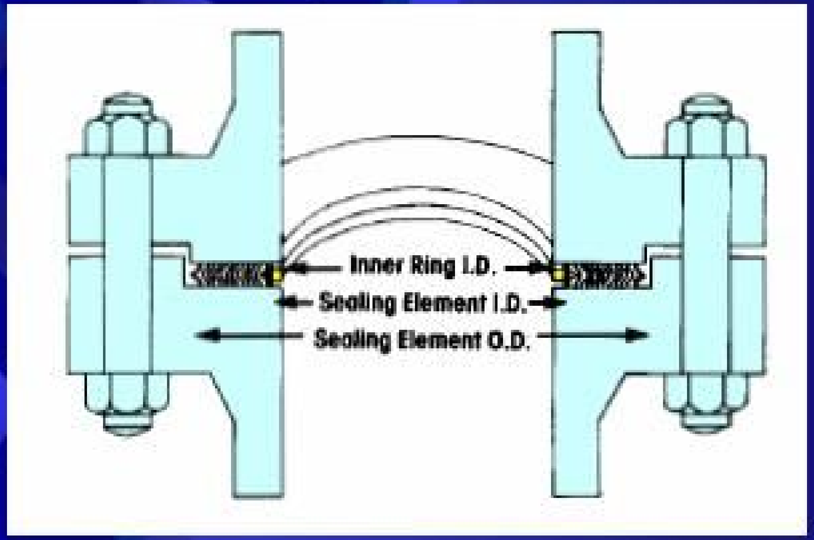


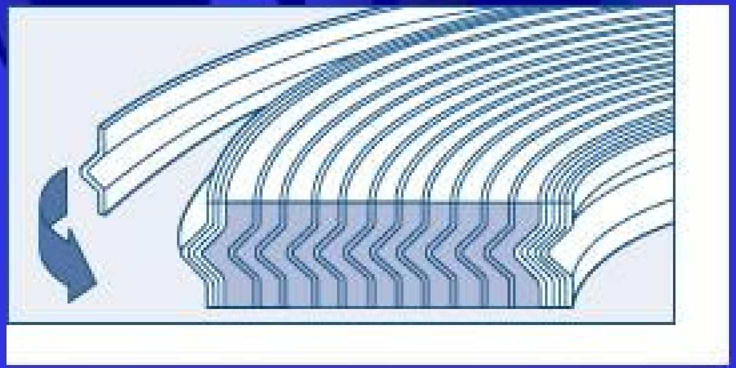


- Spiral wound

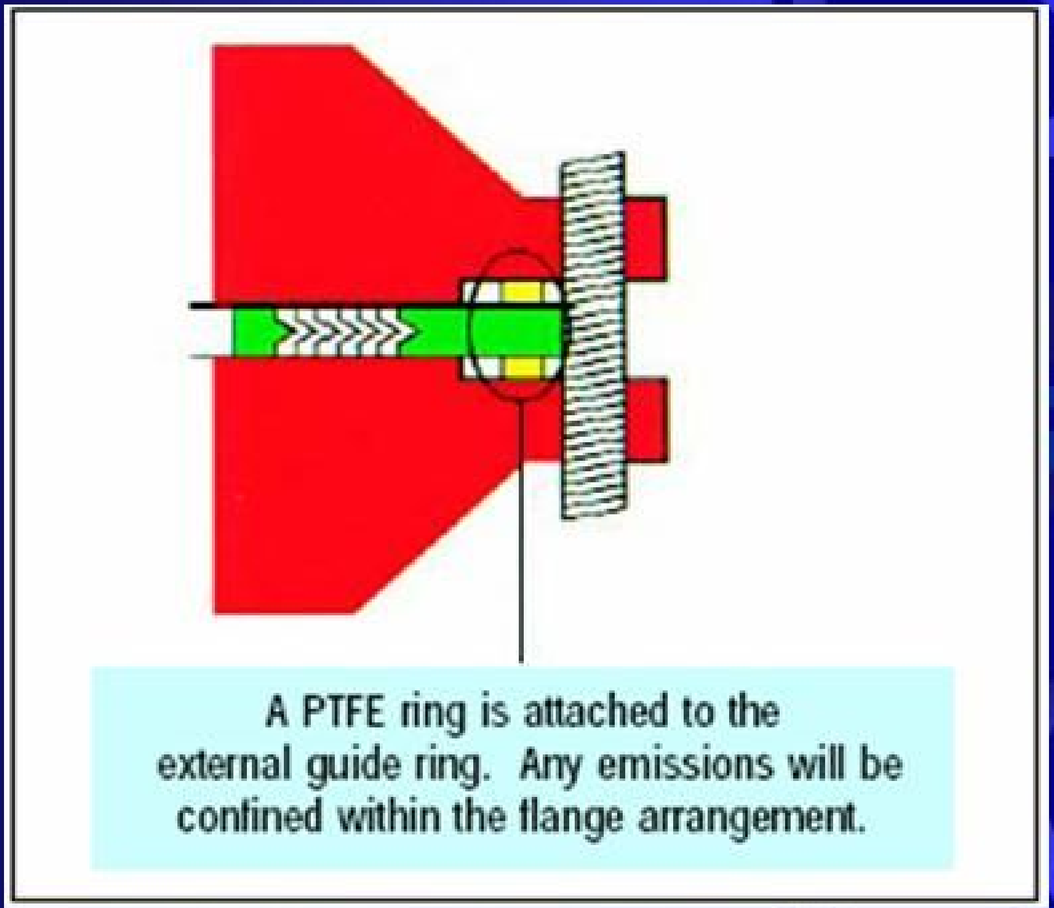


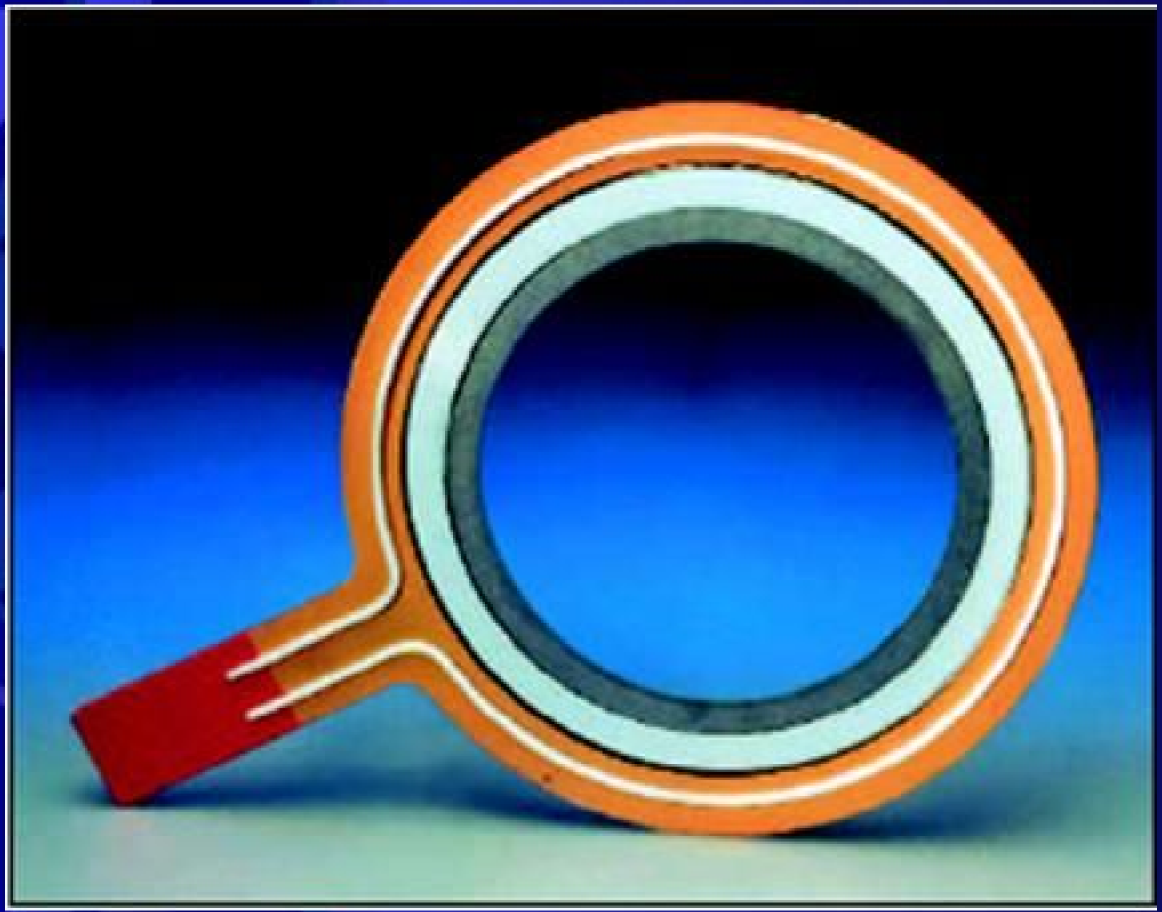




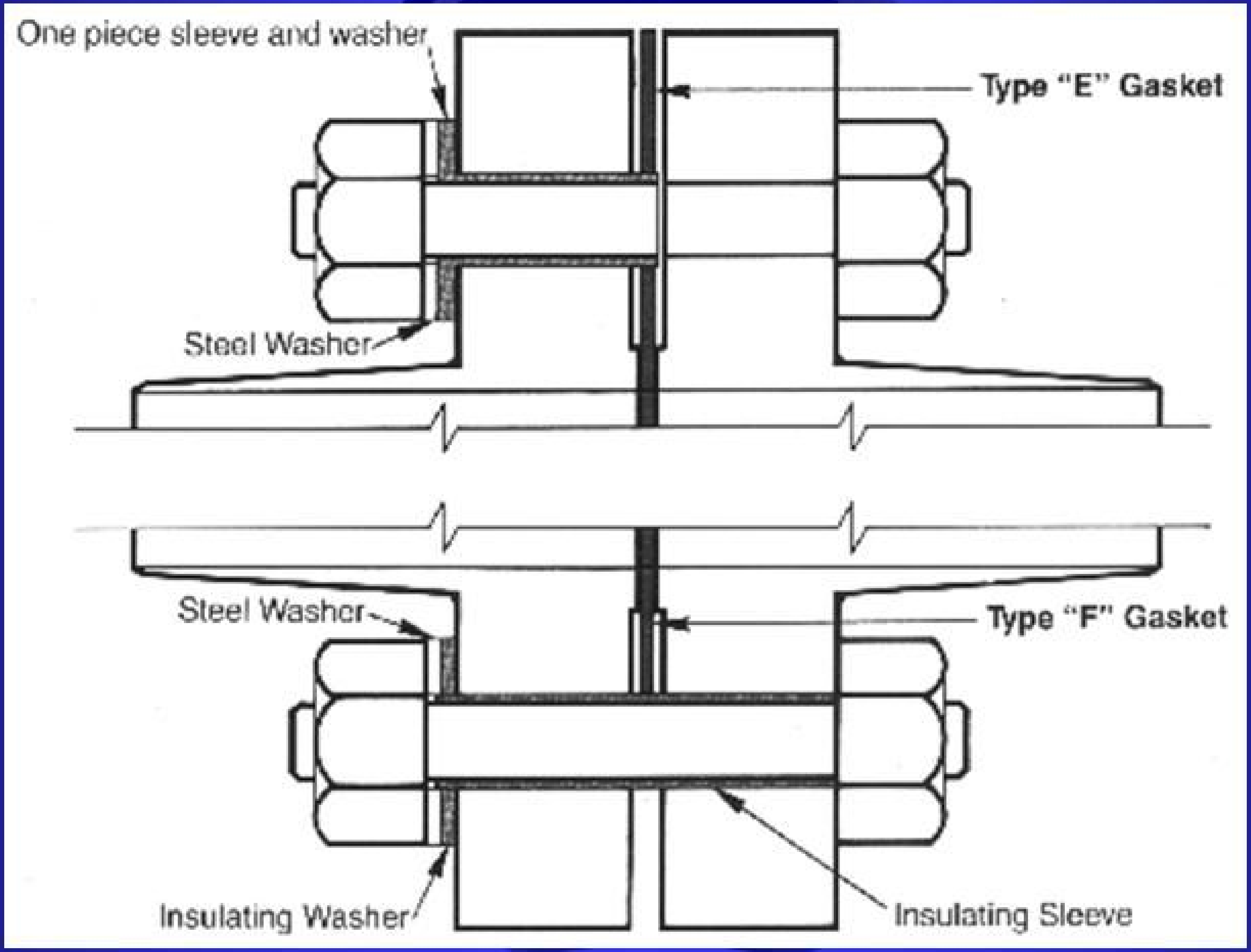


- Spiral wound

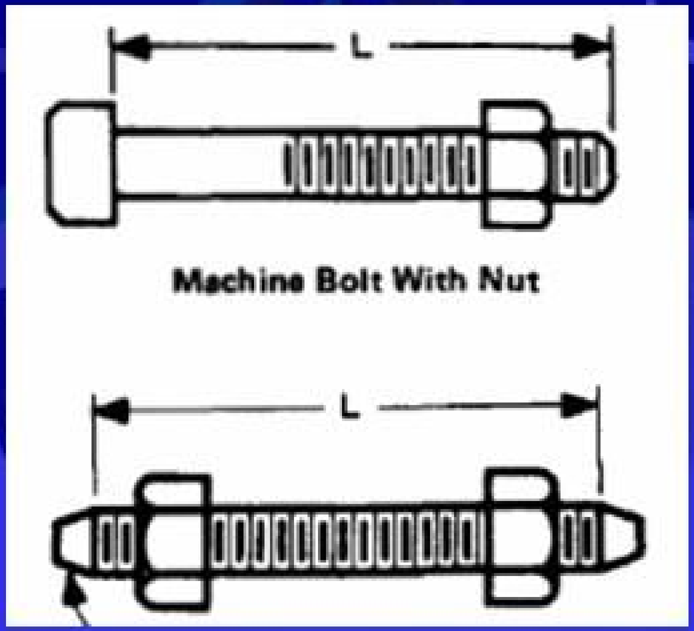




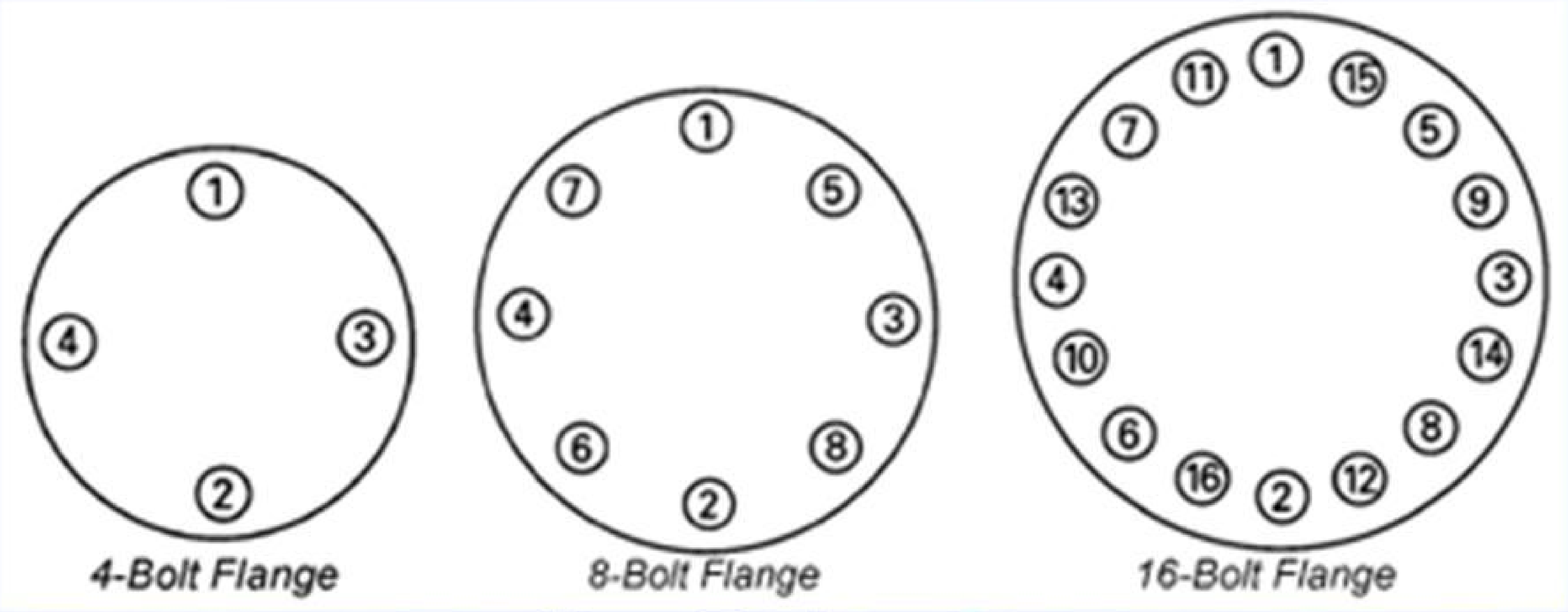
- Insulation gasket



- Bolt type:
  - Stud bolt
    - Easily remove if corroded
    - Material can be readily made
  - Machine bolt
- Has to be strong enough to seat the gasket

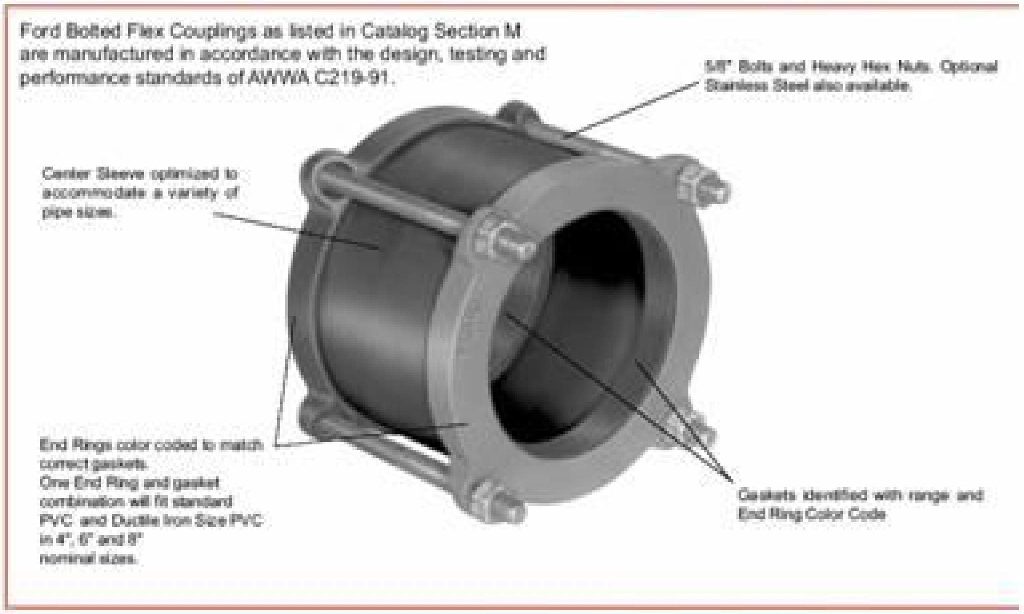


- Tightening arrangement

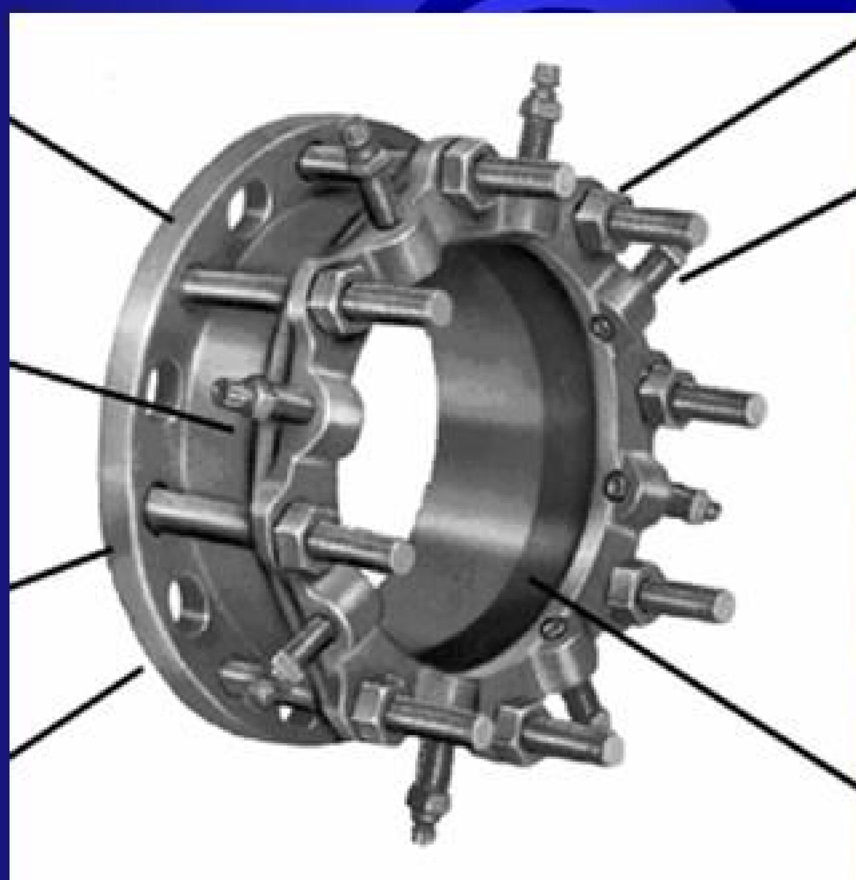


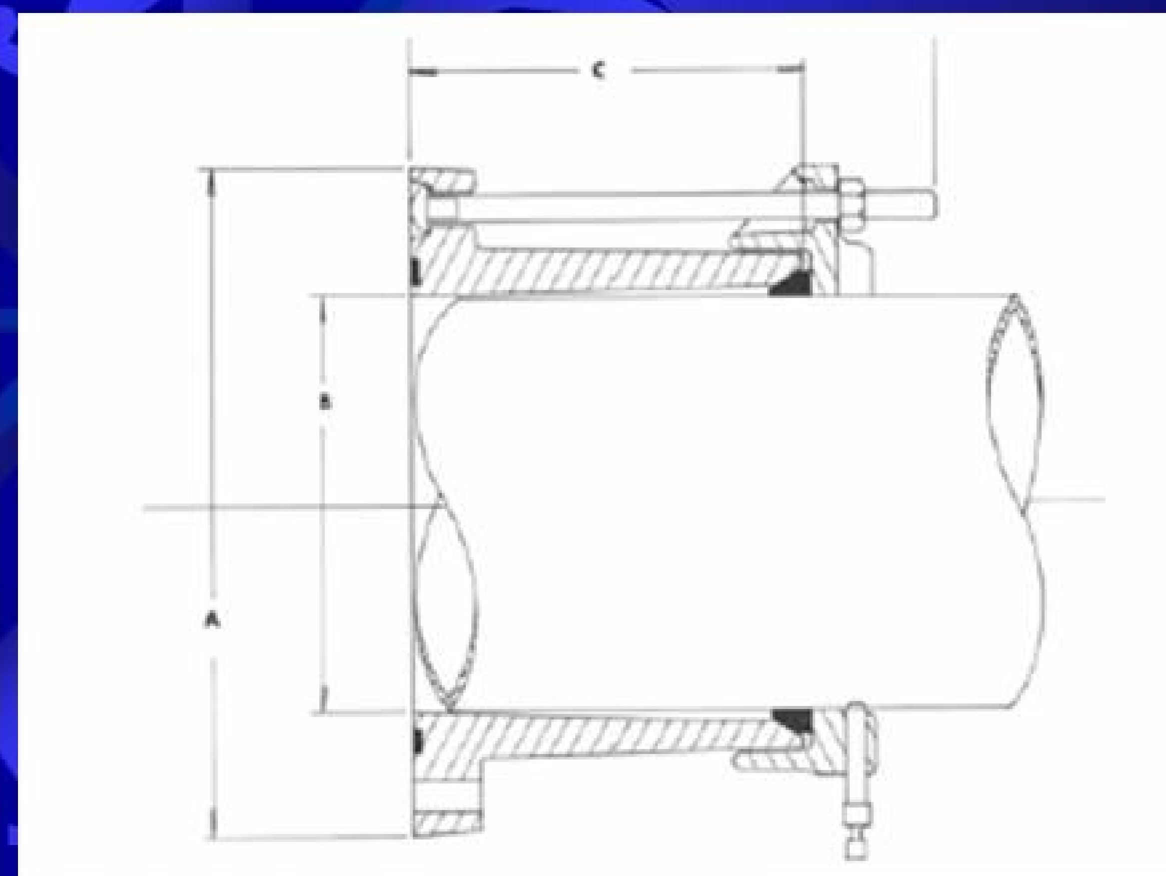
- ASME B16.5, *Pipe Flanges and Flanged Fittings (NPS ≤ 24")*

- Quick coupling

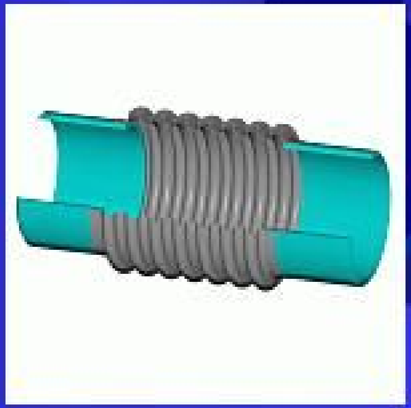


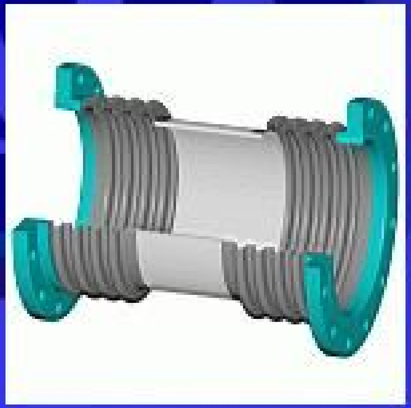
- Flange coupling adaptor



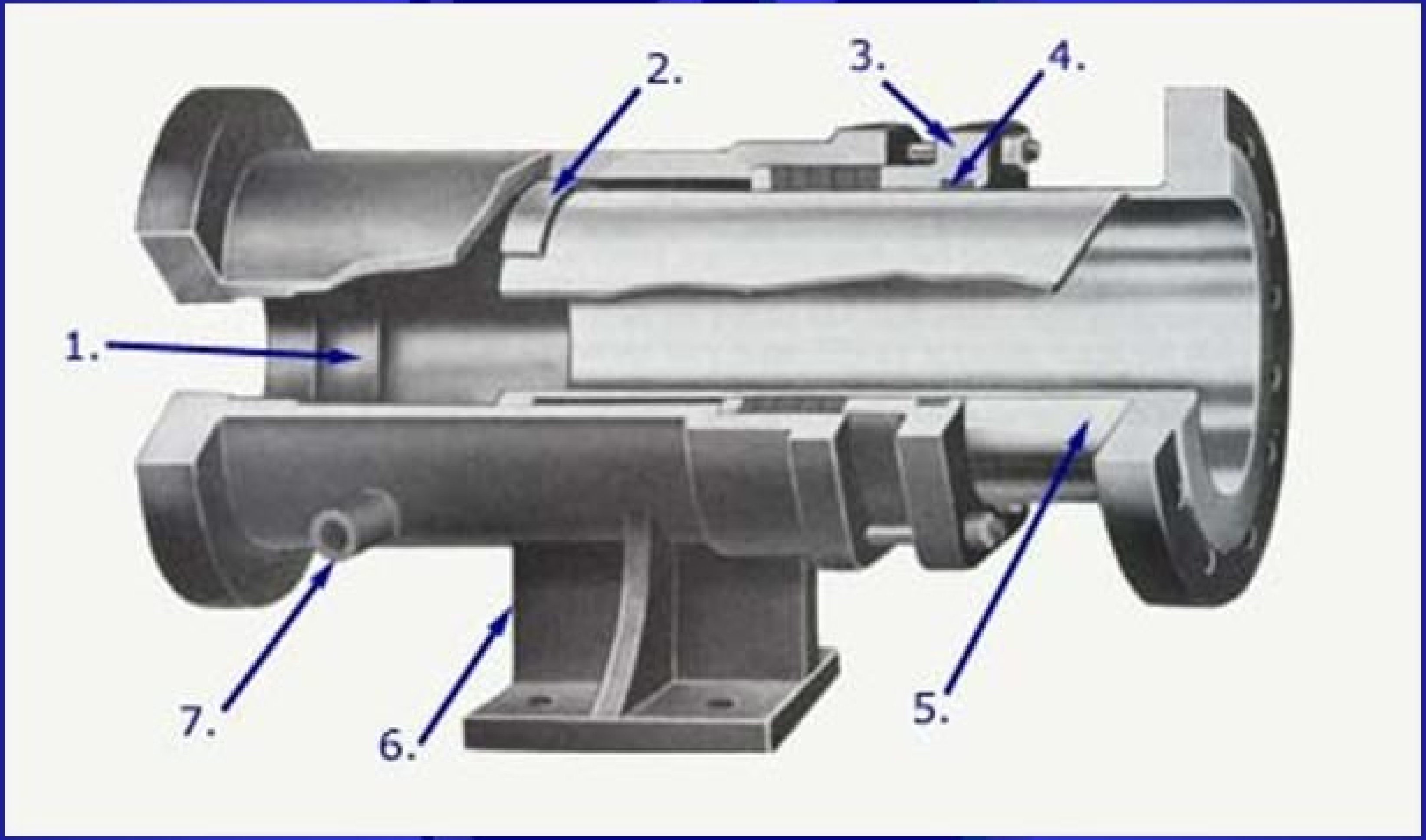


- Expansion joint (Bellows)





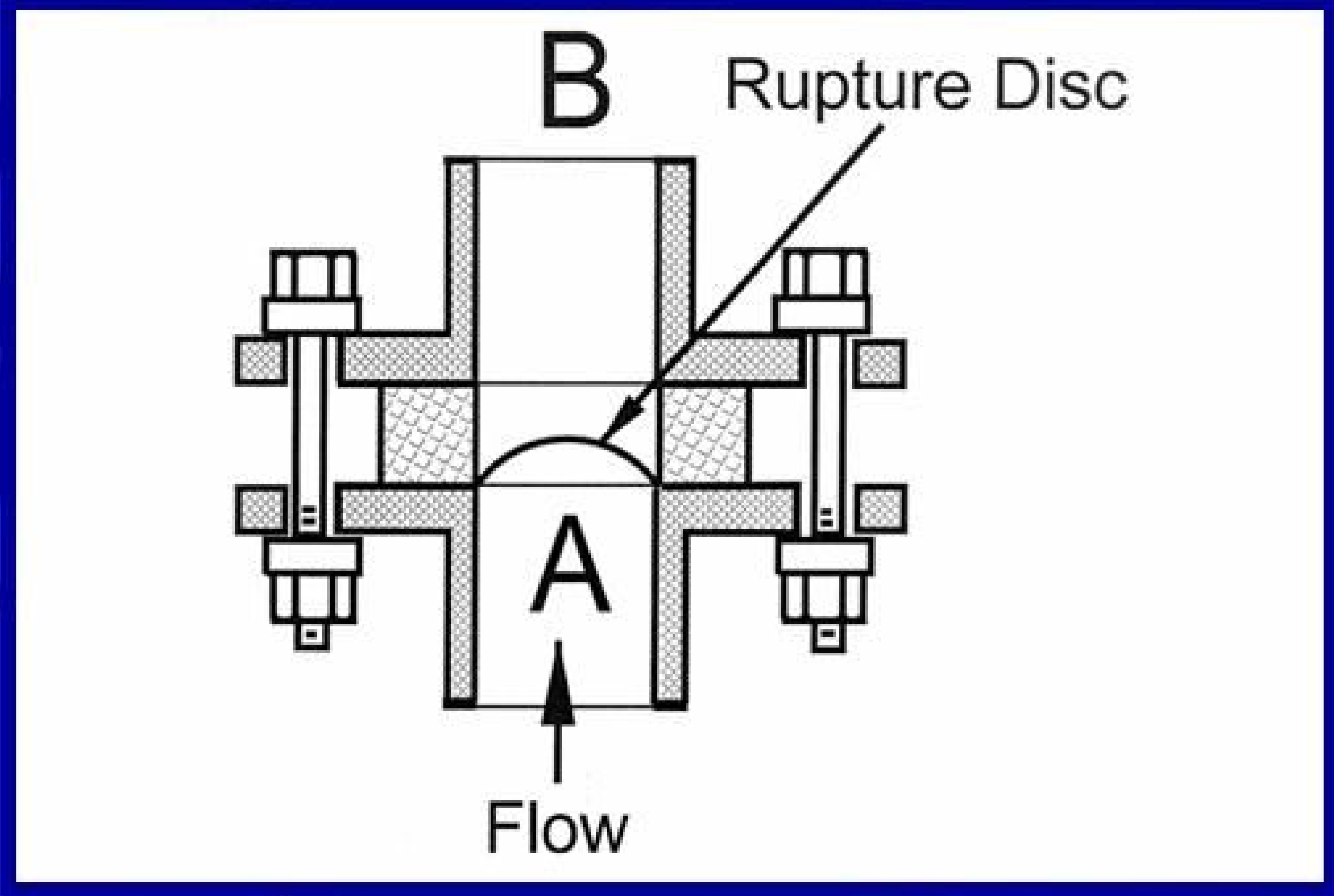
- Expansion joint



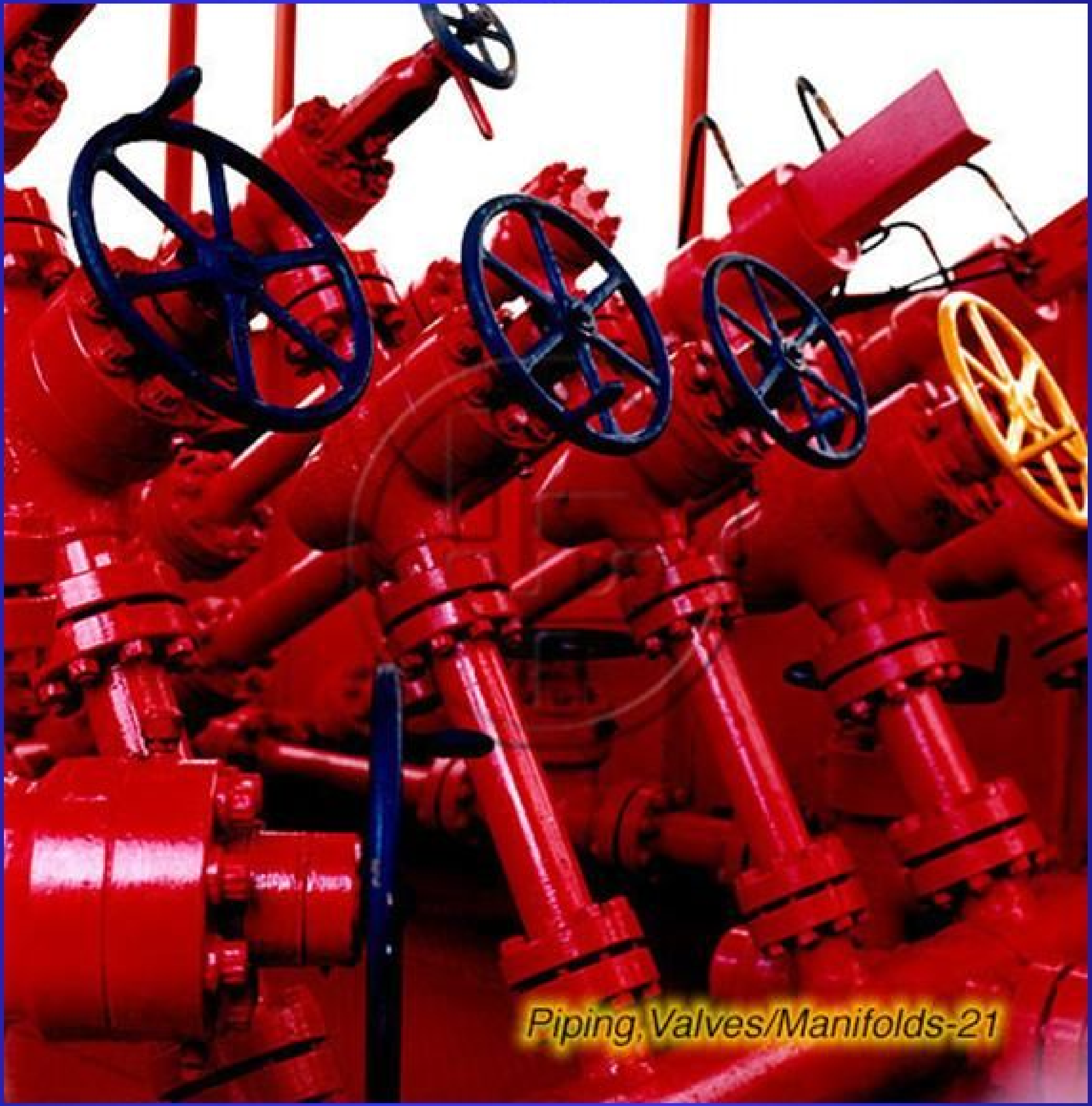
- Double block & bleed

- Spectacle blind

- RUPTURE DISKS OR BURST DIAPHRAGMS:
  - must be replaced after opening



Valves



- Valve are use for
  - Controlling process and utility service
  - Isolating equipment or instrument for maintenances
  - Discharge gas, vapor or liquid
  - Draining piping and equipment on shutdown
  - Emergency shutdown

- Classify valves according to functions:
  - Block flow (On / Off)
  - Regulating (Throttle flow)
  - Checking (Prevent flow reversal)
  - Switching
  - Discharging (pressure relive valve)
- Classify valves according to operating device:
  - Manual
  - Hydraulic
  - Motor (electric and air operated)
  - Solenoid

- Type of valves:
  - Ball valves
  - Gate valves
  - Globe valves
  - Check Valves
  - Plug valve
  - Butterfly valves
  - Pinch valve
  - Needle valves
  - Relief Valve

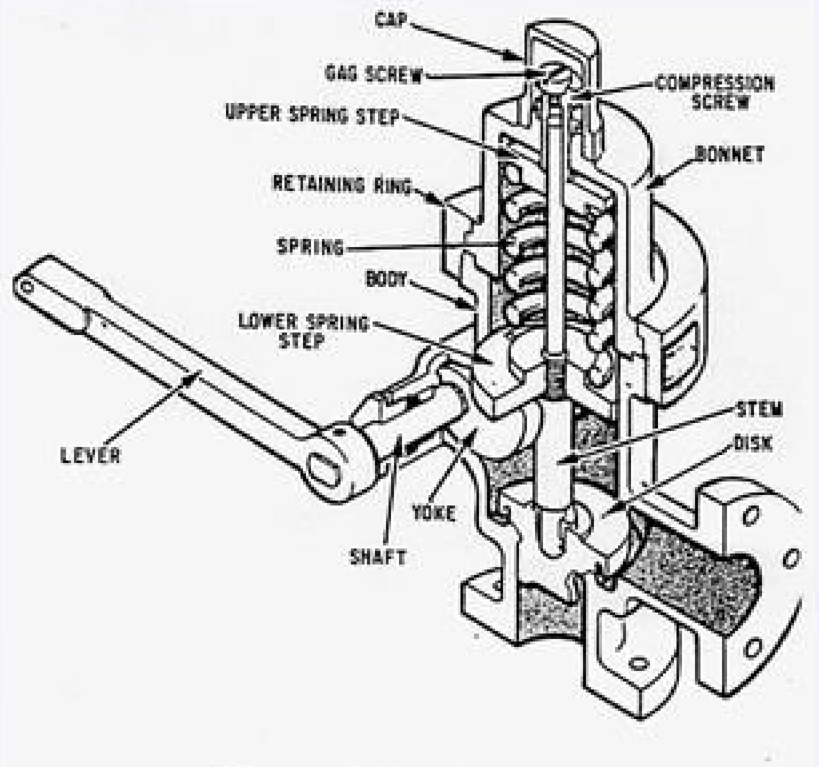
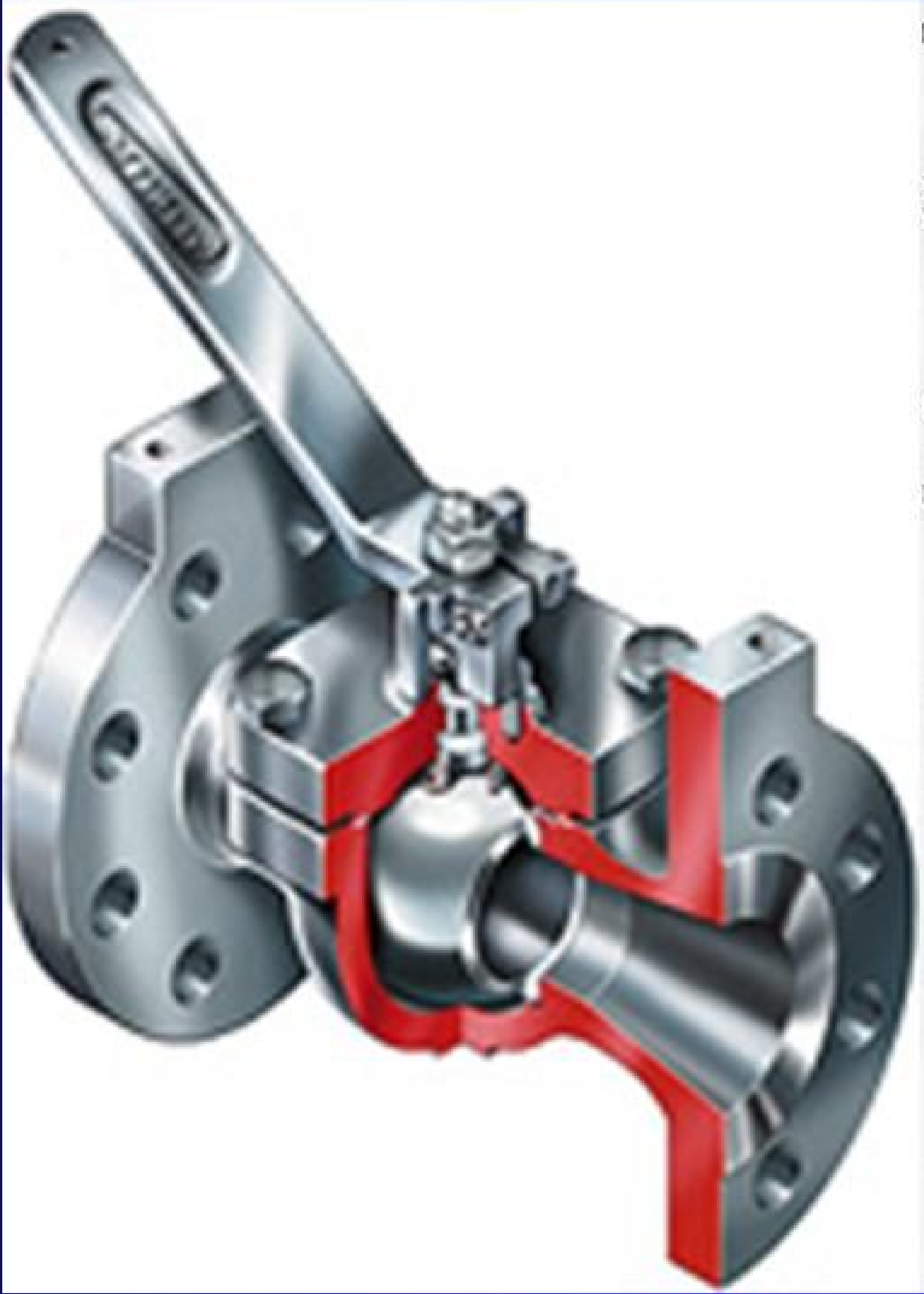


Figure 18-19.—Relief valve.

Ball Valve

Piping components: valve (ball valve)



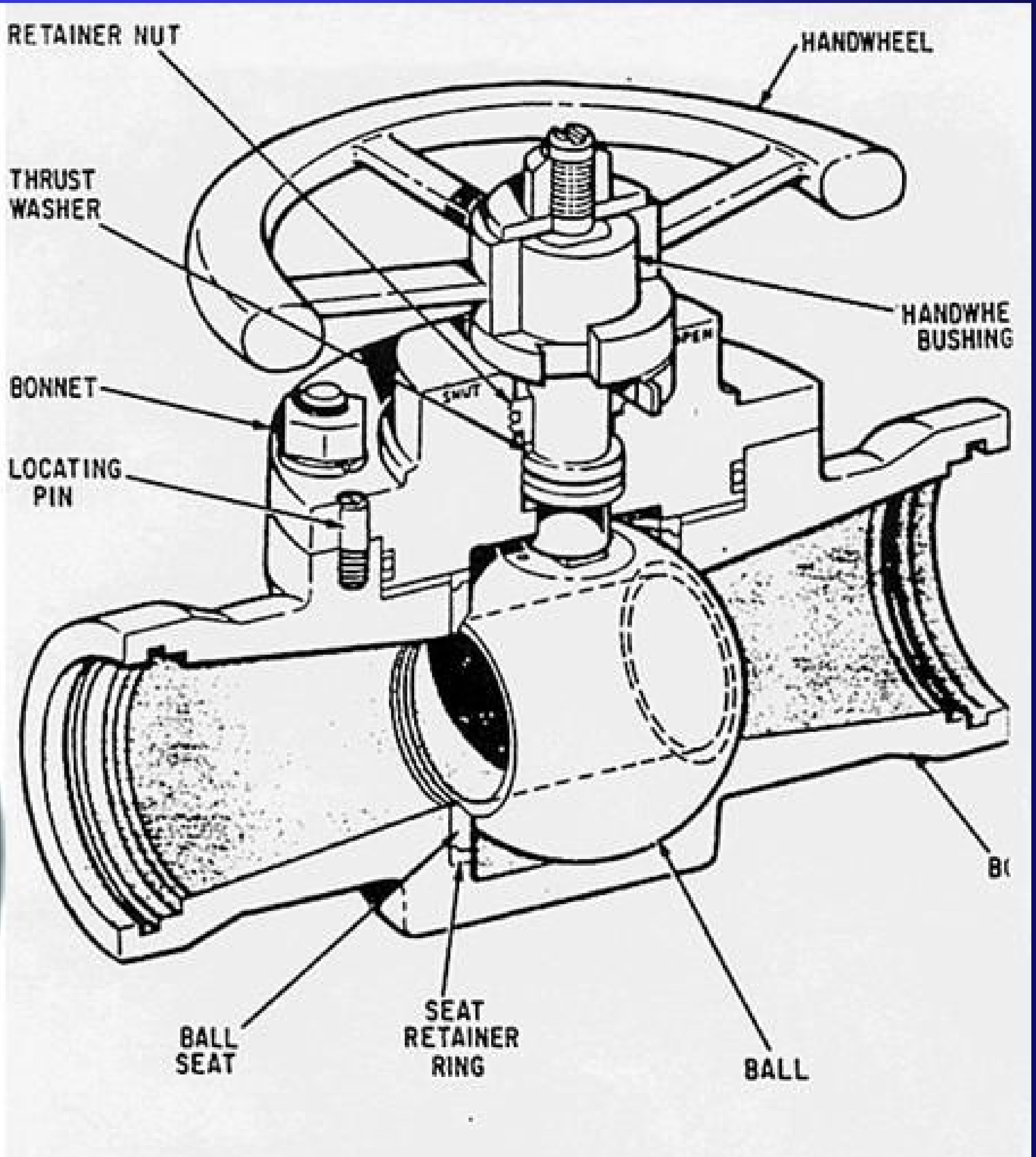


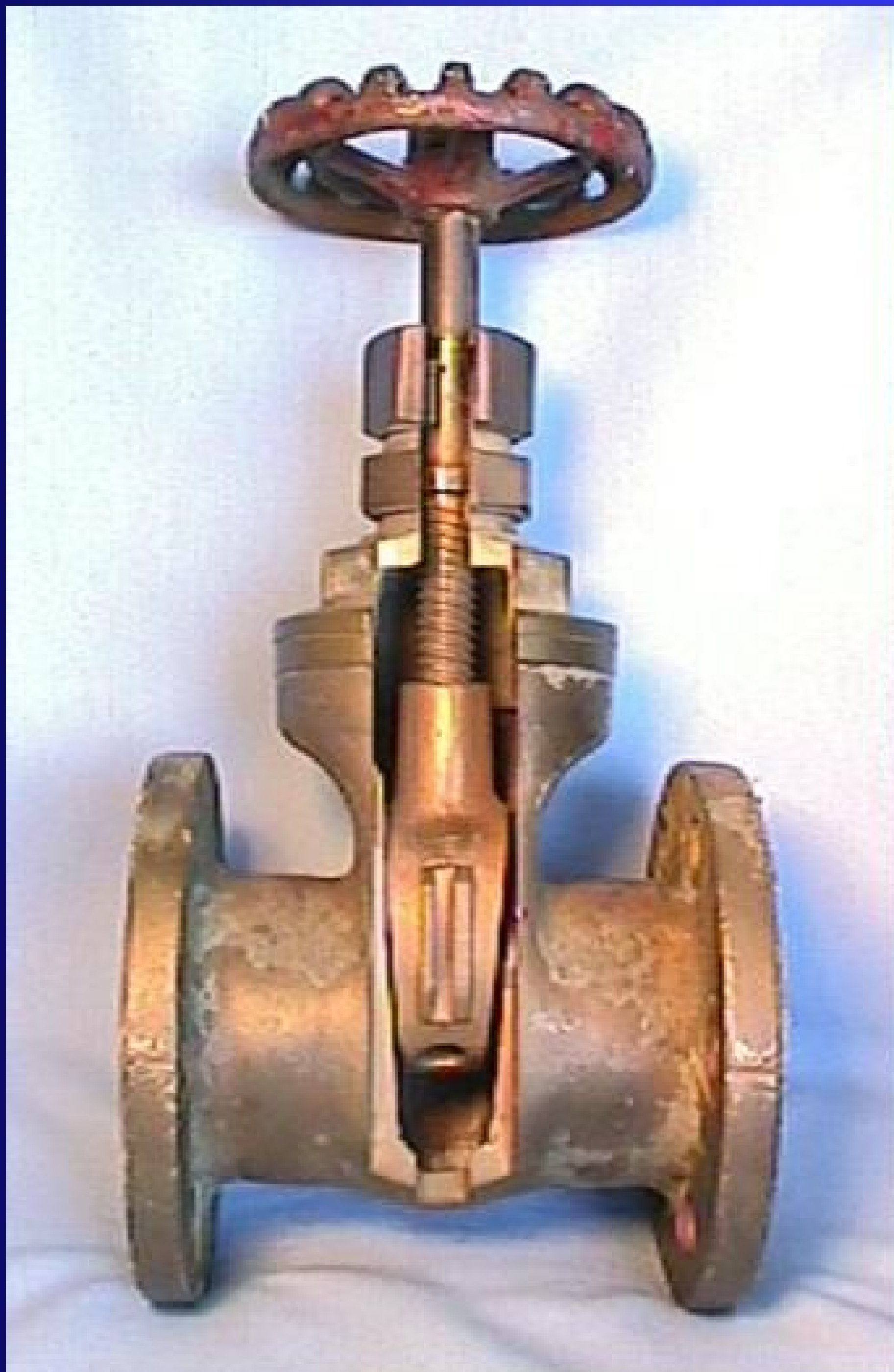
Figure 18-15.—Ball valve.

Piping components: valve (ball valve)

- Used for isolation (quick on / off)
- Soft-sealed ball valves are not normally used for throttling service because the soft-seats are subject to erosion or distortion/displacement caused by fluid flow when the valve is in the partially open position.
- ADV: Low pressure drop, fast operating, bubble-tight shut off, can be throttled Check Valves
- DISADV: Expensive, heavy, poor throttling

Gate Valve

Piping components: valve (gate valve)



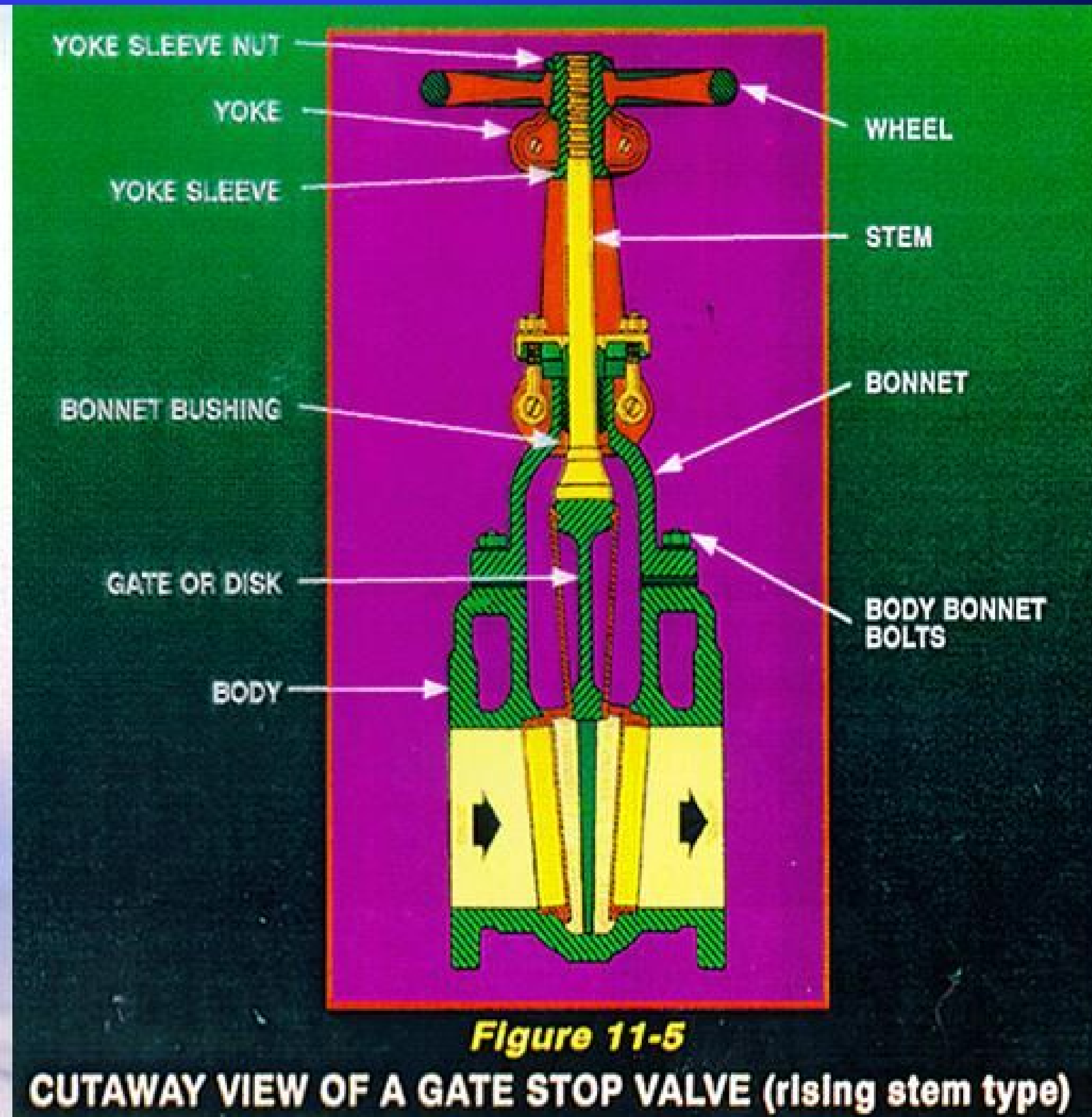
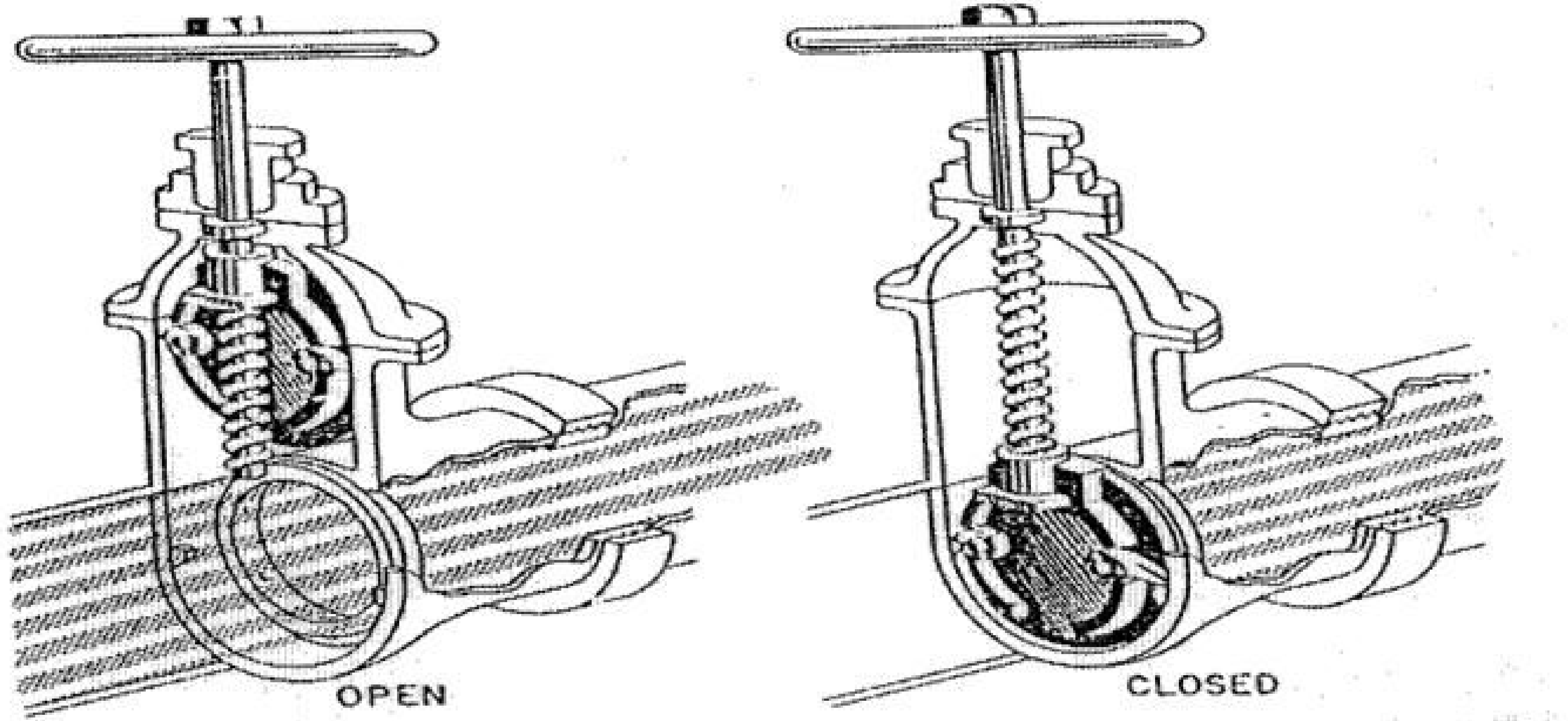


Figure 11-5
CUTAWAY VIEW OF A GATE STOP VALVE (rising stem type)

- About 75% of all valves in process plants
- an optimum engineering and economic choice for on or off service. (cutout or isolation valves)
- ADV: small pressure drop across valve
- DISADV: poor throttling characteristics

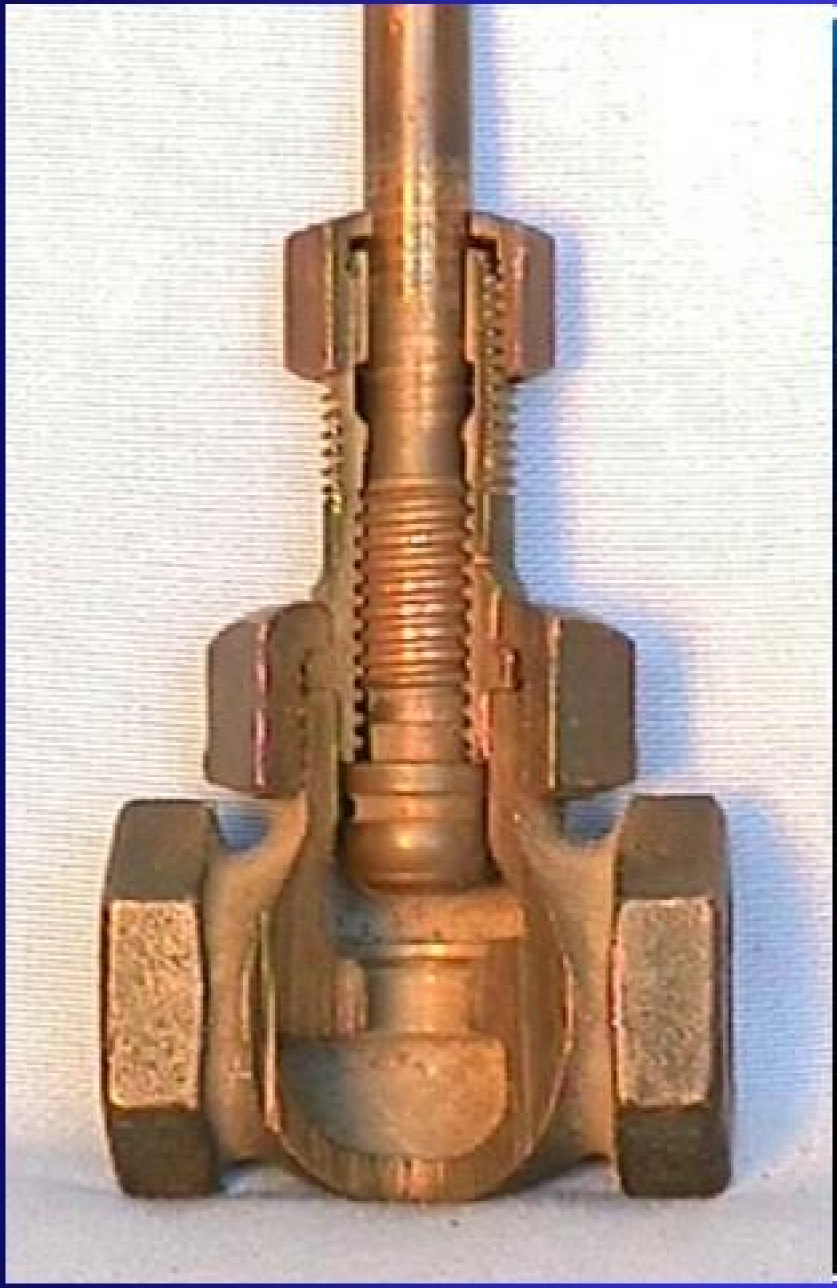
Piping components: valve (gate valve)

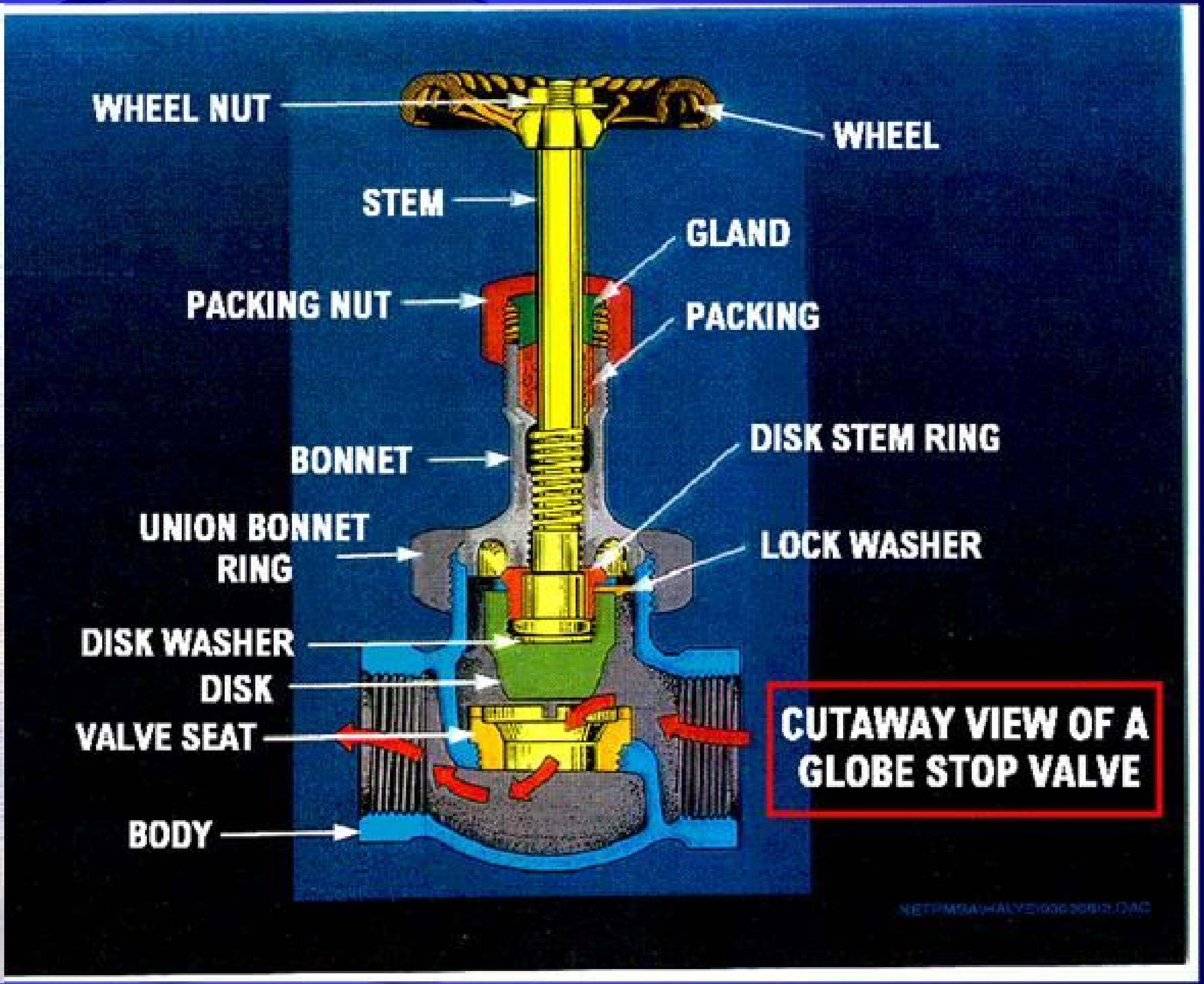


—Operation of gate valve.

Globe Valve

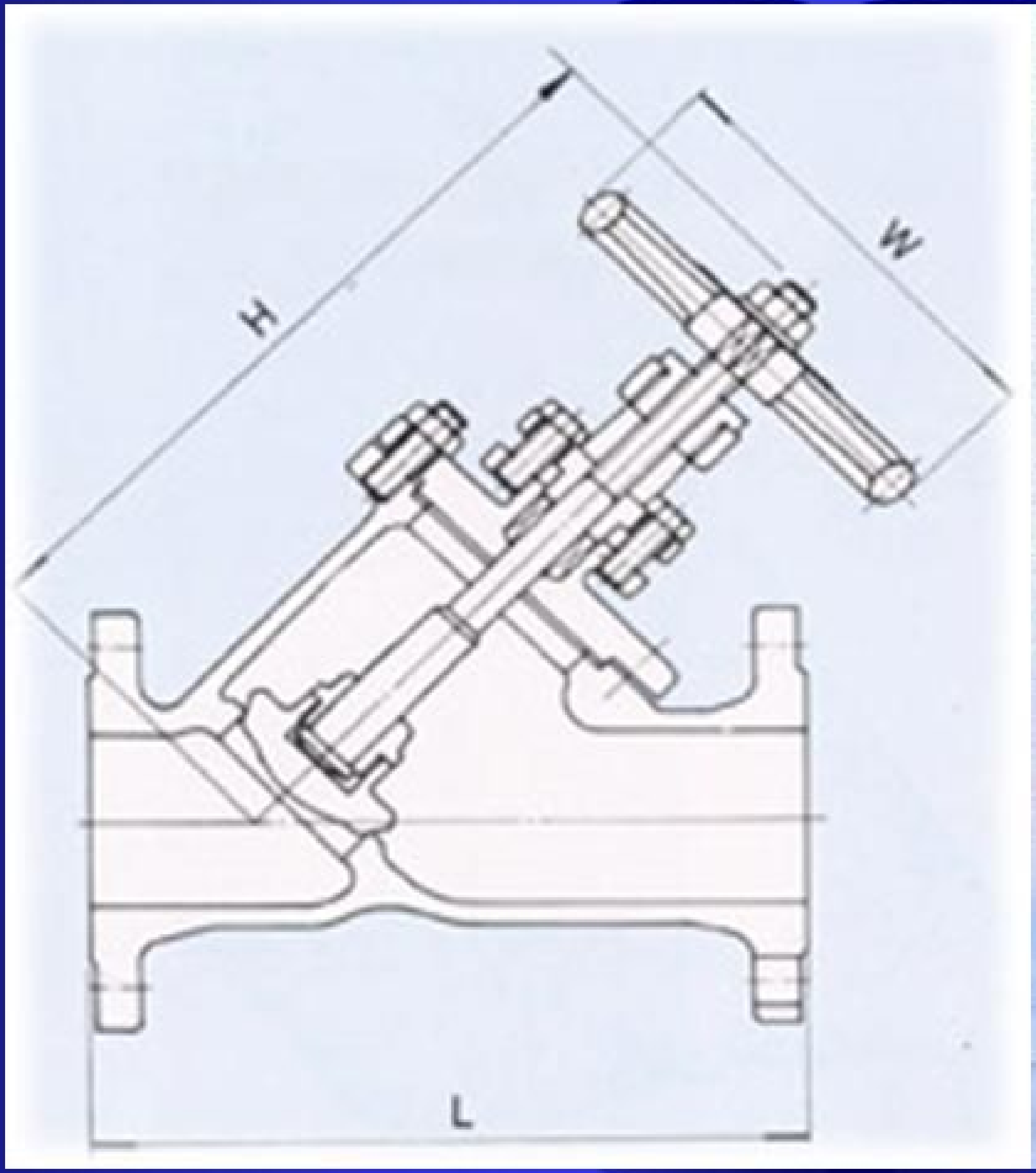
Piping components: valve (globe valve)





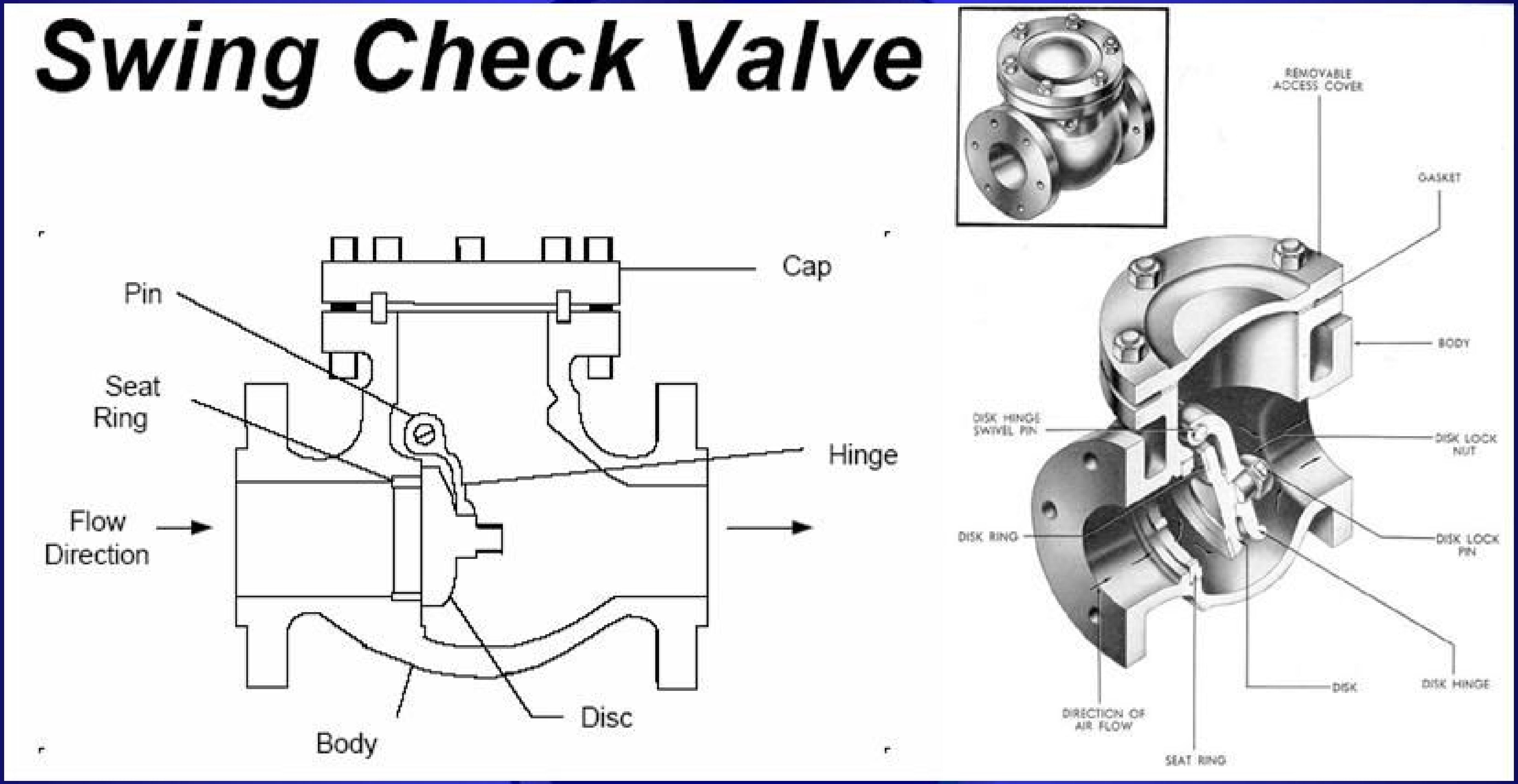
- Most economic for throttling flow and used for flow control
- Can be hand-controlled
- Provides “tight” shutoff
- Not suitable for scraping or rodding
- Too costly for on/off block operations
- ADV: excellent throttling characteristics
- DISADV: large pressure drop across the valve due to the flow restriction (thus more pumping power is required to move the fluid through the system.)

Piping components: valve (globe valve)

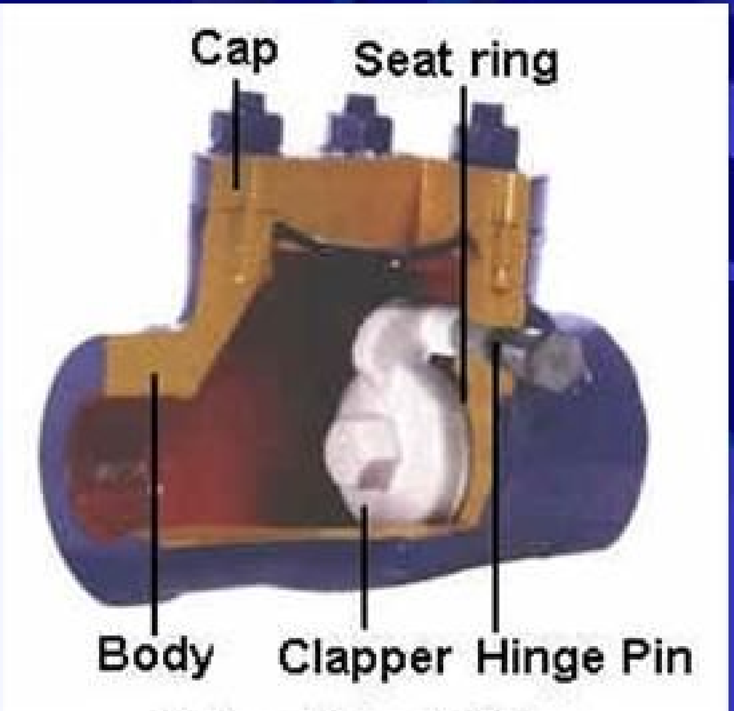


Check Valve

Piping components: (check valve / swing check valve)

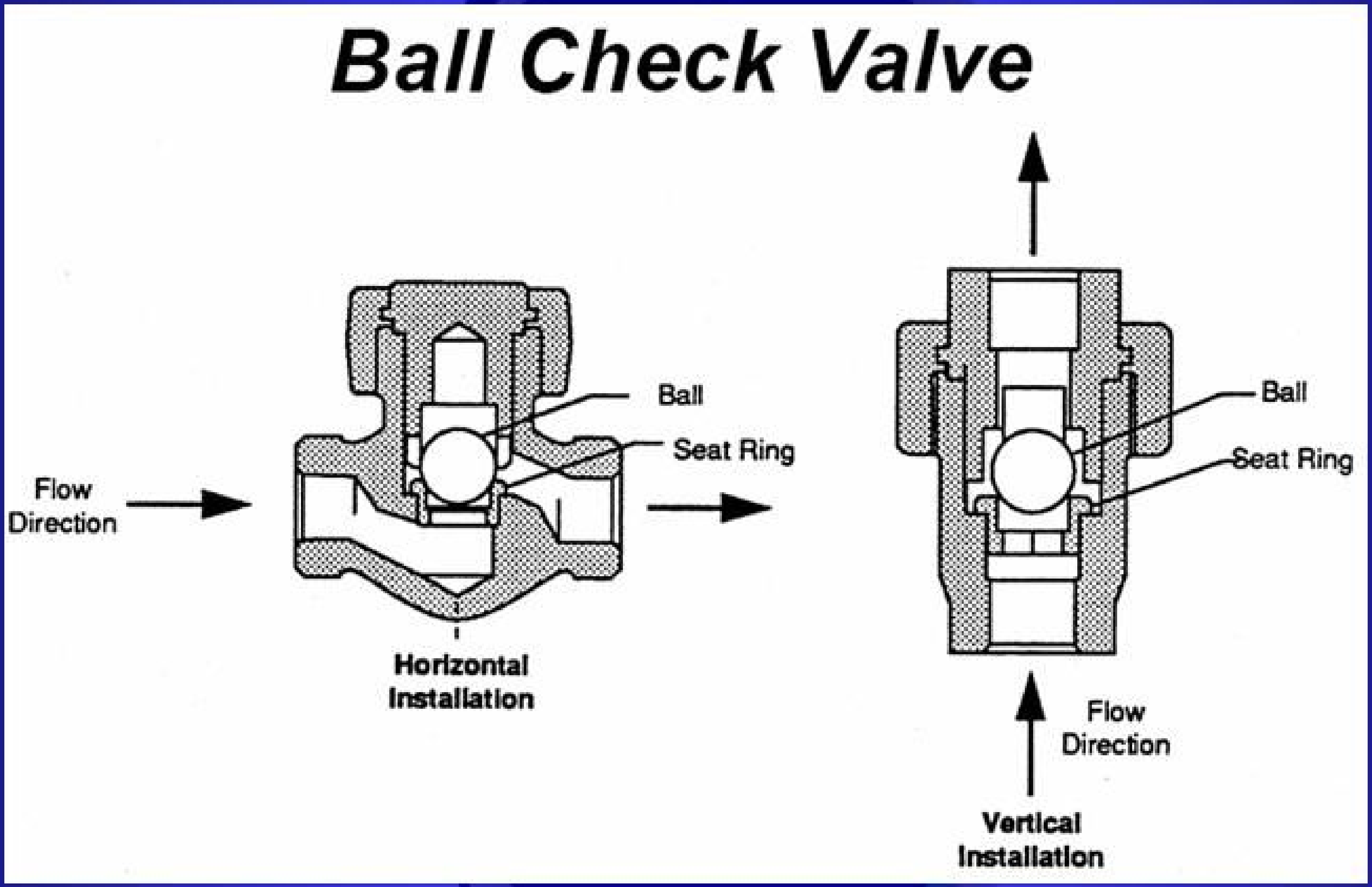


- Simple design
- Allows flow in one direction
- Can not be used as an isolation valve

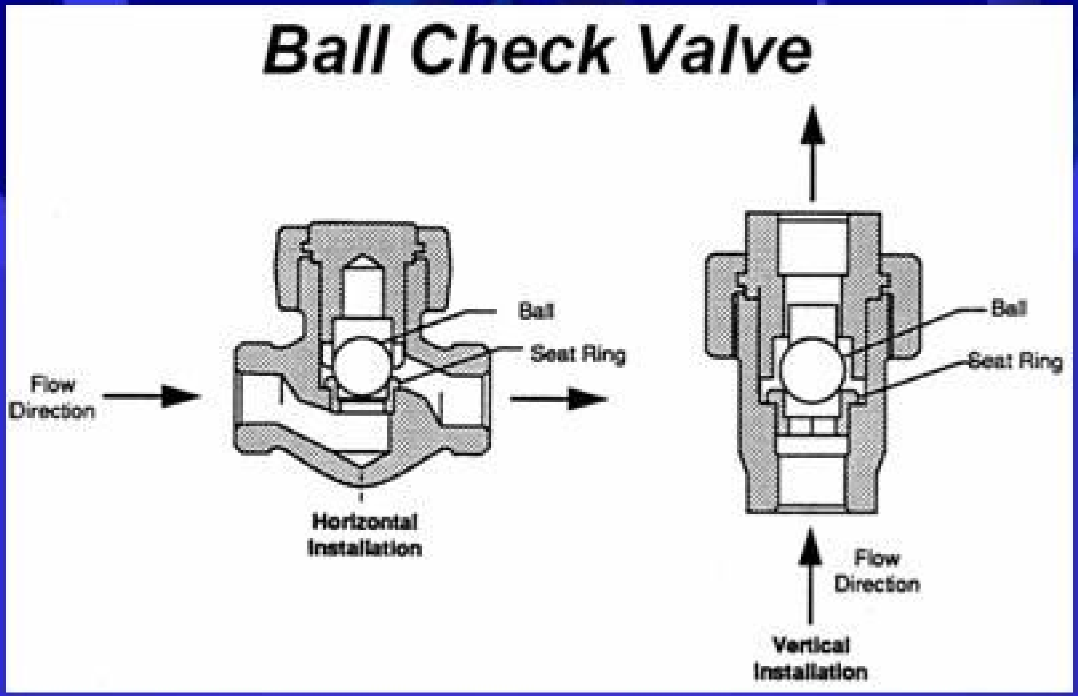


Swing Check Valve

Piping components: (check valve / ball check valve)

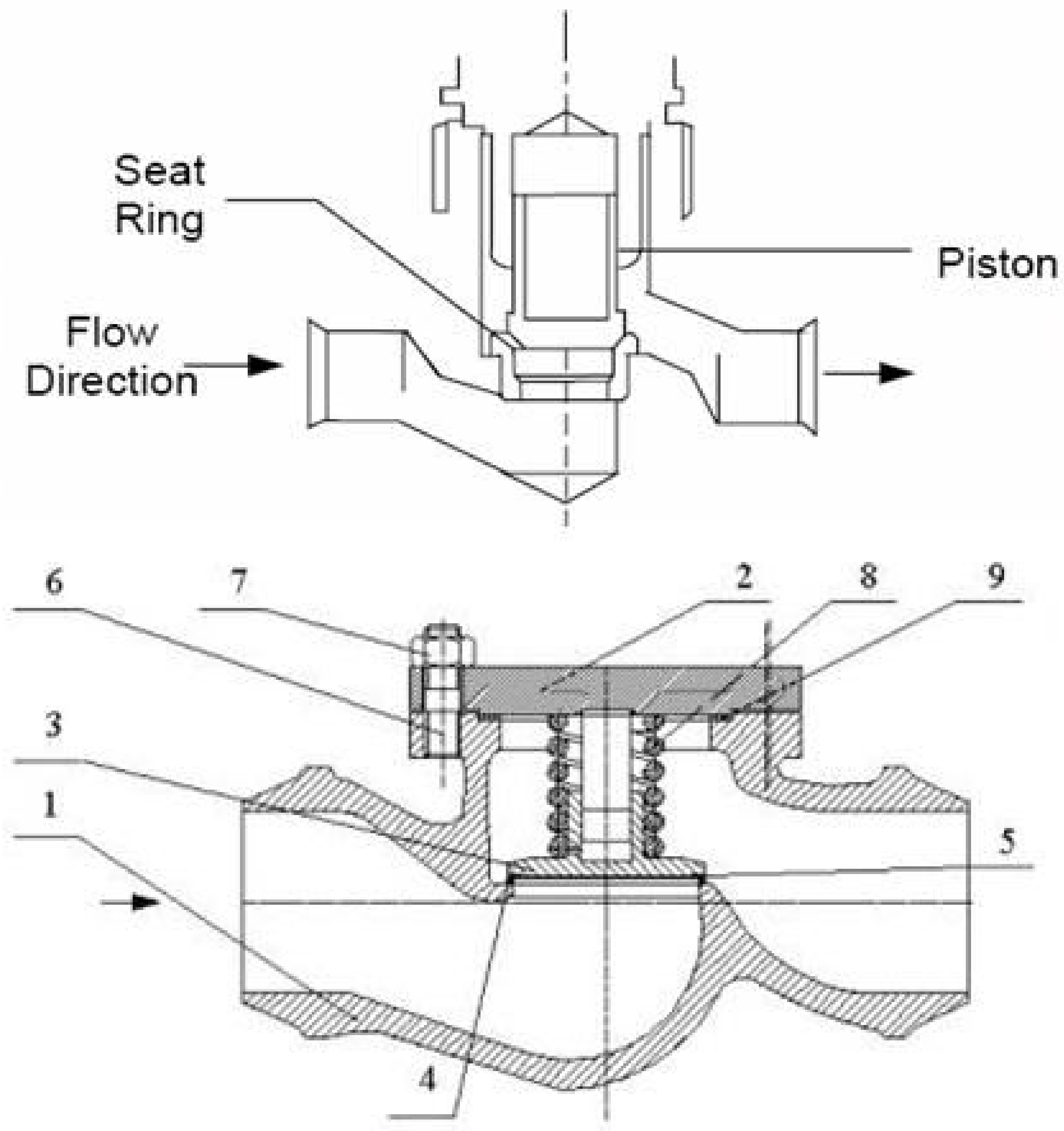


- Their low cost usually makes them the first choice valves sized NPS 2 and smaller (available in sizes NPS ½ through 2)
- Used when pressure drop is not a concern.
- The basic types are the straight-through- and globe-type (90 change in direction)

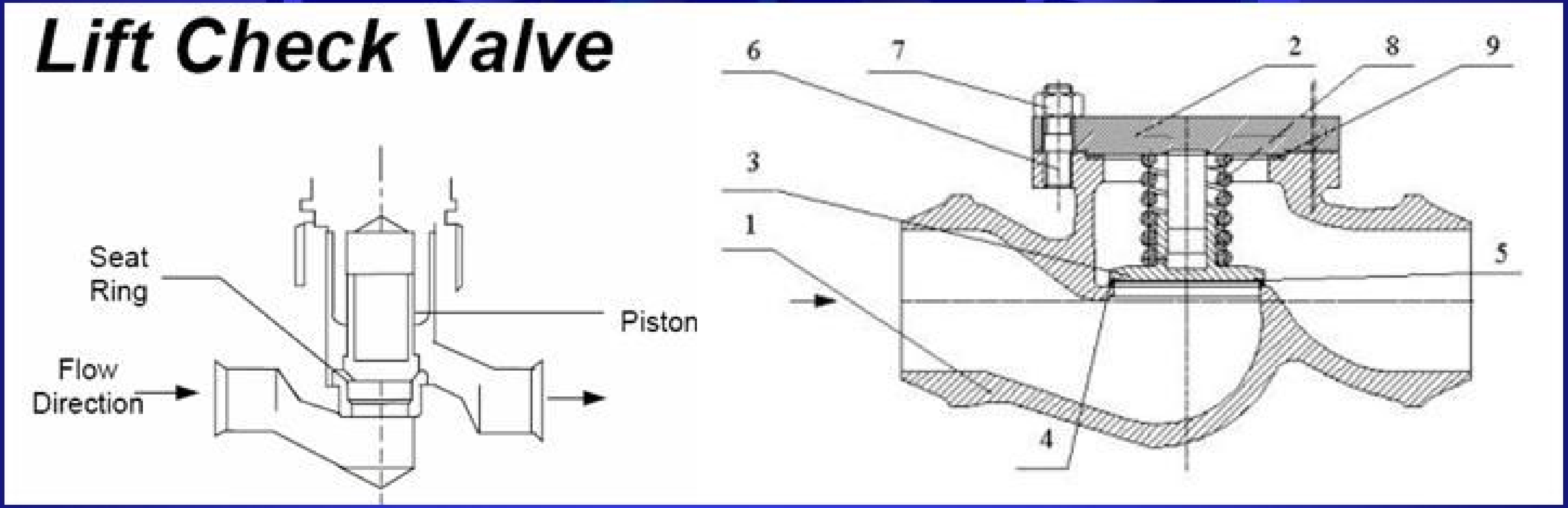


Piping components: (check valve)

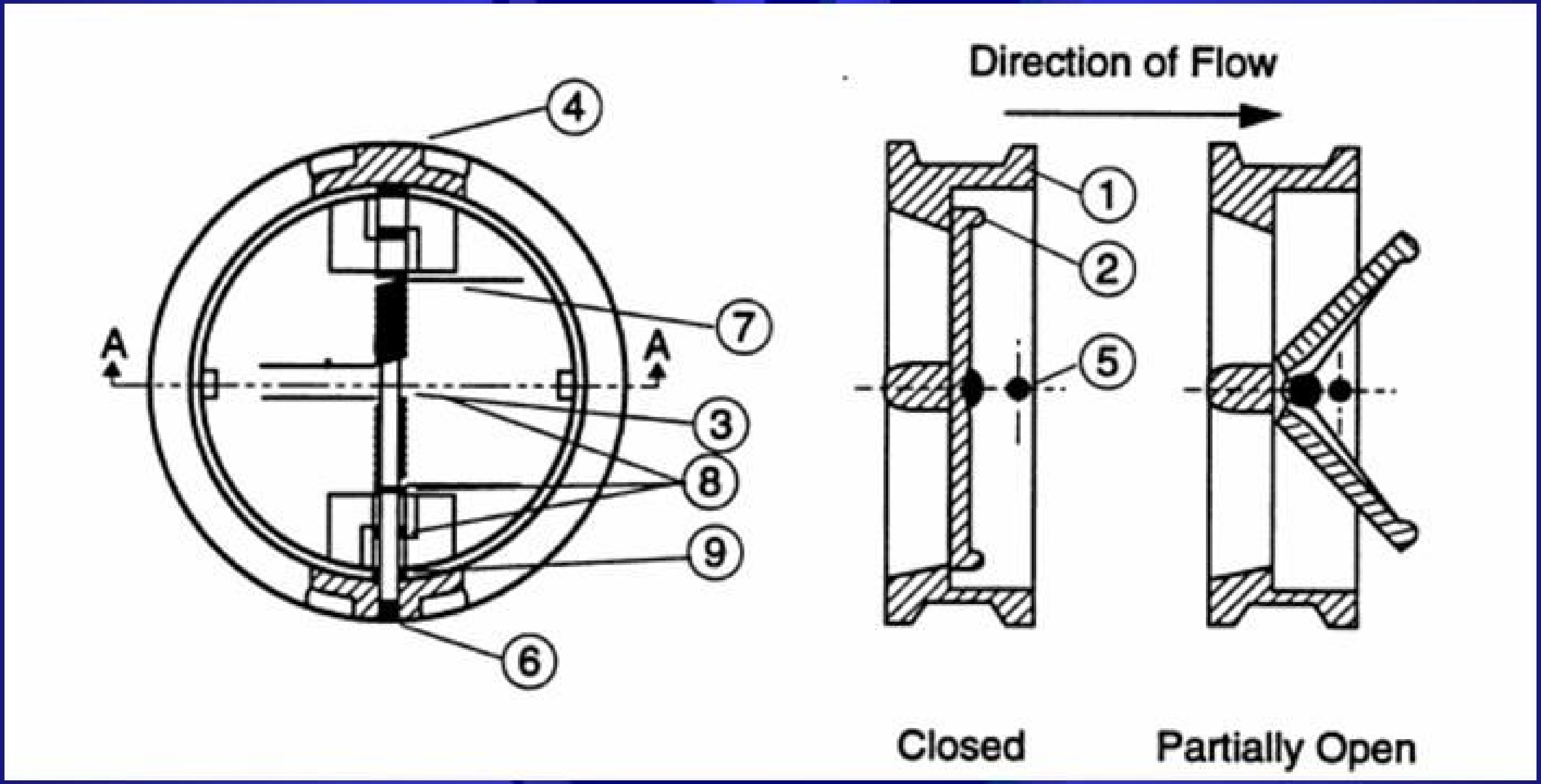
Lift Check Valve



- are available in sizes from NPS ½ through 2 plants.
- They are most commonly used in the higher ASME B16.5 ratings (Class 300 and greater) where tighter shutoff is required.
- Valves of this type should only be used in clean services.

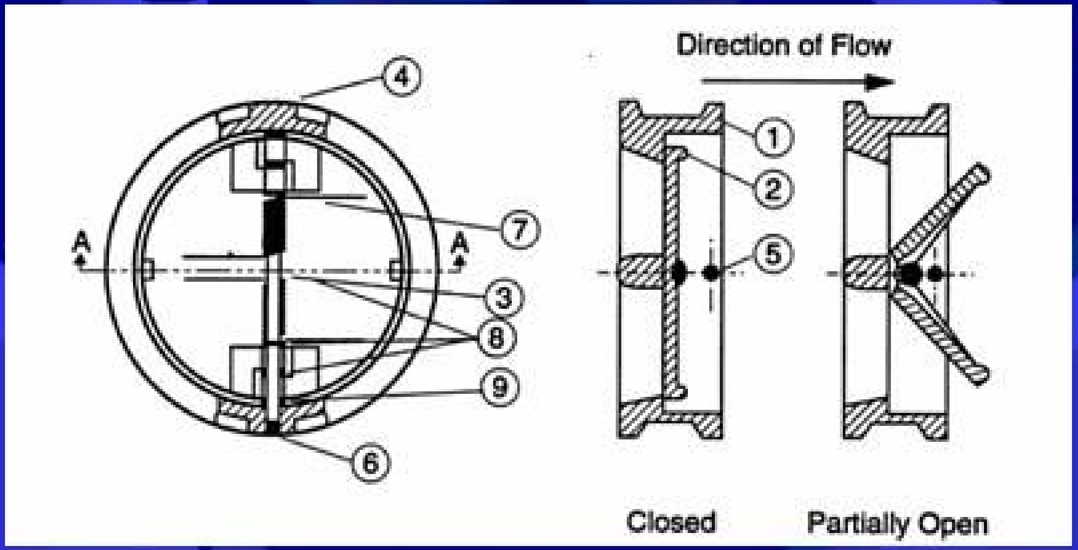


Wafer Check Valve

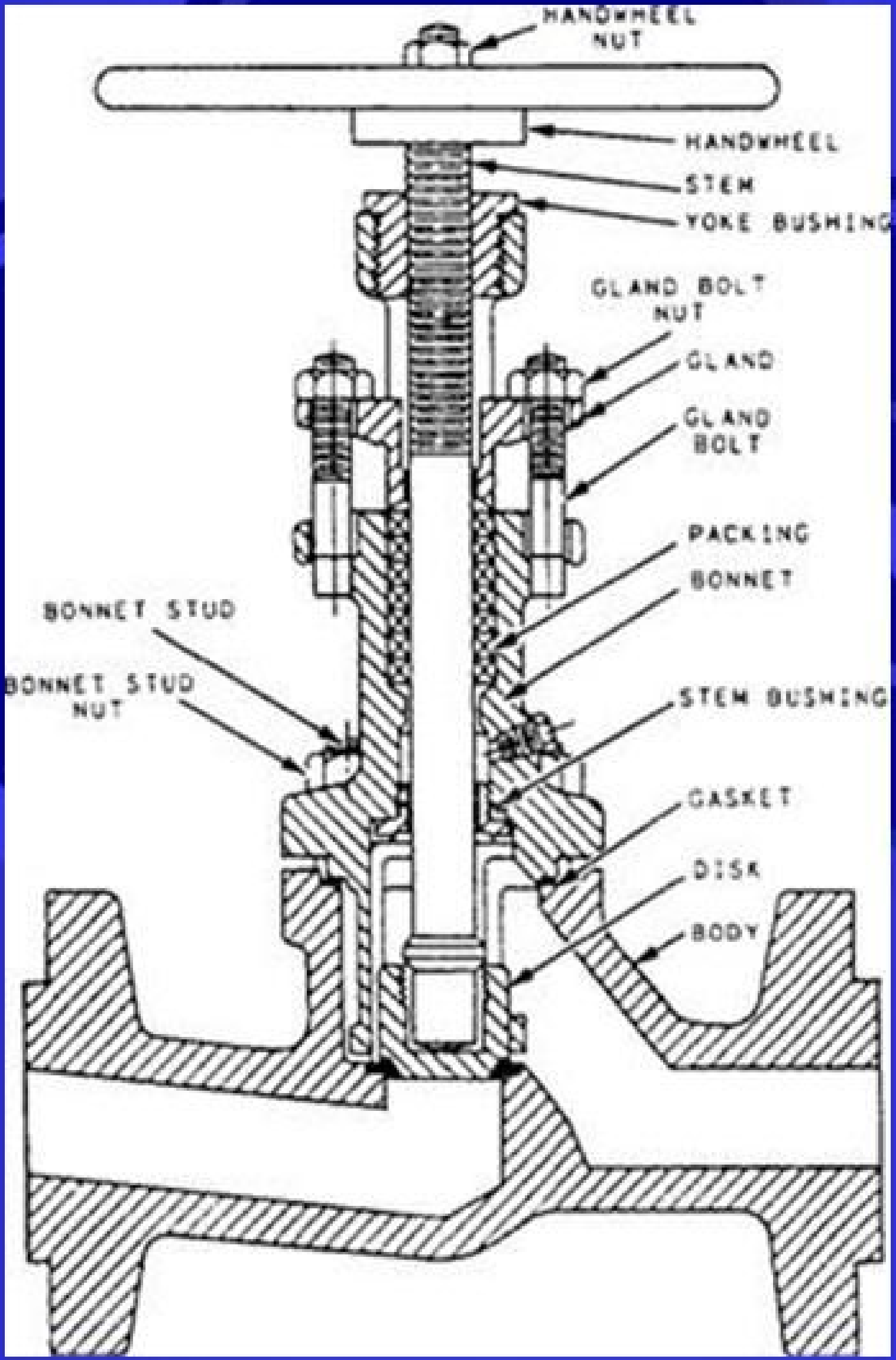


Piping components: (check valve / wafer check valve)

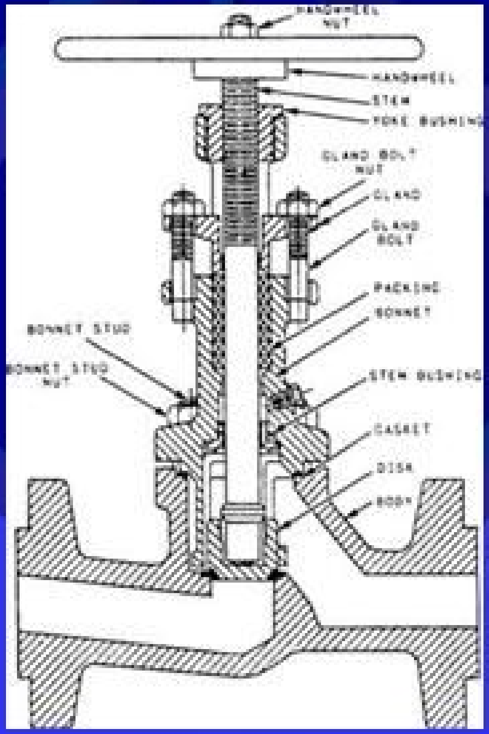
- Valves of this type are placed between pipe flanges and held in place by the compressive force between the flanges and transmitted through the gaskets.



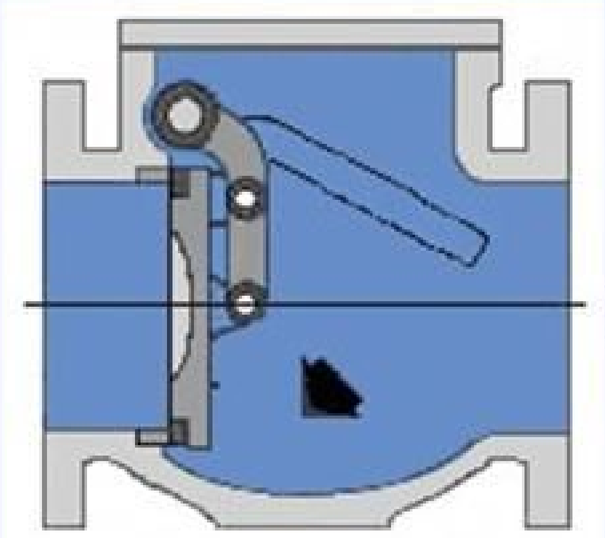
Stop Check Valve



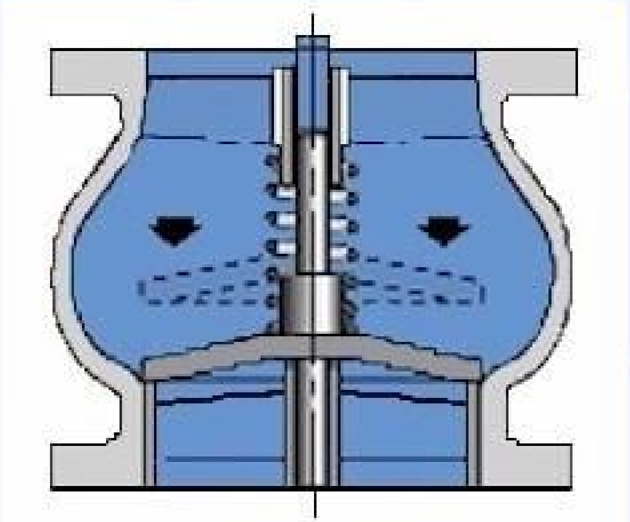
- Internals similar to a globe valve
- Disc is not attached to the stem
- Valve stem - long enough to hold the disc firmly against the seat
- Stem raised - the disc can be opened by pressure on the inlet side
- Can be used as an isolation valve as well as a check valve



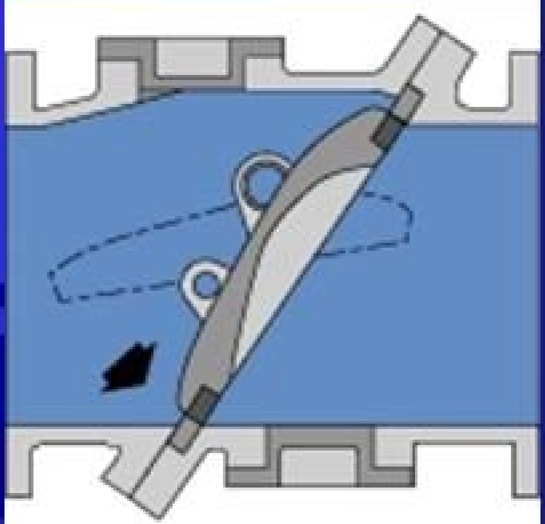
Piping components: (check valve)



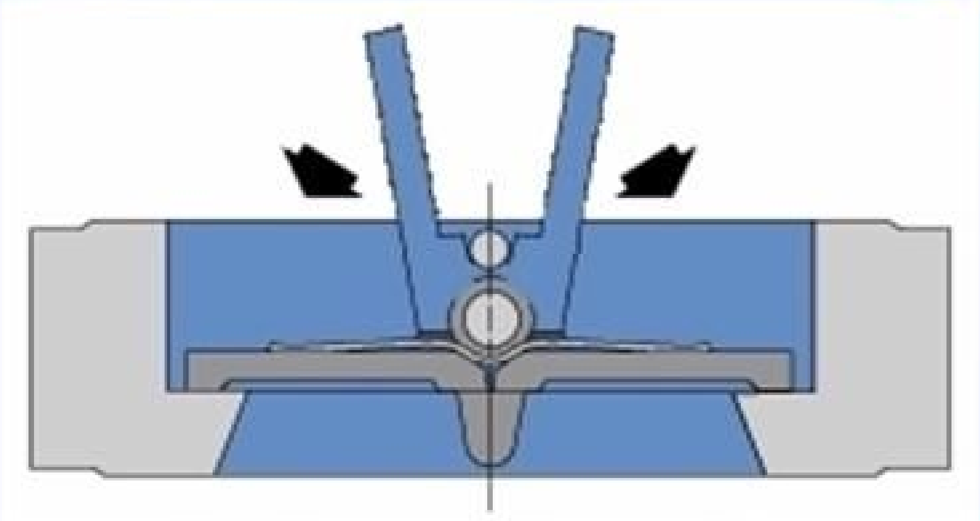
Swing Check Valve



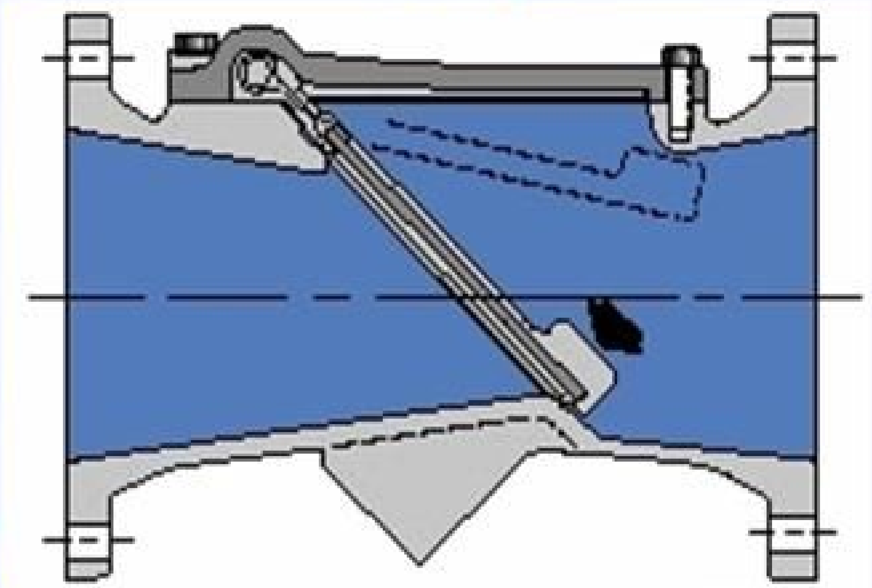
Vertical Style Lift Check Valve
(helical spring loaded)



Slanting/Tilting-Disk
Check Valve



Double Disk Swing Check Valve

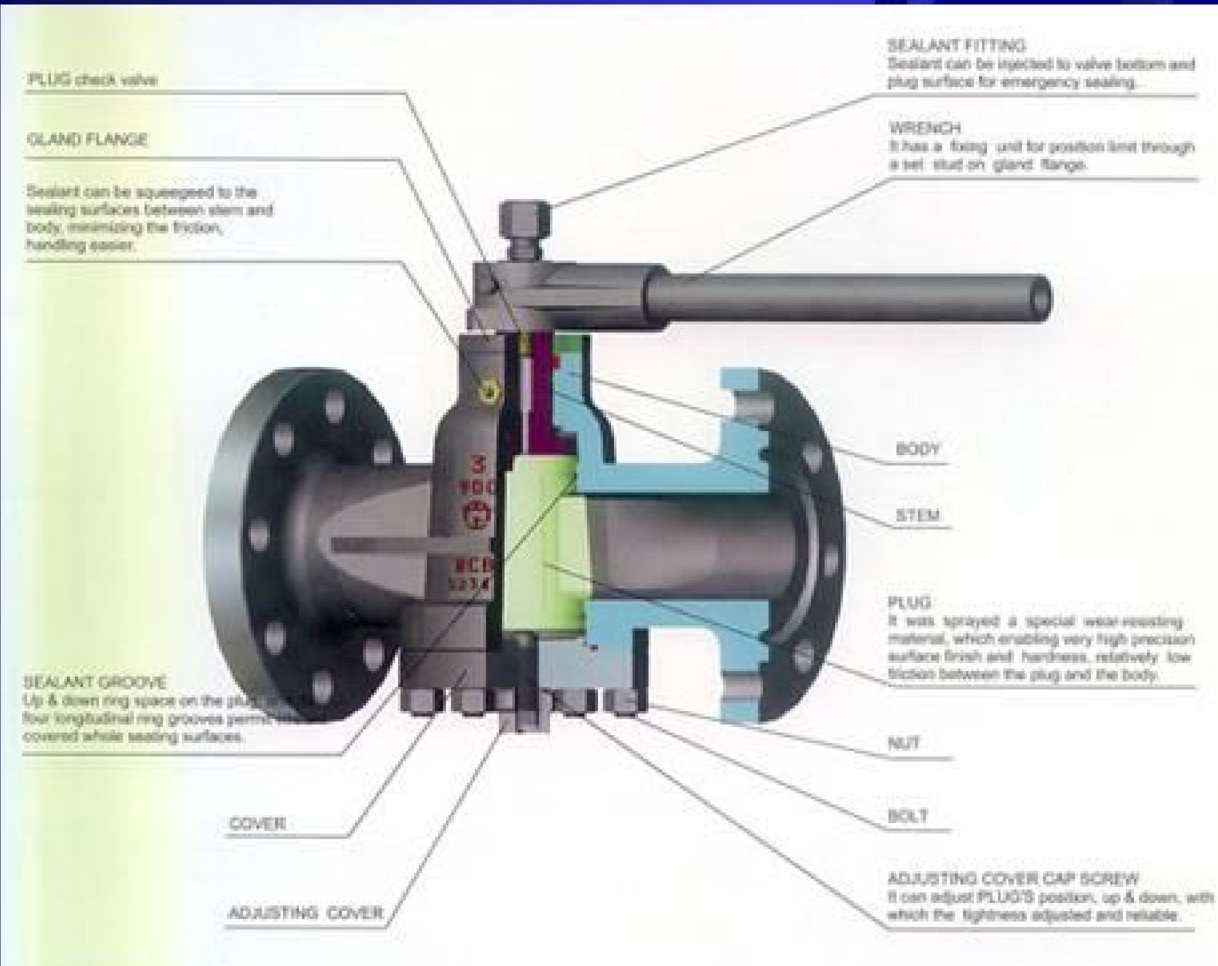


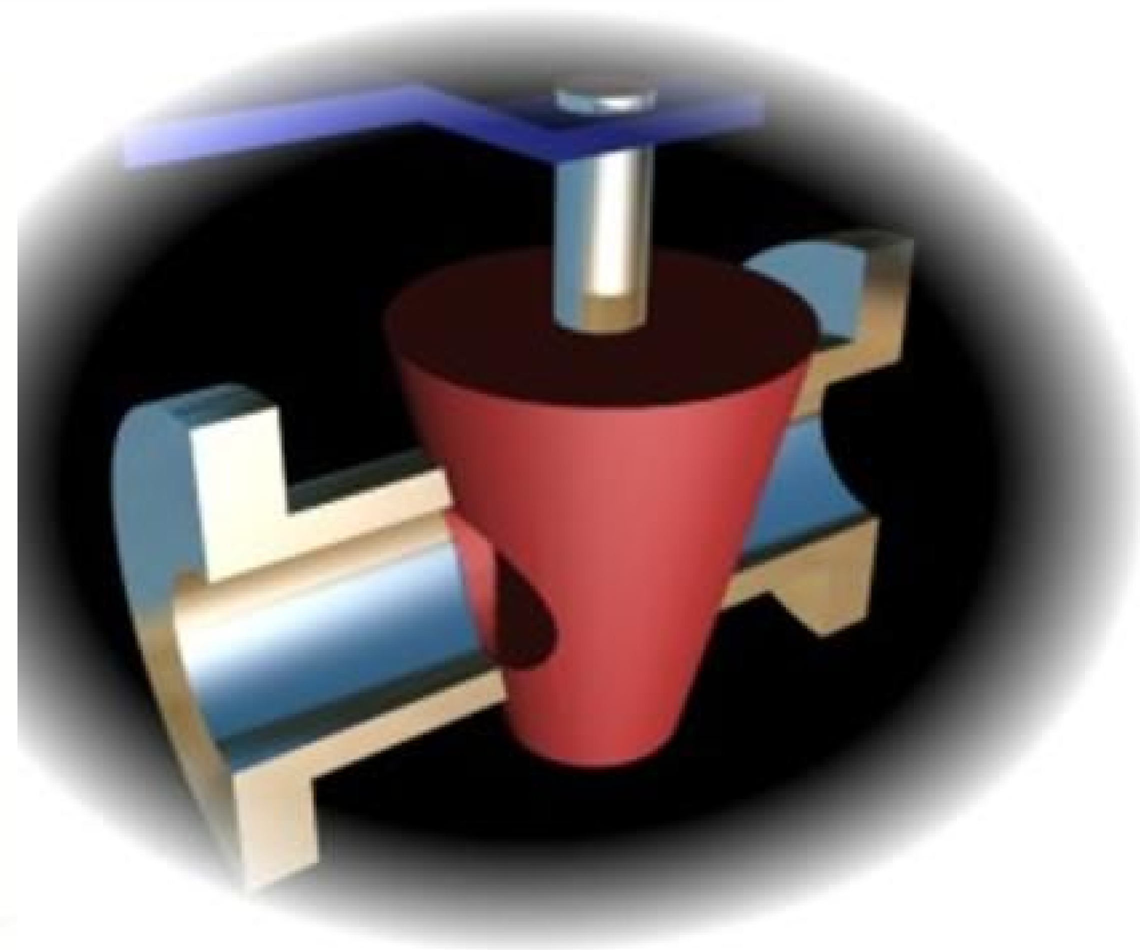
Swing Check Valve (Angle Seating)

- Function of check valve:
  - Prevents flow reversal
  - Does not completely shut off reverse flow
  - Available in all sizes, ratings, materials
  - Valve type selection determined by
    - Size limitations
    - Cost
    - Availability
    - Service

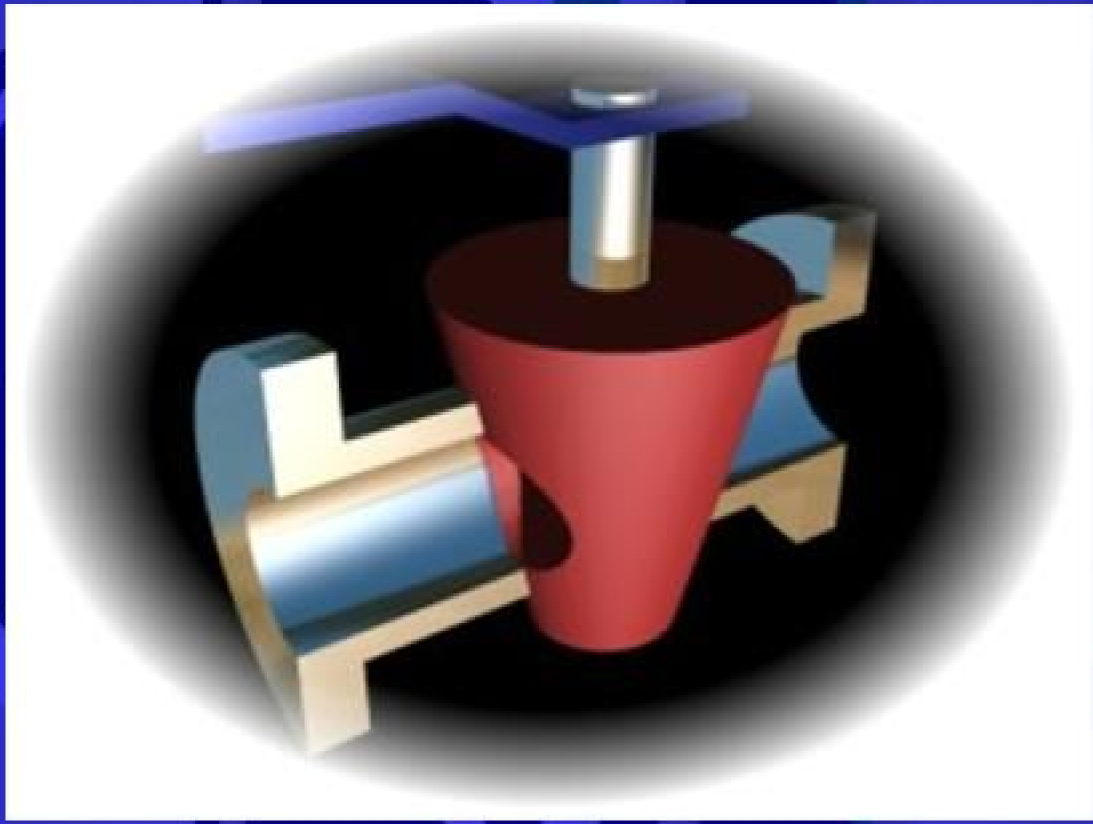
Plug Valve

Plug Valve


PLUG check valve
GLAND FLANGE
Sealant can be squeegeed to the sealing surfaces between stem and body, minimizing the friction, handling easier.
SEALANT GROOVE
Up & down ring space on the plug and four longitudinal ring grooves permit sealant covered whole sealing surfaces.
COVER
ADJUSTING COVER
SEALANT FITTING
Sealant can be injected to valve bottom and plug surface for emergency sealing.
WRENCH
It has a fixing unit for position limit through a set stud on gland flange.
BODY
STEM
PLUG
It was sprayed a special wear-resisting material, which enabling very high precision surface finish and hardness, relatively low friction between the plug and the body.
NUT
BOLT
ADJUSTING COVER CAP SCREW
It can adjust PLUG'S position, up & down, with which the tightness adjusted and reliable.

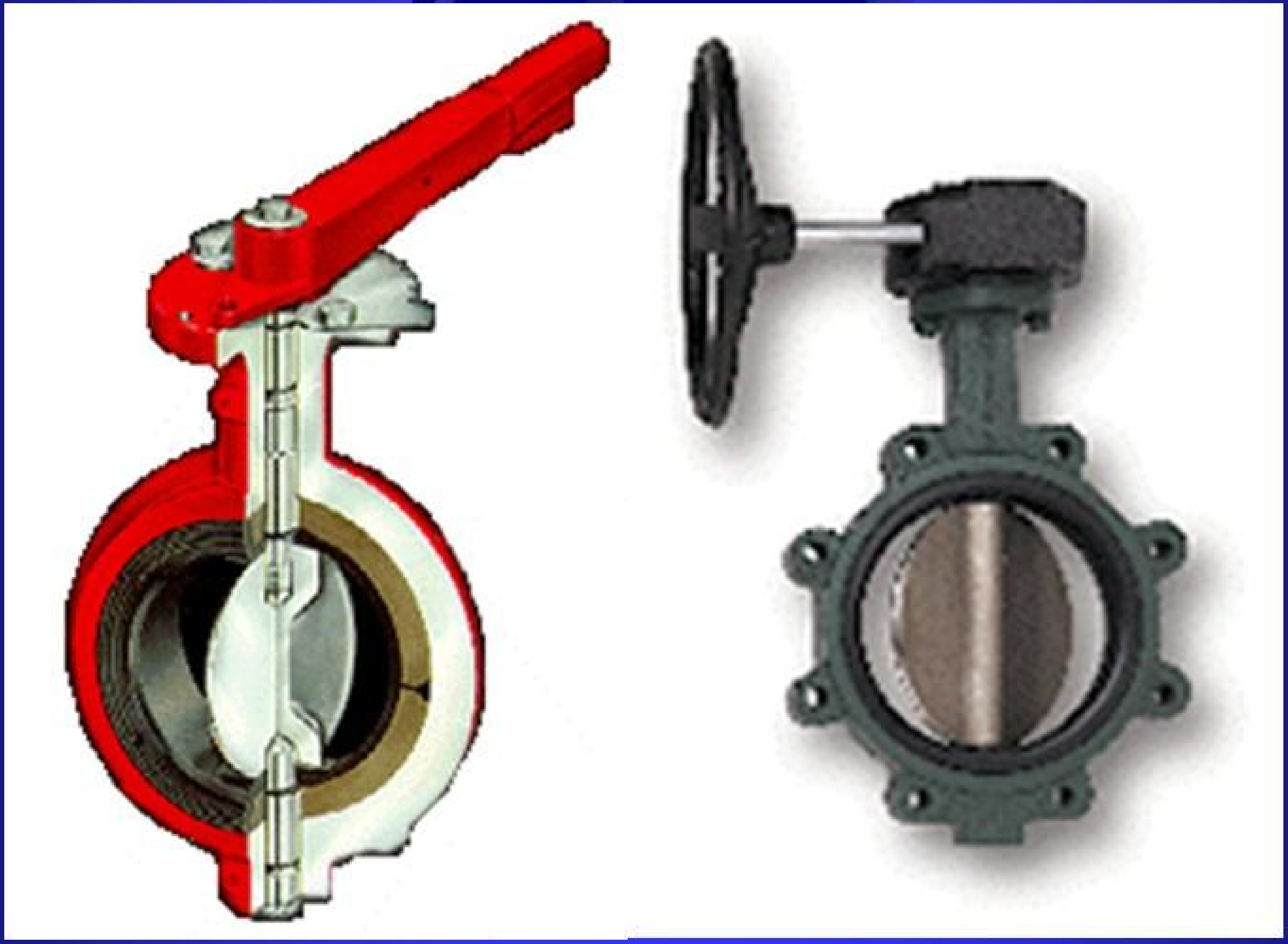


- Similar to ball valve



Butterfly Valve

Butterfly Valve

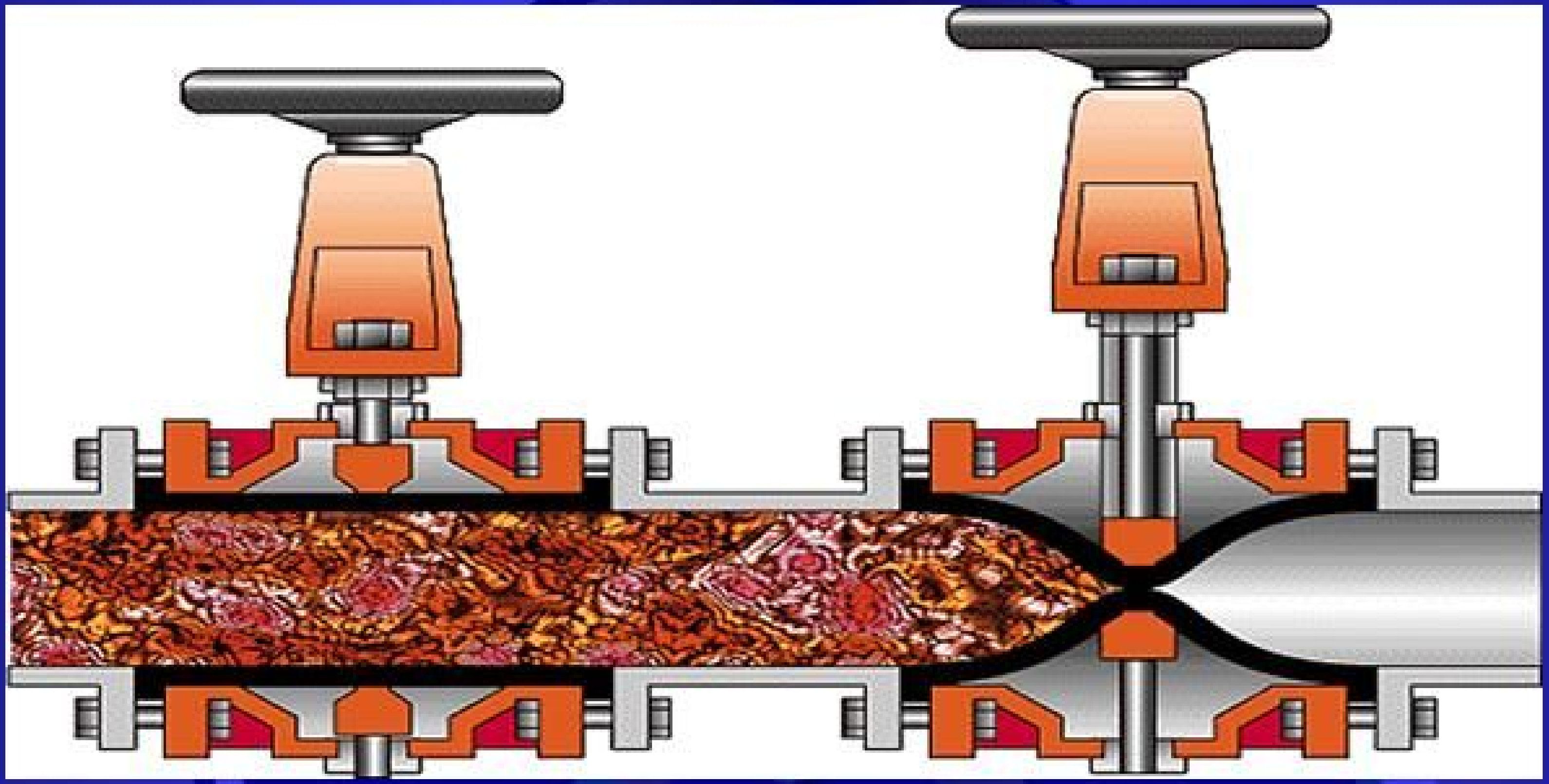


Piping components: valve (butterfly valve)

- used as cutout/isolation valves
- ADV: quick-acting low pressure drop across the valve, has adequate throttling characteristics
- DISADV: only used for low press/low temp systems due to force involved in valve operation

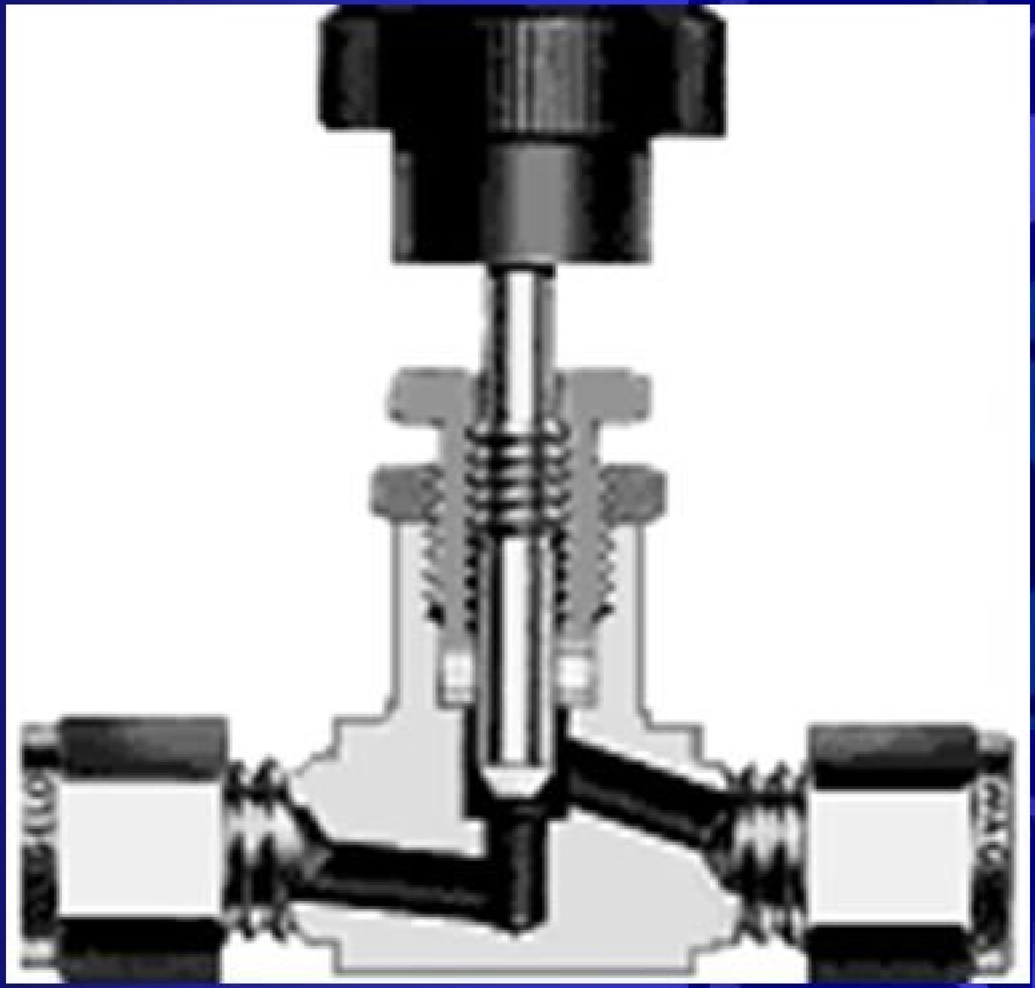
Pinch Valve

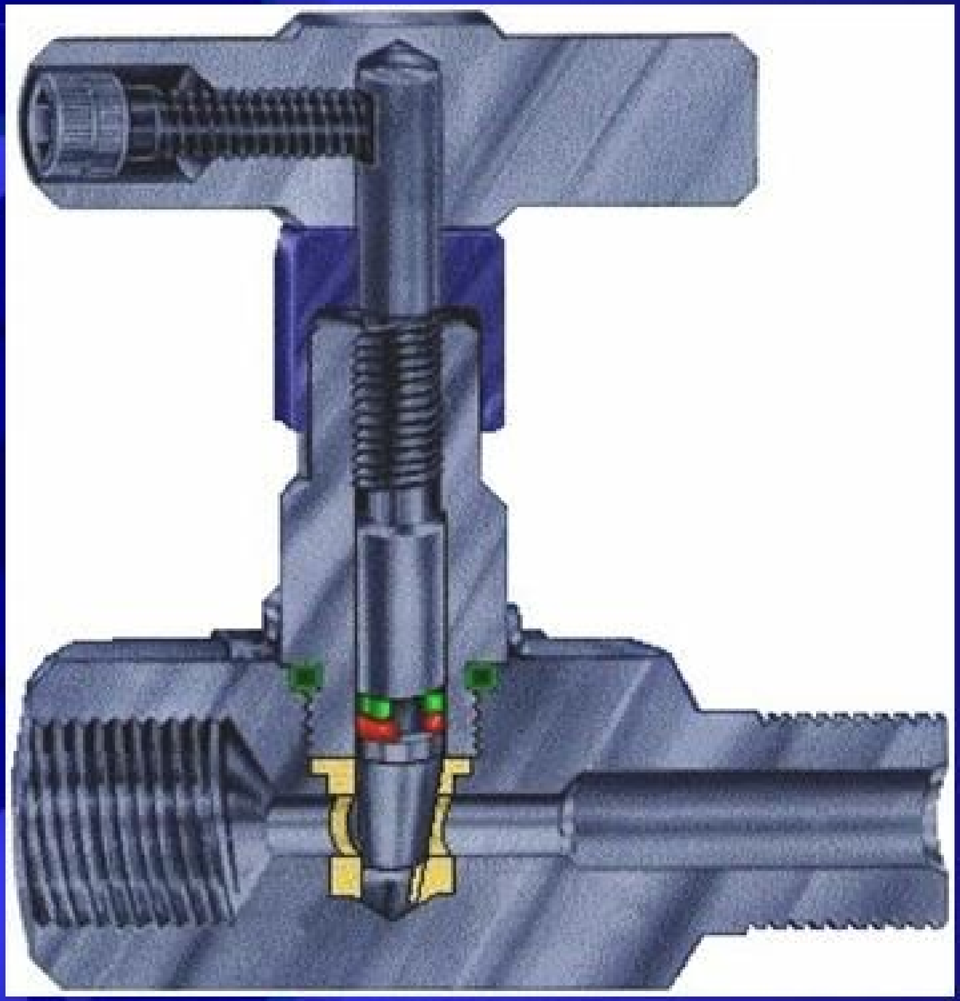
Pinch Valve



Needle Valve

Needle Valve





Relive Valve

Relive Valve

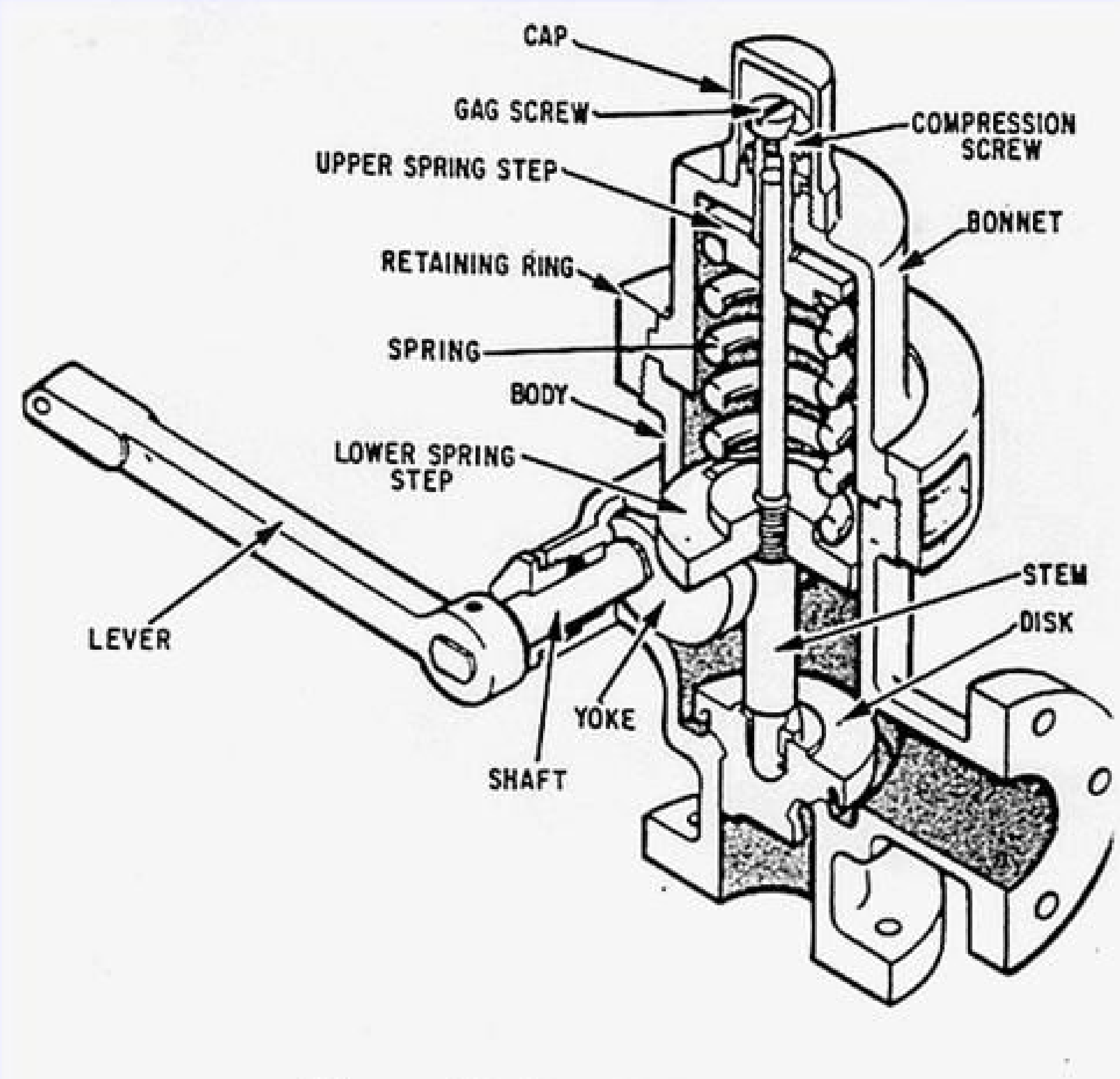
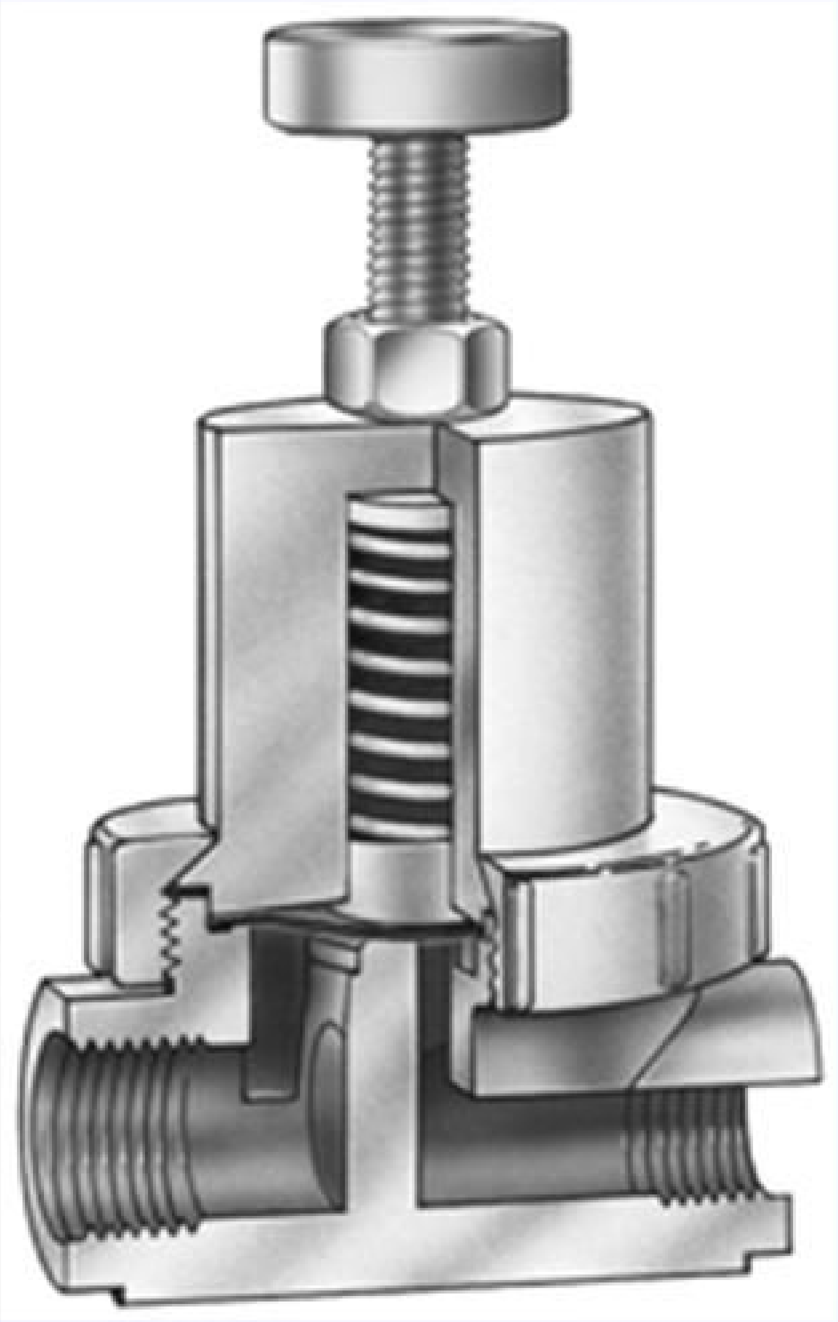


Figure 18-19.—Relief valve.



- special type of valve designed to operate automatically (self actuating) in a system overpressure condition (a protective feature in most systems)
- most relief valves use an adjustable spring to determine lift pressure. System pressure opposes spring pressure, and when pressure is high enough, the valve will open against spring pressure and port the fluid to another location (typically, overboard for 'safe' fluids)
- Type of relive valve:
  - Relief Valve - liquid systems
  - Safety Valve - gas and vapor systems
  - Safety Relief Valve - liquid and/or vapor systems

Interlock sequence

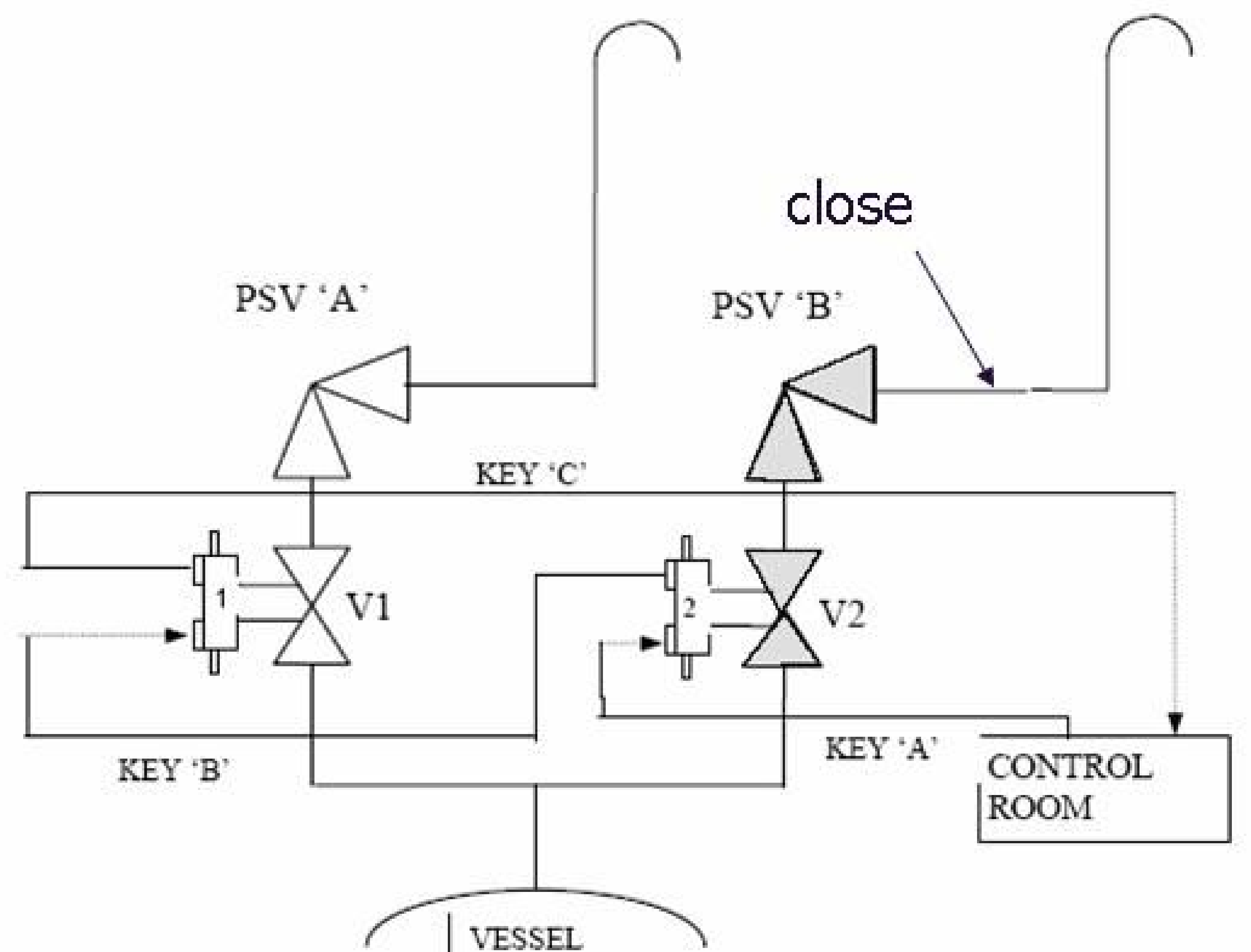
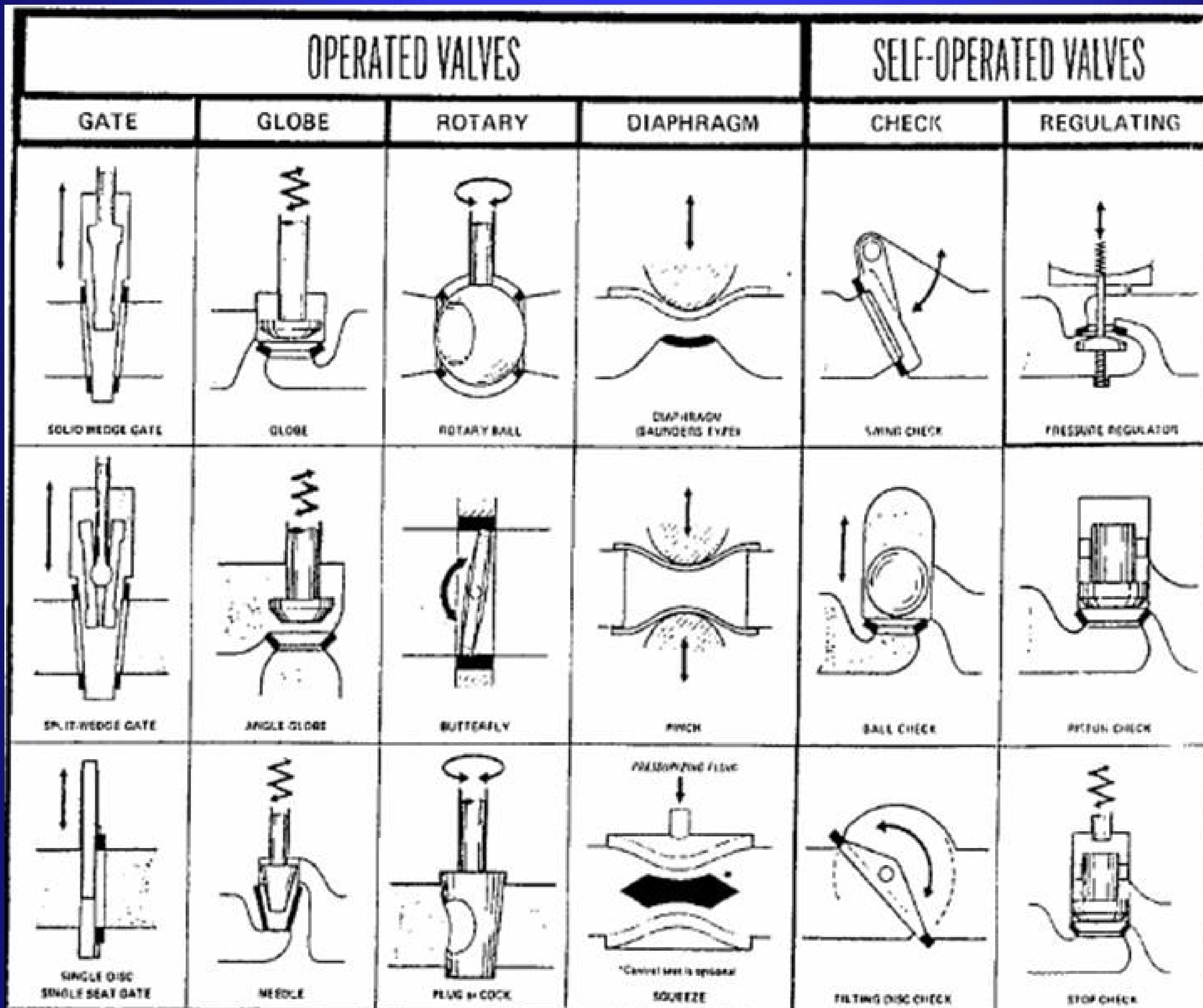


FIG. 5

- Parts of valves:
  - disk:
    - The moving part directly affecting the flow
  - seat:
    - Non-moving part that disk bear on it
      - Metallic
      - Non-metallic (elastomer)
  - port:
    - Maximum internal opening for flow when the valve is fully open
  - Stem:
    - Move the disk
  - Handwheel:
    - Rise with the stem
    - Stem rise thru the handwheel

Piping components: valve (result)



- General procedure for valve selection.
  - Identify design information including pressure and temperature, valve function, material, etc.
  - Identify potentially appropriate valve types and components based on application and function (i.e., block, throttle, or reverse flow prevention).

- Determine valve application requirements (i.e., design or service limitations).
- Finalize valve selection. Check factors to consider if two or more valves are suitable.
- Provide full technical description specifying type, material, flange rating, etc.

Piping components: valve (valve selection process)

Valve data sheet

TECHNIP	PLANT LAYOUT AND PIPING GROUP VALVE DATA SHEET	PROJECT 5270 TITLE SOUTH PARS GAS FIELD DEV.	
SIZE RANGE	1/2" - 8"	TAG NO.	VBFDE01/VBFDE01-G *(D1B / D1D / D1F)*
SPECIFICATION	B.S. 5351	CLASS	150

VALVE DESCRIPTION	BALL VALVE, CS, CL 150, FLANGED, R.F, REDUCED BORE, FIRE SAFE, FITTED WITH GRAPHITE FIRE SEALS, SIDE ENTRY, ANTI-BLOWOUT STEM, ANTI -STATIC DEVICE
GENERAL	
-FACE TO FACE DIM	B.S. 2080 TABLE 19 COLUMN 5
-BONNET/ADAPTER FIXING	BOLTED ,
-OPERATION	LEVER OPERATED = < 6", GEAR OPERATED 8" & LARGER
-END CONNECTIONS	CLASS 150 FLANGED ENDS TO ANSI B16.5, RAISED FACE
-FLANGE FINISH	GASKET CONTACT SURFACE FINISH 3.2-6.3 Micrometres Ra IN ACCORDANCE WITH ANSI B46.1
MATERIAL	
-BODY/BONNET/ADAPTER	ASTM A105 N/A216 WCB
-BALL	SOLID ONE PIECE AISI 316 Stainless Steel BALL/A351 CF8M
-TRIM/STEM	AISI 316 Stainless Steel /17-4PH
-SEATS and SEALS	PTFE SEAT INSERTS & ELAST-O-LION MINUS 40 SEALS
O-RING	GRAPHOIL/ELAST-0-LION MINUS 40
-BOLTING	ASTM A193 GRADE B7 STUDS WITH ASTM A194 GRADE 2H NUTS, PTFE COATED
-BONNET GASKET	316 St .St. SPIRAL WOUND WITH GRAPHITE FILLER AND EITHER TRAPPED DESIGN OR 316 St. St. INNER AND OUTER RINGS
DESIGN	
-PRESSURE	RATING CLASS ANSI 150
-TEMPERATURE	MINUS 29 ° to PLUS 130 °C
-SERVICE	HYDROCARBON
TESTS	
-HYDROSTATIC	BODY 29.5 barg SEAT 21.6 barg AIR SEAT 6 barg
CERTIFICATION	PRESSURE CONTAINING PARTS TO B.S. EN 10204 TYPE 3.1B ALL OTHER WETTED PARTS TO B.S. EN10204 TYPE 2.2
INSPECTION	IN ACCORDANCE WITH PURCHASE ORDER
MATERIAL REQUIREMENTS	ALL WETTED PARTS CERTIFIED TO NACE MR0175

NOTES:

1) PROCEDURE & RESULTS OF HYDROSTATIC TESTS SHALL BE IN ACCORDANCE WITH BS 6755 PART 1, RATE 'A' AT PRESSURES STATED ABOVE.

SPECIFICATION NO : SP1-220-0000-00-PI-SP-109 REQUISITION NO : SP1-220-0000-00-PI-MR-601	PAGE : 11 REV : D3

- According to ANSI, leakage classify by class (I, II, III, IV, VI)

Table 10-5
Valve Seat Leakage Classifications

Leakage Class Designation	Maximum Allowable Leakage
I	---
II	0.5% of rated capacity
III	0.1% of rated capacity
IV	0.01% of rated capacity
V	5 x 10^{-12} m^3/s of water per mm of seat diameter per bar differential (0.0005 ml/min per inch of seat diameter per psi differential)
VI	Not to exceed amounts shown in Table 10-6 (based on seat diameter)

Source: ANSI/FCI 70-2-1991

Table 10-6
Class VI Seat Allowable Leakage

Nominal Port Diameter mm (in)	Allowable Leakage Rate (ml per minute)
≤25 (≤1)	0.15
38 (1½)	0.30
51 (2)	0.45
64 (2½)	0.60
76 (3)	0.90
102 (4)	1.70
152 (6)	4.00
203 (8)	6.75

Source: ANSI/FCI 70-2-1991

Pipe Supports and Restraints

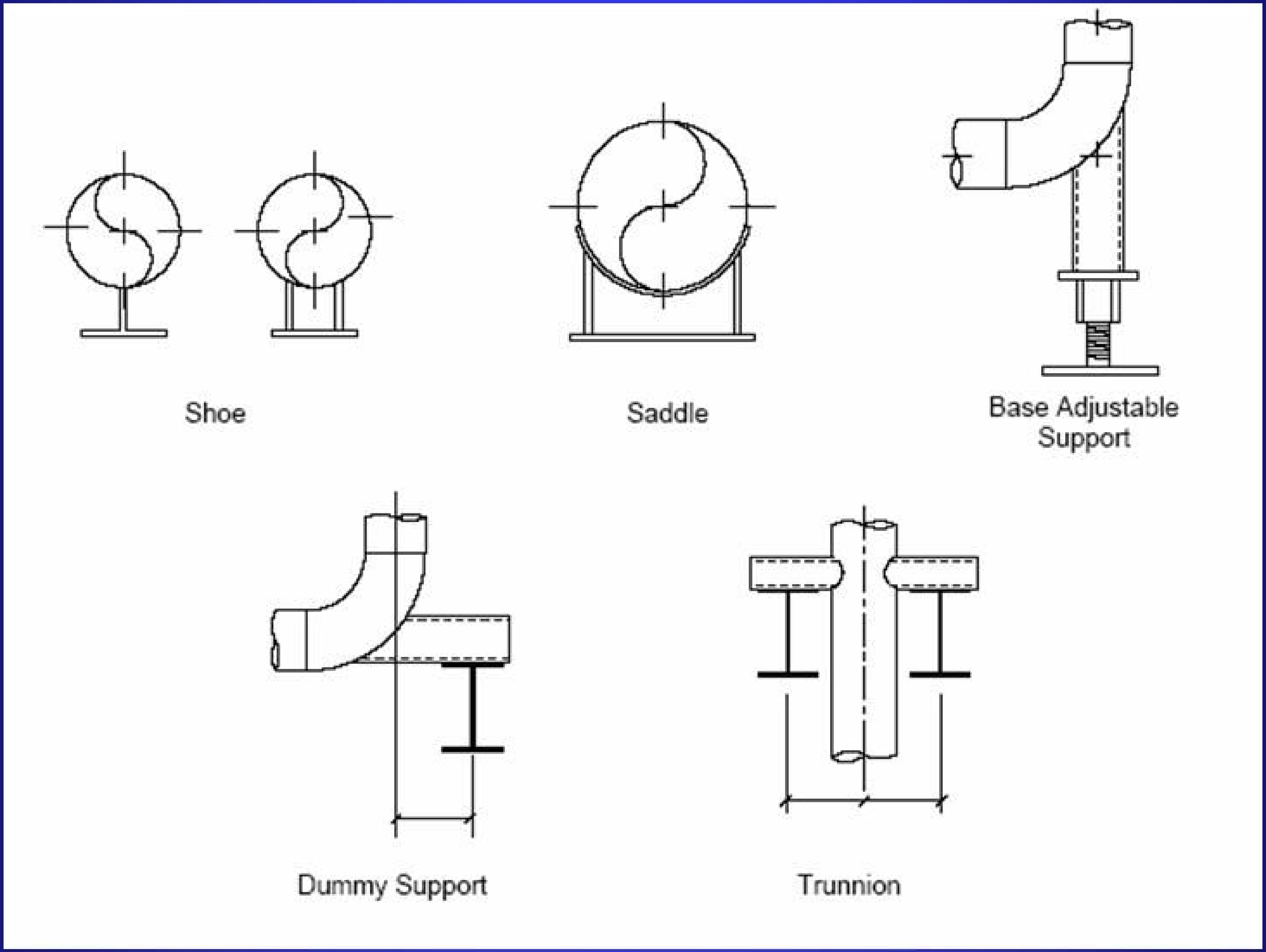
- Function of supports and restraints:
  - To carry load
  - To ensure that material is not stressed beyond a safe limit
  - Holdup of liquid can occurred due to pipe sagging (allow draining)
  - To permit thermal expansion
  - To withstand and dampen vibrational forces applied to the piping

- Supports:
  - Absorb system weight
  - Reduce:
    - longitudinal pipe stress
    - pipe sag
    - end point reaction loads

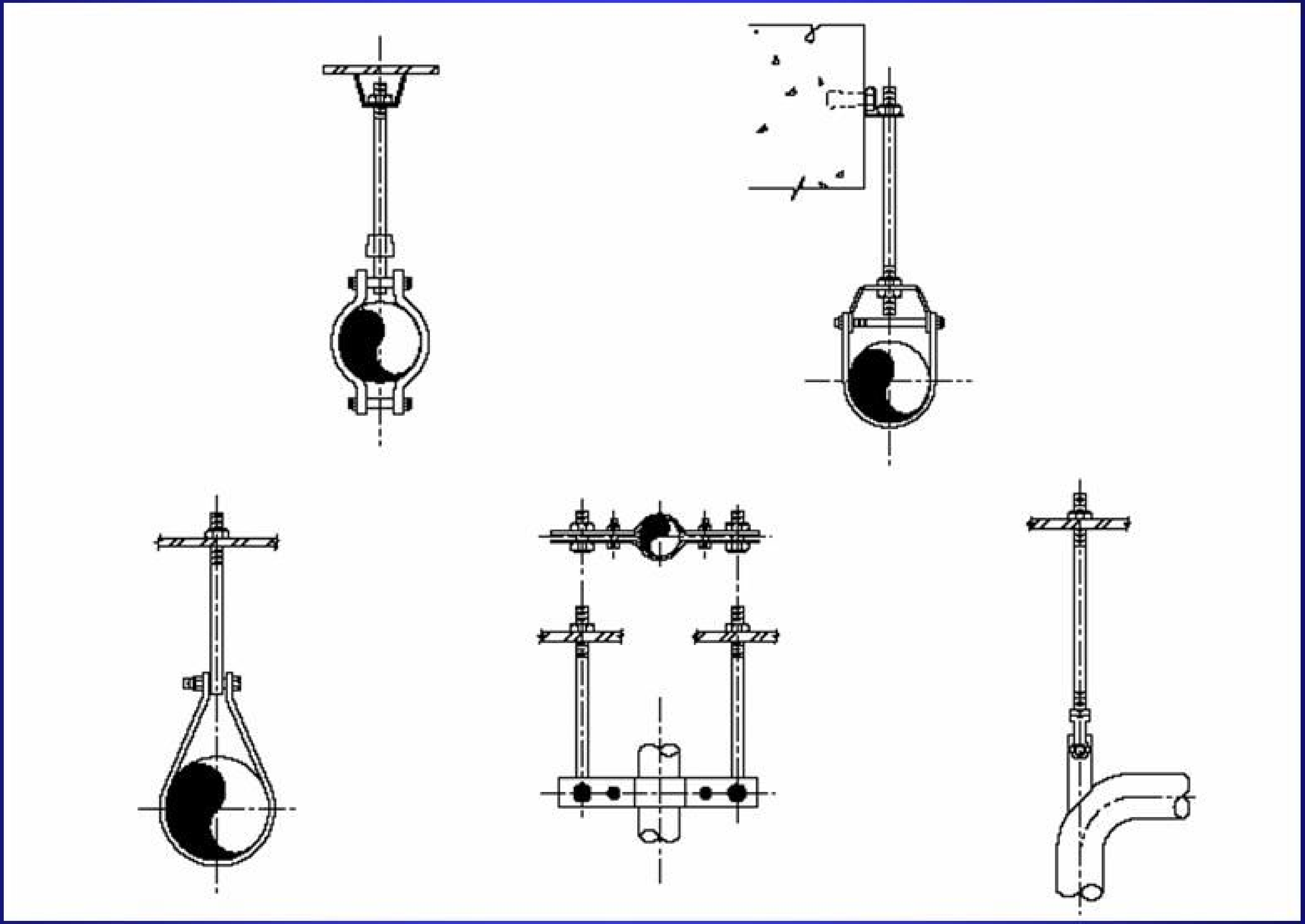
- Restraints
  - Control, limit, redirect thermal movement
    - Reduce thermal stress
    - Reduce loads on equipment connections
  - Absorb imposed loads
    - Wind
    - Earthquake
    - Slug flow
    - Water hammer
    - Flow induced-vibration

- *Support and Restraint Selection Factors:*
  - Weight load
  - Available attachment clearance
  - Availability of structural steel
  - Direction of loads and/or movement
  - Design temperature
  - Vertical thermal movement at supports

Piping components: pipe supports and restraints (rigid support)

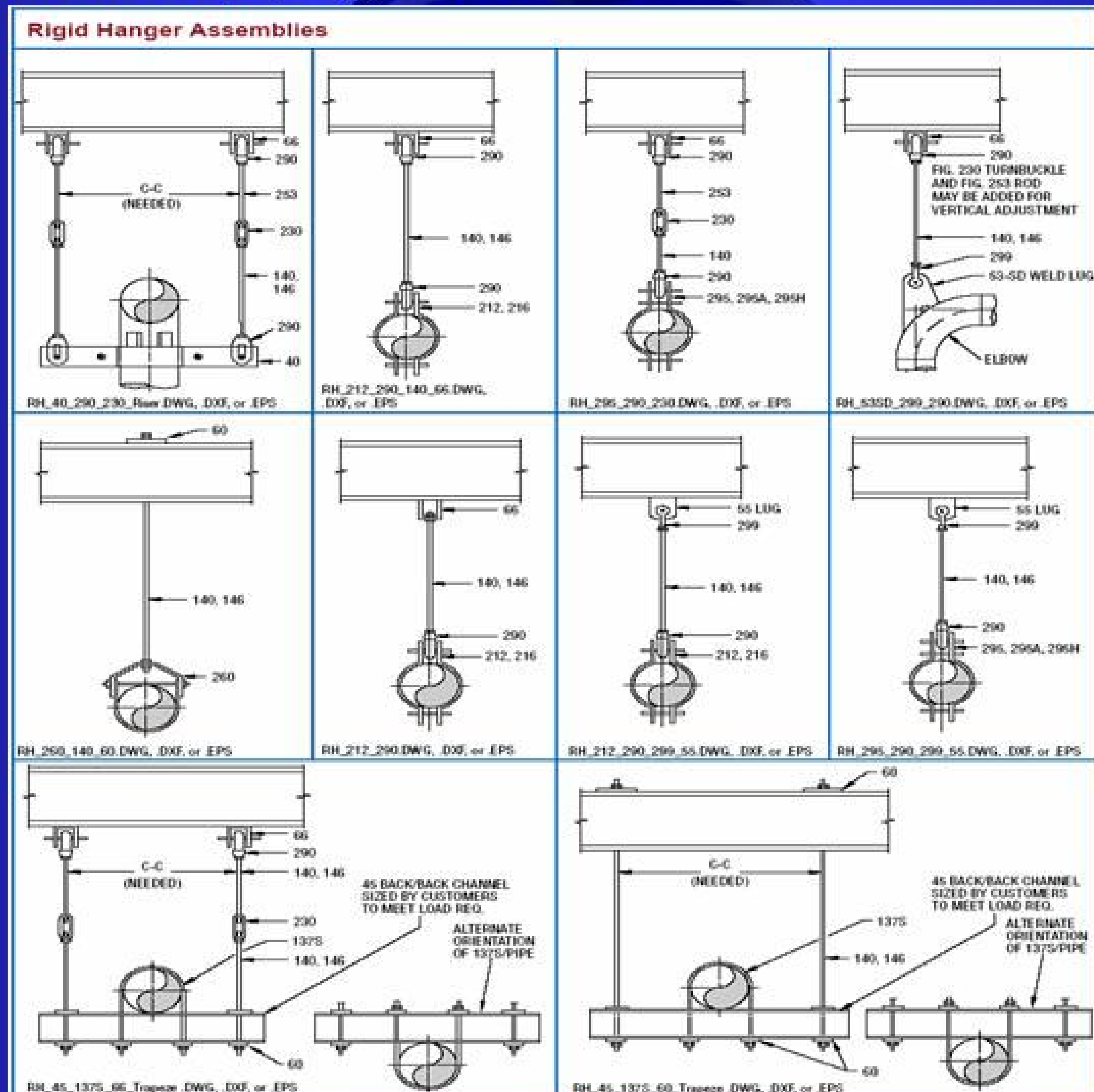


Piping components: pipe supports and restraints (hanger support)

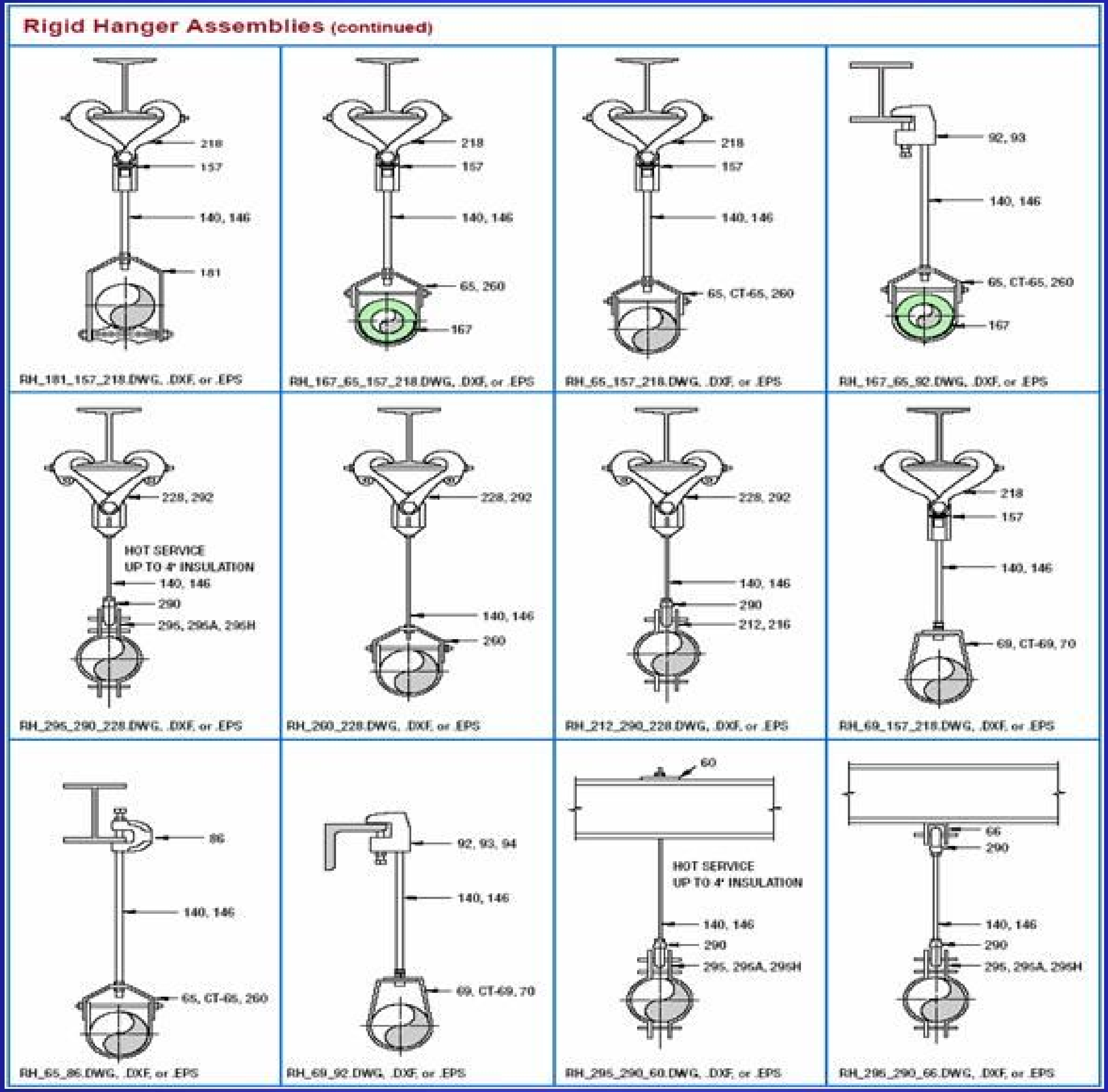


Piping components: pipe supports and restraints (flexible support)

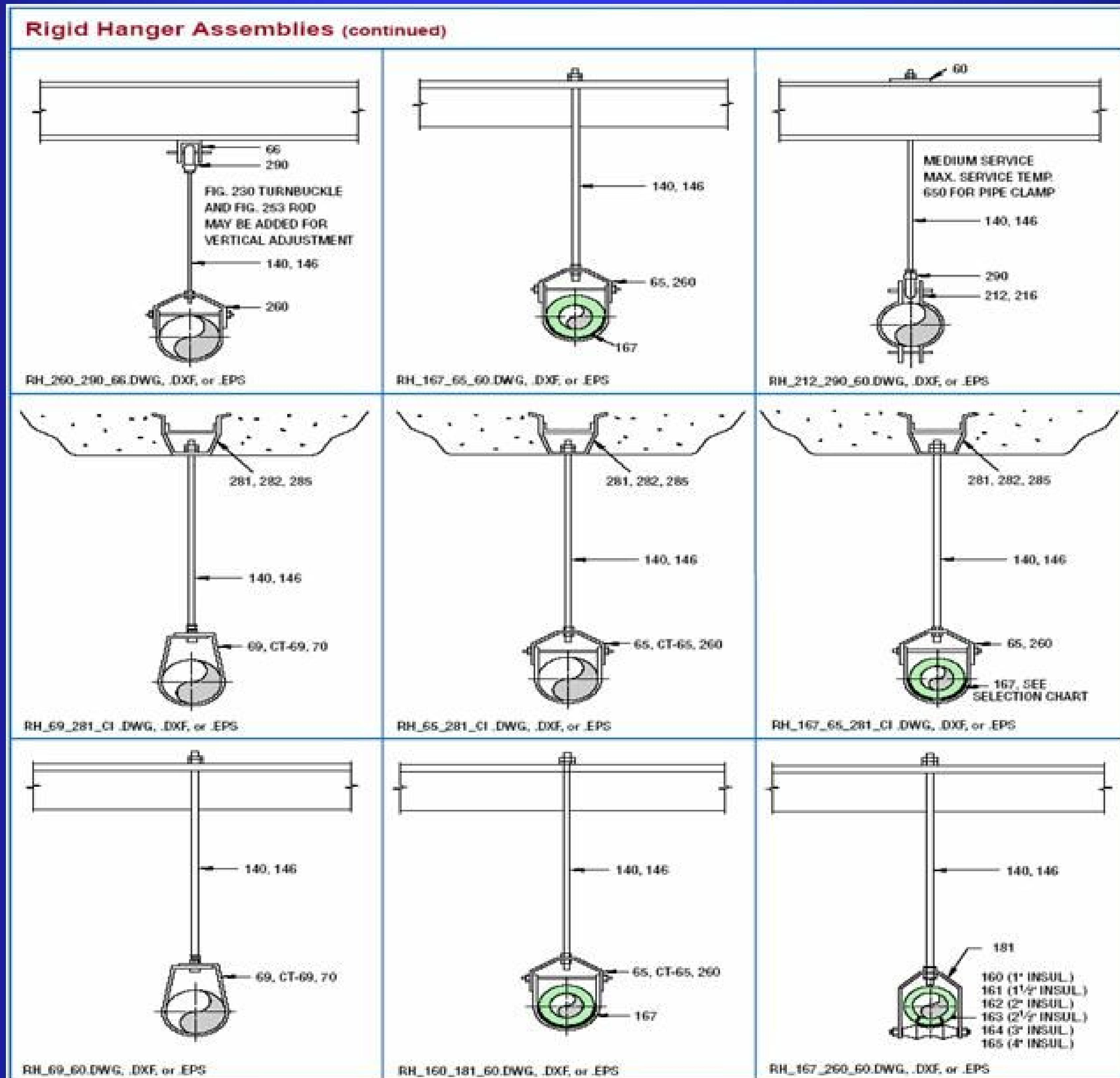
- Rigid hangers are normally used at locations where no vertical movement of the piping occurs.



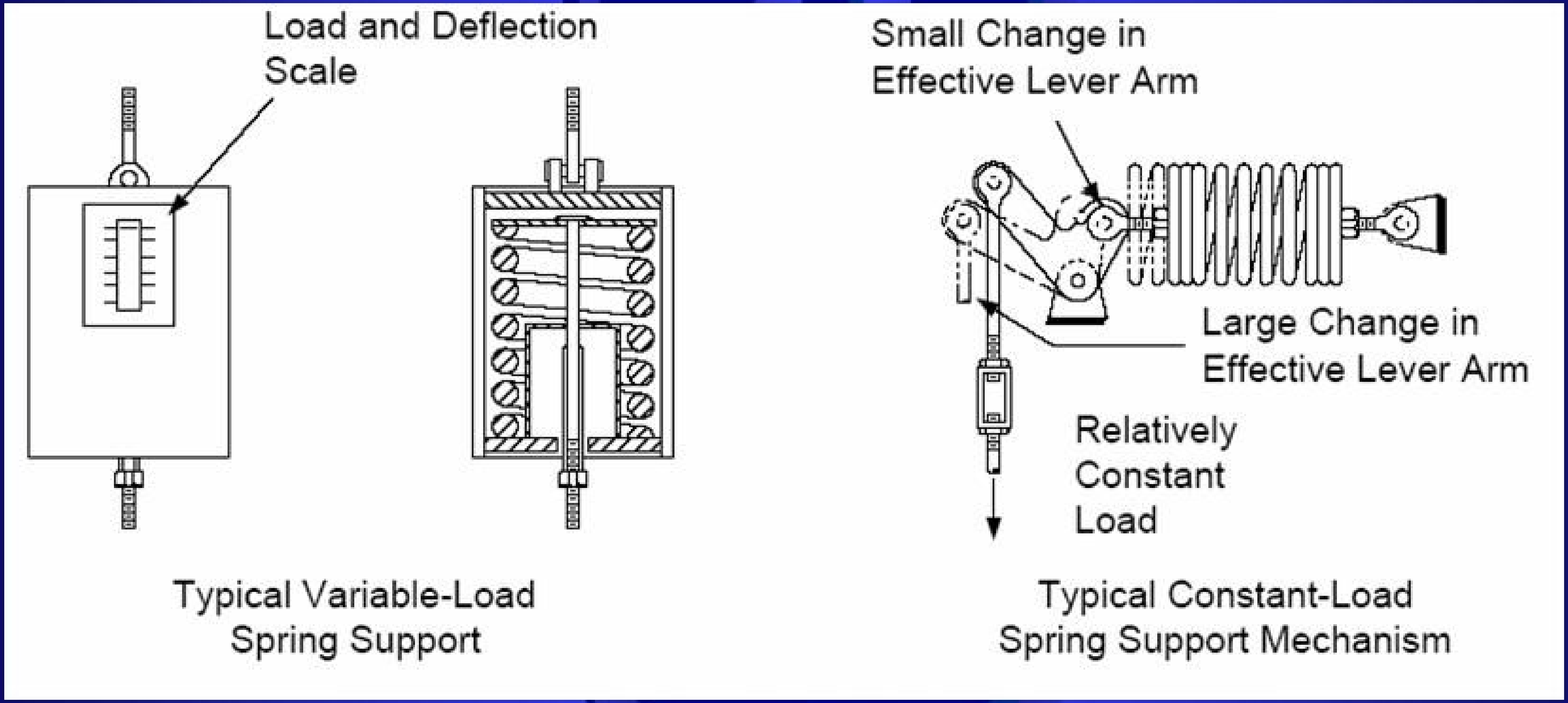
Piping components: pipe supports and restraints (flexible support)



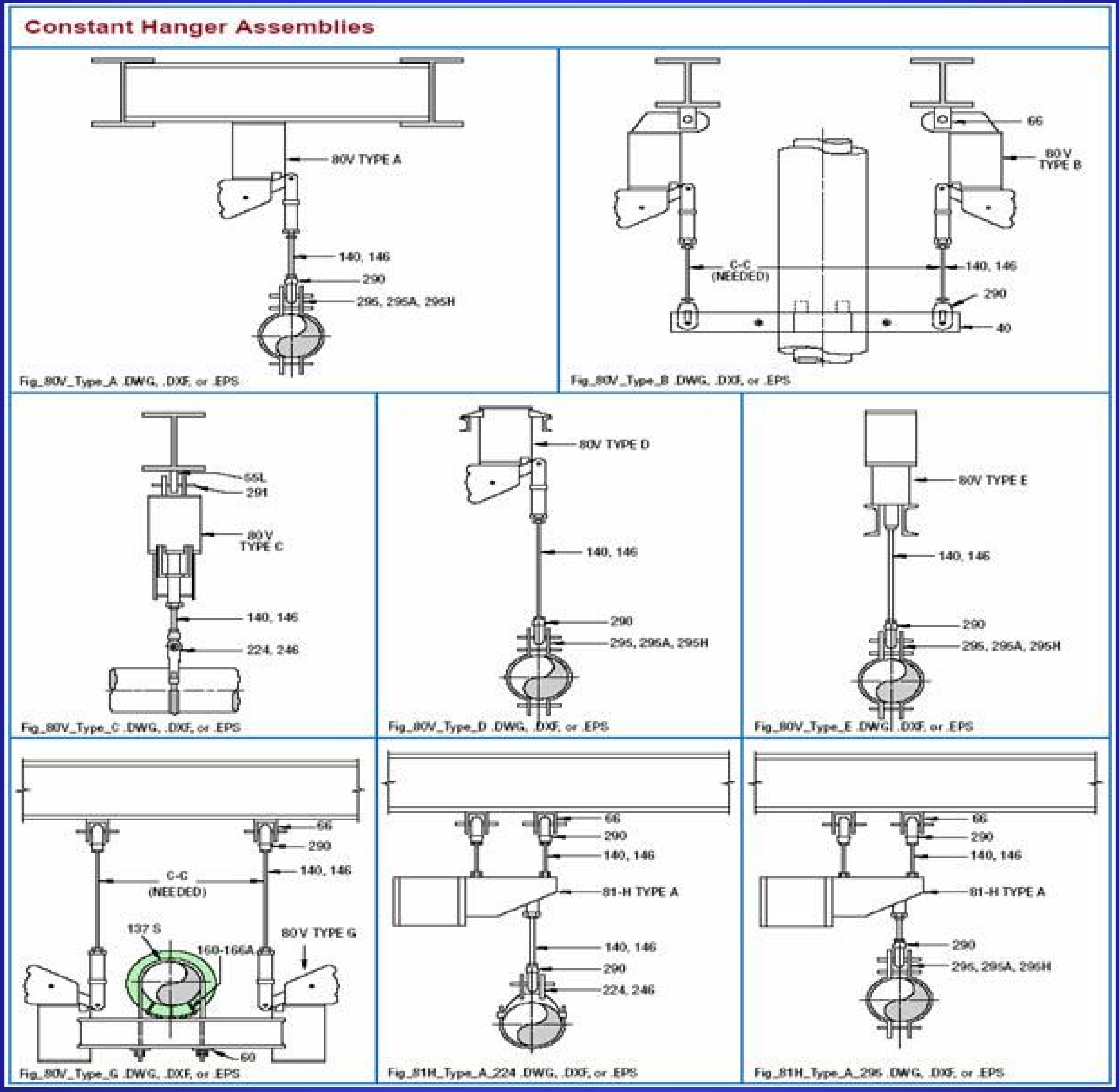
Piping components: pipe supports and restraints (flexible support)



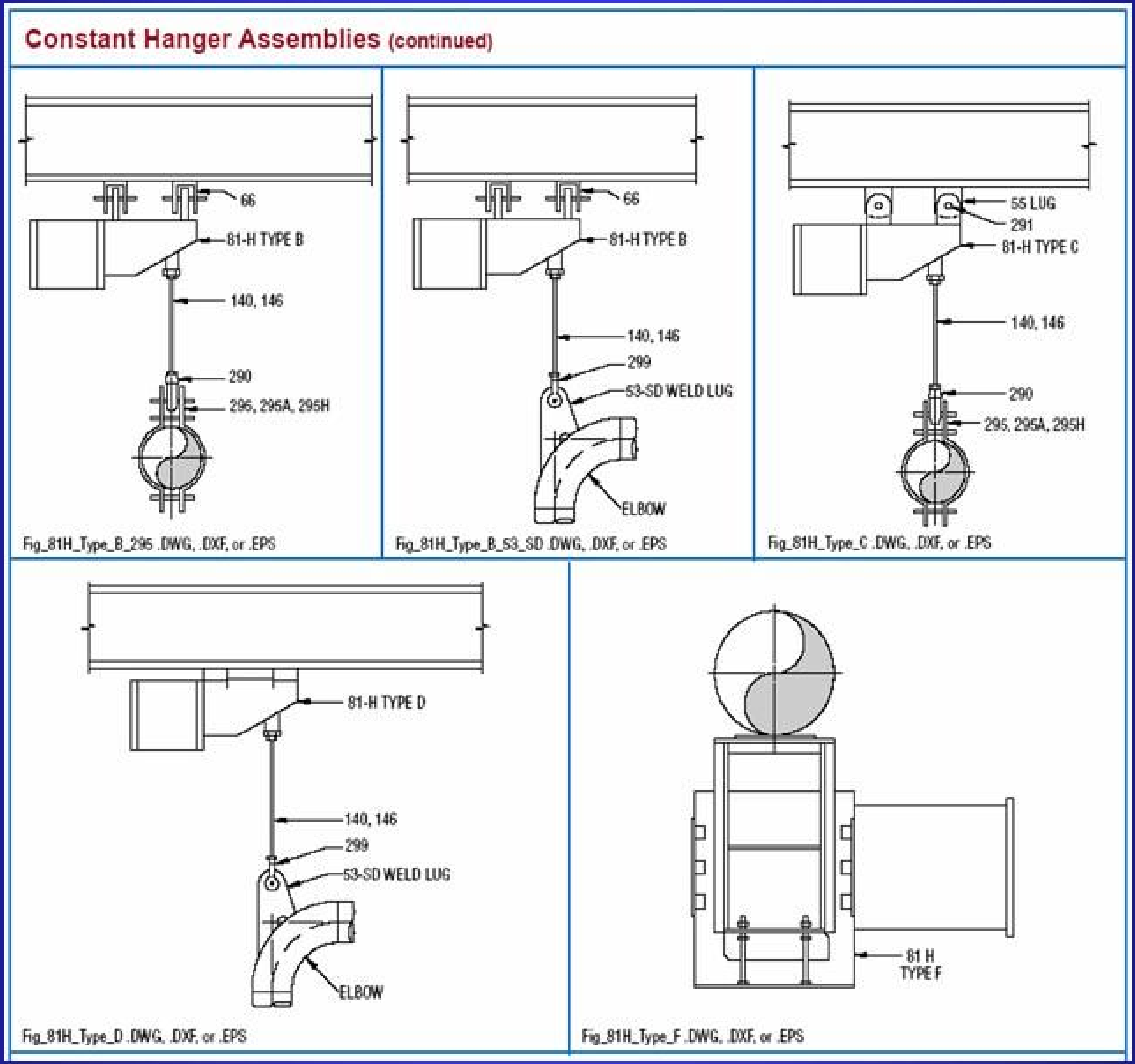
Piping components: pipe supports and restraints (flexible support)



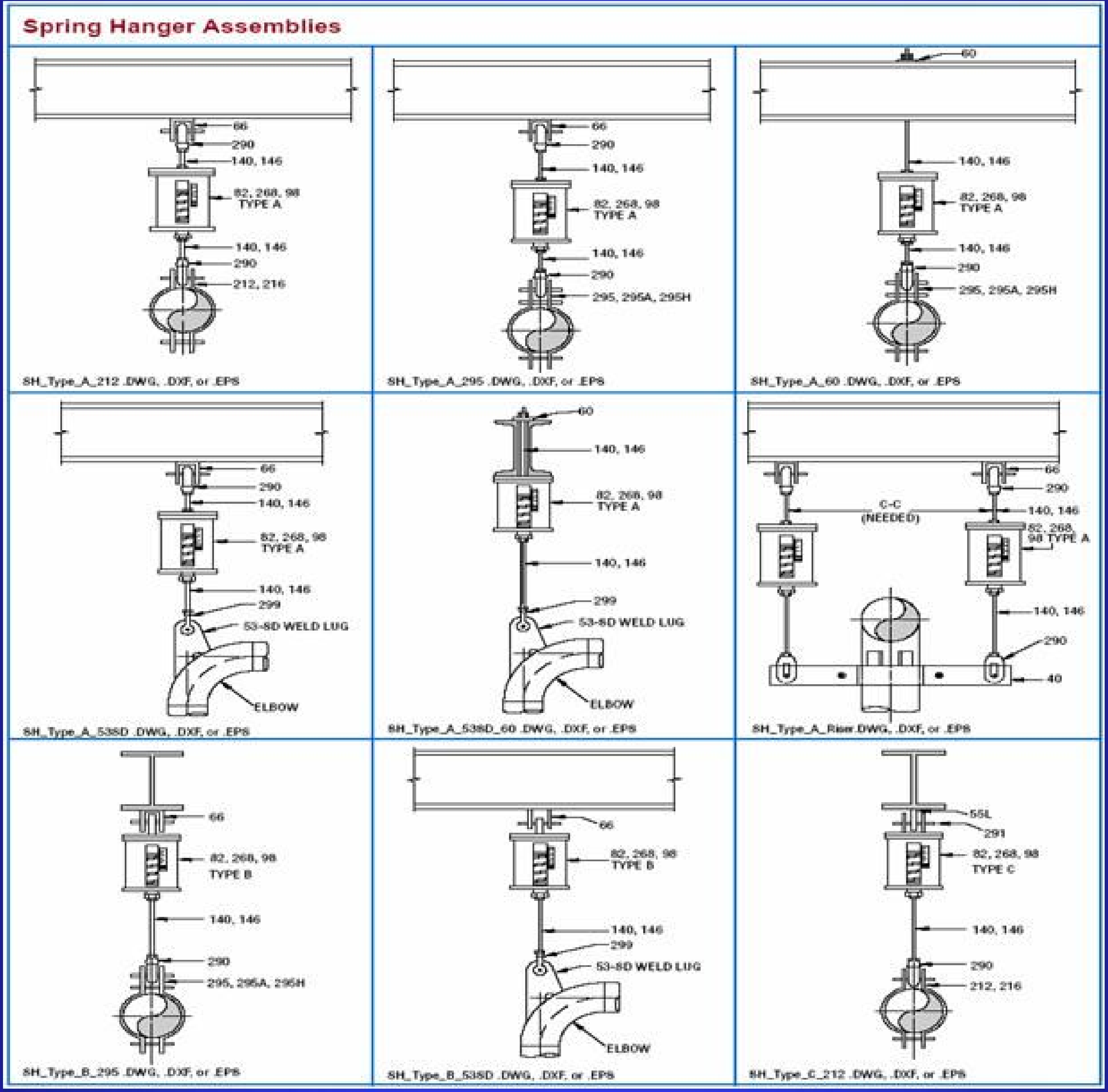
Piping components: pipe supports and restraints (flexible support)



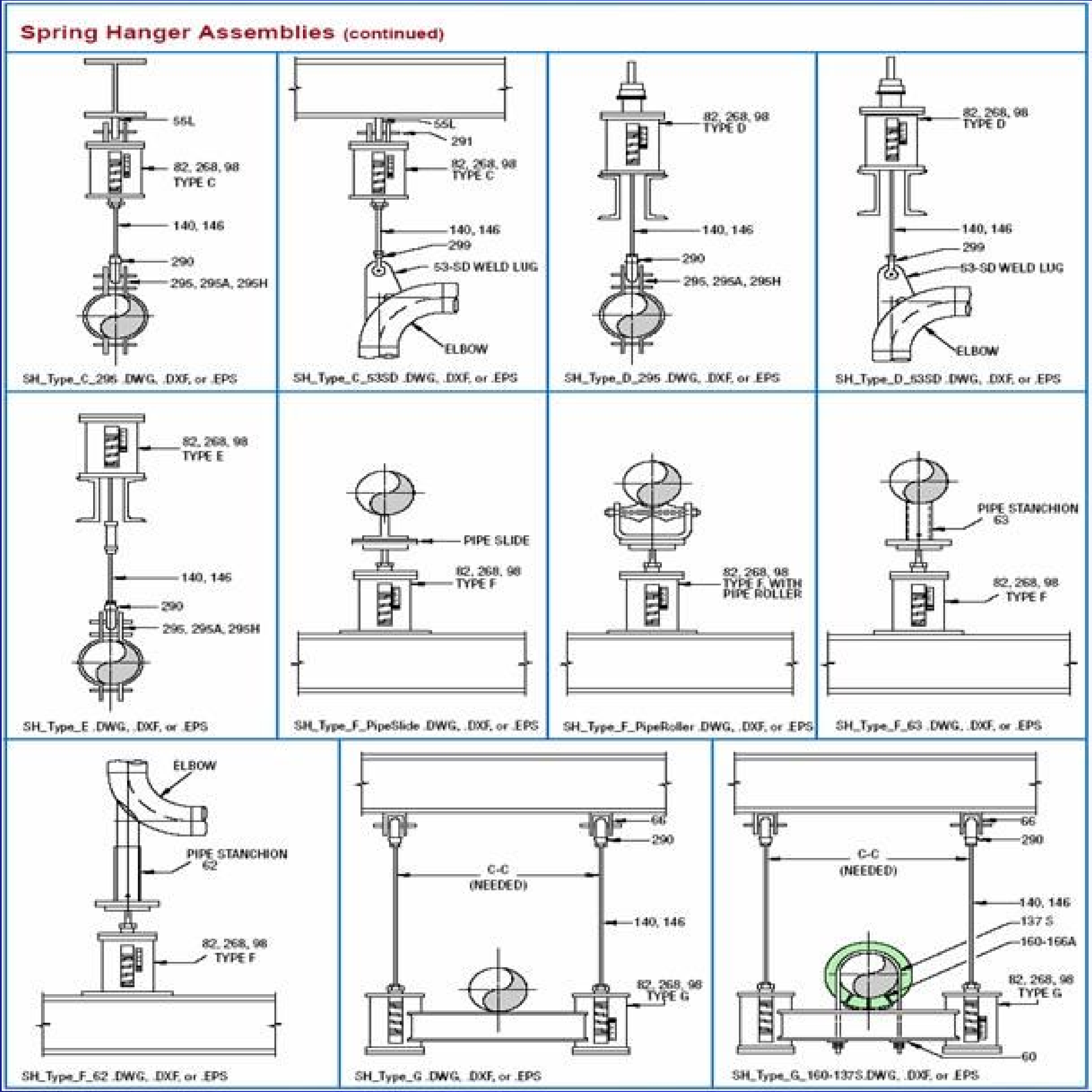
Piping components: pipe supports and restraints (flexible support)



Piping components: pipe supports and restraints (flexible support)

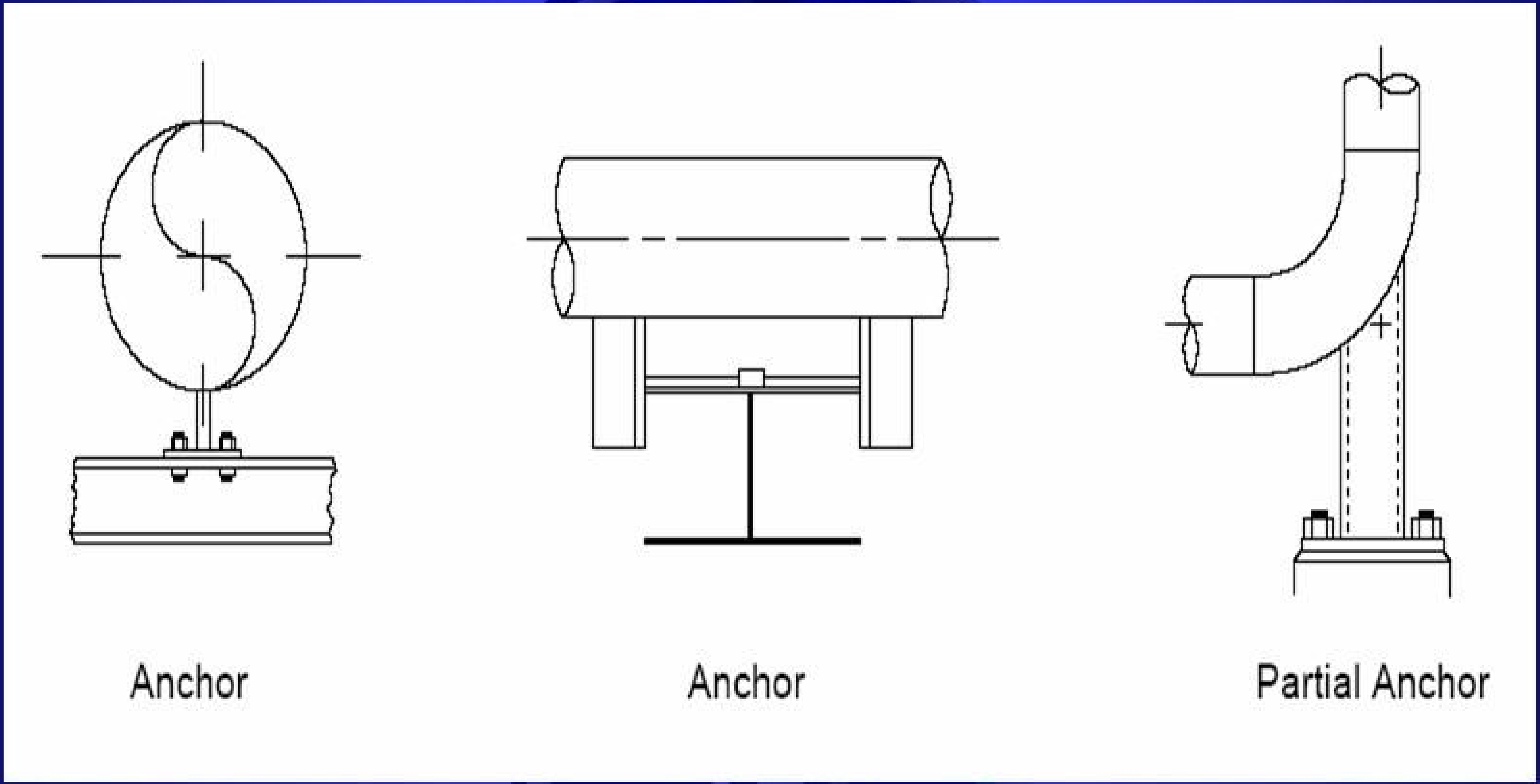


Piping components: pipe supports and restraints (flexible support)

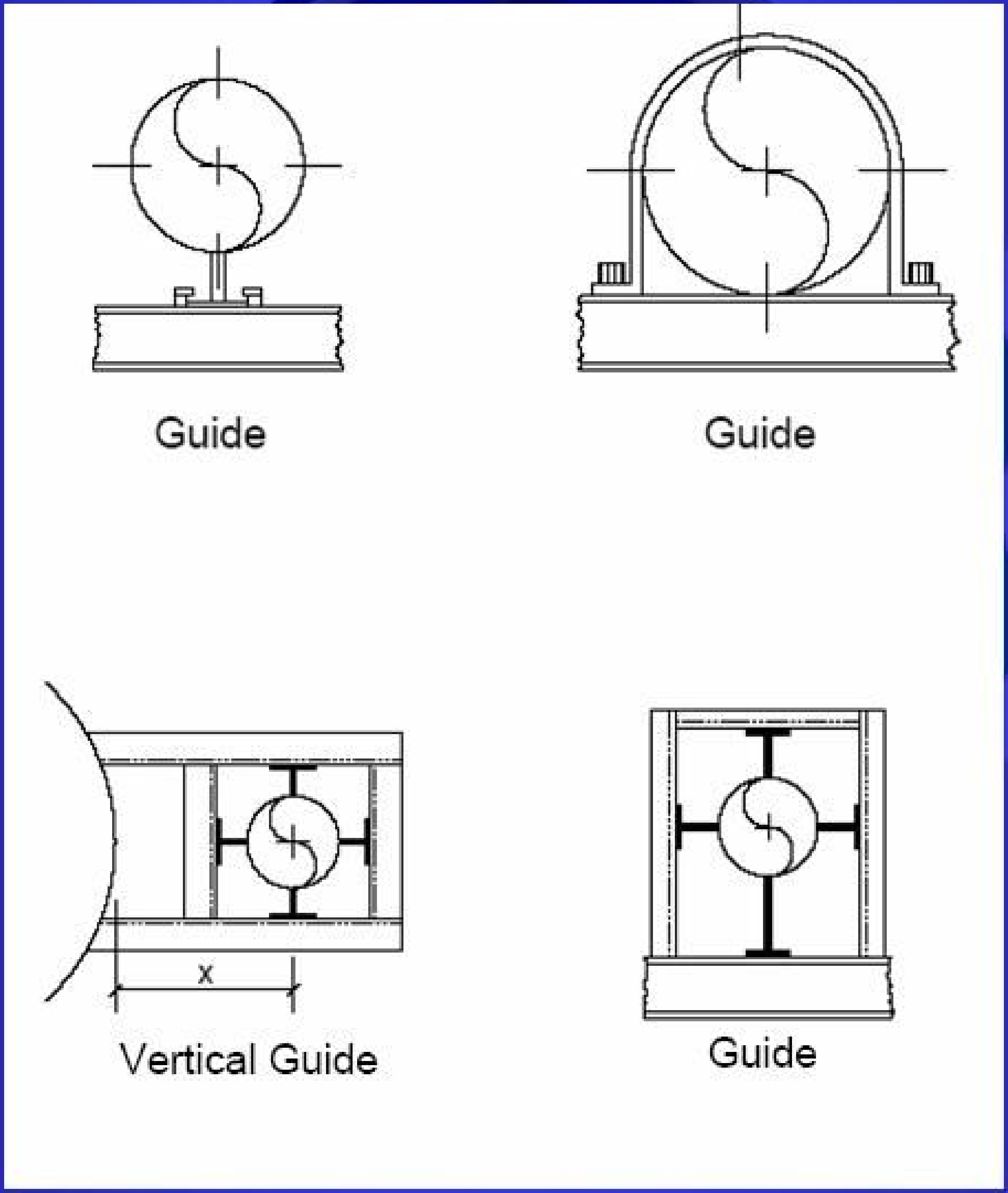


- Anchor
  - Full fixation
  - Permits very limited (if any) translation or rotation
- Guide
  - Permits movement along pipe axis
  - Prevents lateral movement
  - May permit pipe rotation

Piping components: pipe supports and restraints (Restraints - Anchors)



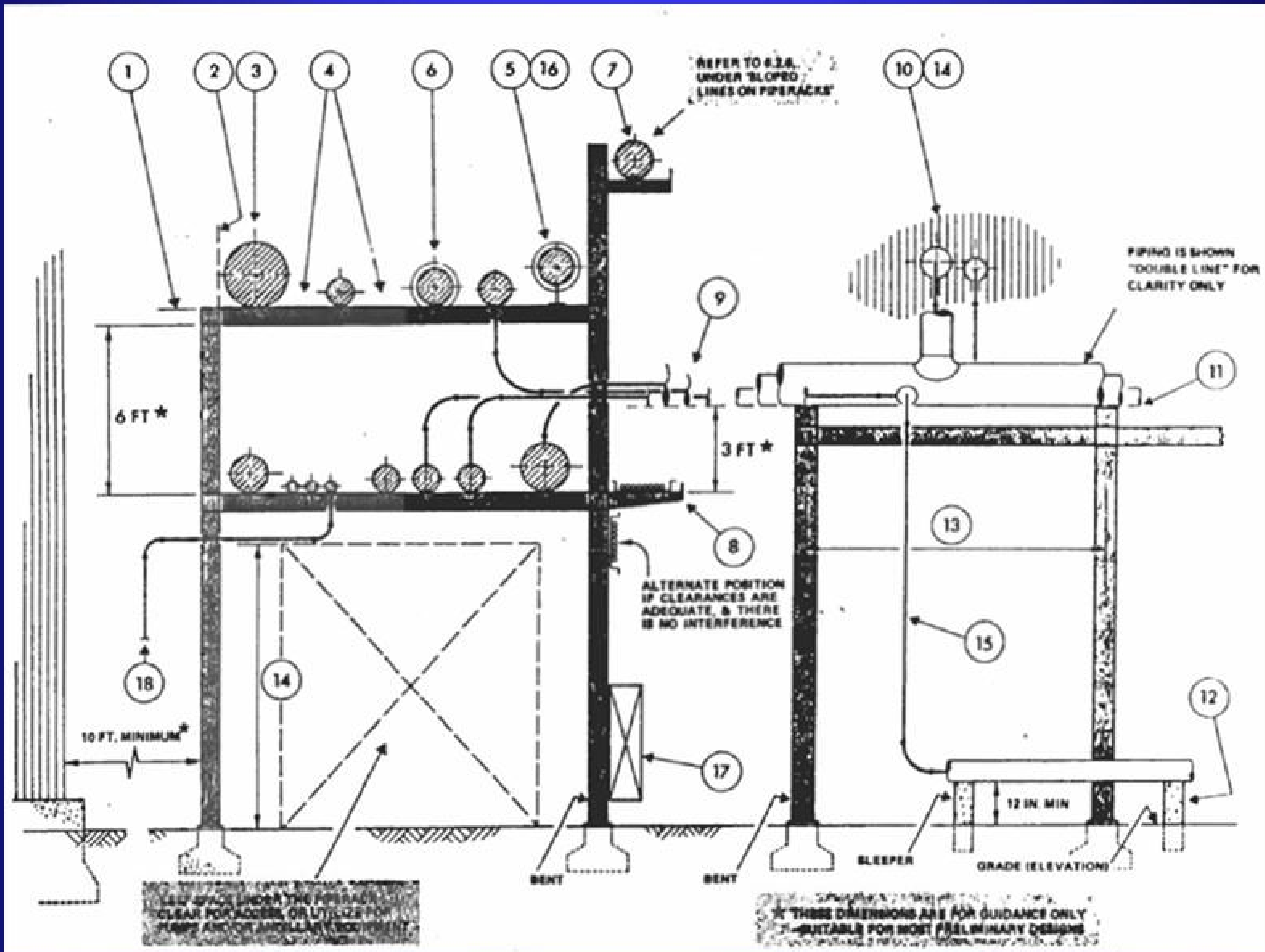
Piping components: pipe supports and restraints (Restraints - Guide)



- Piping can be arranged
  - On piperacks
  - Near grade on sleeper
  - In trench
  - Near steelwork or equipment

Piping components: pipe supports and restraints (Piping and support arrangement)

Piping components: pipe supports and restraints (Piping and support arrangement)



Piping components: pipe supports and restraints (Piping and support arrangement)

Piping components: pipe supports and restraints (Piping and support arrangement / support definition)

- Pipeway:
  - Is the space allocated for routing several parallel adjacent lines
  - Group lines in pipeway

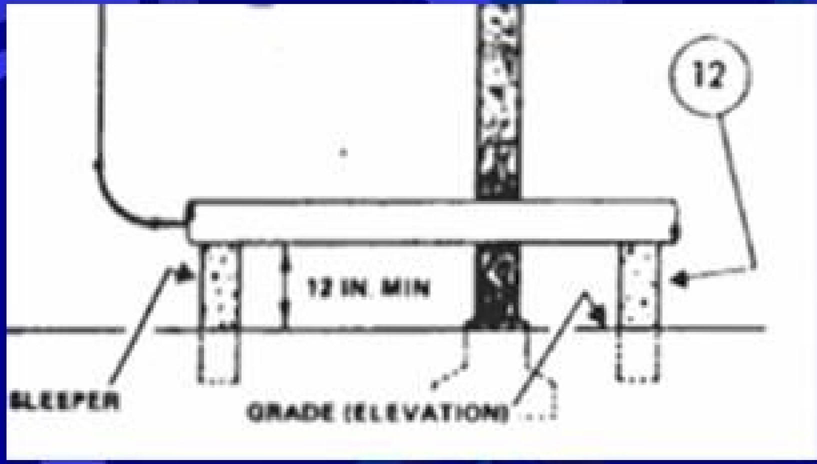
- Piperack
  - Is a structure in the pipeway for carrying pipes and is usually fabricated from Steel, Concrete & steel, also provide protected location for ancillary equipment (pump, utility station, …)
  - Piperack T shape termed tee-head support

- Piperack consist:
  - Bent:
    - Connected ⊓ shape frame
  - Stanchion:
    - The vertical member of bents are termed stanchion

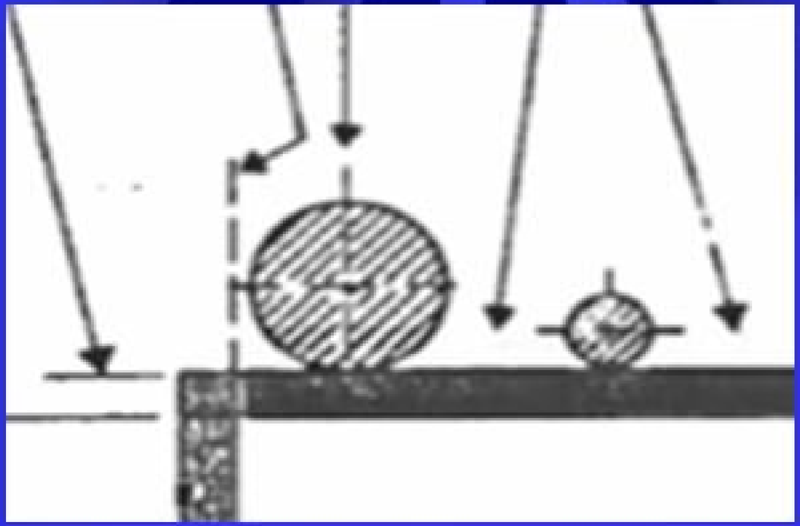
- Piperack arrangement:
  - Single deck
  - Double deck, …

◈ *Arrangement of pipe on support:*

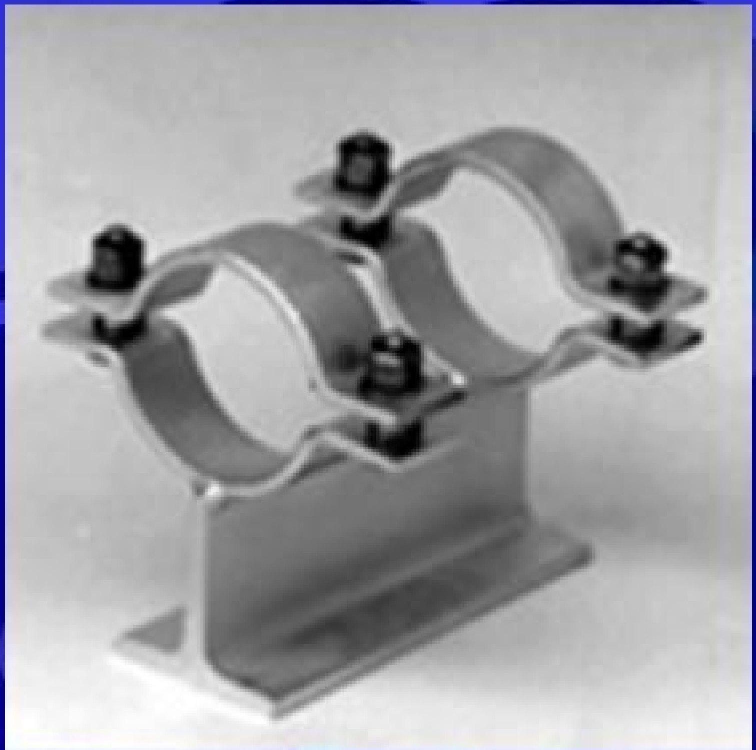
- Usually 2” < NPS < 12” mounted on piperack and larger pipes are mounted on sleeper

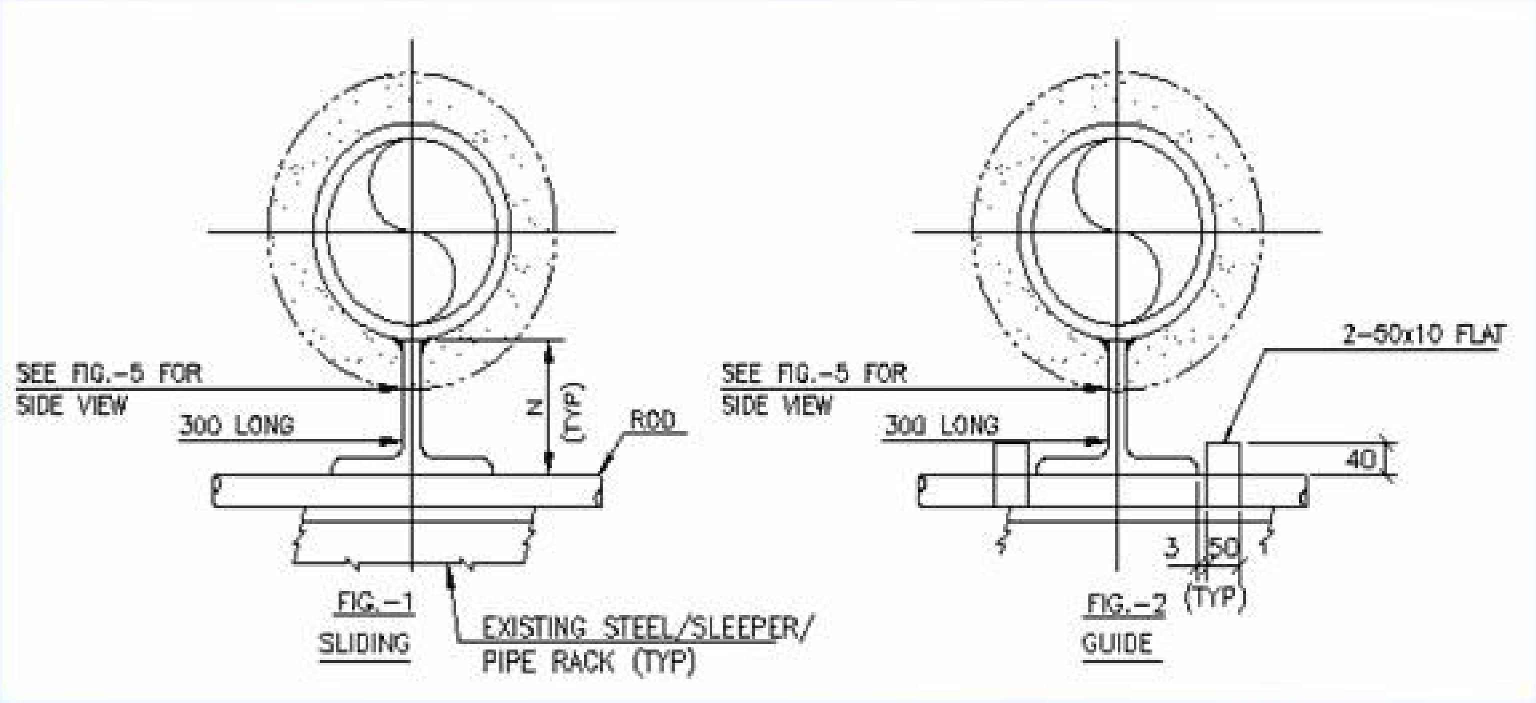


- Mounted large diameter pipe near stanchion for uniform distribution of load

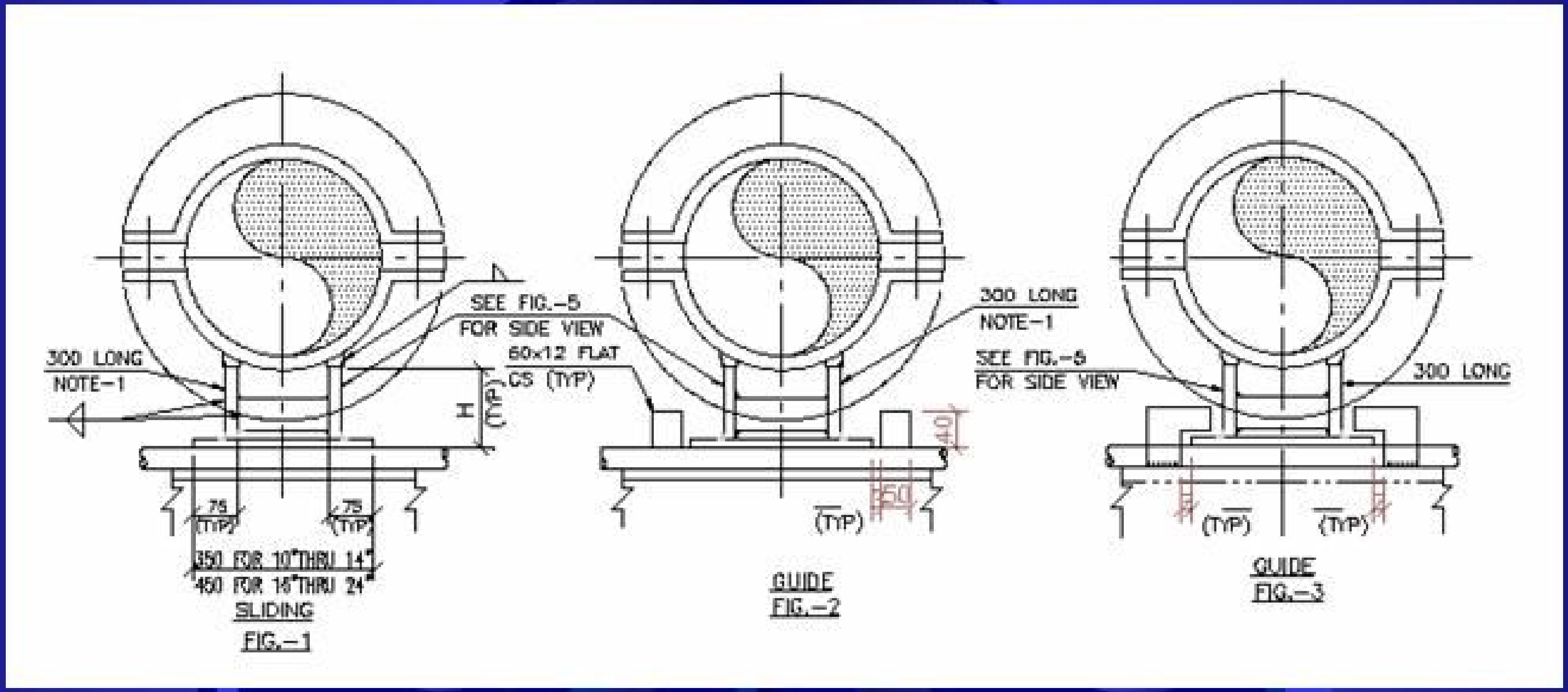


– Hot pipe usually insulated and mounted on shoes

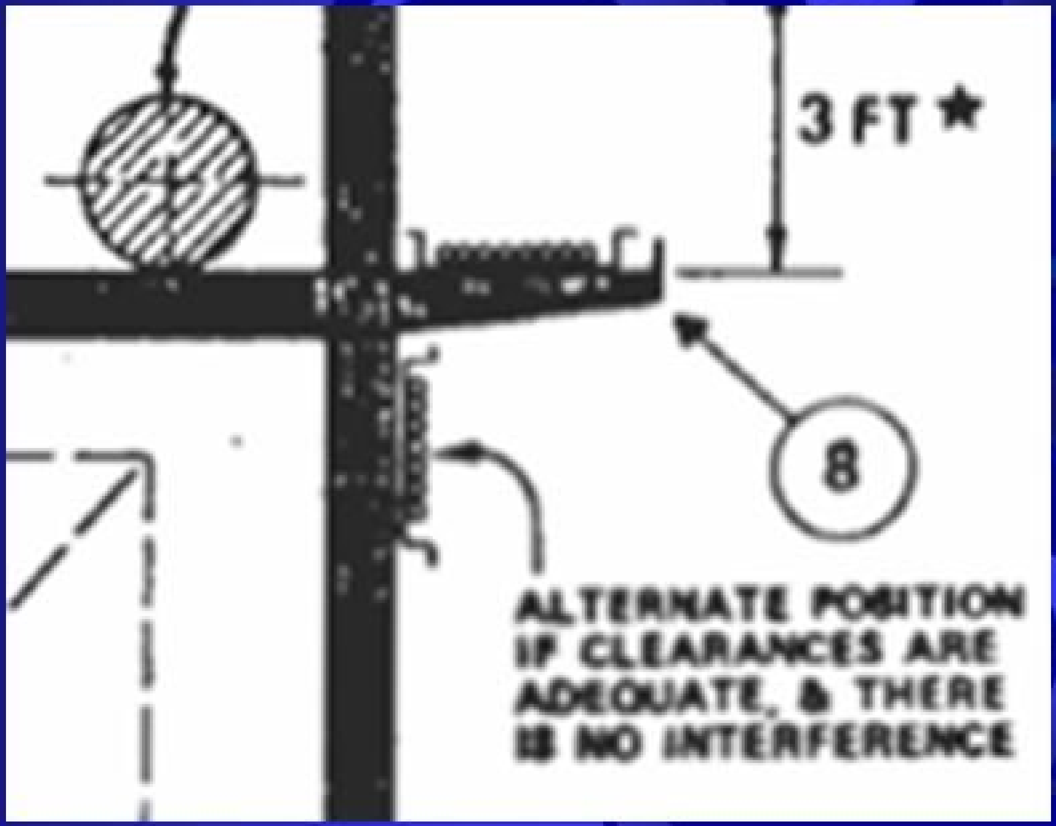


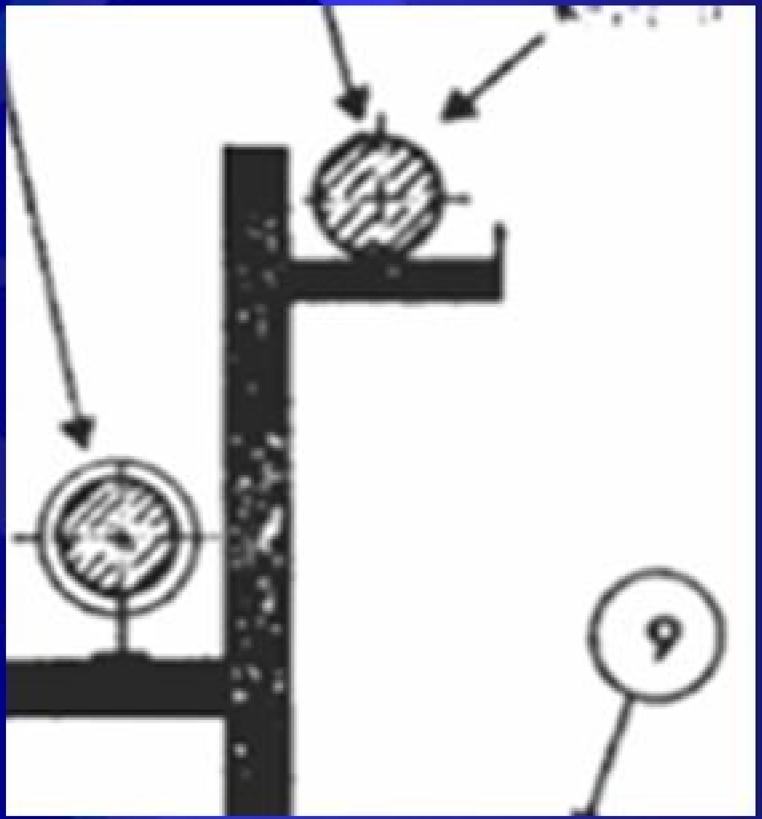


– Other type of shoes



- Use bracket or outrigger for
  - Installation of electrical and instrument tray
  - Pipes with slope





- Group requiring expansion loop at one side of the pipe rack

- Design hanger for 2 ½" and larger pipe

- For better stress distribution in the pipe wall, saddle used on large line and used for lines that twist over when moving

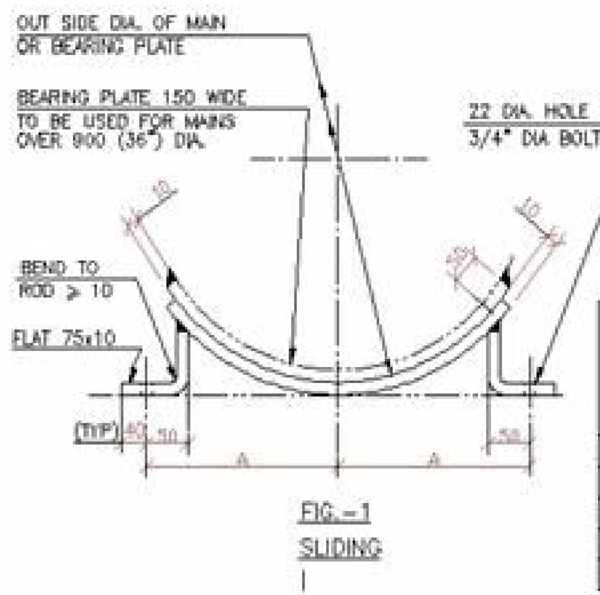
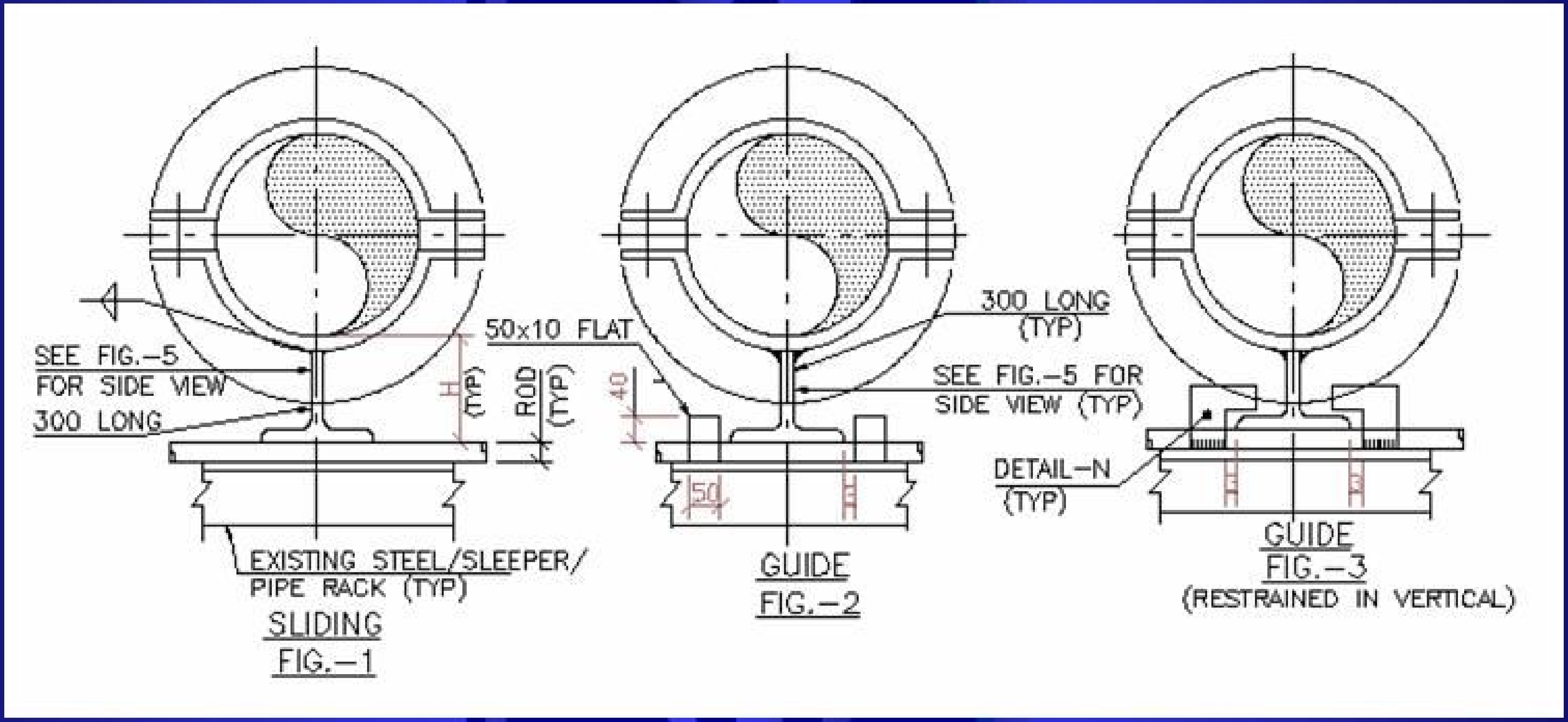


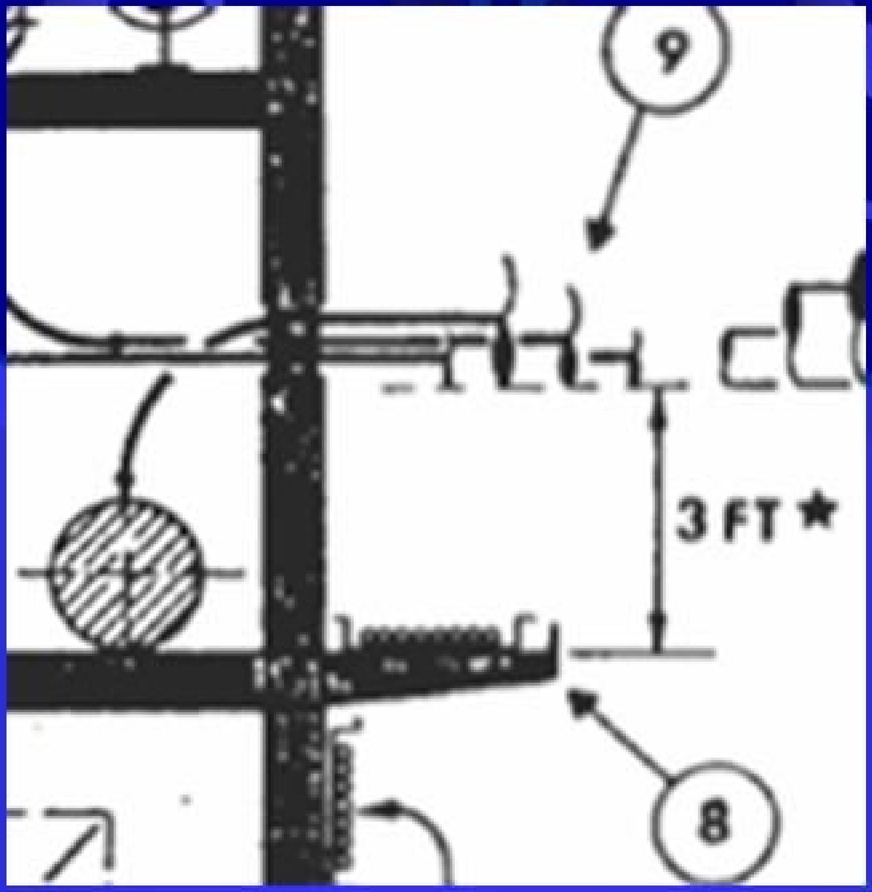
FIG.–1
SLIDING

NOM. PIPE DIA. INCH	PIPE O.D. mm	A	DEVELOPED LENGTH OF BEARING PLATE	DEVELOPED LENGTH OF SADDLE
20	508	235	–	880
21	533	245	–	915
22	559	255	–	945
23	584	260	–	950
24	610	270	–	985

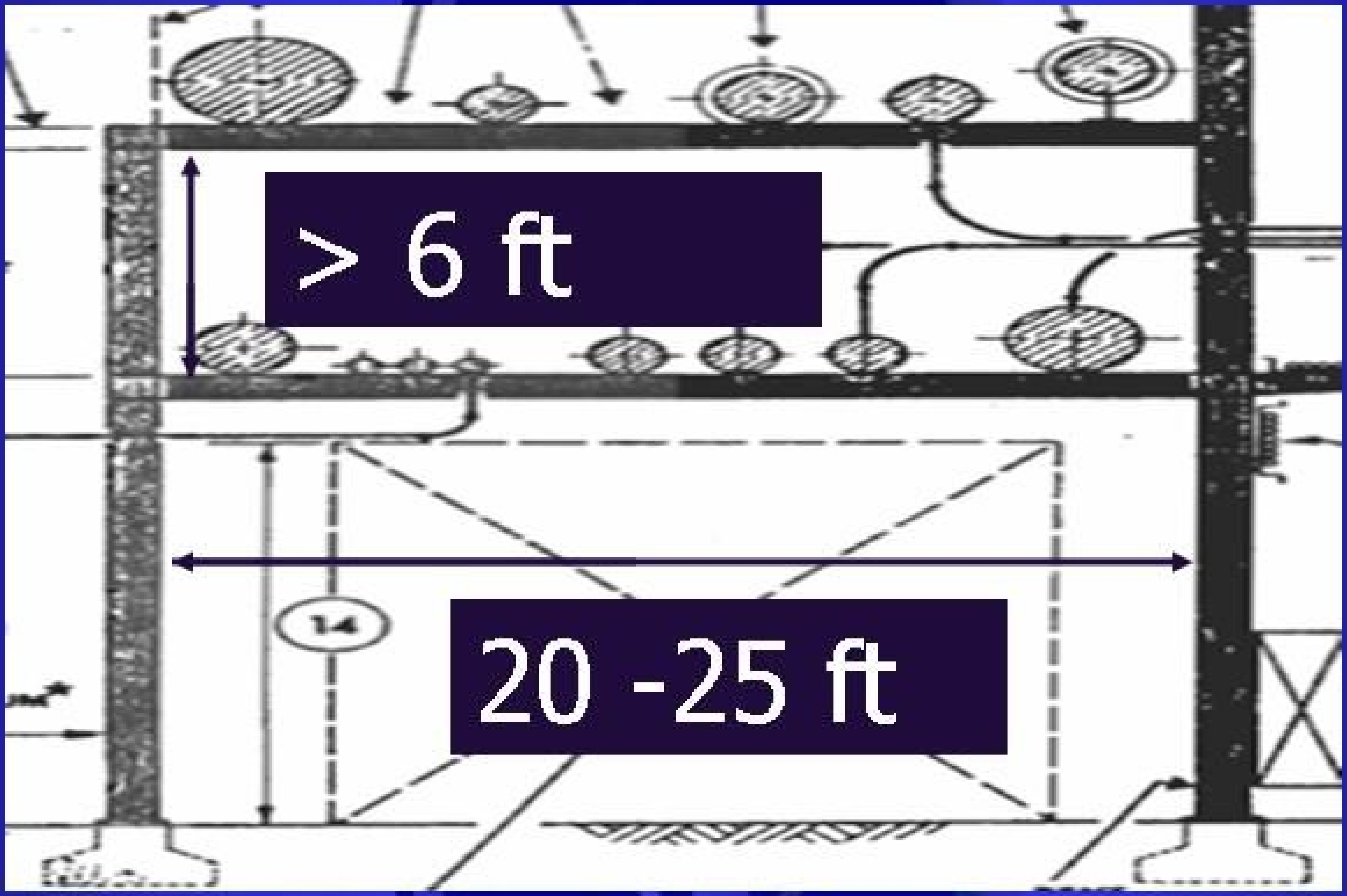
– Provide guide for long straight pipes subject to thermal movement



- The smallest size of pipe run on a piperack 2”
- If necessary, suspend pipe smaller 2” from 4” and larger
- For making horizontal branch, change height of pipe

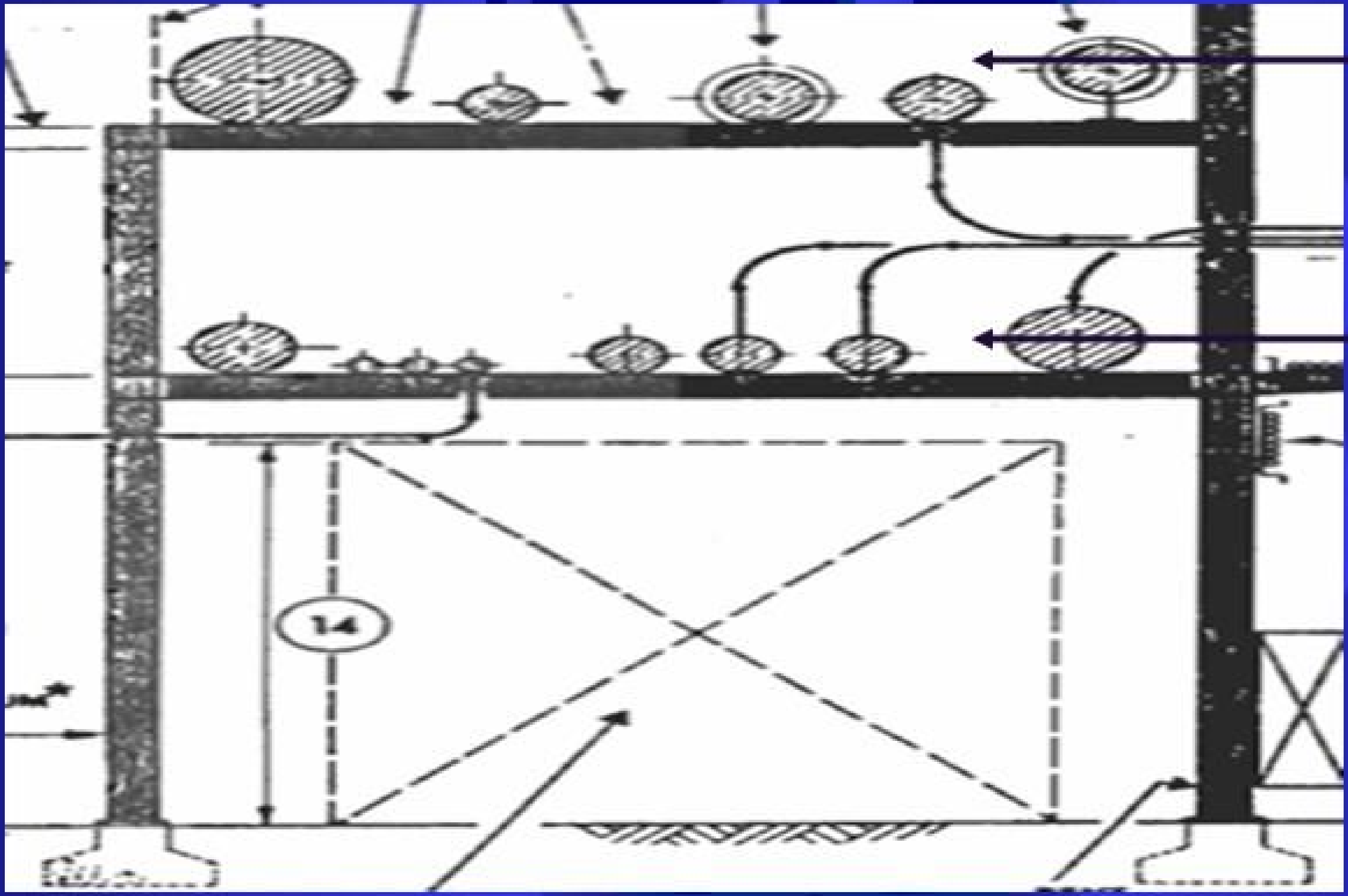


– The most economic beam section desired for the piperack



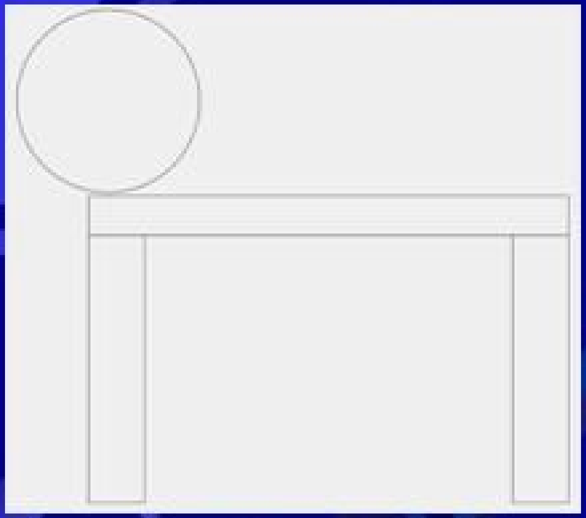
– If more room is needed, make double or triple piperack

– Categorize piperack, for example if using double deck, place utility service piping on the upper level of the piperack

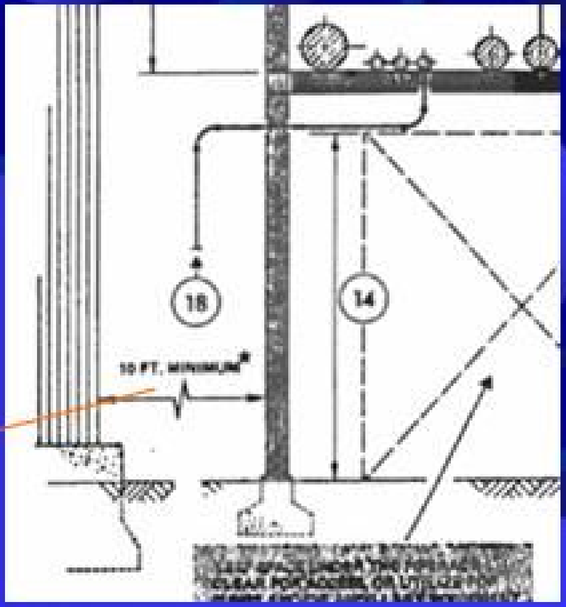


Determine by lifting equipment required access

- Don't install pipe on stanchion, this will prevent adding another deck



- Consider sufficient space beside piperack

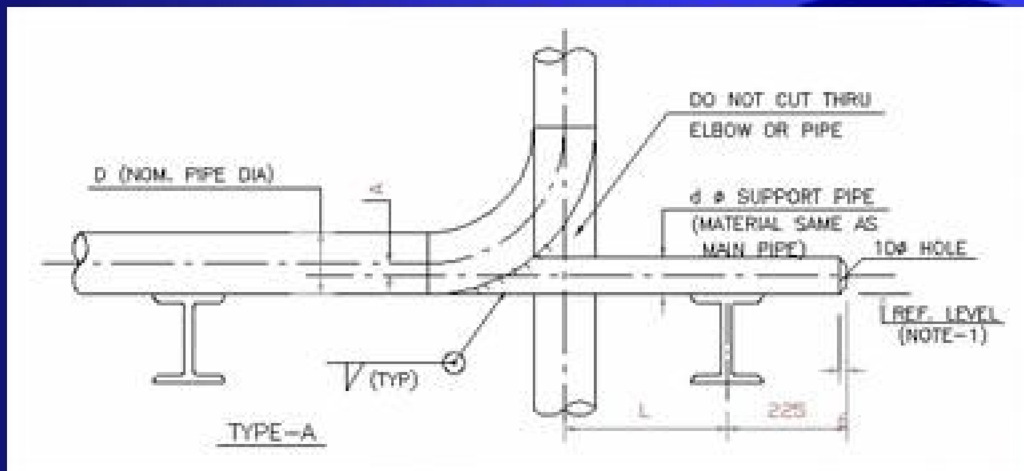


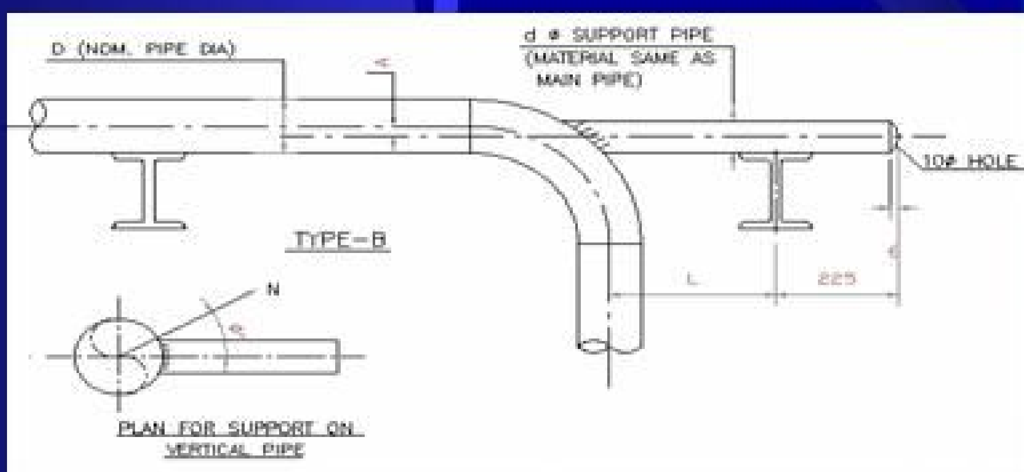
10 ft

- Ensure that nozzles on equipment are free from transmitted by the piping
- Equipment suppliers will state max. loading permissible at nozzles

Equipment Item	Industry Standard	Parameters Used To Determine Acceptable Loads
Centrifugal Pumps	API 610	Nozzle size
Centrifugal Compressors	API 617, 1.85 times NEMA SM-23 allowable	Nozzle size, material
Air-Cooled Heat Exchangers	API 661	Nozzle size
Pressure Vessels, Shell-and-Tube Heat Exchanger Nozzles	ASME Code Section VIII, WRC 107, WRC 297	Nozzle size, thickness, reinforcement details, vessel/exchanger diameter, and wall thickness. Stress analysis required.
Tank Nozzles	API 650	Nozzle size, tank diameter, height, shell thickness, nozzle elevation.
Steam Turbines	NEMA SM-23	Nozzle size

– Dummy leg length

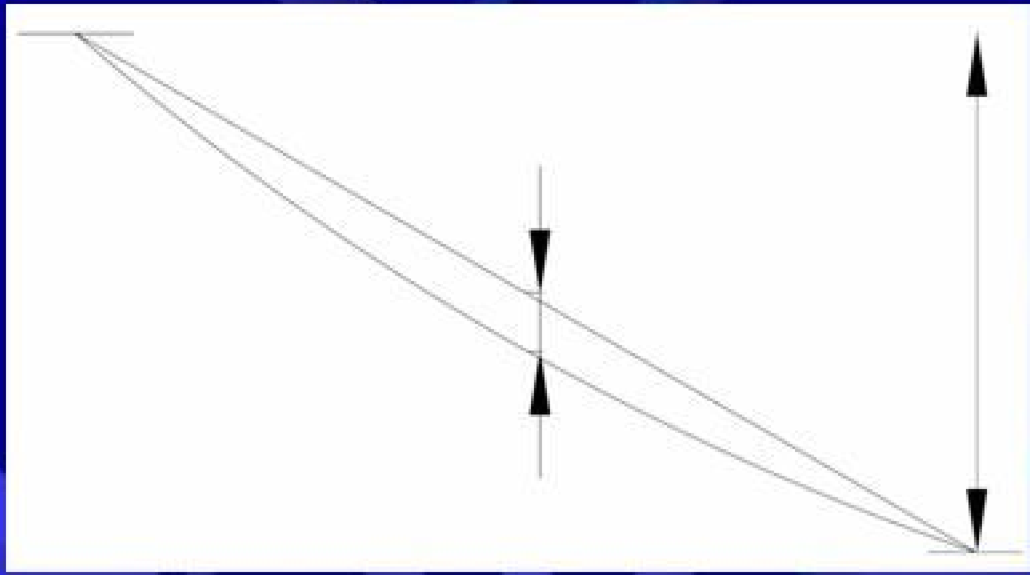




FOR L 1500 OR LESS		
D	d (NOTE 2)	A
2"	2"-SCH,40	–
3"	2"-SCH,40	15
4"	3"-SCH,40	13
6"	3"-SCH,40	40
8"	4"-SCH,40	52
10"	6"-SCH,40	52
12"	6"-SEC.40	78
14"	6"-SCH.40	68
16"	8"-SCH.40	94
18"	8"-SCH.40	119
20"	10"-SCH.40	118
24"	10"-SCH.40	168

FOR L OVER 1500		
D	d (NOTE 2)	A
2"	2"-SCH,40	–
3"	2"-SCH,40	15
4"	3"-SCH,40	23
6"	4"-SCH,40	27
8"	6"-SCH,40	25
10"	8"-SCH,40	27
12"	8"-SEC.40	52
14"	10"-SCH.40	41
16"	10"-SCH.40	67
18"	10"-SCH.40	92
20"	12"-SCH.40	92
24"	12"-SCH.40	143

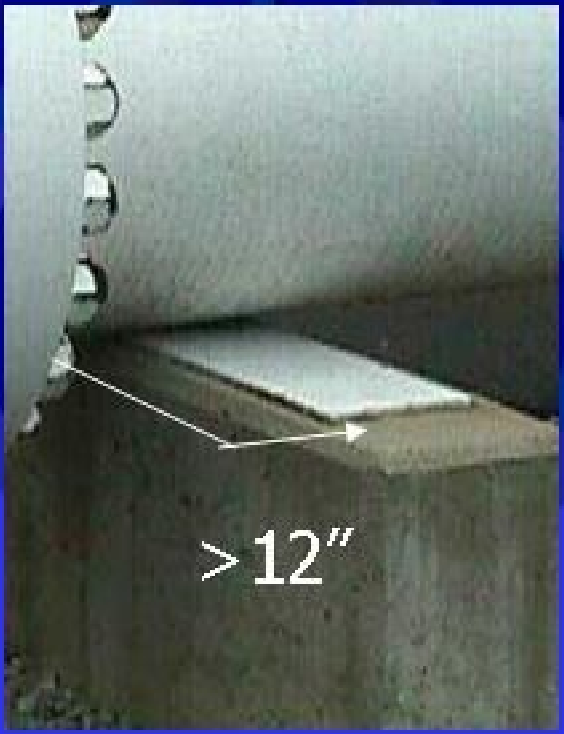
- For line smaller than 2” and non-critical arrange supports in the field
- Pocketing of liquid due to sagging can be eliminated by sloping the line so that the difference in height between adjacent supports is at least equal to triple deflection at the midpoint



- As a rule of thumb, spans for insulated lines should be reduced by approximately %30 from those for uninsulated pipes

– Support piping from overhead, in preference to underneath

– Install flange, with 12" minimum clearance from supporting steel



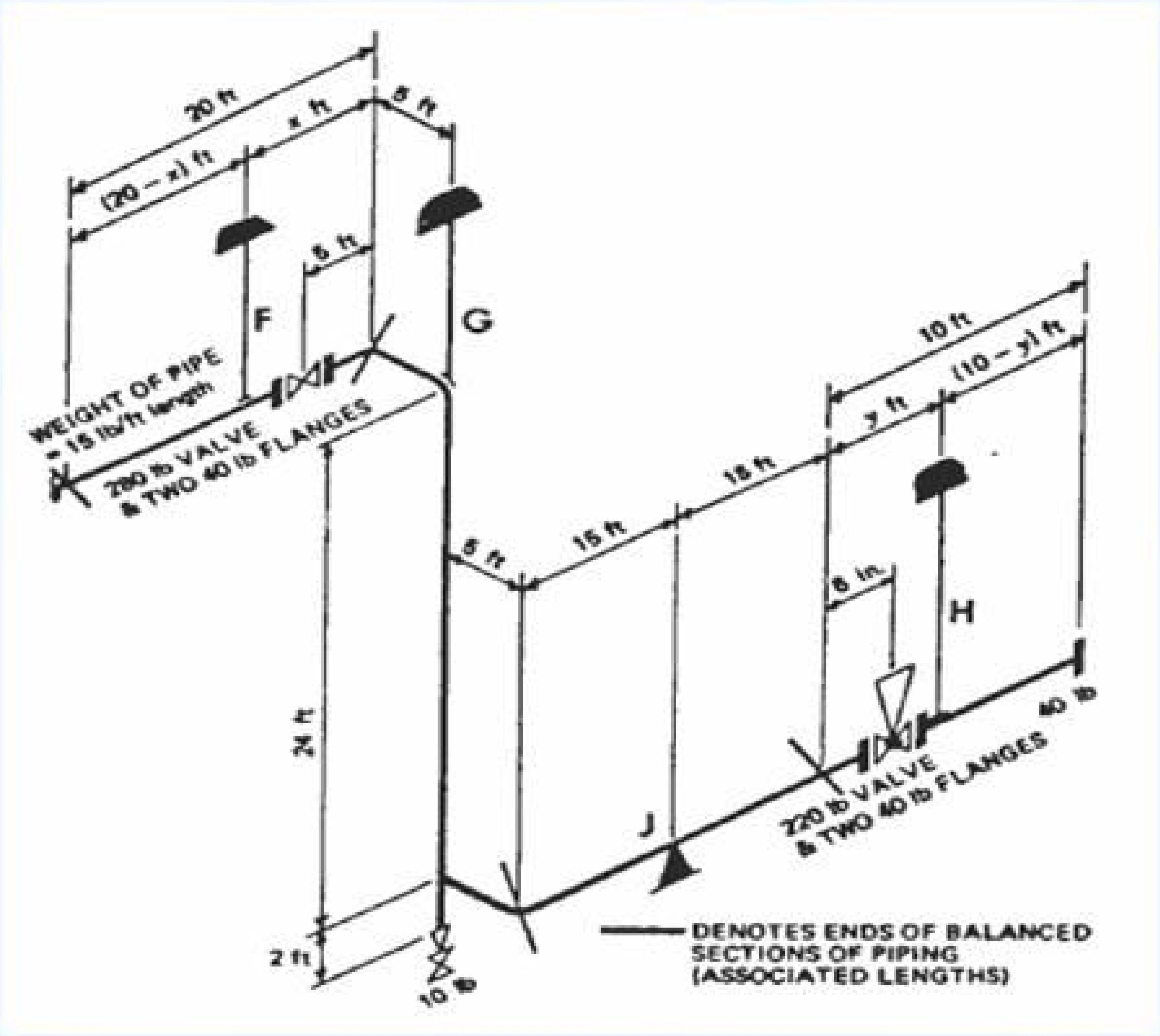
– Keep weld joints at least 3” from supporting steel or other obstruction

– To carry the weight of the piping use a FOS = 3

– In general, one hanger or other support should be specified for each side of a valve.

– Field support
  - For line smaller than 2” and non-critical, arrange supports in the field

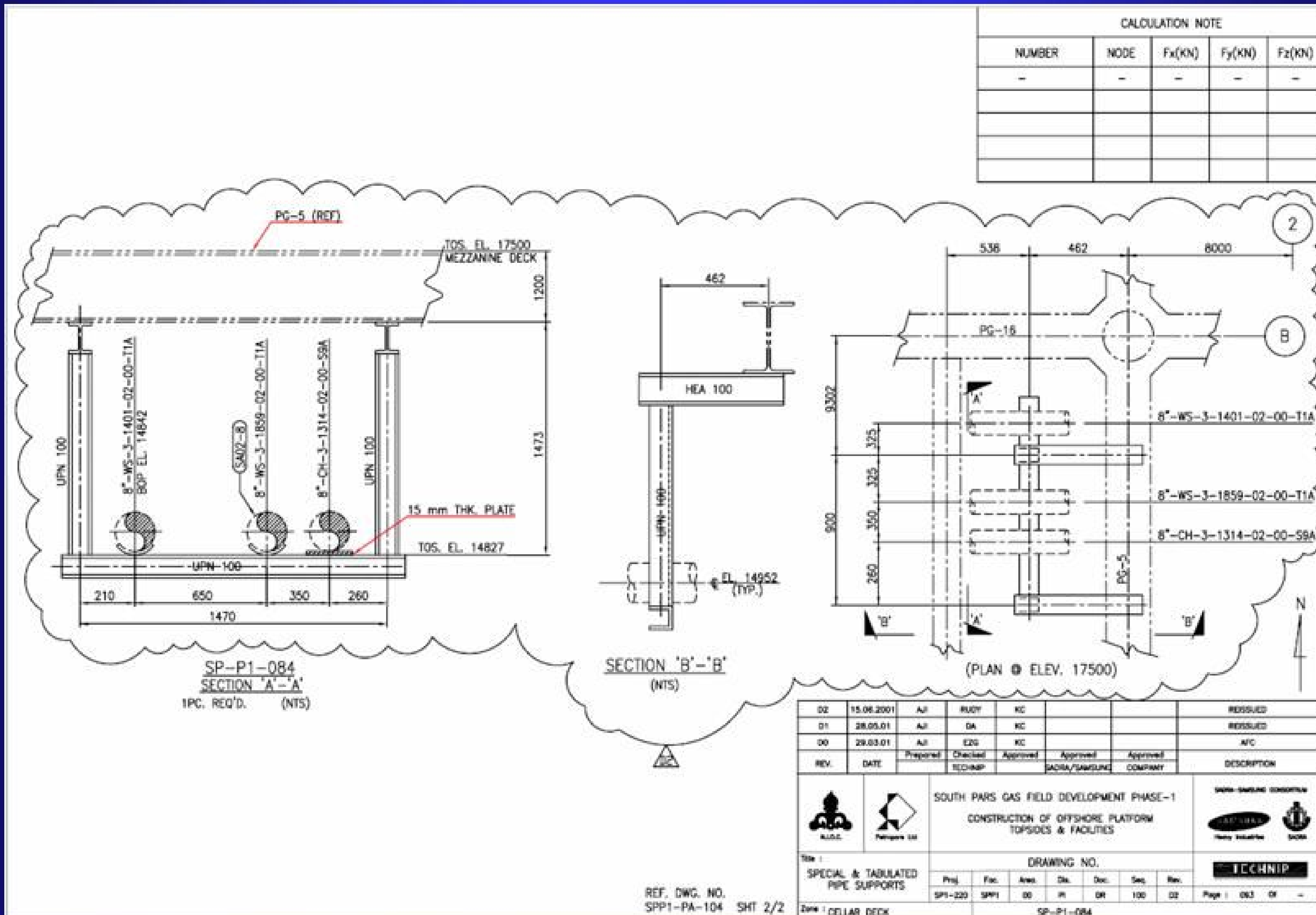
– Finding location of support



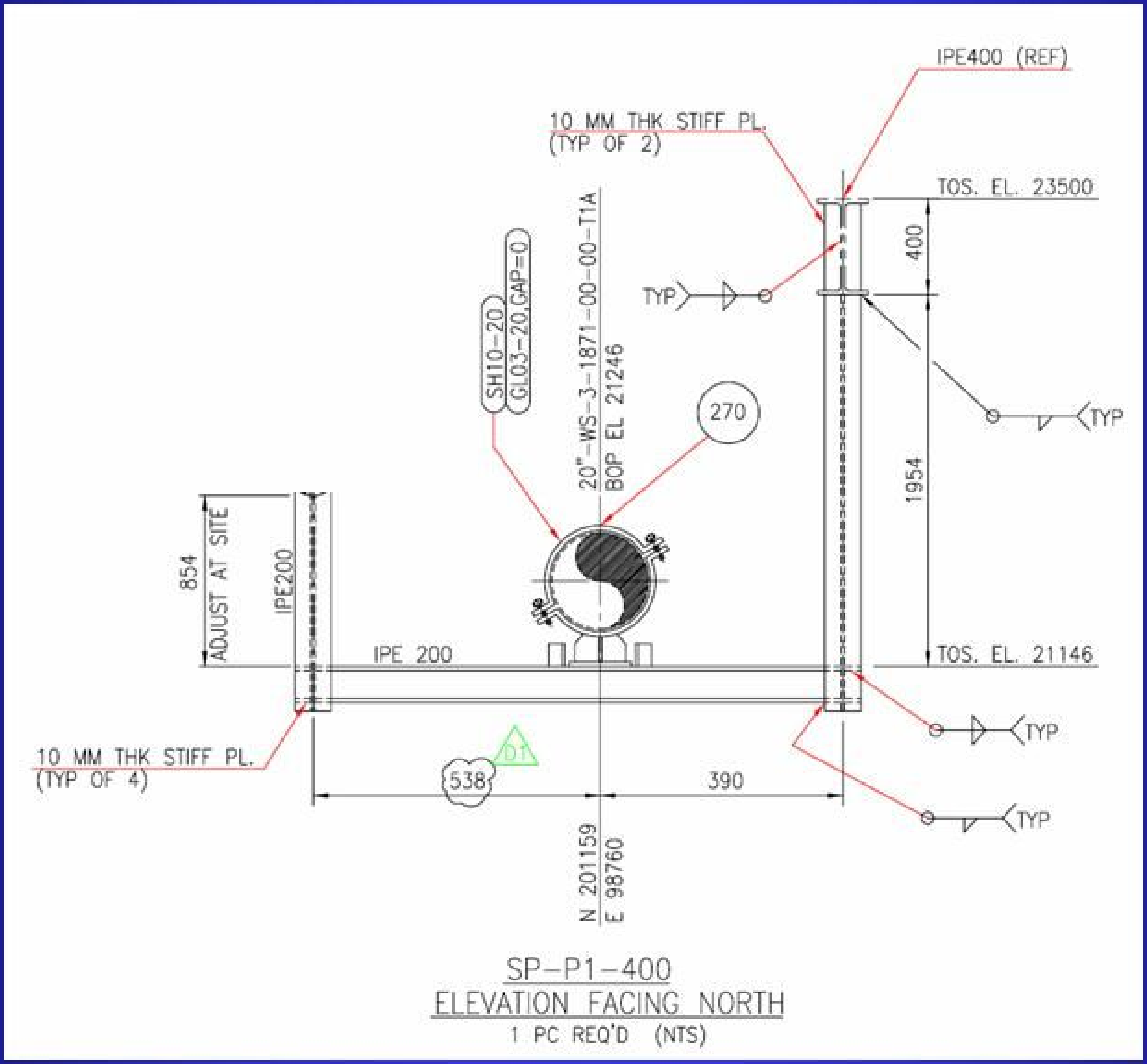
Piping components: pipe supports and restraints (piping support document)

PIPE SUPPORT NO.	TYPE NO.	VARIABLE DIMENSIONS & REMARKS							LINE NUMBER	PIPING PLAN DWG. NO. SPP1-
		A	B	C	D	E	F	FACING VIEW		
BA01-PI-301	1	23500	1000	HEA100				N	8"-VH-3-1385-02-00-S1C	PA-108 2/2
BA01-PI-302	3	23500	1138	HEA200				N	12"-GD-3-1450-00-00-D9B	PA-112 2/2
BA01-PI-303	3	23500	1138	HEA200				N	12"-GD-3-1450-00-00-D9B	PA-112 2/2
BA01-PI-304	1	17500	1050	HEA200				N	SS02-PI-310	PA-108 1/2
BA01-PI-305	1	17500	1000	HEA160				N	SS02-PI-324	PA-108 1/2
BA01-PI-306	1	17500	1000	HEA100				N	SS02-PI-325	PA-108 1/2
BA01-PI-307	1	17500	1000	HEA100				N	SS02-PI-327	PA-108 1/2
BA01-PI-308	1	17500	1000	HEA100				N	SS02-PI-329	PA-108 1/2
BA01-PI-309	1	23500	1000	HEA100				N	8"-VH-3-1385-02-00-S1C	PA-108 2/2

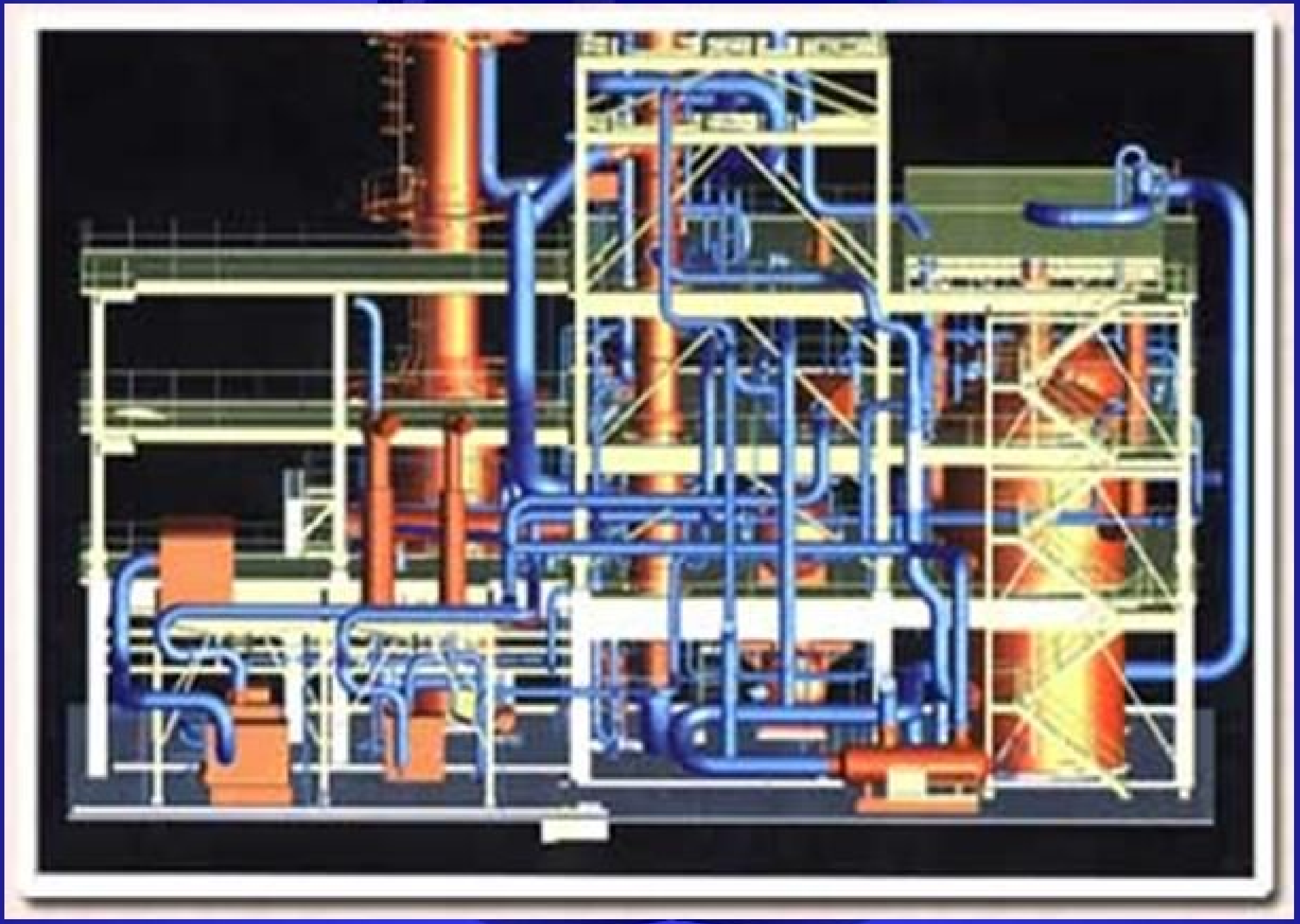
Piping components: pipe supports and restraints (piping support document)



Piping components: pipe supports and restraints (piping support drawing)



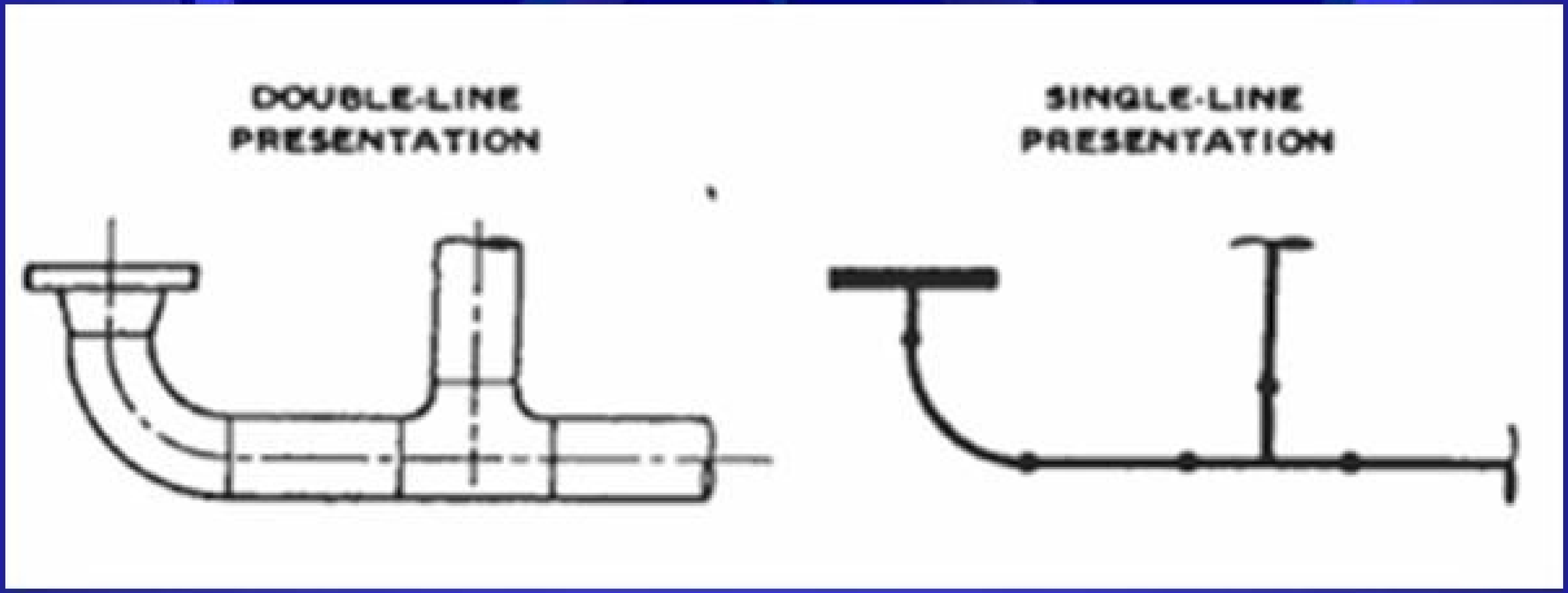
Piping Drawing



Piping drawings:

- The main purpose of a drawing is to communicate information in a simple and explicit way for construction apart from specification

- Pipe represent by
  - Single line:
    - Only centerline of the pipe is drawn
  - Double line:
    - Very time-consuming
    - Difficult to read

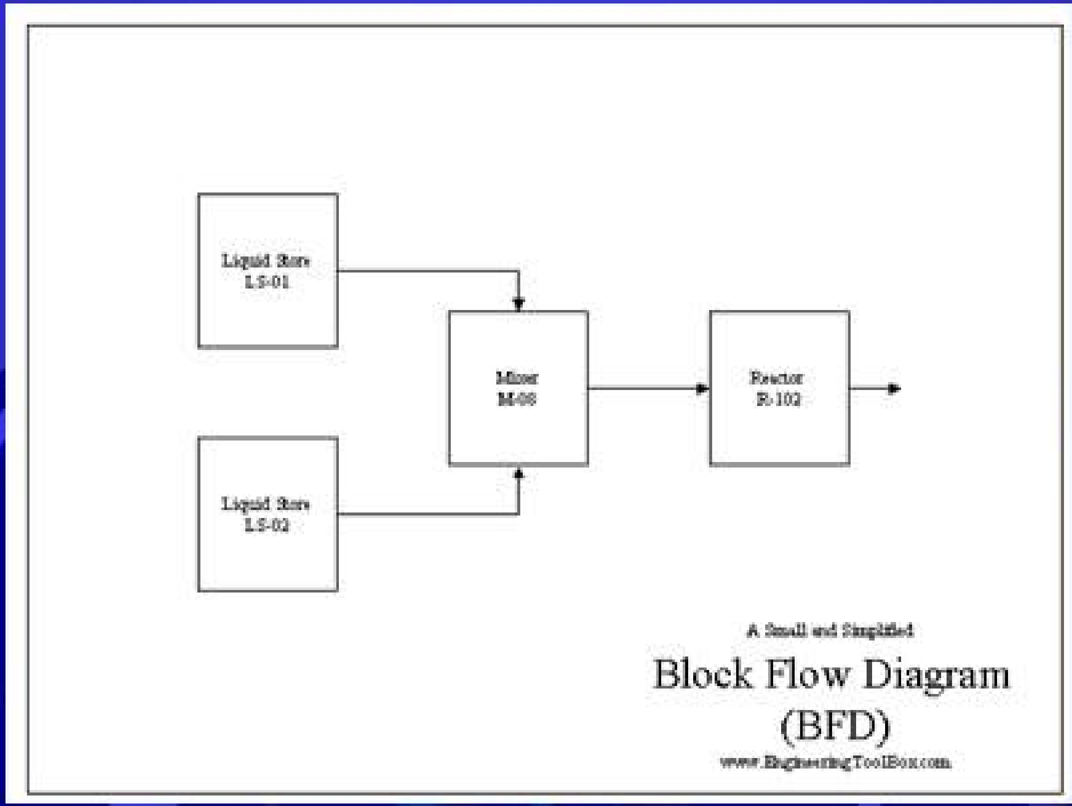


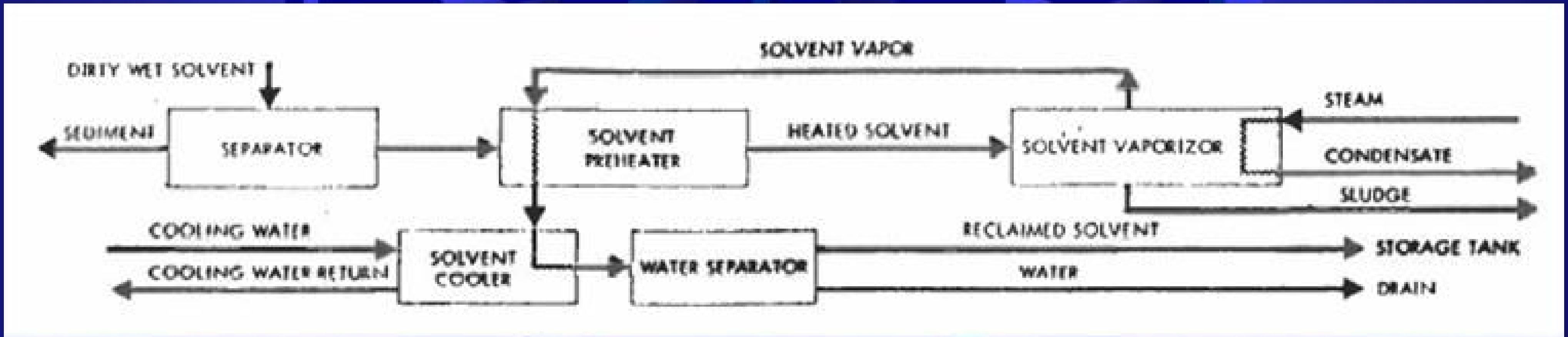
Piping drawings:

- Three type of drawing that developed from schematic (Block Flow Diagram (BFD)) diagram are:
  - Process Flow Diagram (PFD)
  - Piping & Instrument Diagram (P&ID)
  - Piping drawing

Block Flow Diagram
BFD

Piping drawings: block flow diagram





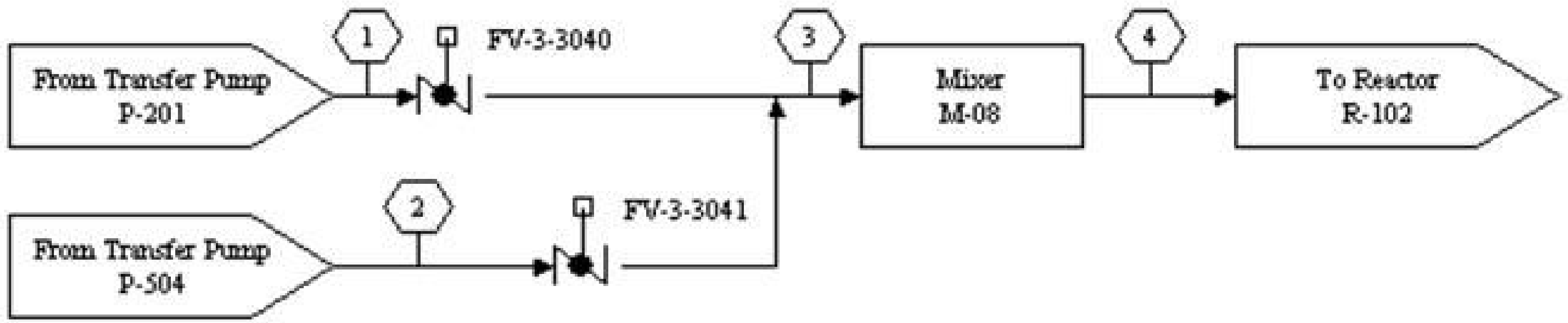
- A **Block Flow Diagram - BFD**, is a schematic illustration of the major process. The block or rectangles used represent a unit operation. The blocks are connected by straight lines which represent the process flow streams which flow between the units. These process flow streams may be mixtures of liquids, gases and solids flowing in pipes or ducts, or solids.

Piping drawings: block flow diagram

- In order to prepare block flow diagrams a number of rules should be followed:
  - unit operations such as mixers, separators, reactors, distillation columns and heat exchangers are usually denoted by a simple block or rectangle.
  - groups of unit operations may be noted by a single block or rectangle.
  - process flow streams flowing into and out of the blocks are represented by neatly drawn straight lines. These lines should either be horizontal or vertical.
  - the direction of flow of each of the process flow streams must be clearly indicated by arrows.
  - flow streams should be numbered sequentially in a logical order.
  - unit operations (i.e., blocks) should be labeled.
  - where possible the diagram should be arranged so that the process material flows from left to right, with upstream units on the left and downstream units on the right.

Process Flow Diagram
PFD

Piping drawings: process flow diagram



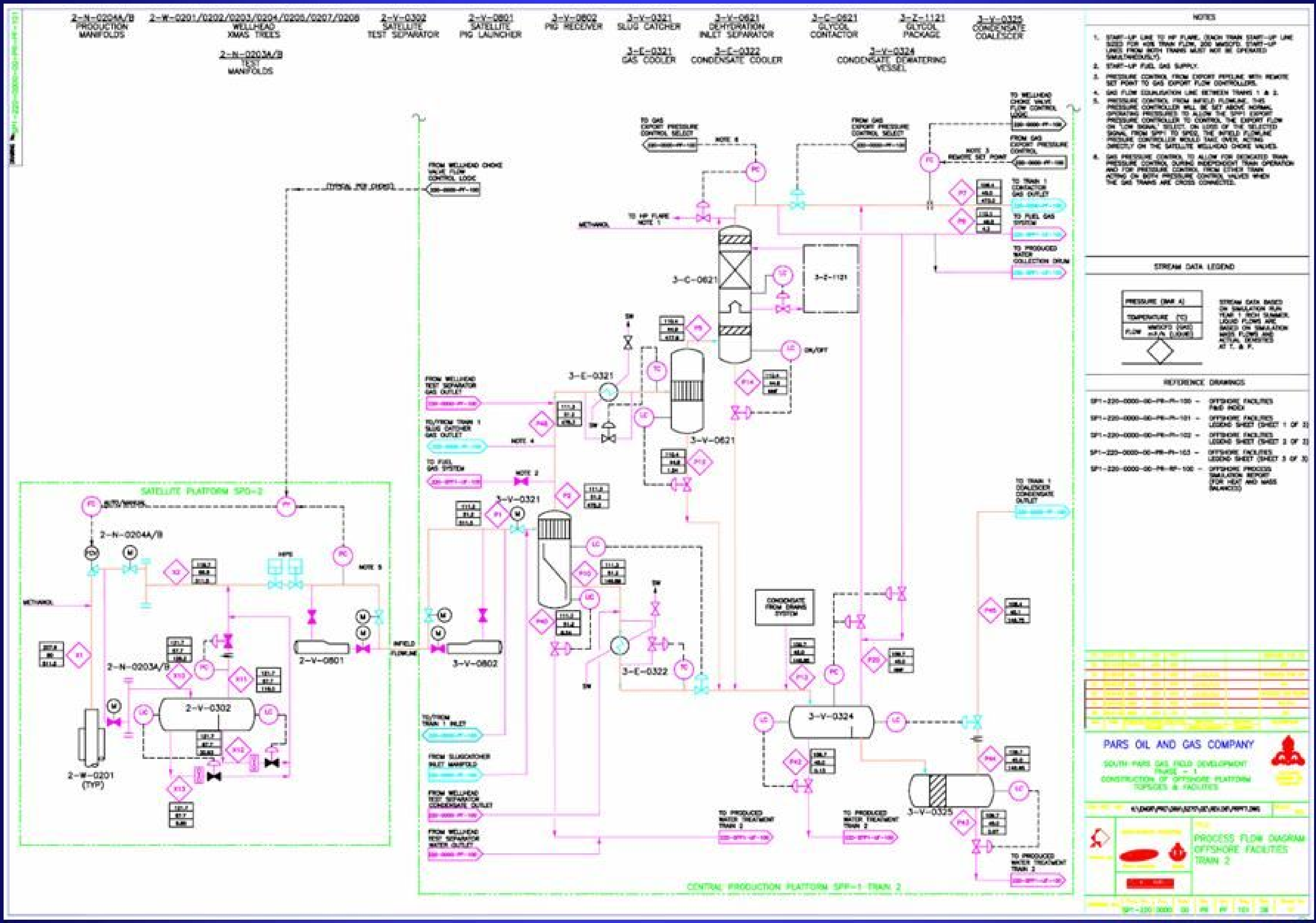
Mode	Parameter	Points			
		1	2	3	4
Normal	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Maximum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Minimum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				

A Small and Simplified

Process Flow Diagram

www.EngineeringToolBox.com

Piping drawings: process flow diagram



- A ***Process Flow Diagram - PFD***, *is a schematic illustration of the system.PFD's shows the* ***relationships*** *between the major components in the system. PFD also tabulate process design values for the components in different operating modes, typical minimum, normal and maximum. PFD's do not show minor components, piping systems, piping ratings, standby equipment*
  - *It is advisable to draw equipment that is operated cyclically*

- A PFD should include:
  - Process Piping
  - Major equipment symbols, names and identification numbers
  - Control, valves and valves that affect operation of the system
  - Interconnection with other systems
  - System ratings and operational values as minimum, normal and maximum flow, temperature and pressure
  - Composition of fluids
  - This figure depict a small and simplified PFD:

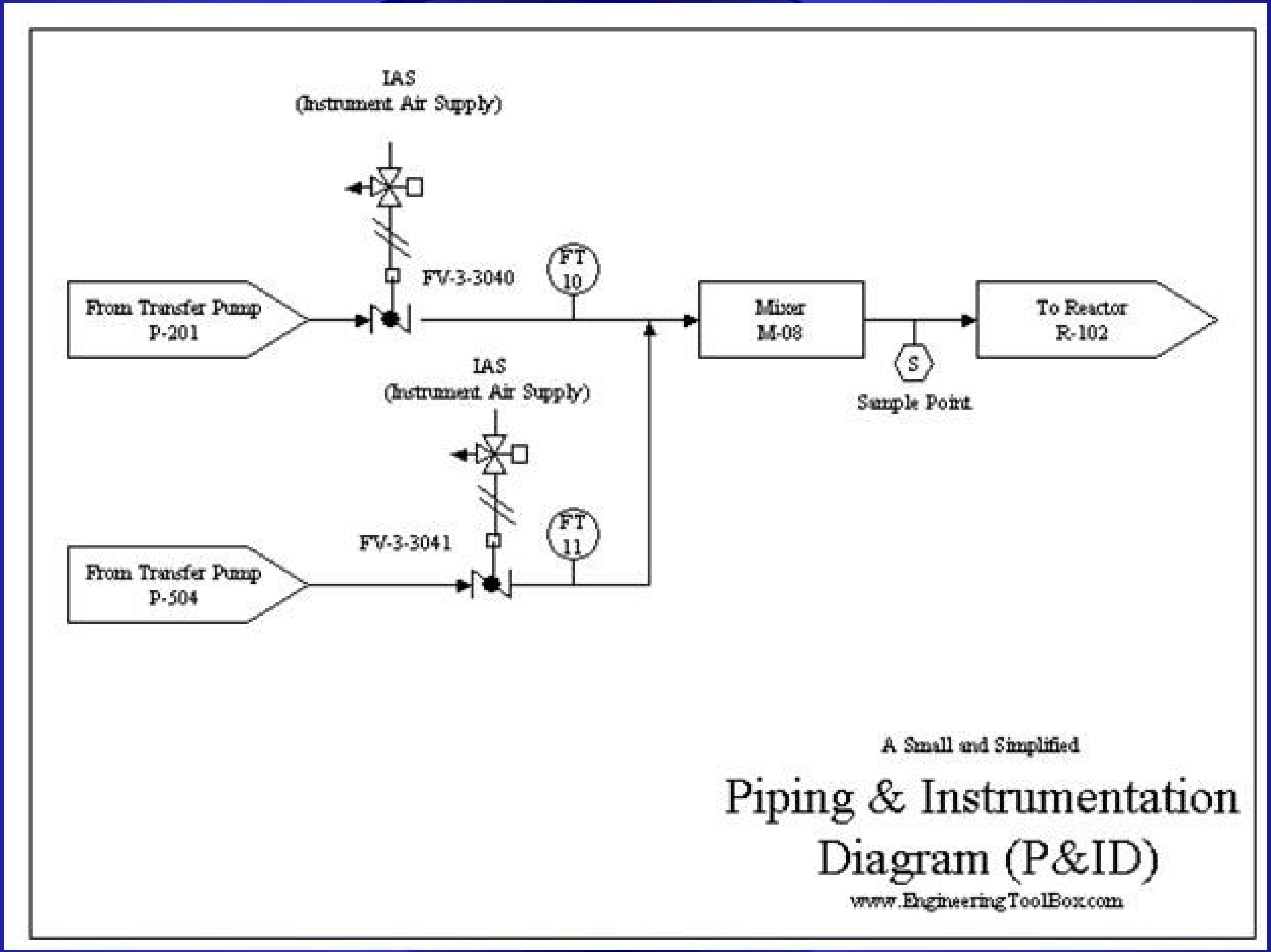
Piping drawings: process flow diagram

- *Each item of equipment should bear the same number on all drawings.*
- *Standby or identical equipment if in the same service, may be identified by adding letters A, B, C*
- *Process material balance can be tabulated on separate 8½" * 11"*
- *Use of arrowhead at all junction and corners aids the rapid reading of the diagram, keep parallel line at least 3/8" apart*
- *Process & service stream entering or leaving the process are noted by hollow arrow with*

Mode	Parameter	Points			
		1	2	3	4
Normal	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Maximum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				
Minimum	Pressure MPa				
	Temp °C				
	Flow m^3/hr				

Piping and Instrumentation Diagram
P&ID

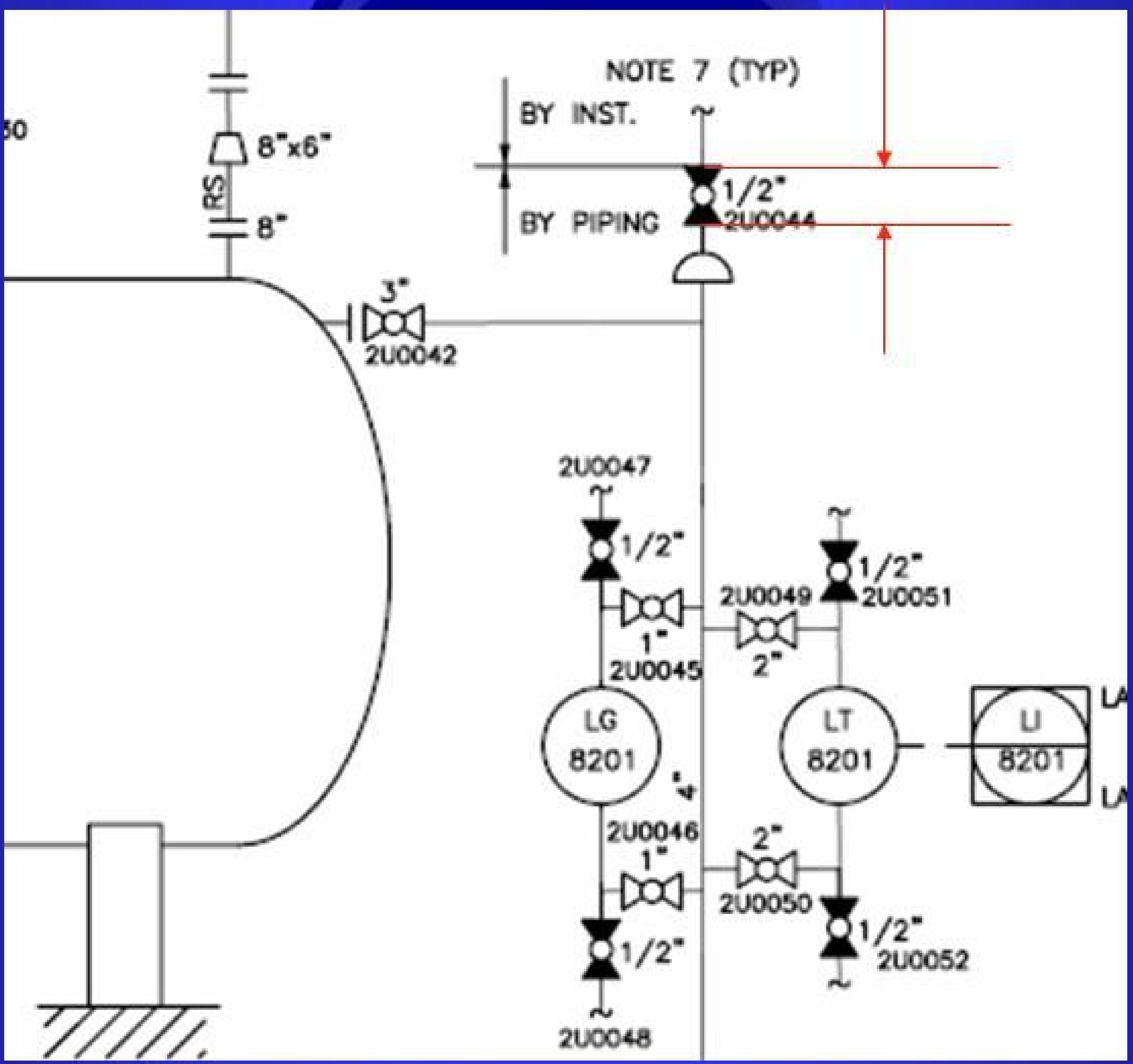
Piping drawings: piping and instrumentation diagram



- A **Piping and Instrumentation Diagram - P&ID**, is a schematic illustration of functional relationship of piping, instrumentation and system equipment components.P&ID shows all of piping including the physical sequence of branches, reducers, valves, equipment, instrumentation and **control interlocks.** The P&ID are used to operate the process system.

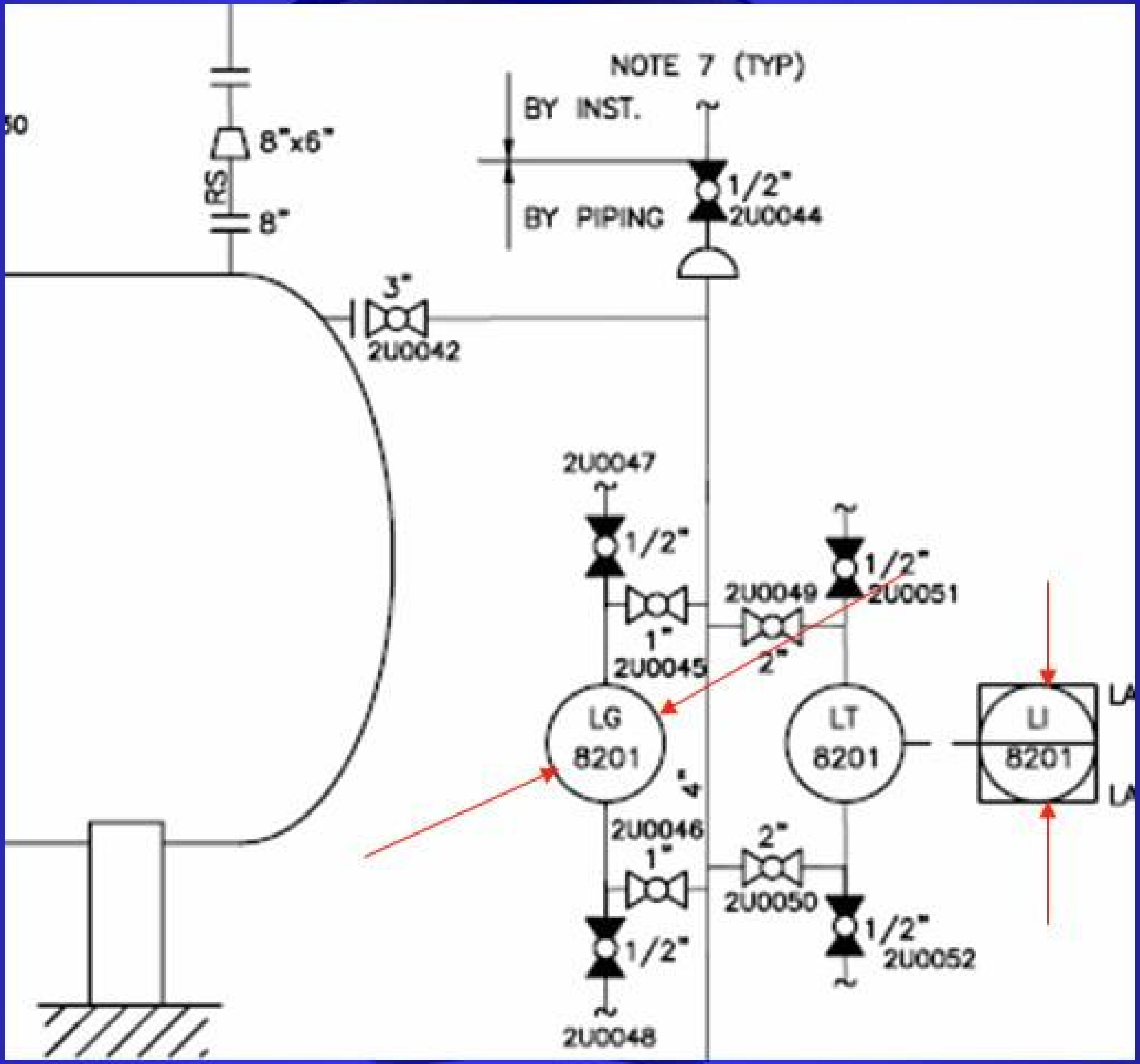
- A P&ID should include:
  - Instrumentation and designations
  - Mechanical equipment with names and numbers
  - All valves and their identifications
  - Process piping, sizes and identification
  - Miscellaneous - vents, drains, special fittings, sampling lines, reducers and increasers
  - Flow directions
  - Interconnections
  - Control inputs and outputs, interlocks

- Preferably draw all valves with the same size ¼" long



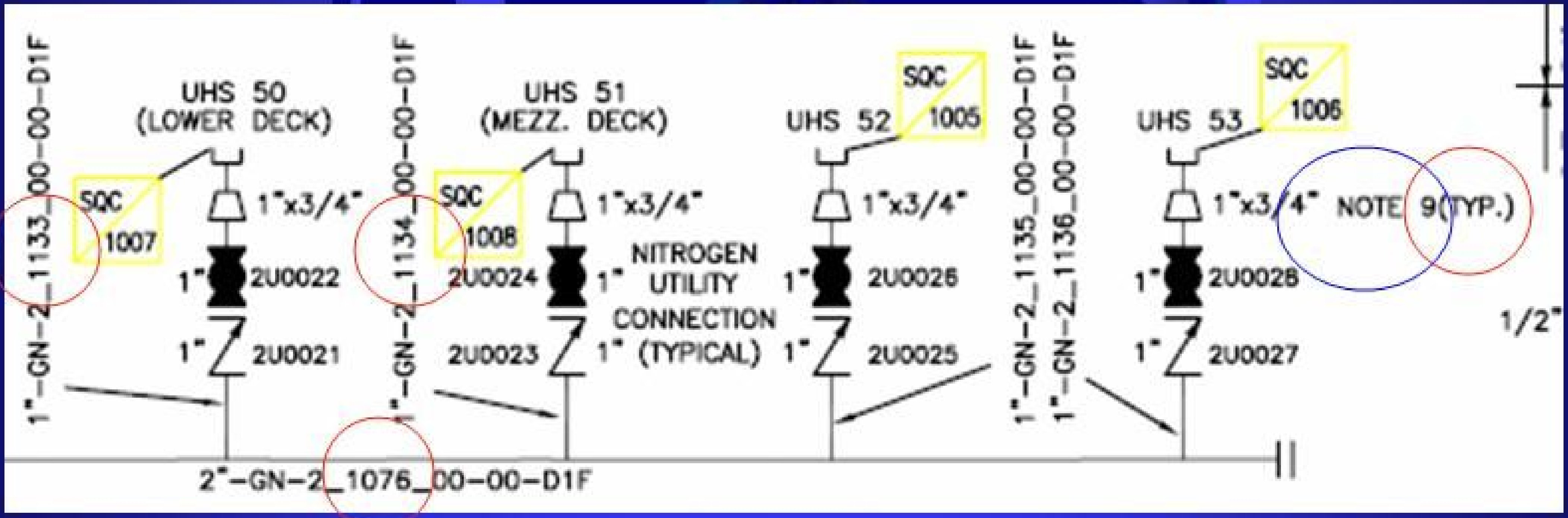
Piping drawings: piping and instrumentation diagram

- Draw instrument identification balloons 7/16” diameter

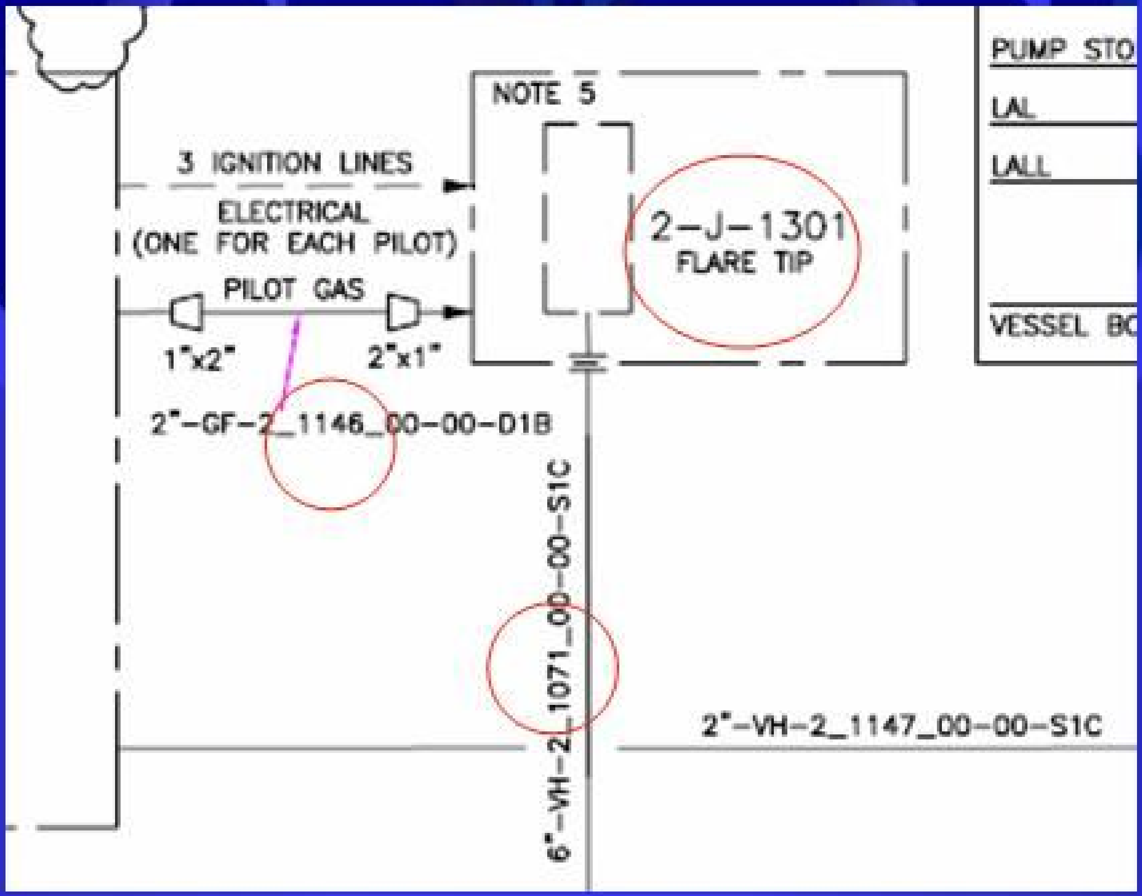


- Draw square with 3/8” width

- Allocate new number to branch
- A typical note may be used to describe multiple piece of identical equipment in the same service
- Special point for design and operation procedure are noted – such as line which need to be sloped for gravity flow, line which need careful cleaning, …

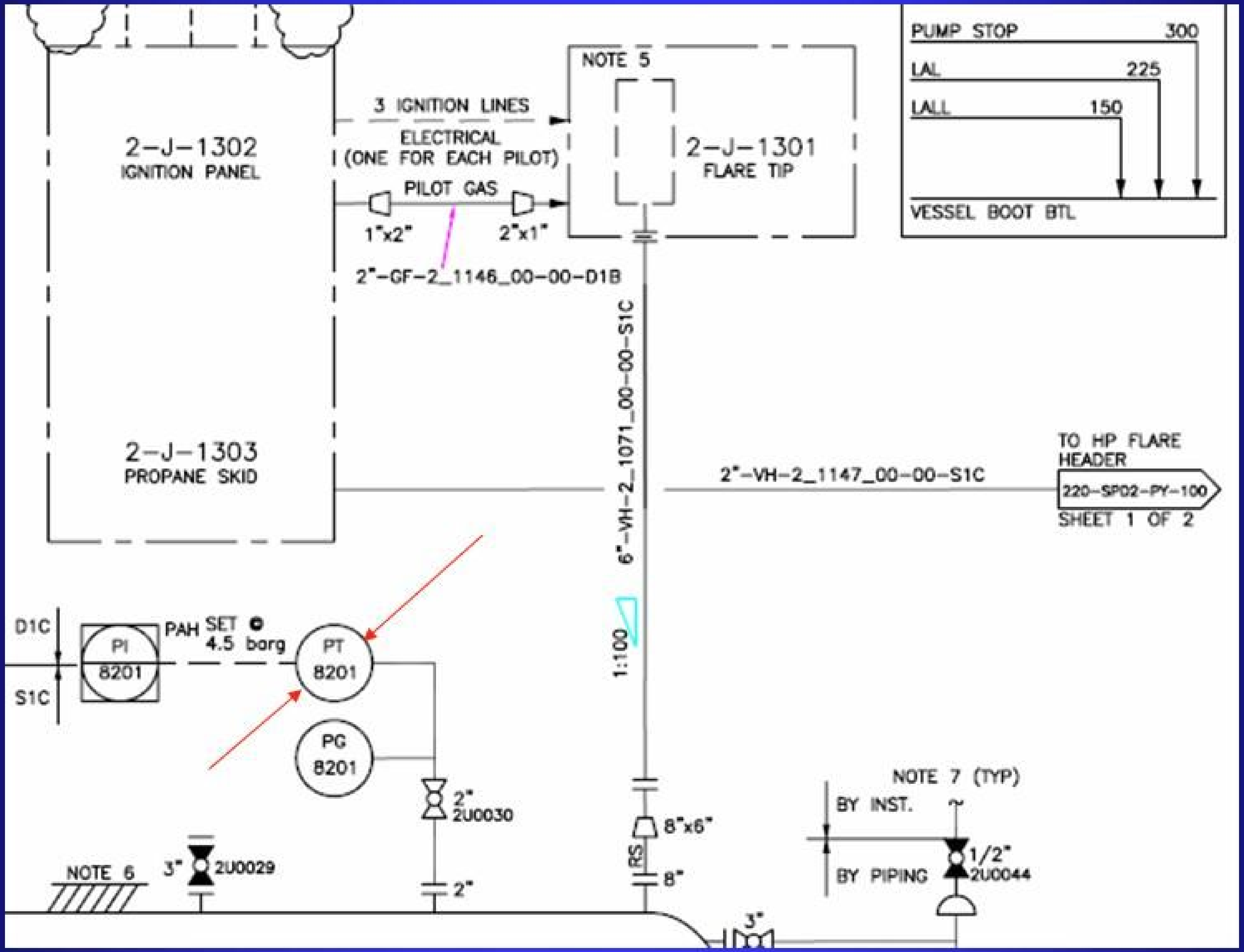


- Terminate the number at major number of a equipment such as tank, pressure vessel, mixer or any equipment carrying an individual equipment number
- Show and tag process and service valve with size and identification number



Piping drawings: line number

- Flow direction



Piping drawings: piping and instrumentation diagram

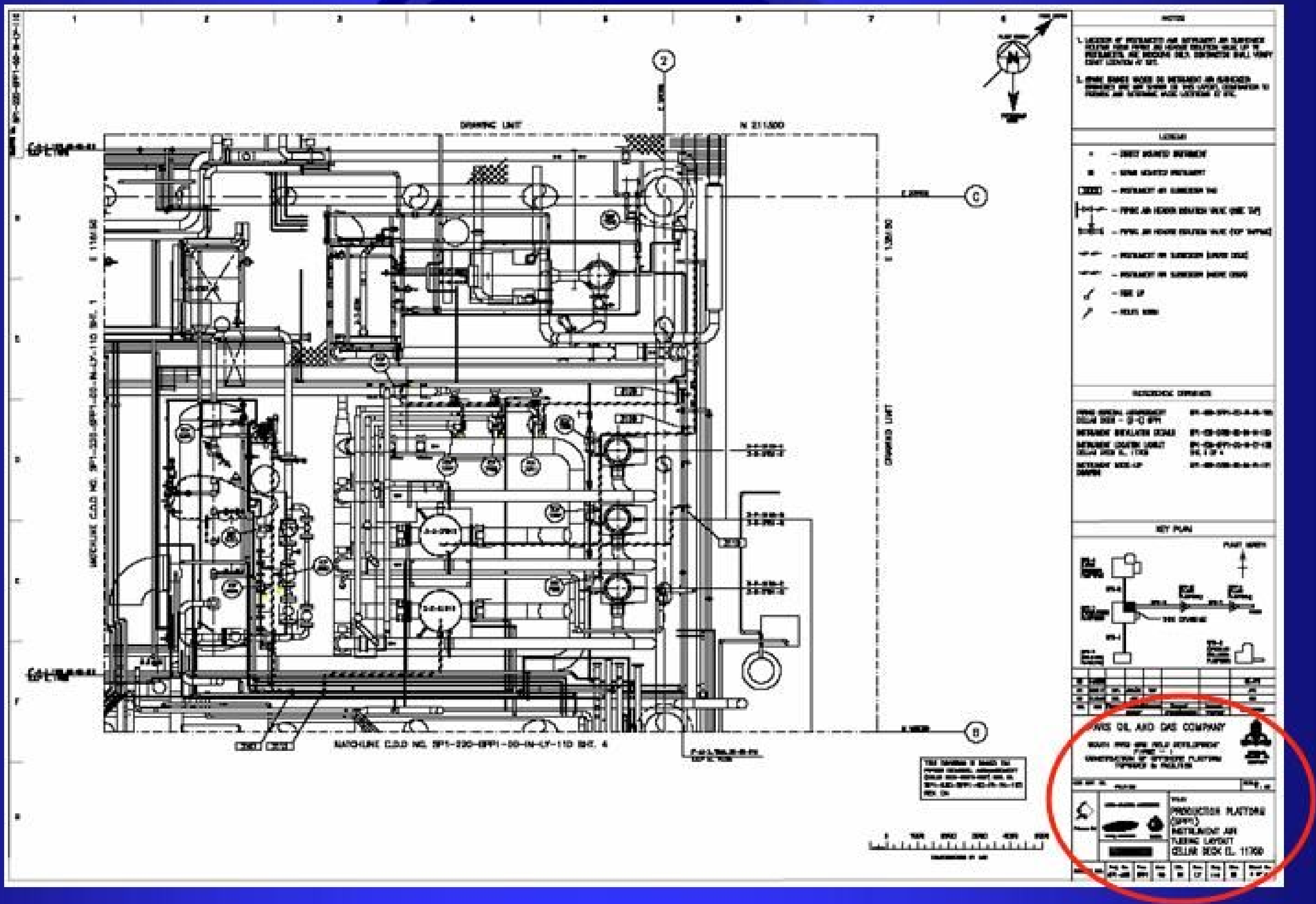
- Standby and parallel equipment are shown
- Dripleg are not shown but steam trap are shown
- vent and drain to be used for hydrostatic testing are not shown
- Insulation, insulation thickness and tracing are shown

Drawing component

- Drawing components include:
  - Title block
  - Revision
  - Key plan
  - Reference drawings
  - Legend
  - Important notes
  - Graphic reference point
  - line number
  - Flow directions
  - connections

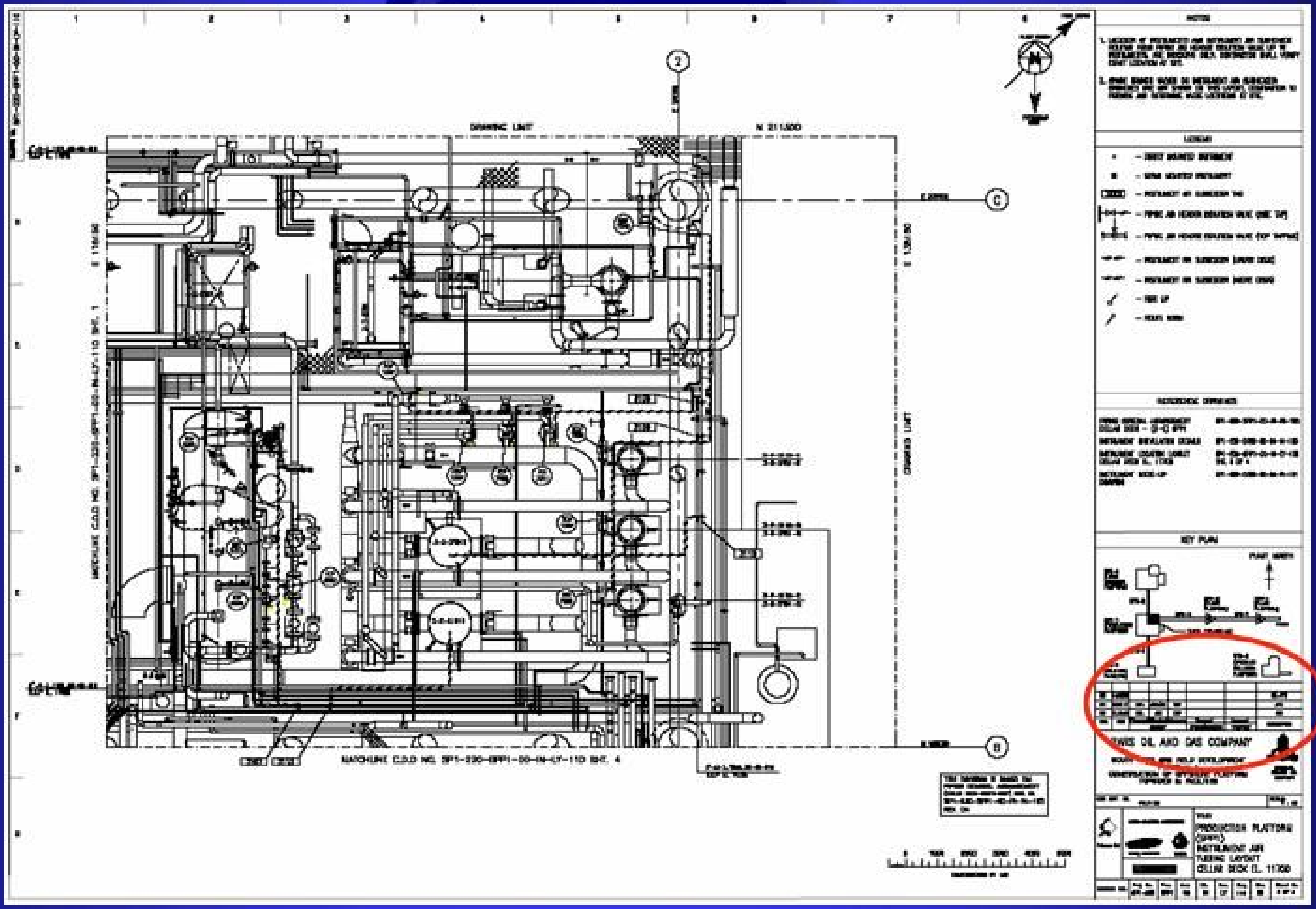
Piping drawings: drawing component (title block)

- Title block



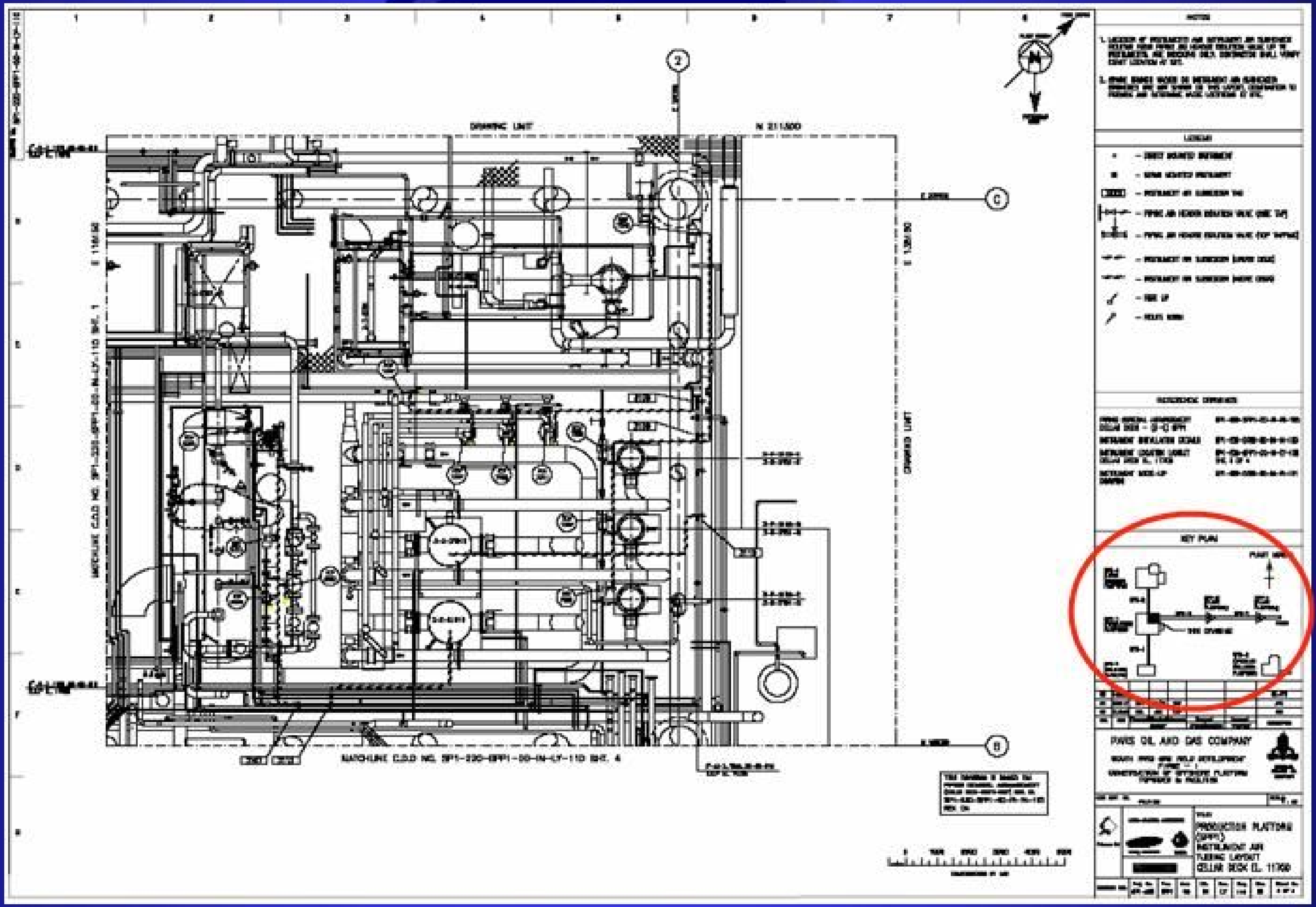
Piping drawings: drawing component (space for revision)

- Space for revision



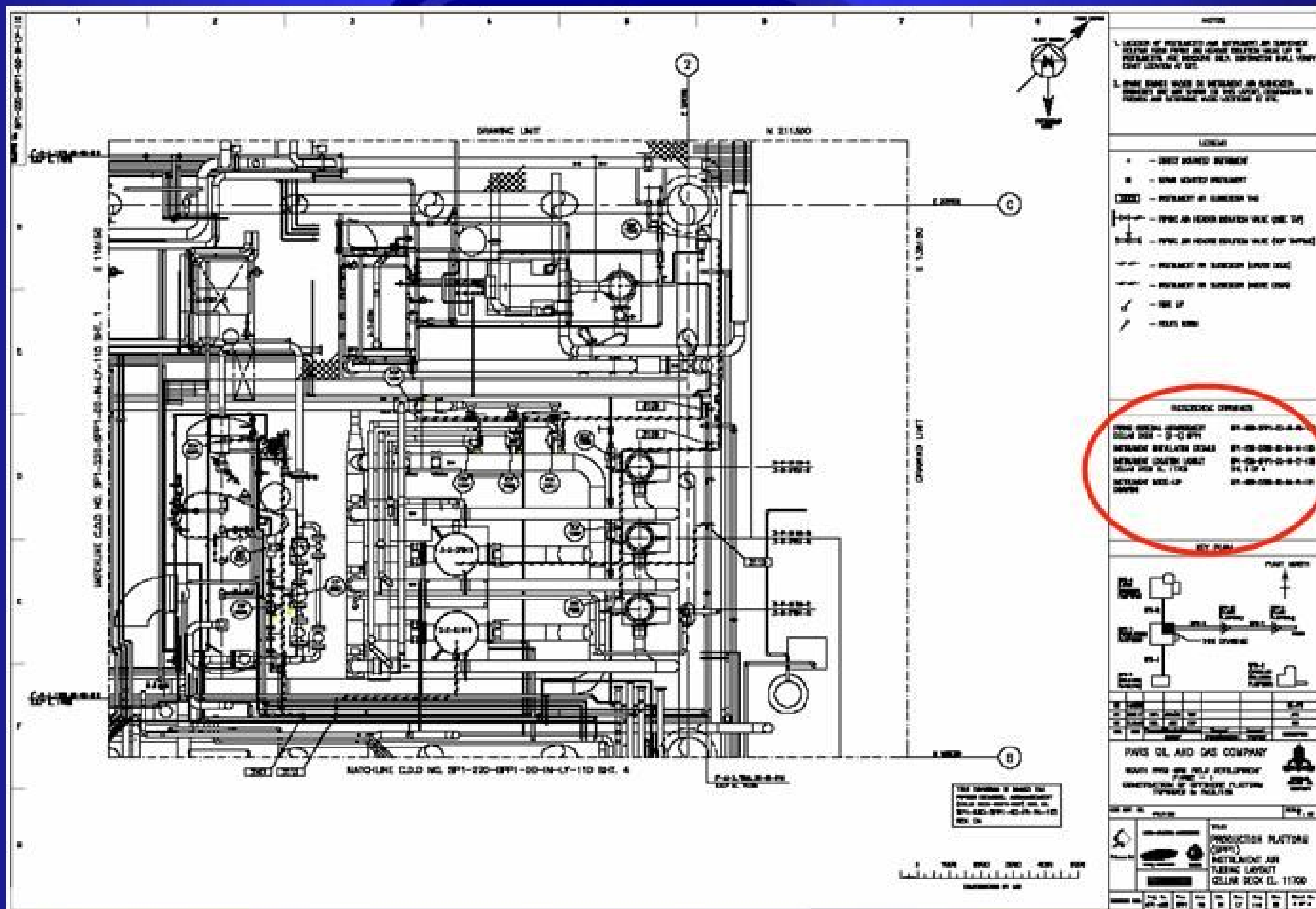
Piping drawings: drawing component (key plan)

- Key plan



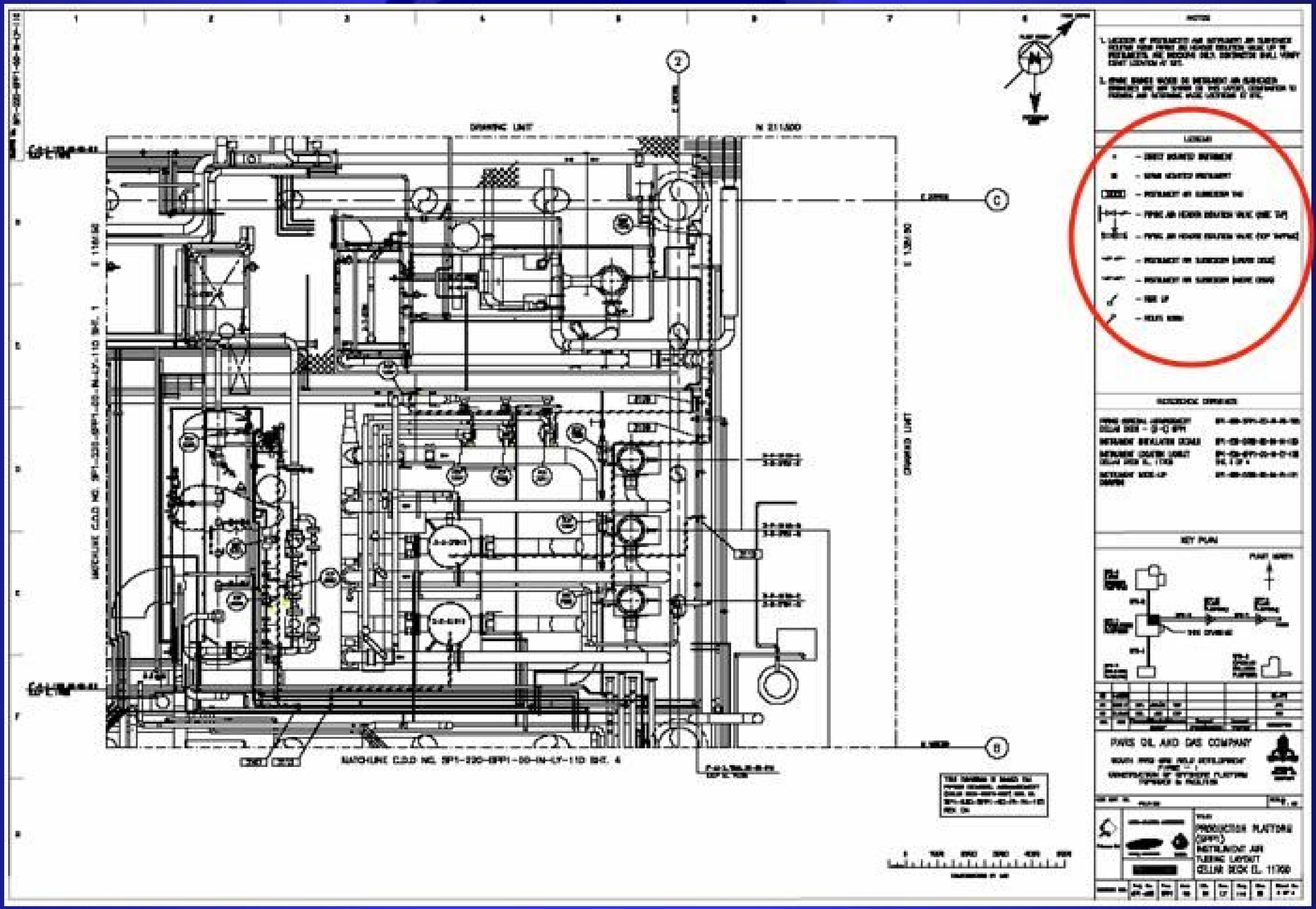
Piping drawings: drawing component (reference drawing)

- reference drawing



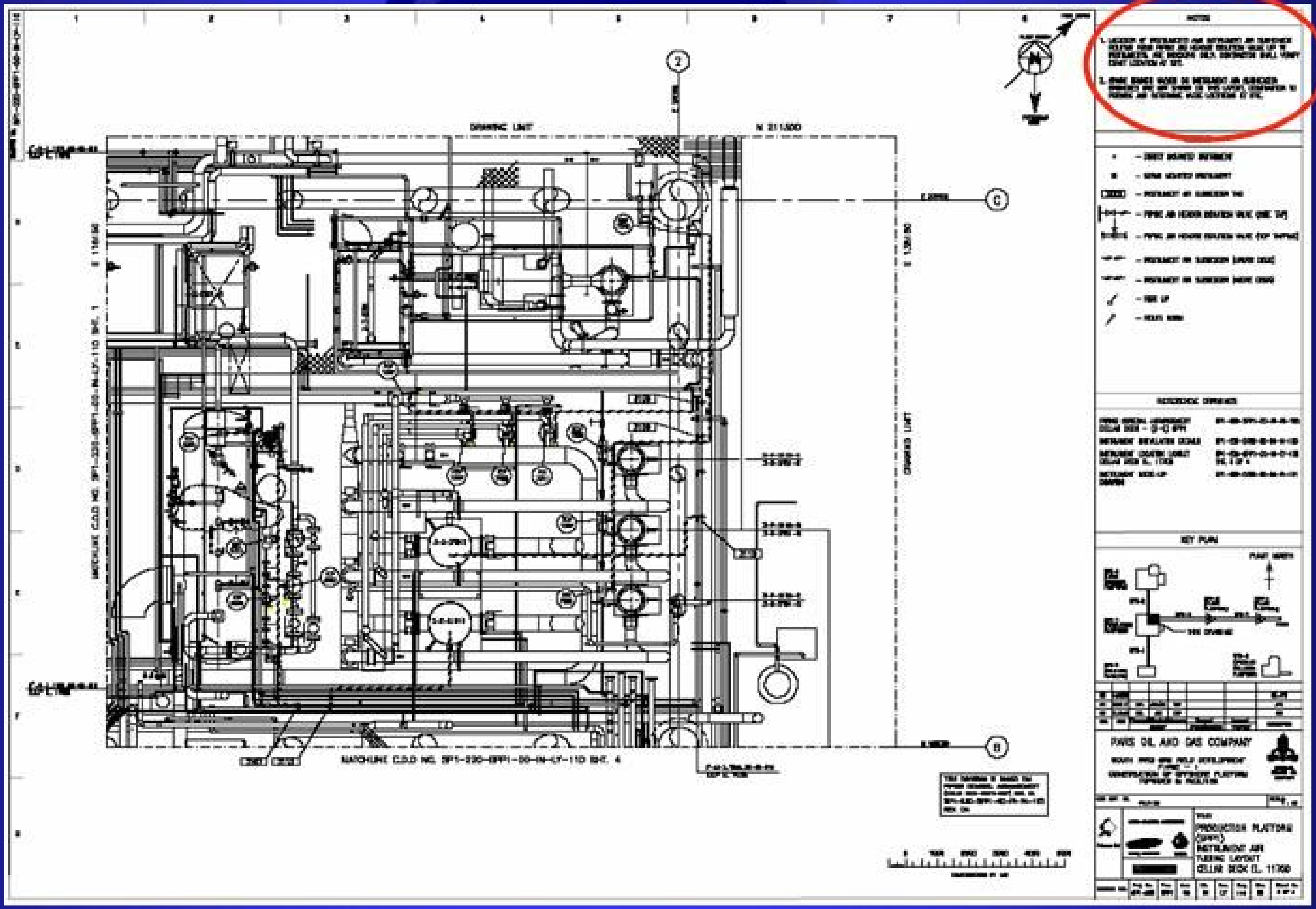
Piping drawings: drawing component (legend)

- legend



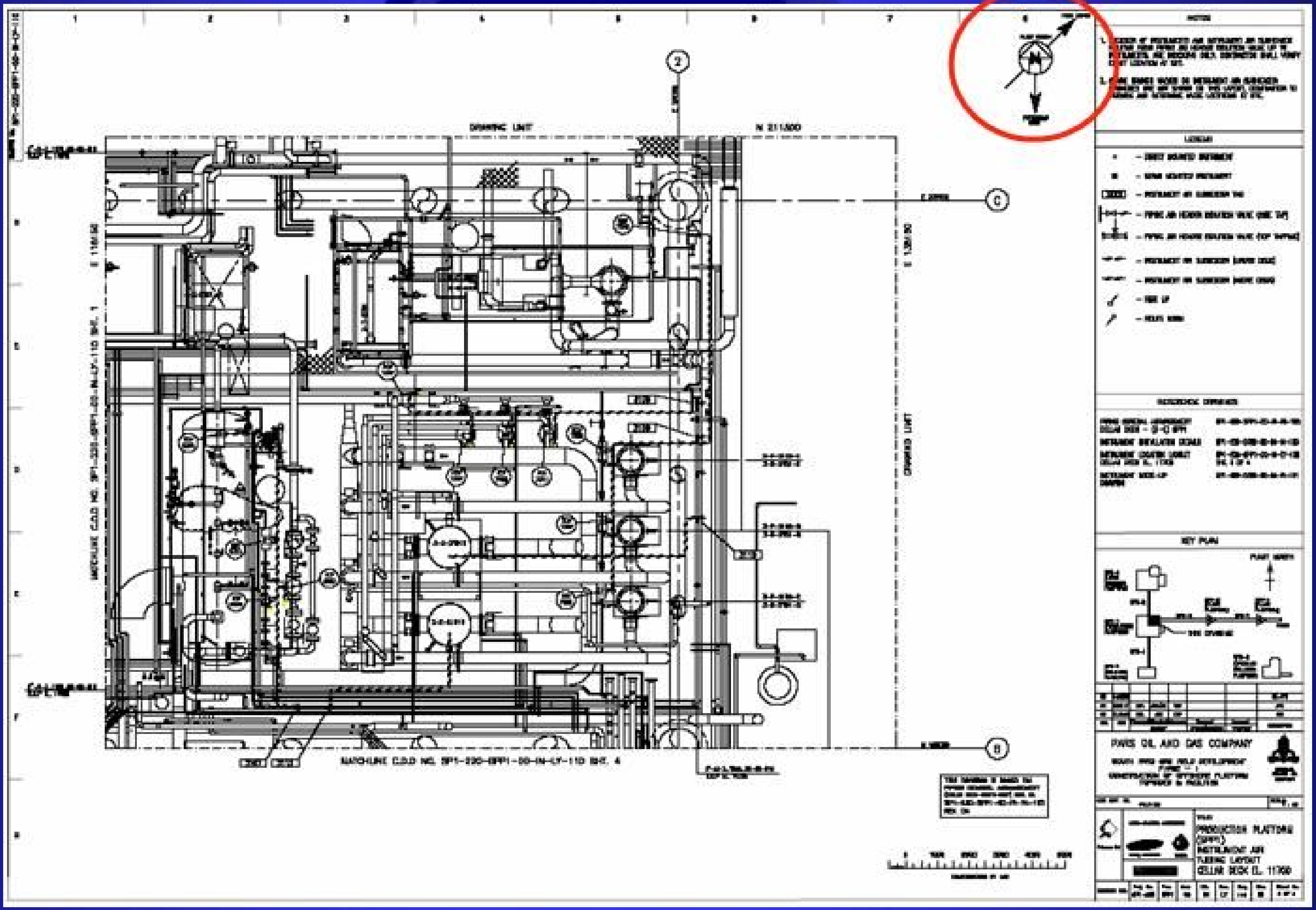
Piping drawings: drawing component (important note)

- Important note

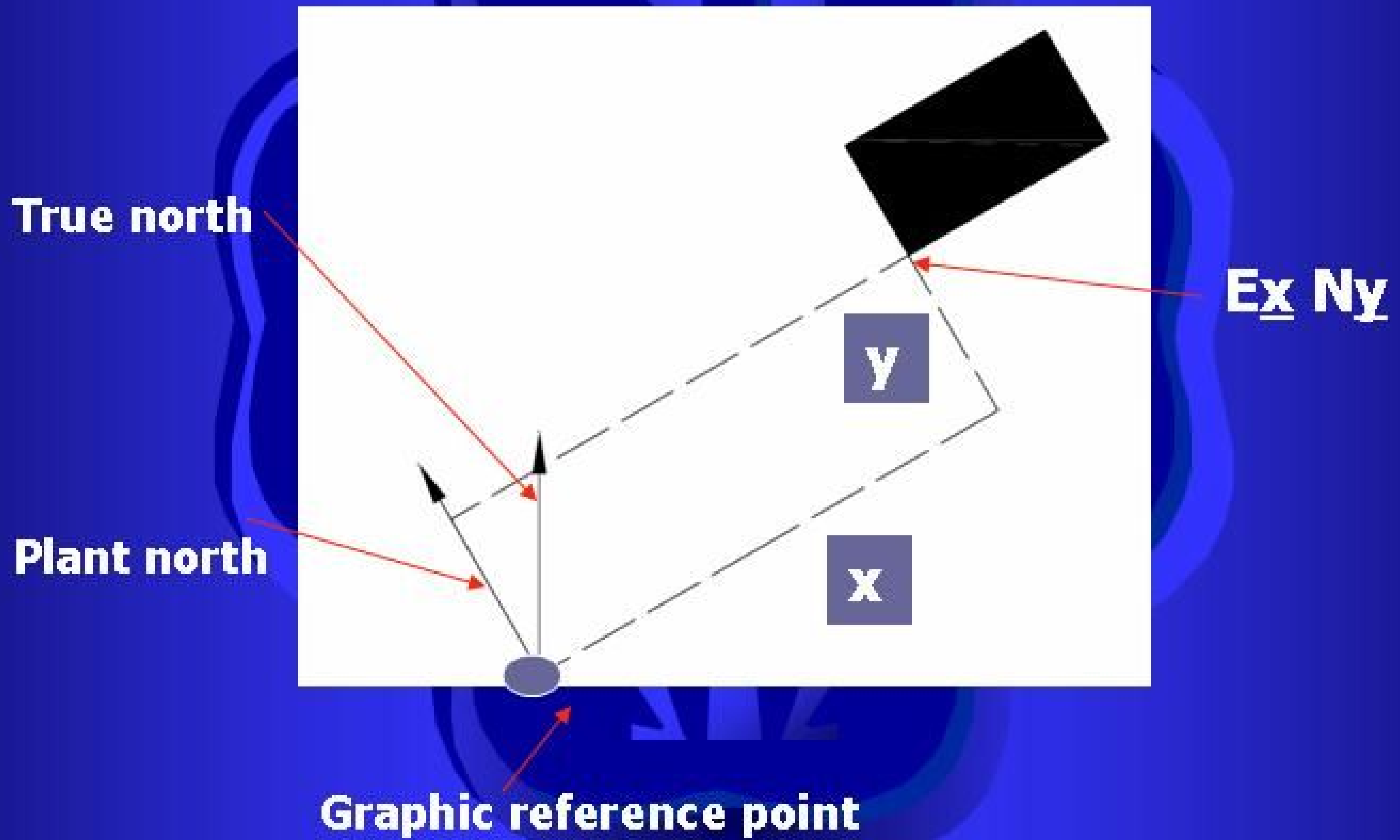


Piping drawings: drawing component (Graphic reference point)

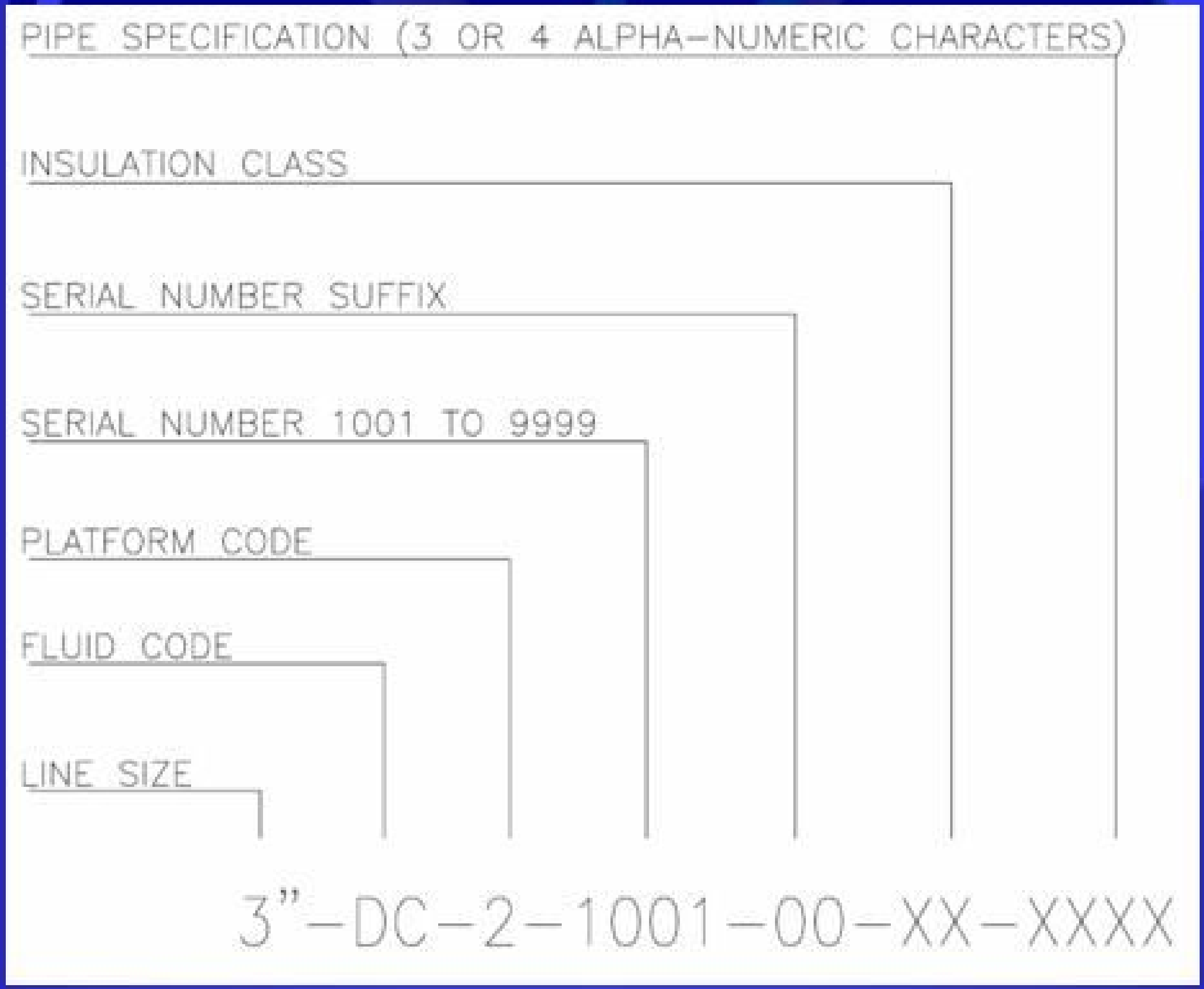
- Graphic reference point



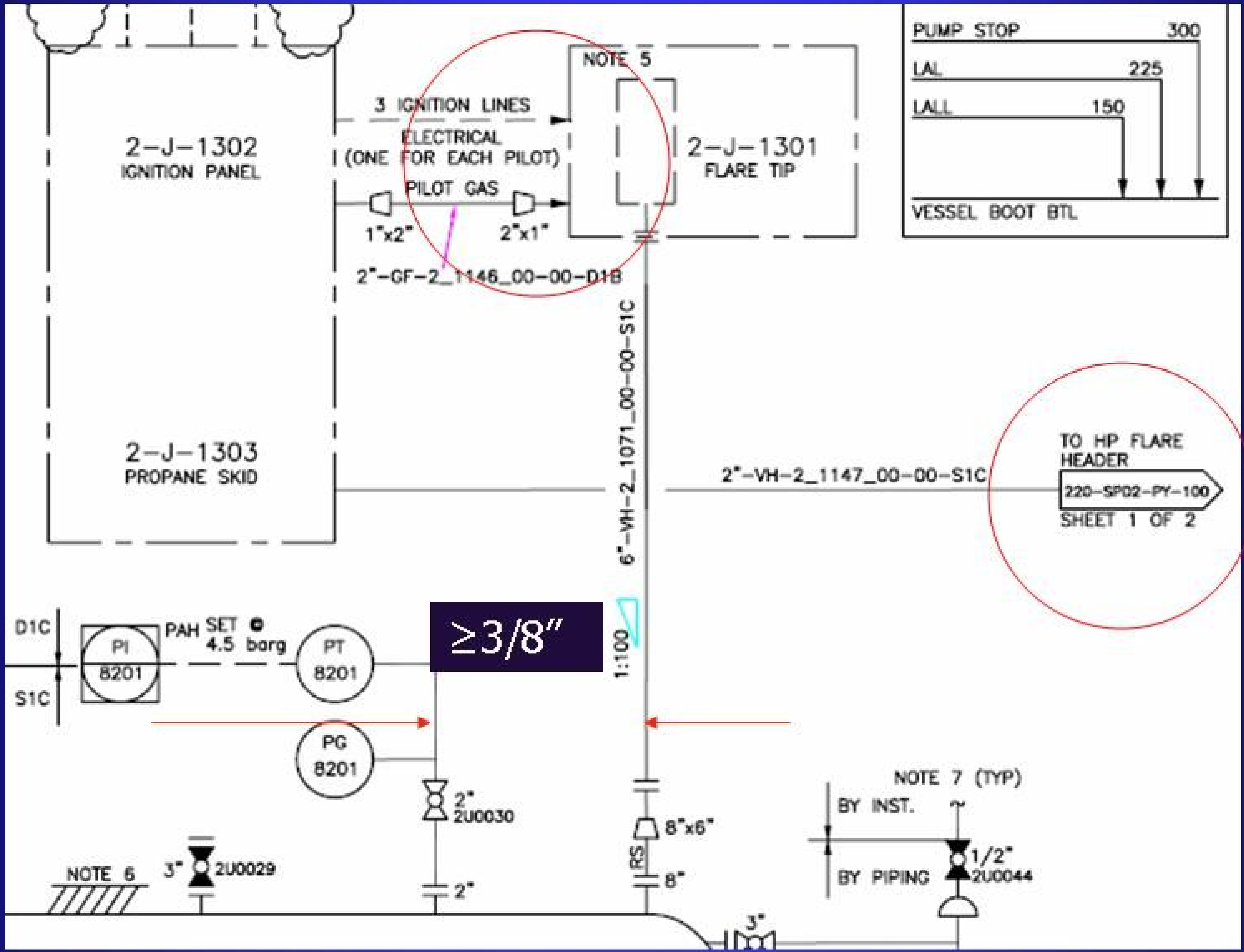
- Graphic reference point



- Line number shall be labeled to show the area of project, conveyed fluid, line size, piping material or specification code number and number of line
- Allocate new number to branch



Flow direction & connection



Line list

- Line list (line designation sheet or table) include:
  - The number of the line
  - Line size
  - Material of construction
  - Conveyed fluid
  - Pressure, temperature, flow rate
  - Test pressure
  - Insulation and jacketing
  - Connected line (which will usually branch)

Piping drawings: line list

LINE NUMBER								OPERATING			
SIZE / SERVICE		NUMBER		SPEC		FROM	TO	PRES BAR G		TEMP °C	
								max	min	max	min
10"	AA	3_	2924	00	D1C	SAFE AREA	3-Z-2801C	ATM	-	45.0	7.0
10"	AA	3_	2925	00	D1C	SAFE AREA	3-Z-2801B	ATM	-	45.0	7.0
10"	AA	3_	2926	00	D1C	SAFE AREA	3-Z-2801A	ATM	-	45.0	7.0
3"	AI	3_	1924	00	D1A	3-Z-2802	3-V-2803	10	-	60.0	45.0
3"	AI	3_	1925	00	D1A	3"-AI-3_1924_00-00-D1A	3"-AI-3_1926_00-00-D1A	10	-	60.0	45.0
3"	AI	3_	1926	00	D1A	3-V-2803	3"-AI-3_1970_00-00-D1A	10	-	60.0	45.0
3"	AI	3_	1927	00	D1A	3"-AI-3_1926_00-00-D1A	3-Z-3001	10	-	60.0	45.0
3"	AI	3_	1928	00	D1A	3"-AP-3_1923_00-00-D1A	3"-AI-3_1924_00-00-D1A	11	-	60.0	23.0
2"	AI	3_	1944	00	D1A	3-V-2803	3"-VA-3_1945_00-00-D1C	10	-	60.0	23.0
2"	AI	3_	1948	01	D1A	3"-AI-3_1963_00-00-D1A	3-Z-1611	10	-	60.0	23.0

Piping drawings: line list

DESIGN				FLEXI	TEST		INSULATION		P&ID NOs.	REMARKS		NDE	PAINT	STRES	STRES	REV
PRES BAR G		TEMP °C		TEMP. °C	MEDIUM	PRES BAR G	TYPE	THICKNESS (mm)			PWHT	CLASS TABLE	SYST TABLE	TEMP.	CAT / NO	NO
max	min	max	min													
15	0	85	0	45	WATER	FILL			220-SPP1-PY-130			II	2	85	1	
15	0	85	0	45	WATER	FILL			220-SPP1-PY-130			II	2	85	1	
15	0	85	0	45	WATER	FILL			220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-130			II	2	85	1	
15	0	85	0	70	WATER	22.5	00		220-SPP1-PY-131			II	2	85	1	

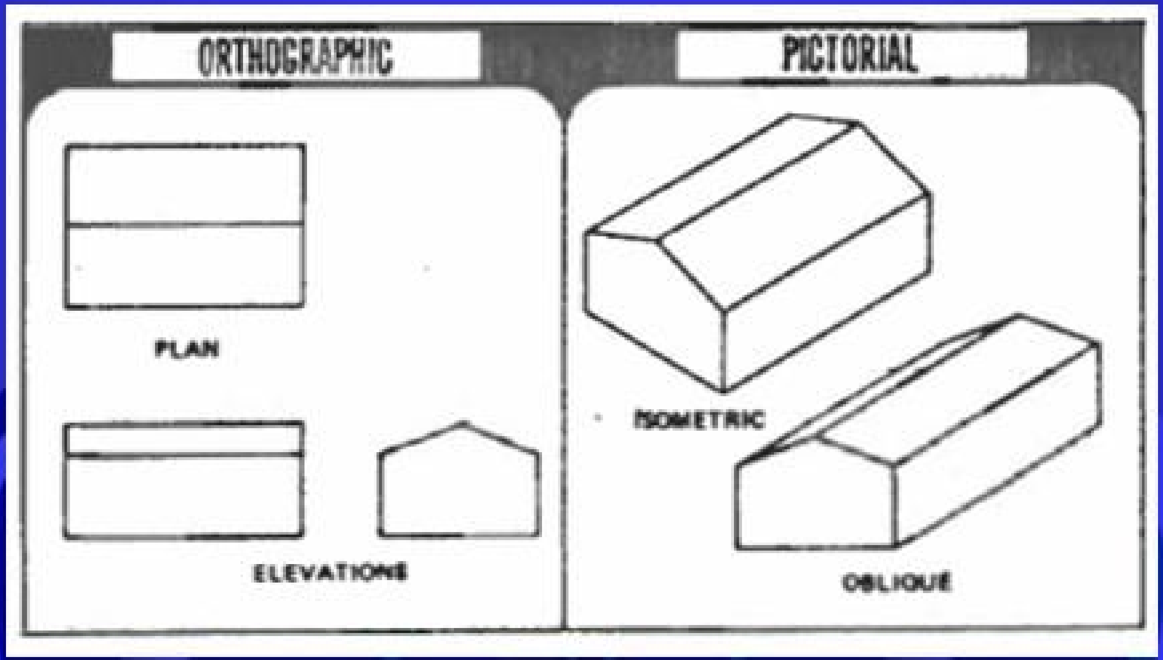
Drawing view

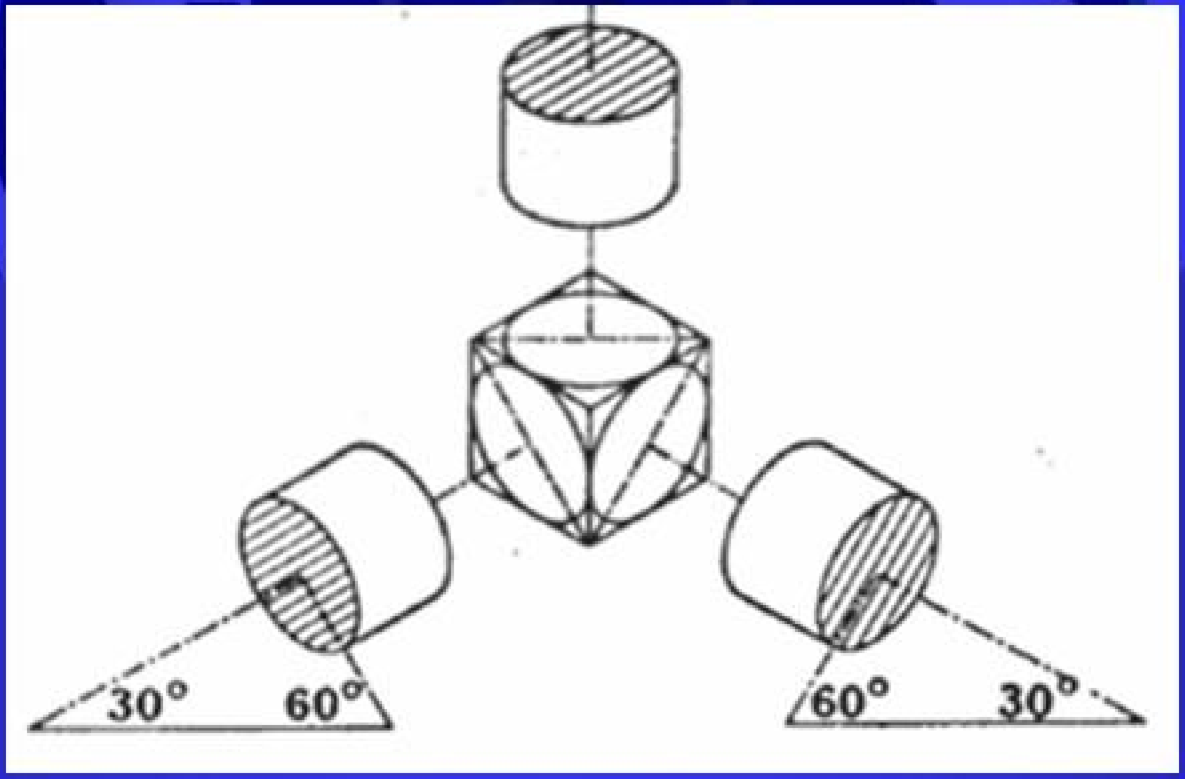
Piping drawings: drawing view

- Two type of view are used for piping drawing:
  - Orthographic
    - Plans √
    - Elevation
  - Pictorial:

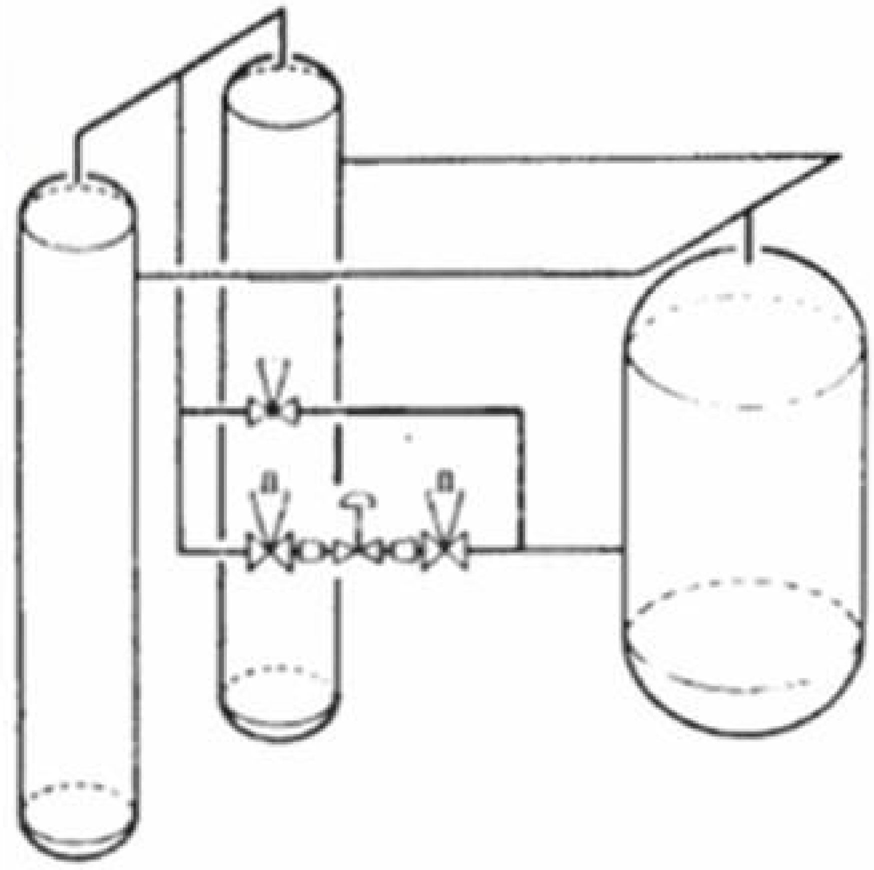
    in complex piping system where orthographic view may not easily illustrate the design
    - Isometric √
    - Oblique

Piping drawings: drawing view





Piping drawings: drawing view



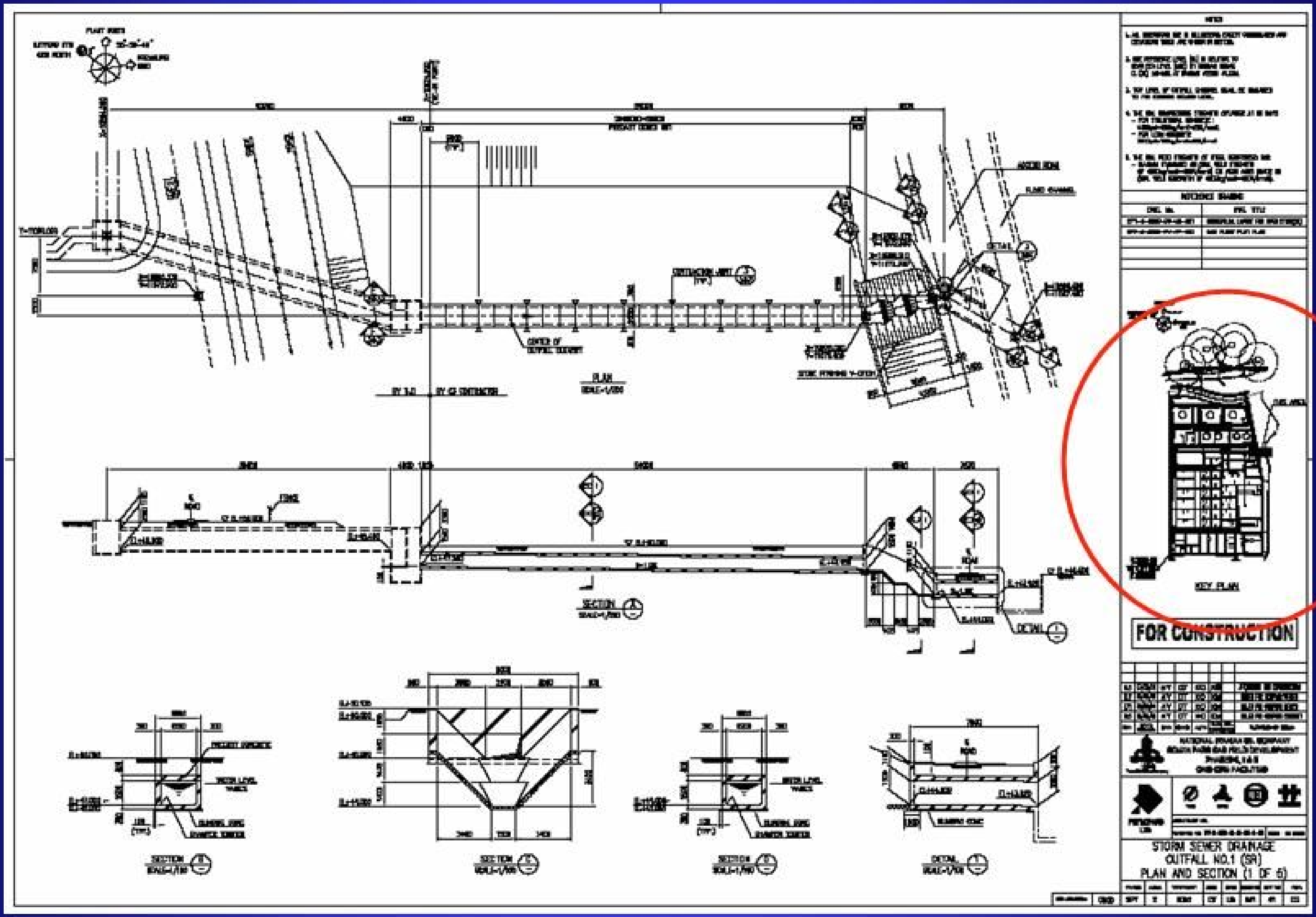
OBLIQUE

Piping drawing

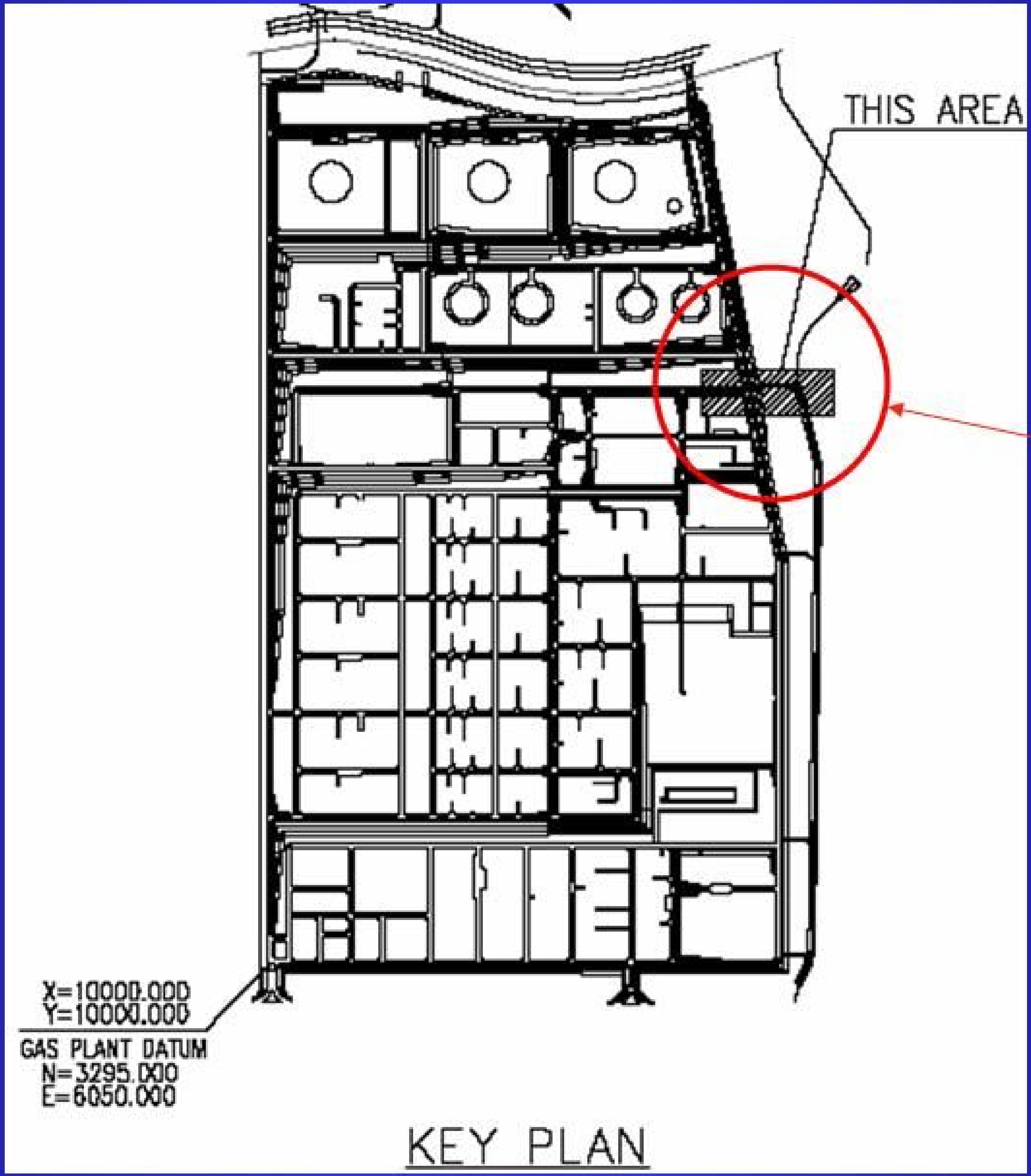
- Piping drawing include:
  - Site plan
    - Key plan
  - Equipment layout
  - Piping layout (plan)
  - Isometric
  - Support drawing
  - …

Piping drawings: piping drawings (site plan)

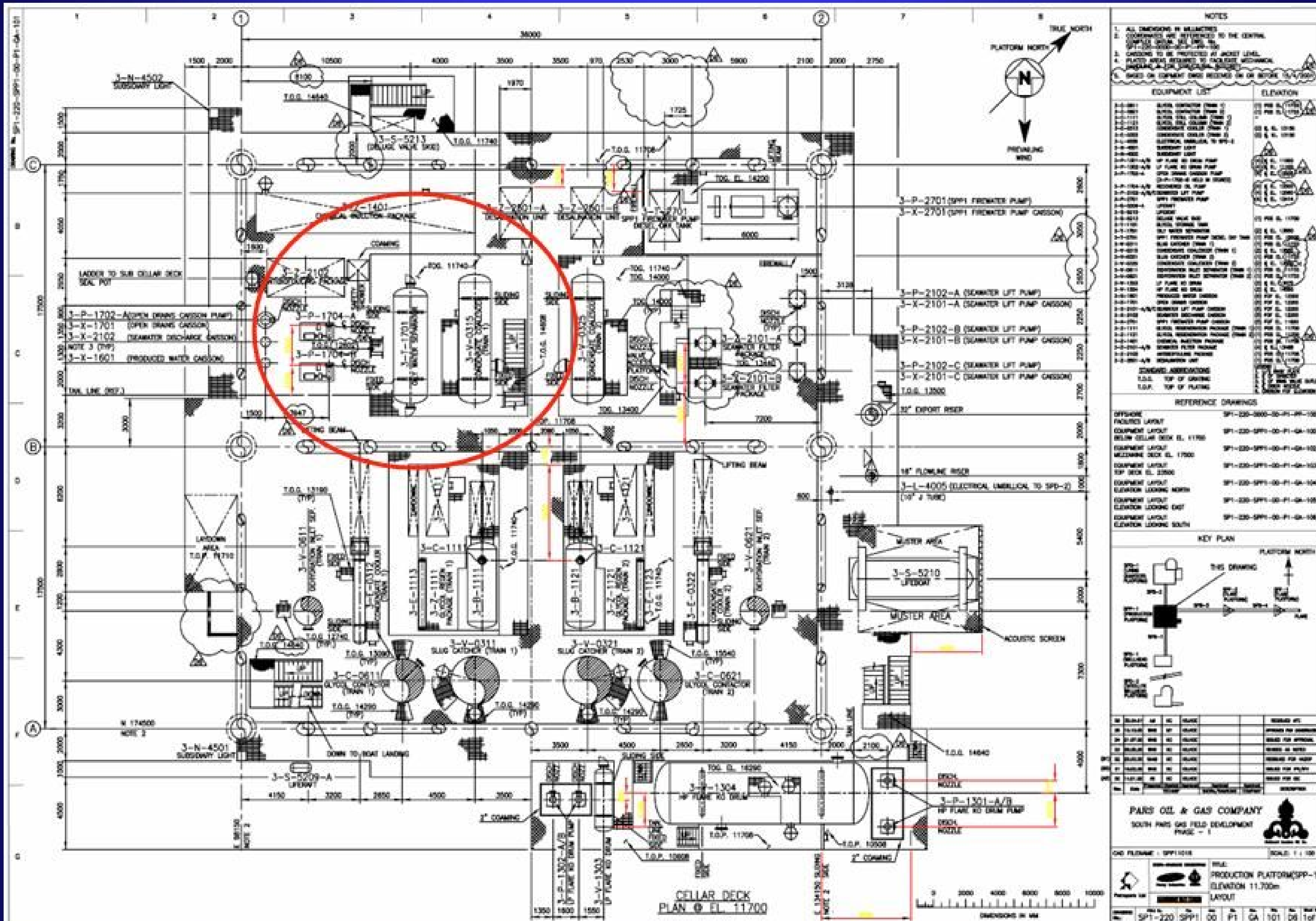
Piping drawings: piping drawings (key plan)



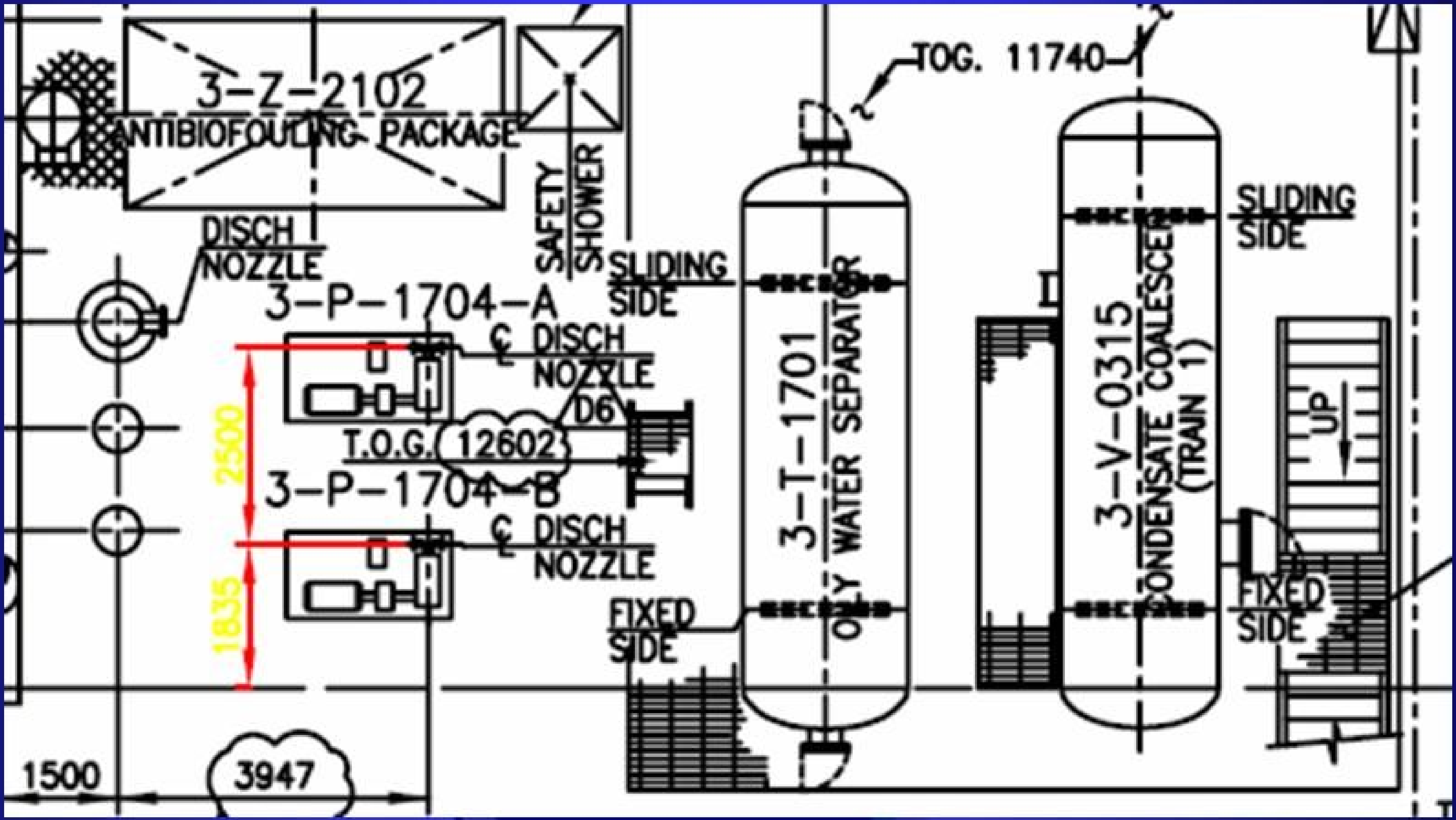
Piping drawings: piping drawings (key plan)



Piping drawings: piping drawings (Equipment arrangement drawing)



Piping drawings: piping drawings (Equipment arrangement drawing)



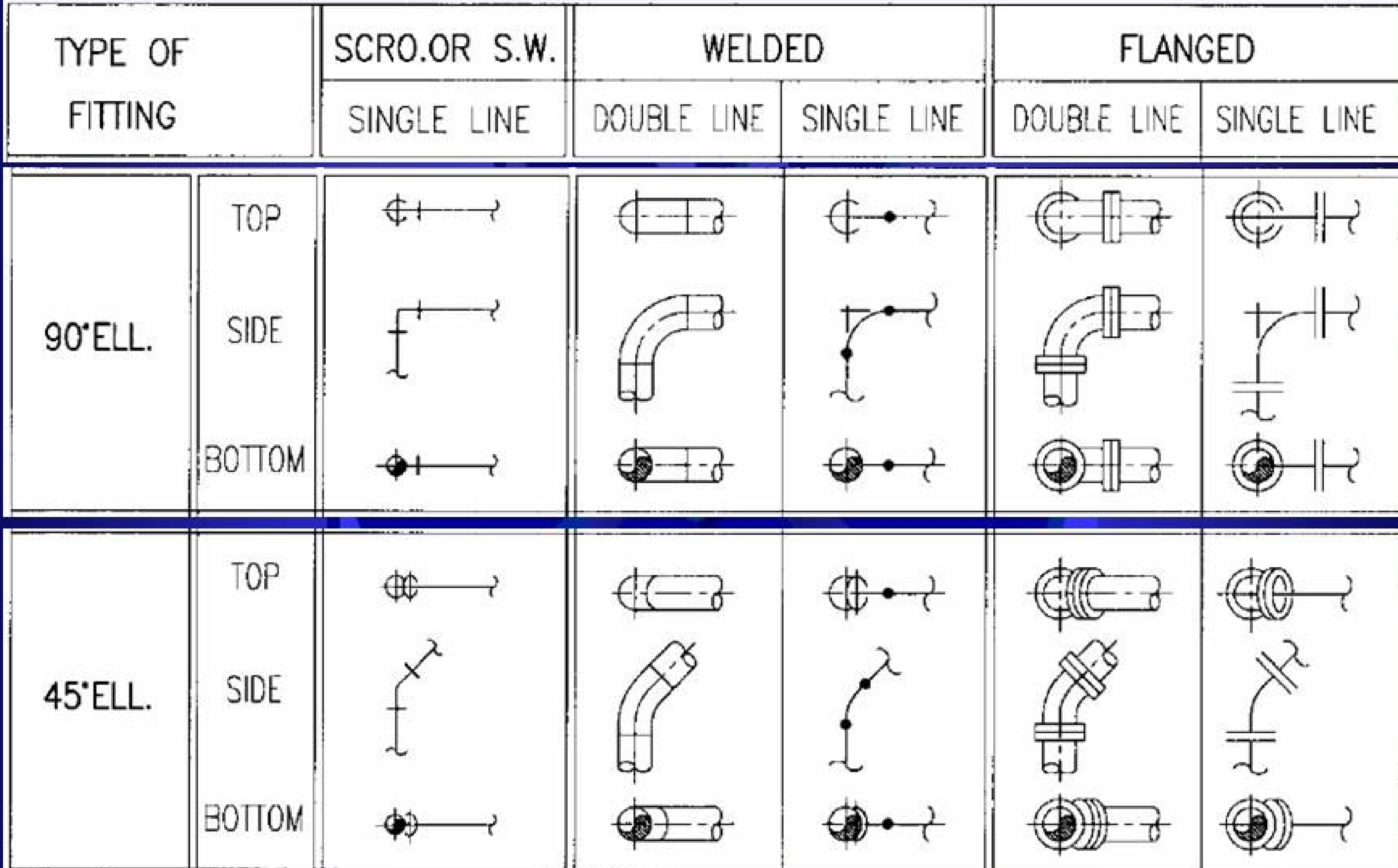
piping symbols for fittings, flanges, special items

Piping abbreviation

FABRICATED	FAB.	MANWAY	MW
FACE OF FLANGE	FOF	MAXIMUM	MAX.
FACE TO FACE	F TO F	MILLIMETER	MM
FITTING	FTG	MINIMUM	MIN.
FIELD WELD	FW	MOTOR OPERATED VALVE	MOV
FLANGE	FLG	MALE PIPE THREAD	MPT
FLANGED	FLGD	NIPPLE	NIP
FLAT FACE	FF	NOMINAL PIPE SIZE	NPS
FLOOR DRAIN	FD	NOMINAL PIPE THREAD	NPT
FULL BORE	FB	OILY DRAINAGE	OY
GALLONS PER MINUTE	GPM	PLAIN BOTH END	PBE
GALVANIZED	GALV.	PLAIN END	PE
GEAR OPERATED	GO	PLAIN LARGE END	PLE

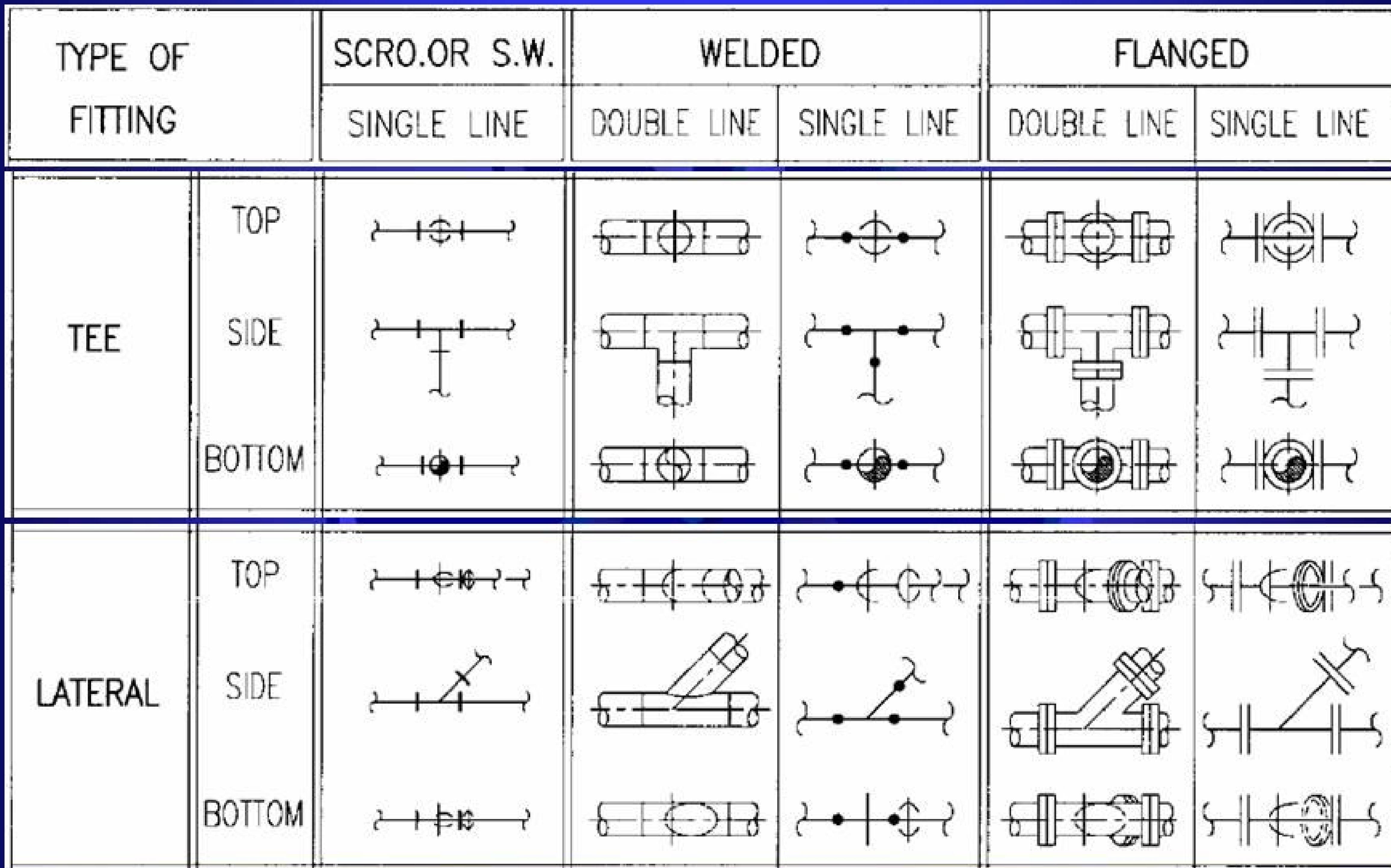
Piping drawings: piping drawings

(piping symbols for fittings, flanges, special items)

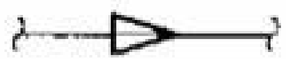
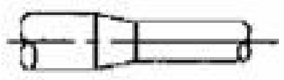
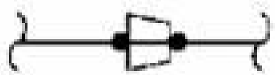
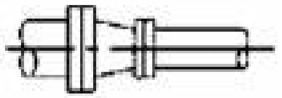
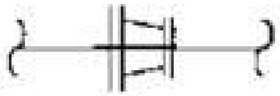
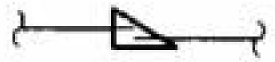
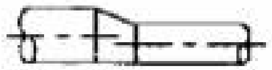
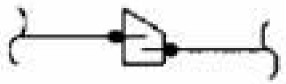
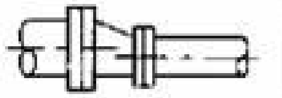
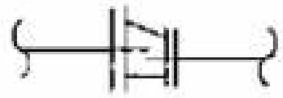


Piping drawings: piping drawings

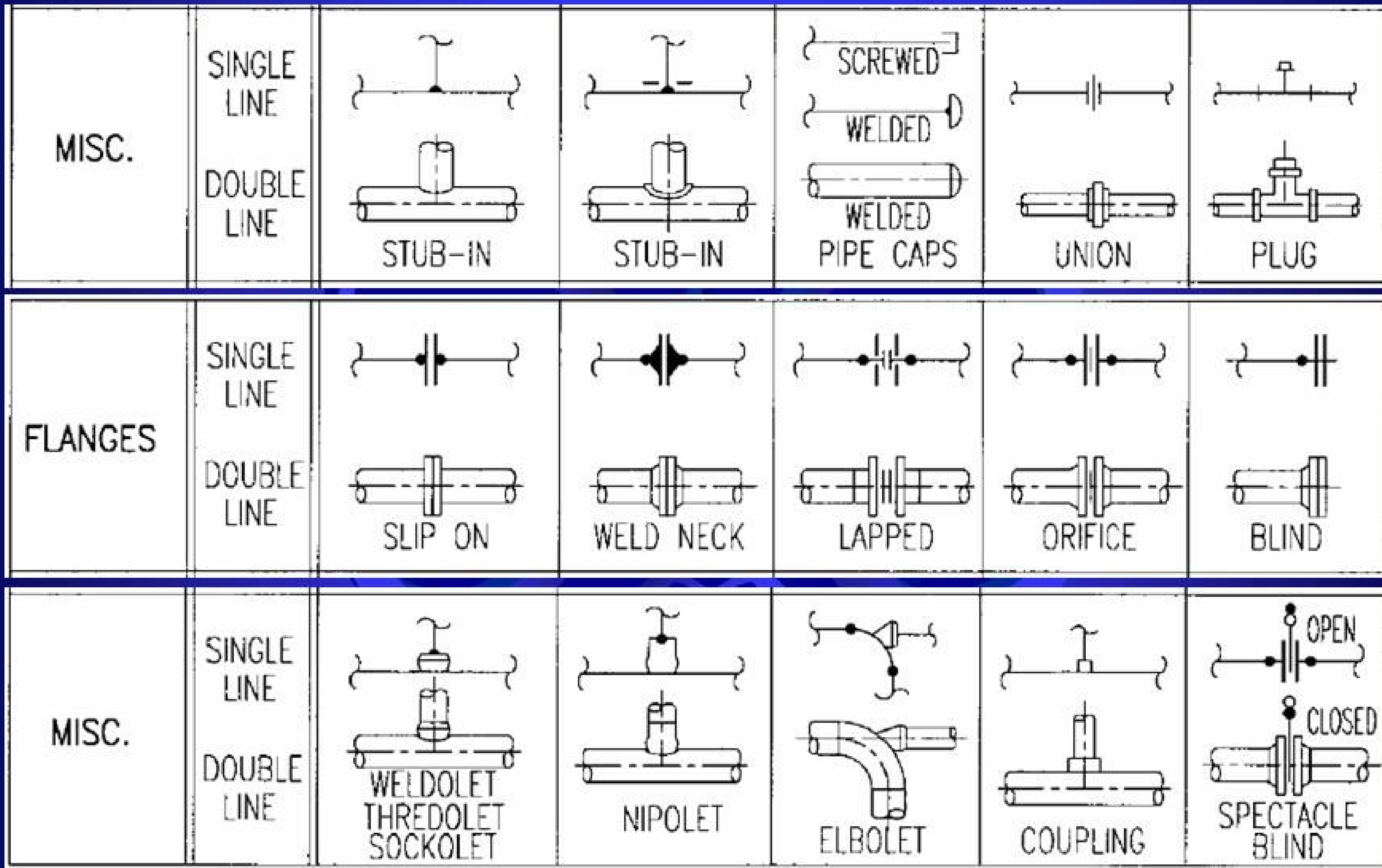
(piping symbols for fittings, flanges, special items)



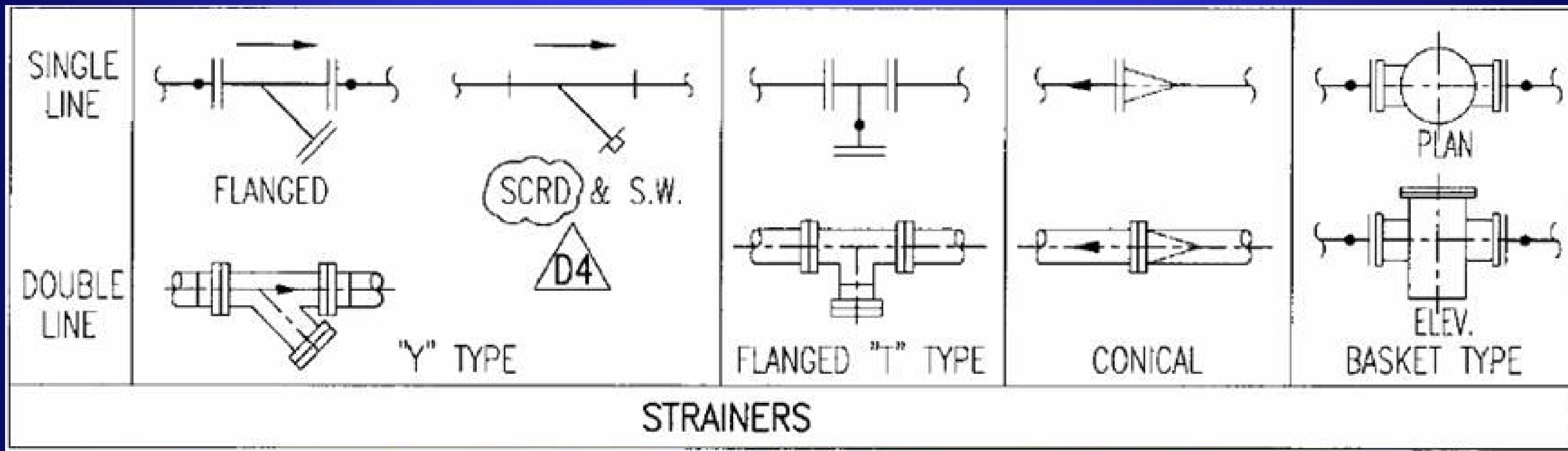
Piping drawings: piping drawings
(piping symbols for fittings, flanges, special items)

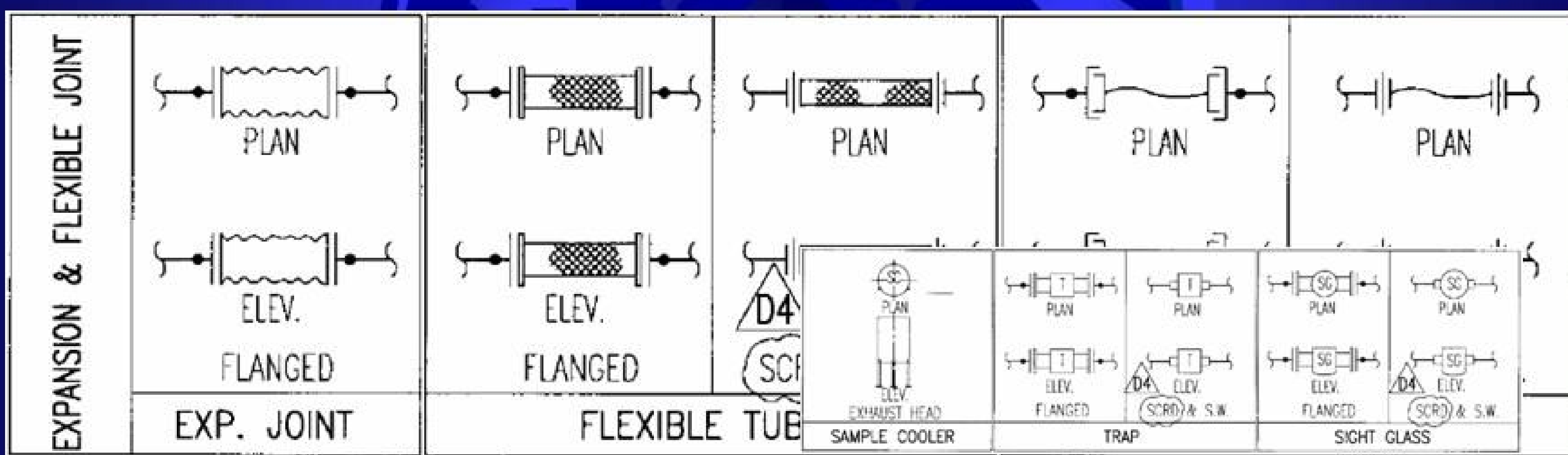
TYPE OF FITTING		SCRO.OR S.W.	WELDED		FLANGED	
		SINGLE LINE	DOUBLE LINE	SINGLE LINE	DOUBLE LINE	SINGLE LINE
REDUCER	CON-CENTRIC					
	ECCEN-TRIC					

Piping drawings: piping drawings
(piping symbols for fittings, flanges, special items)

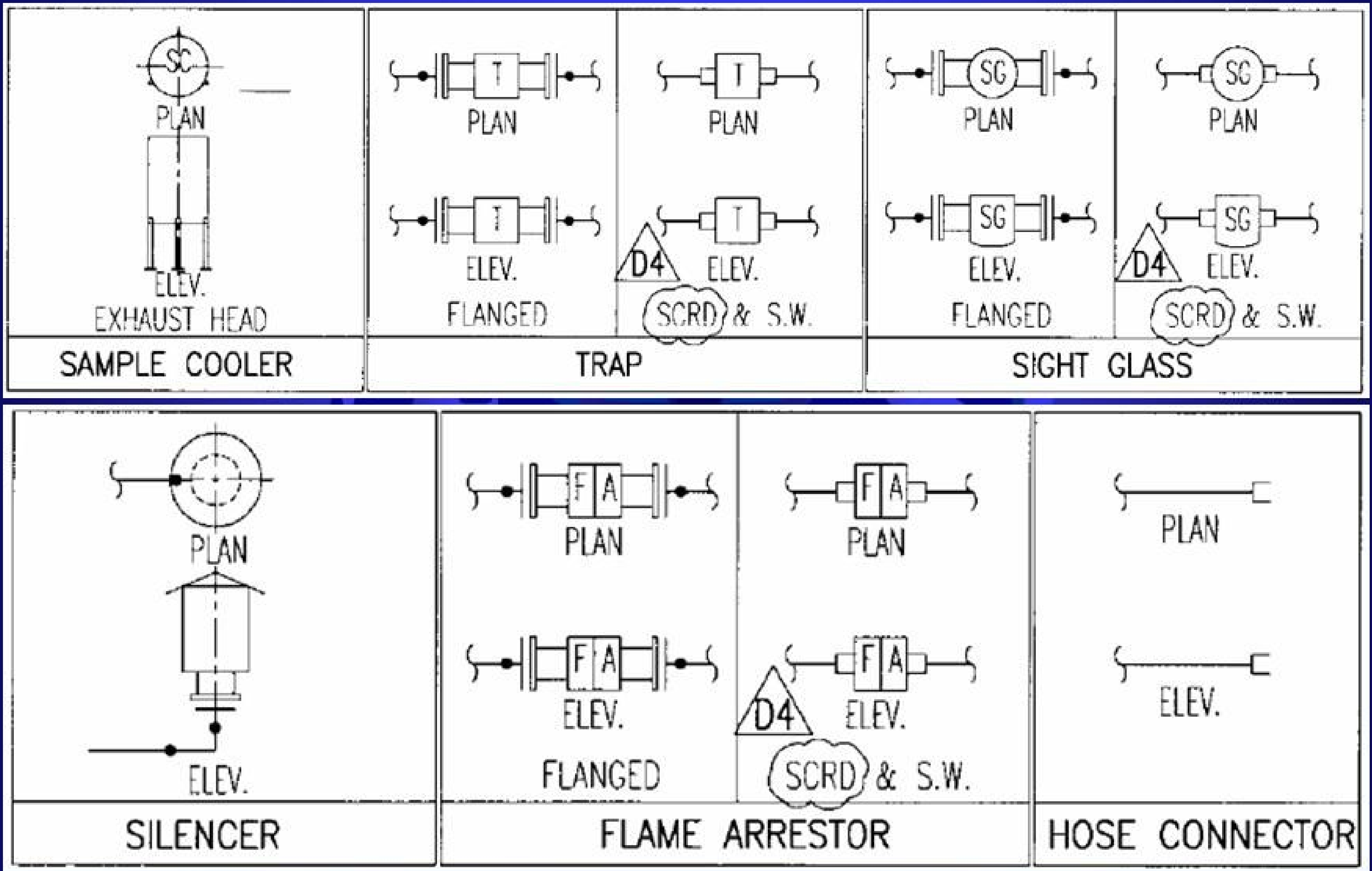


Piping drawings: piping drawings
(piping symbols for fittings, flanges, special items)

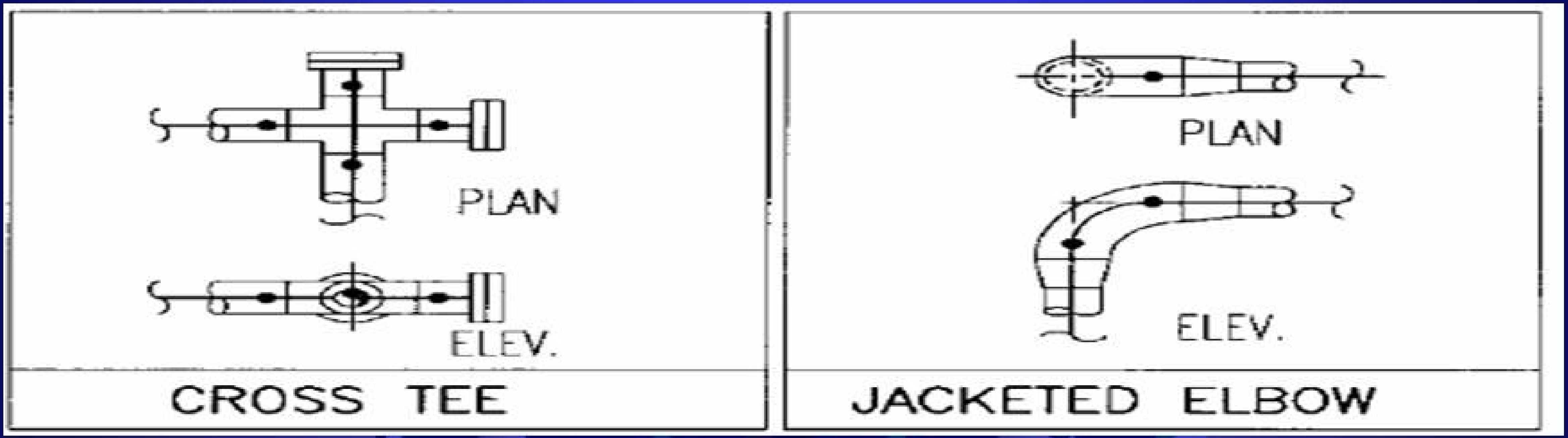


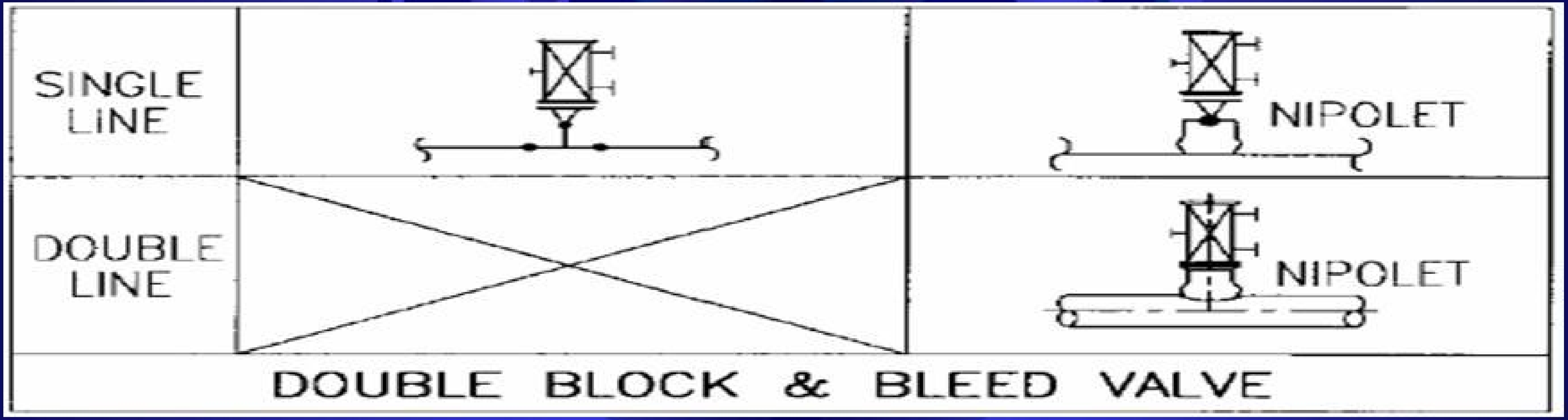


Piping drawings: piping drawings (piping symbols for fittings, flanges, special items)

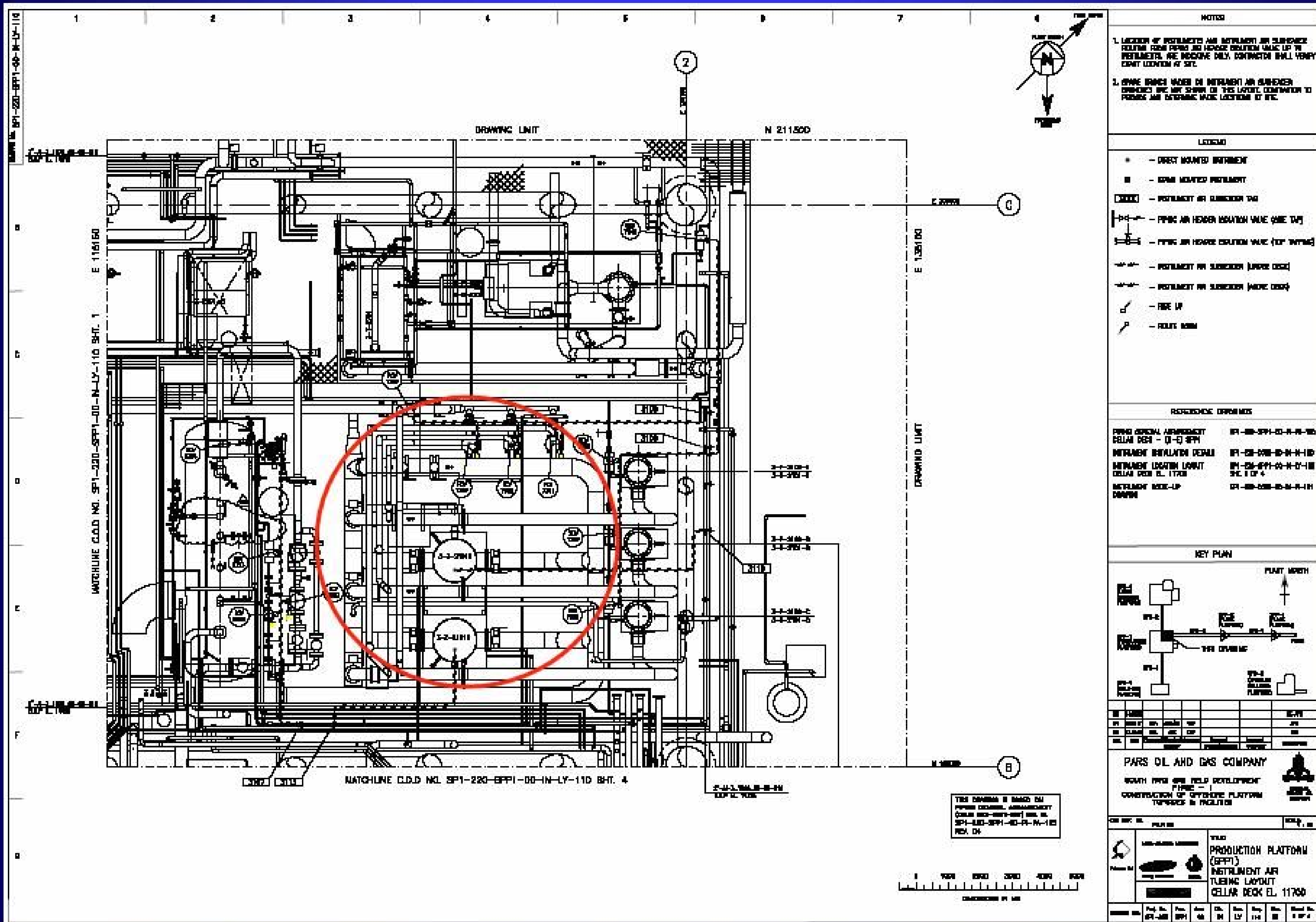


Piping drawings: piping drawings
(piping symbols for fittings, flanges, special items)

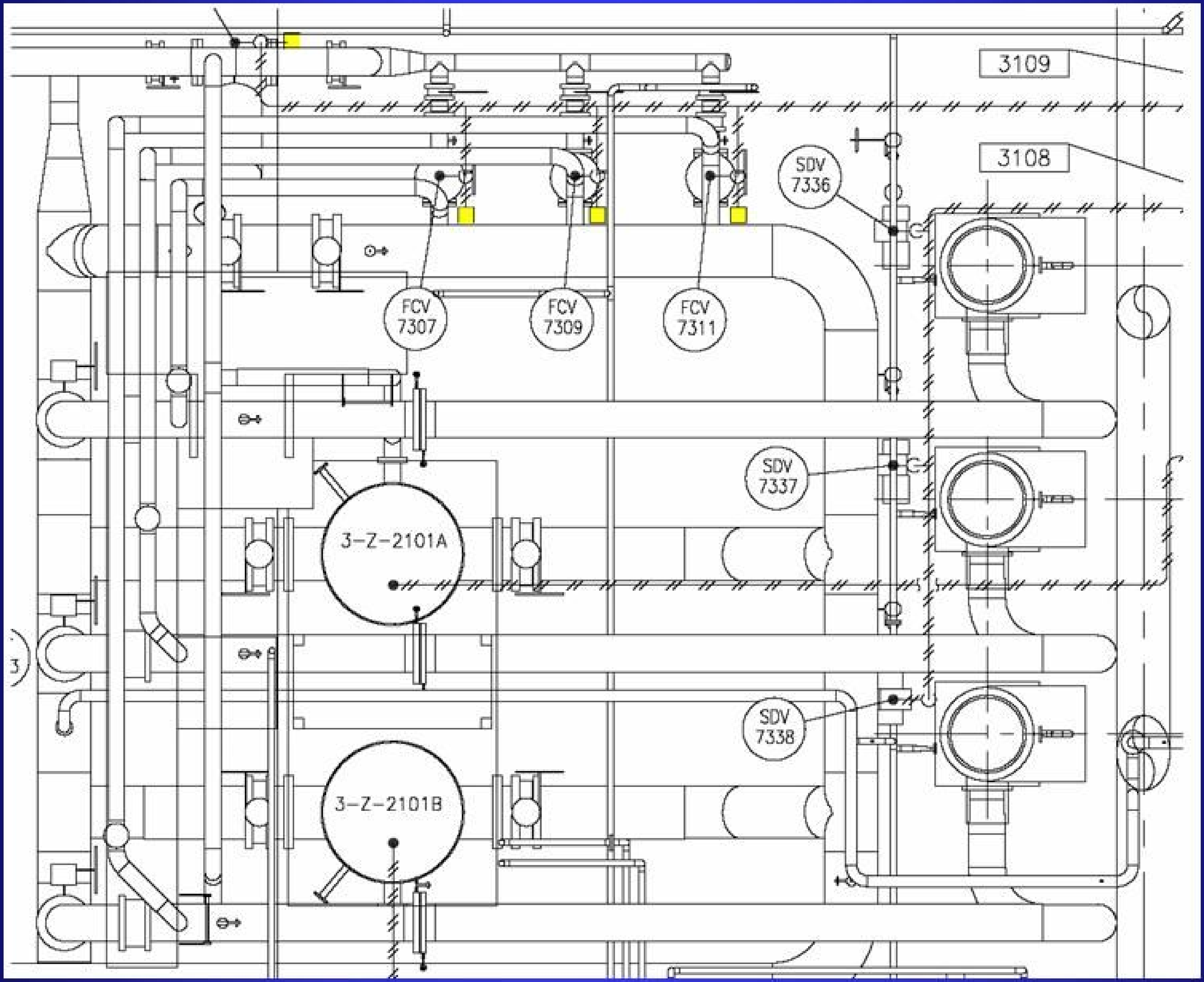




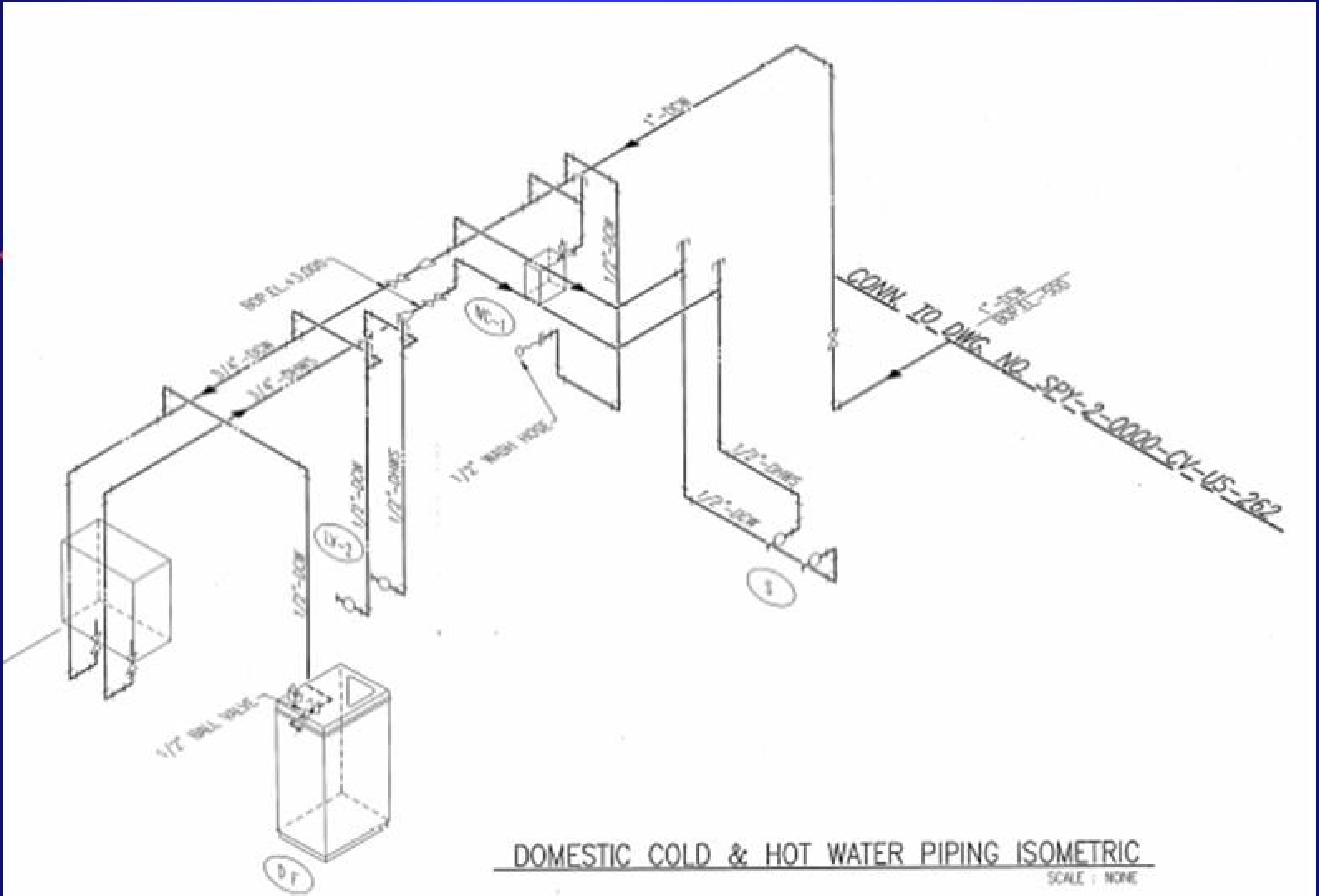
Piping drawings: piping drawings (piping layout = plan)



Piping drawings: piping drawings (piping layout = plan)



Piping drawings: piping drawings (Isometric)



DOMESTIC COLD & HOT WATER PIPING ISOMETRIC

Piping take off material (bill of material, material list)

Project :

Platform/Unit :

Date : **19/06/01**

Platform/ Unit	Line Number/ Location	Sht. No.	Rev.	Piping Spec.	Short Code	Tag Number	Stock Code	End	Nominal Diameter Size 1	Nominal Diameter Size 2
SPP1	AA 2490			D1C1	*90E	8	WAAAAAWASA	BW	6 IN	
SPP1	AA 2490			D1C1	*FLG	10	FAAAIAWAAA	RF	6 IN	
SPP1	AA 2490			D1C1	*PIP	208	PAAAAAKABT	BE	10 IN	
SPP1	AA 2490			D1C1	*90E	209	WAAAAAWASA	BW	10 IN	
SPP1	AA 2490			D1C1	*FLG	210	FAAAIAWAAA	RF	10 IN	
SPP1	AA 2490			D1C1	*BOL	1209	BTFB72HBA	RF	7/8	120
SPP1	AA 2490			D1C1	*GAS	1261	XWAANZZTGS	RF	6 IN	
SPP1	AA 2490			D1C1	*GAS	1788	XWAANZZTGS	RF	10 IN	

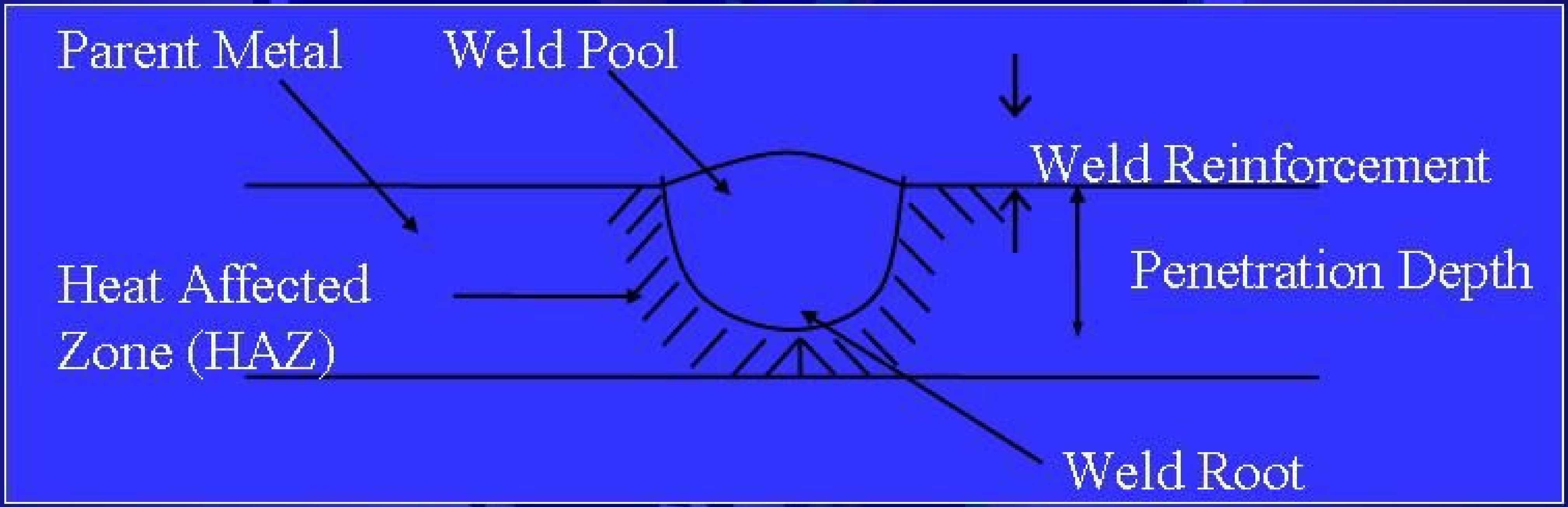
Piping material take off

Rating	Thickness	Qty.	Weight	Description
	SCH/MM		(kg/ps)	
	80	1	15.35	90 DEG. LR ELBOW, A234 GR.WPB SS SEAMLESS, B16.9
150	80	1	10.6	WELDING NECK FLANGE, ASTM A105N SS, B16.5.
	80	4.8	95.74	SEAMLESS PIPE, API 5L GR.B SS
	80	1	59.8	90 DEG. LR ELBOW, A234 GR.WPB SS SEAMLESS, B16.9
150	80	2	23.9	WELDING NECK FLANGE, ASTM A105N SS, B16.5.
		12	0	STUD BOLT, A193 GR.B7, WITH 2 HEAVY HEX.NUTS, A194 GR.2H, PTFE COATED
150		1	0	FLAT GASKET, TANGED GRAPHITE/AISI 316 INSERT,ANSI B16.21 (B16.5), THK = 1.5MM
150		1	0	FLAT GASKET, TANGED GRAPHITE/AISI 316 INSERT,ANSI B16.21 (B16.5), THK = 1.5MM

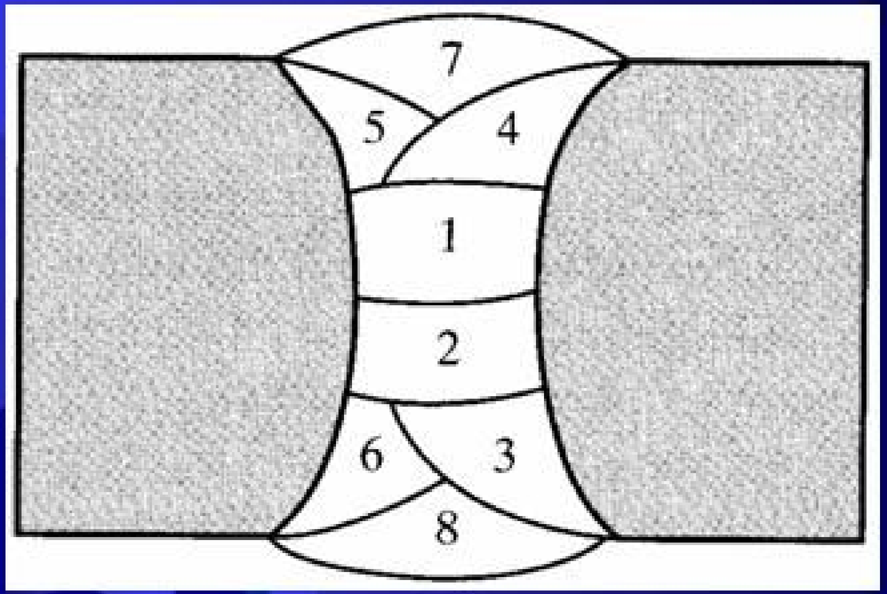
Welding

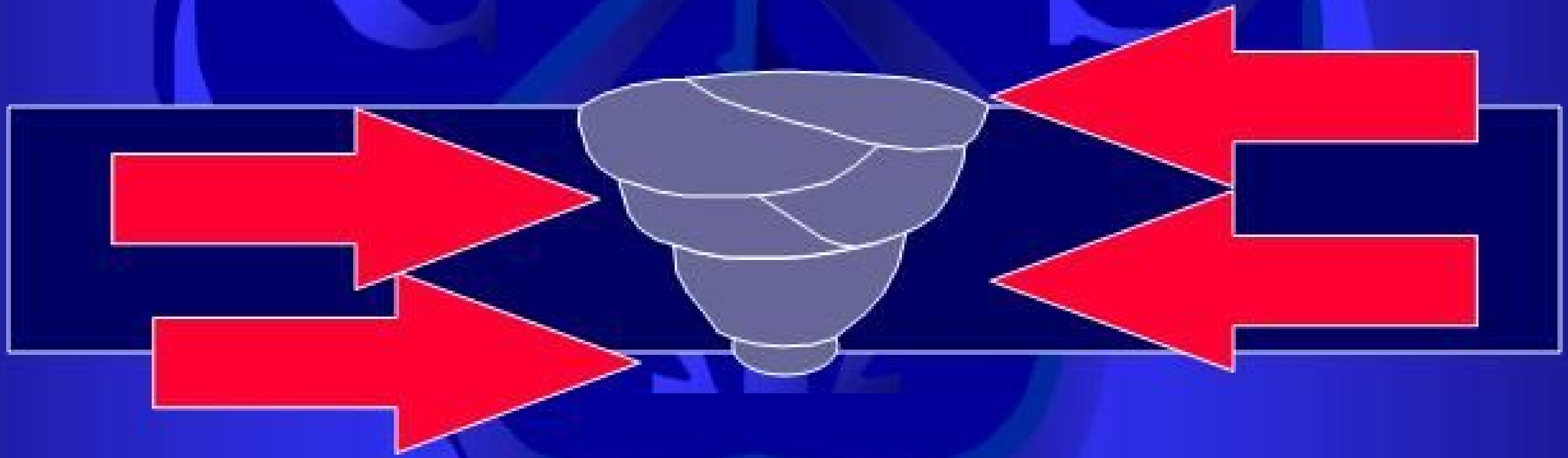
What is Welding?

- *Welding is a joining process in which metals are heated, melted and mixed to produce a joint with properties similar to those of the materials being joined.*



- Pass Name:
  - Root Pass
  - Hot Pass
  - Fill Pass
  - Cover Pass (capping pass)





- Weld type:
  - Fillet
    - Used when joining two pieces of metal without preparing the surface of the metal first.
  - Groove
    - used when preparing the metal before welding it into place, include:
      - Square
      - Bevel
      - Single or double V
      - Single or double U
      - Single or double J

- **Fillet**
  - Approximately triangular
  - Most common weld in structural work

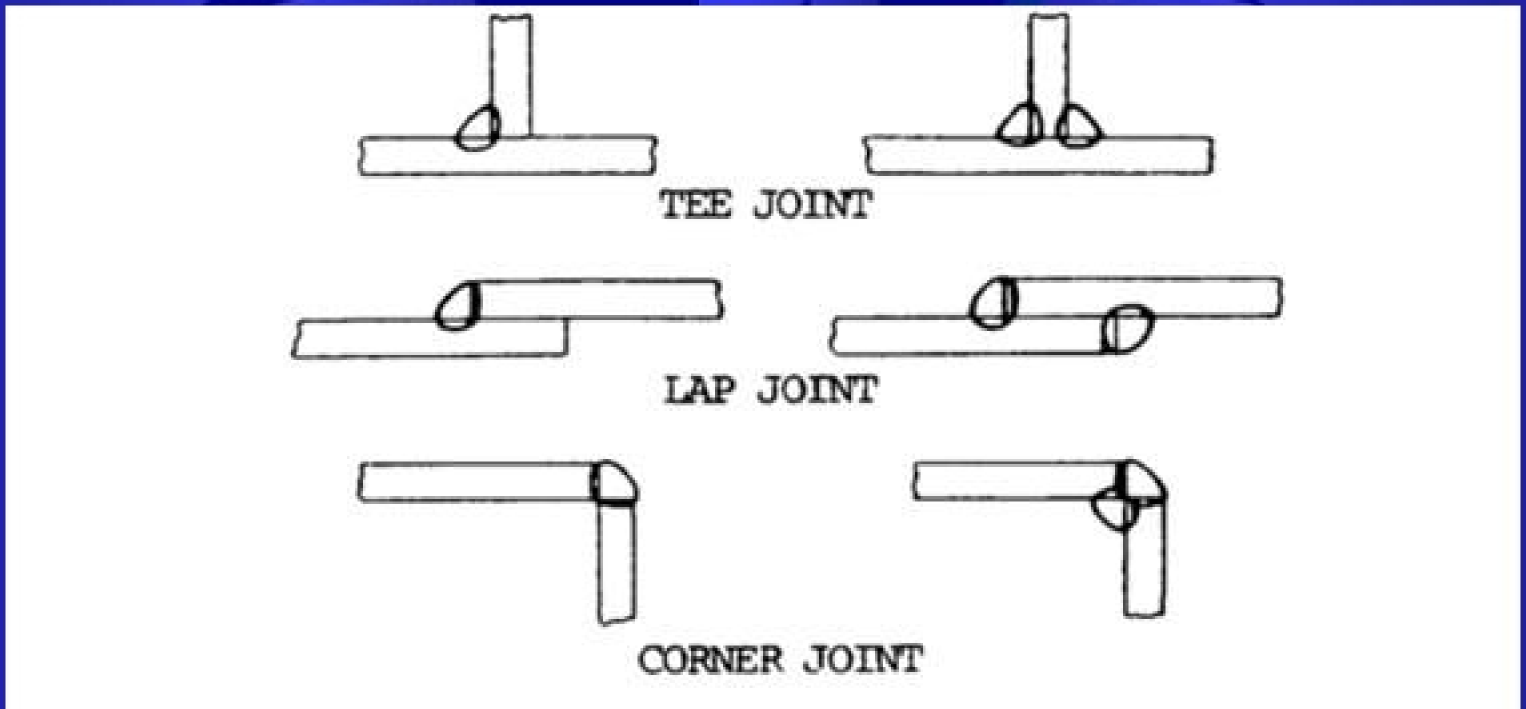
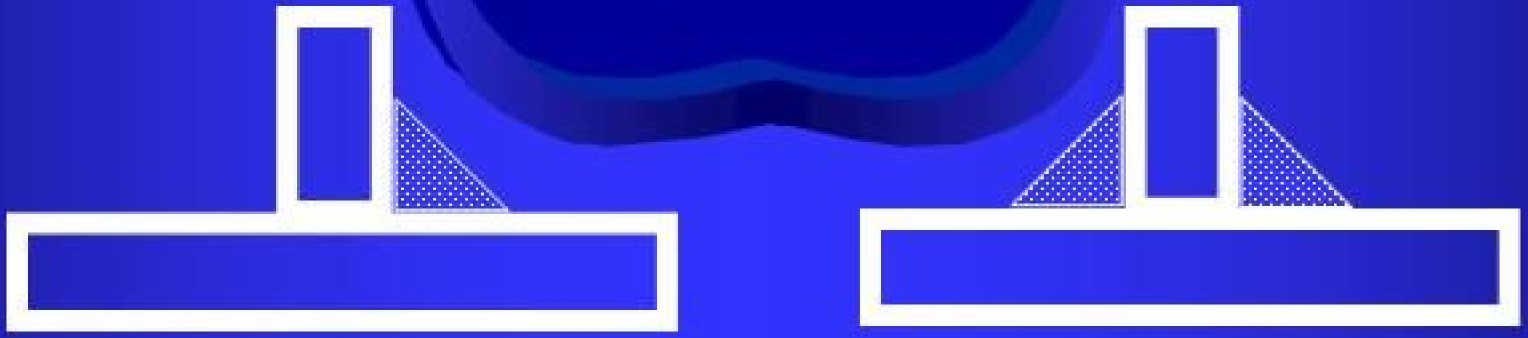
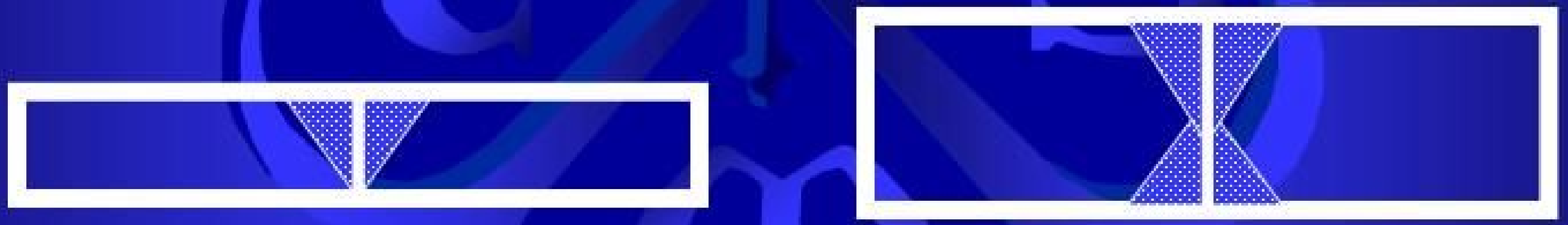


Figure 6-24. Applications of fillet welds--single and double.

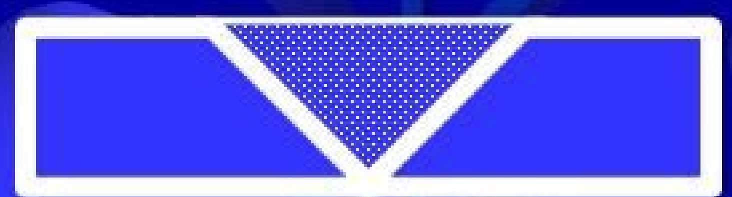


- groove
  - Square
    - Penetration difficult with single; double used to ensure strength
    - Sometimes root is opened and a backing bar is used



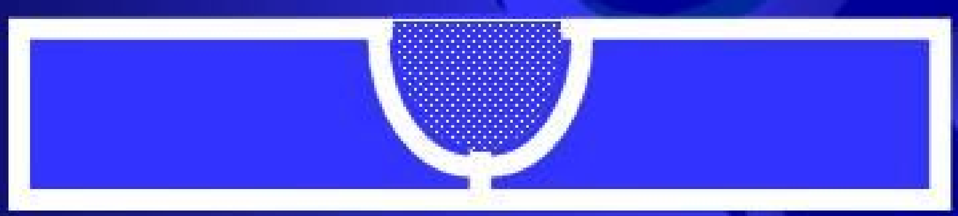
- groove
  - Bevel
    - Single bevel is widely used
    - Double preferred if metal thickness >3/4

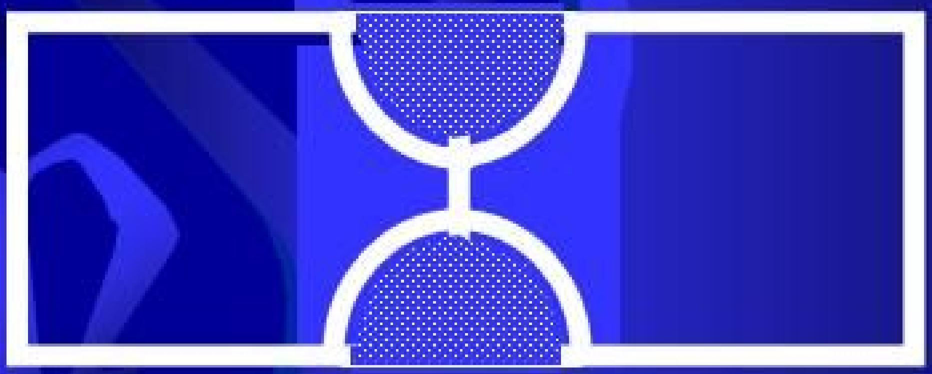
- groove
  - Single V
    - Both members beveled
    - Butt joints for plate thickness greater than 1/4 inch



  - Double V:
    - welds reduce distortion

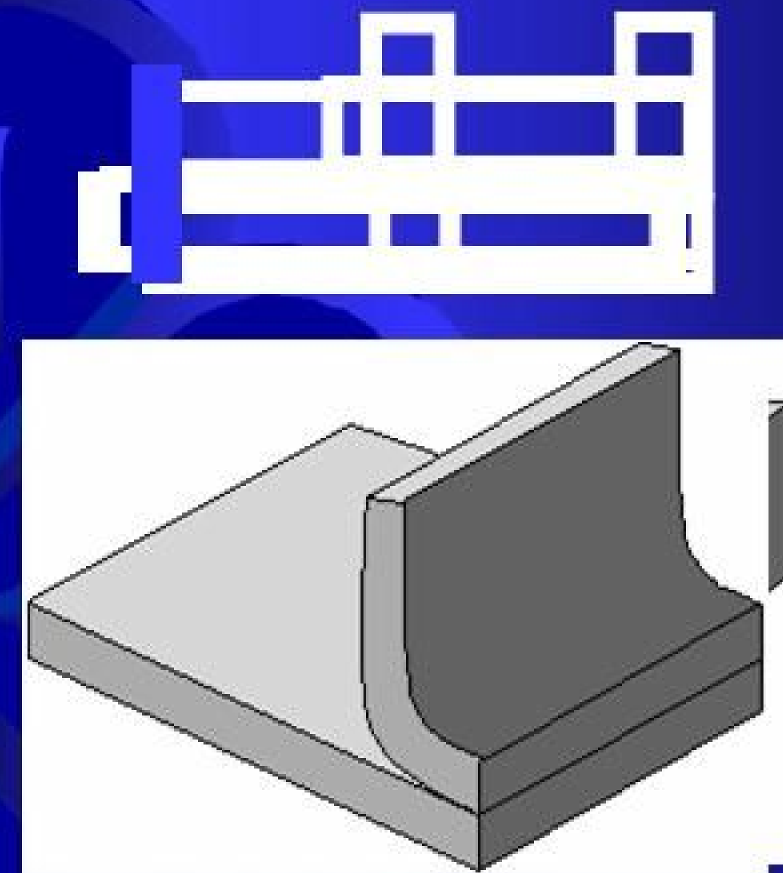
- groove
  - Single and double U:
    - Rounded base allows larger electrodes for narrower groove angles
    - Machined or carbon arc gouged preparation



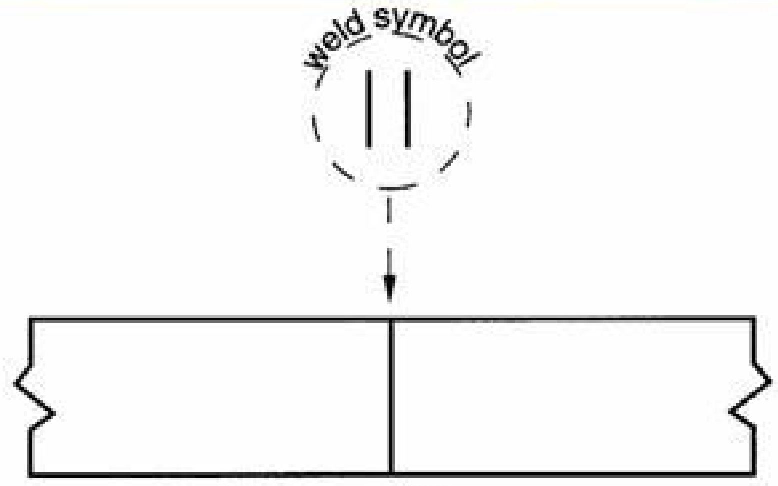


- groove
  - Single or double J
    - Single well suited for butted corner and T joints
    - Machined or carbon arc gouged preparation

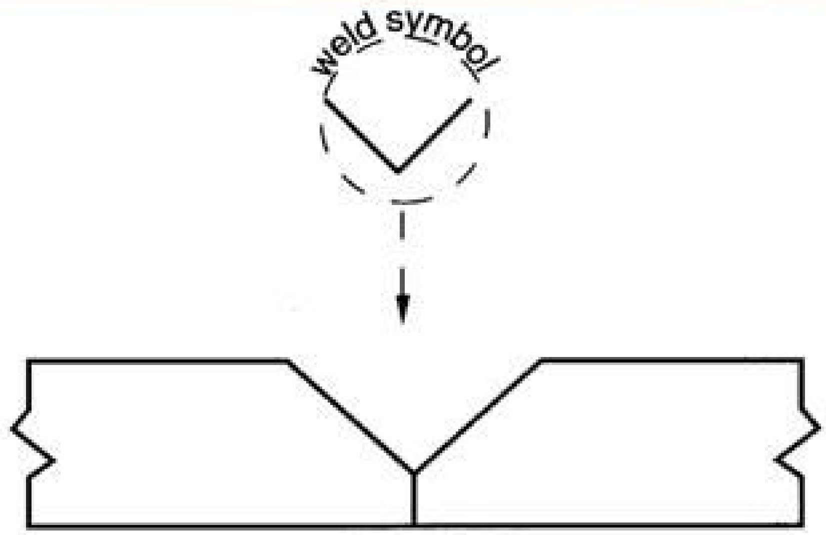
- Type of joints:
  - Butt joint
  - T joint
  - Lap joint
  - Corner joint
  - Edge joint



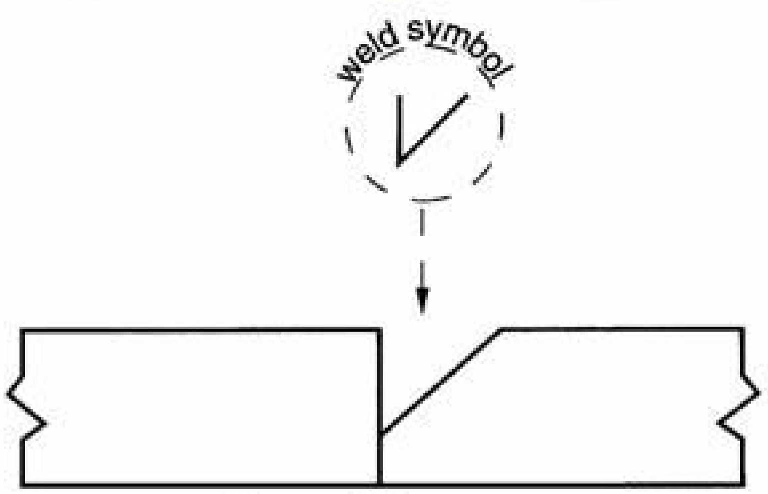
- Type of joints:
  - Butt joint



Square-Groove

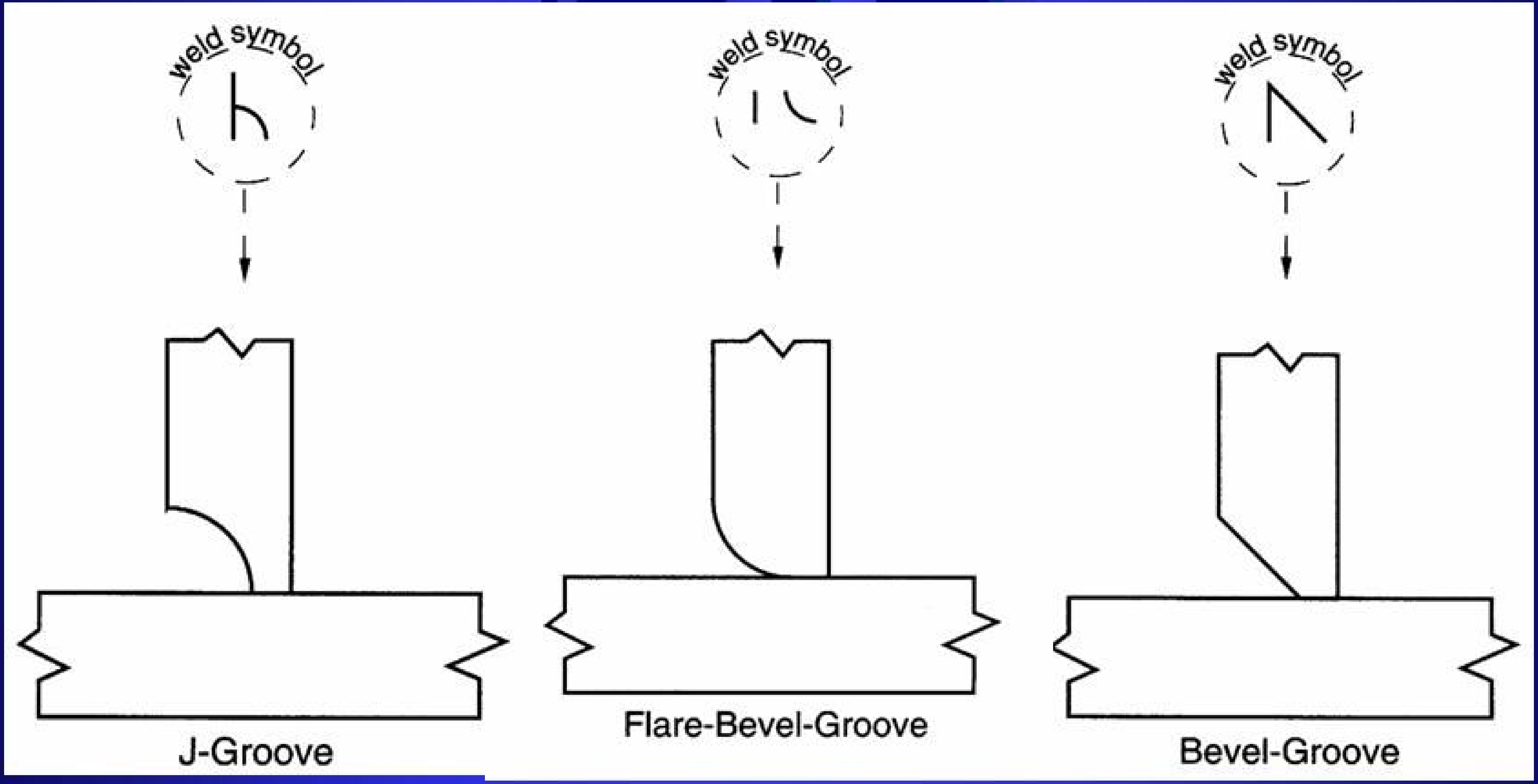


V-Groove

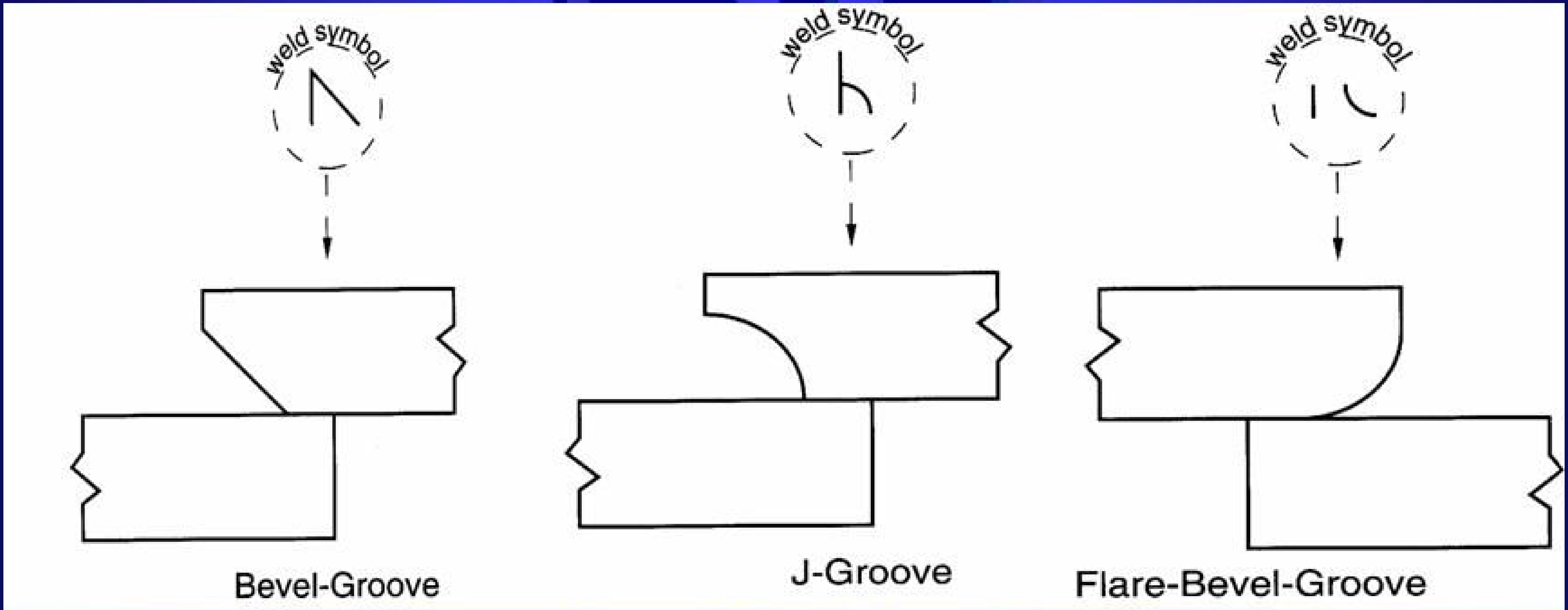


Bevel-Groove

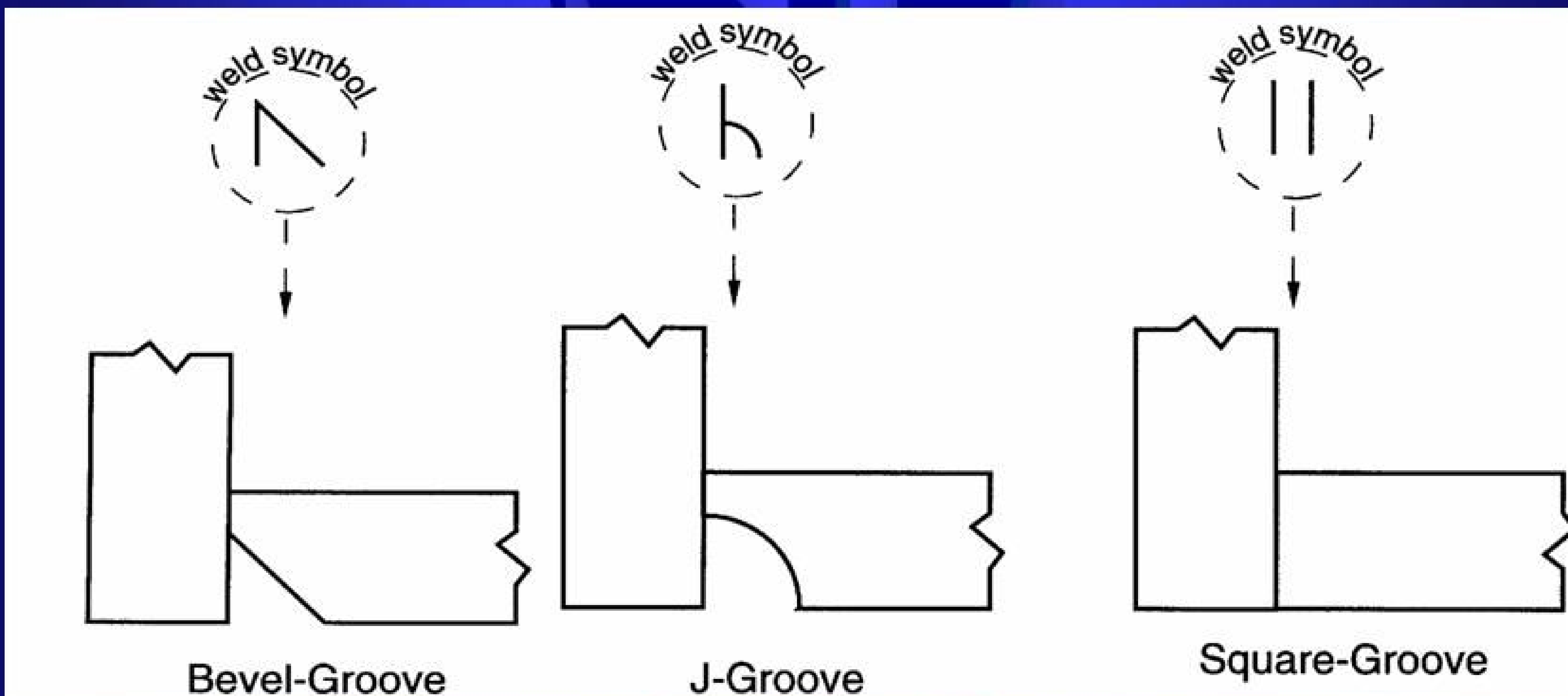
- Type of joints:
  - T joint



- Type of joints:
  - Lap joint

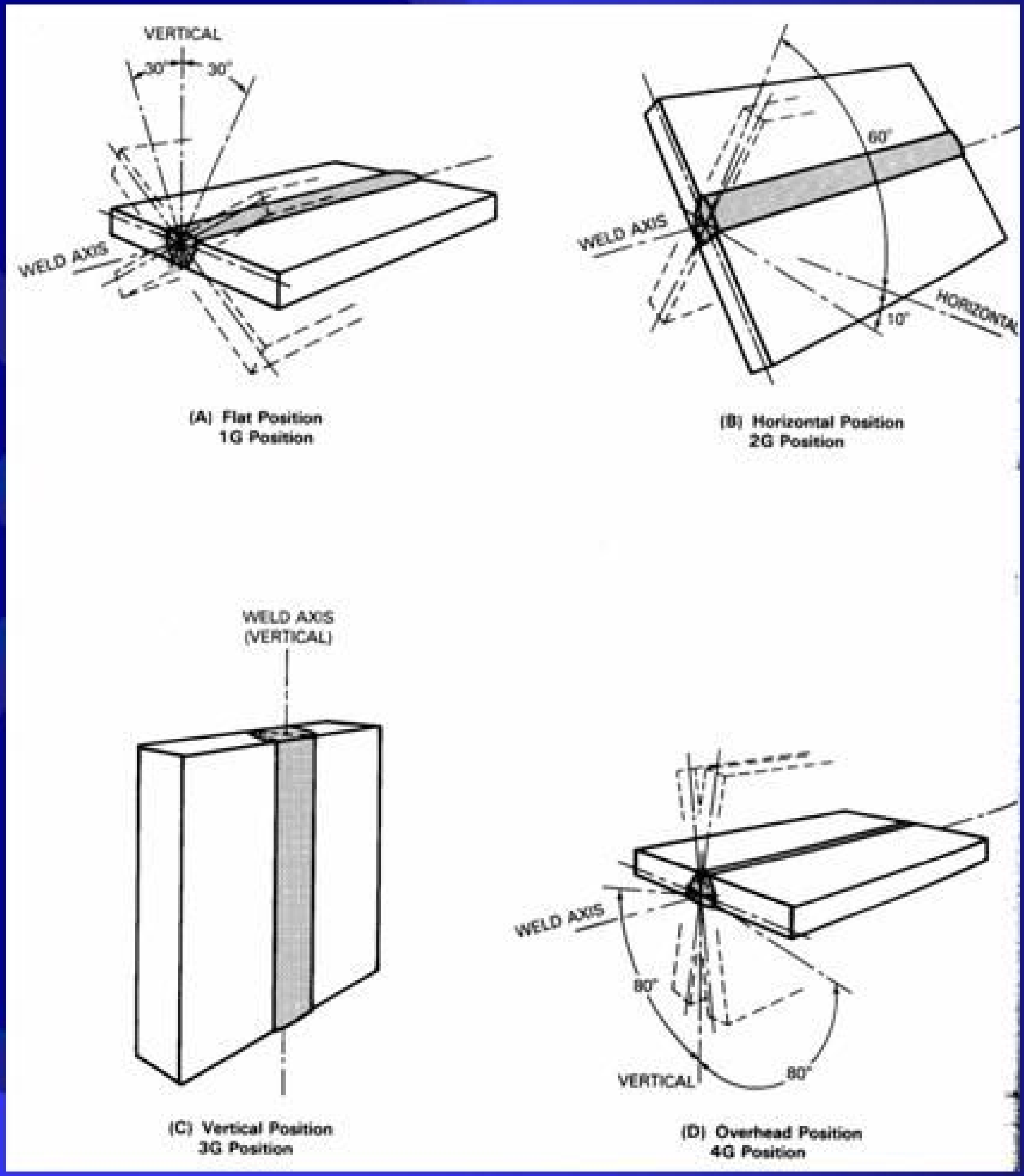


- Type of joints:
  - Corner joint



Pipe welding position

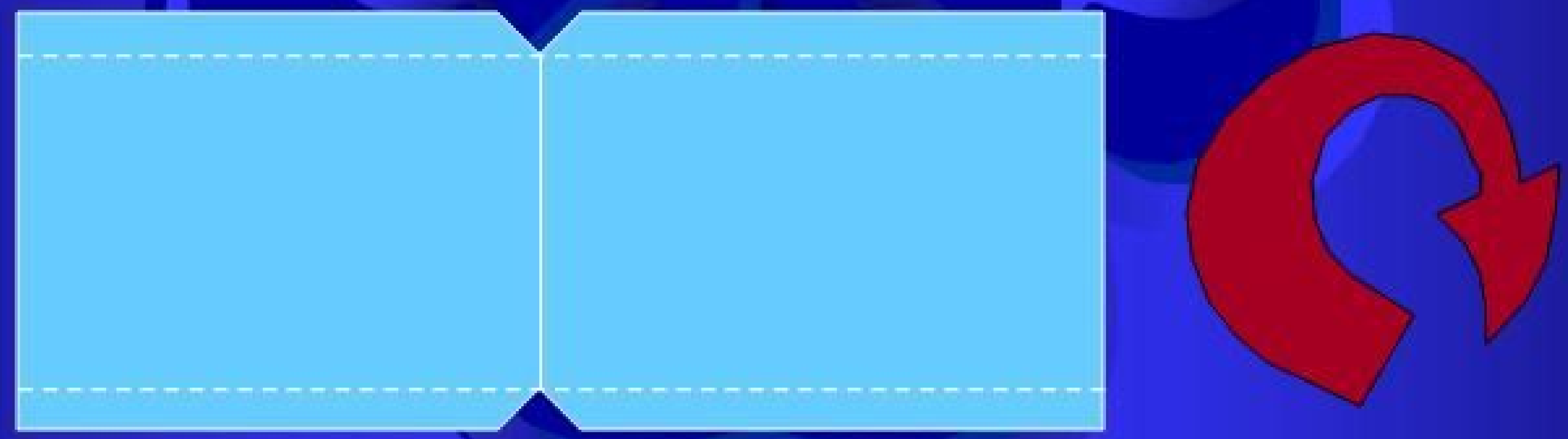
- **Position:**
  - Flat
  - Horizontal
  - Vertical
  - Overhead



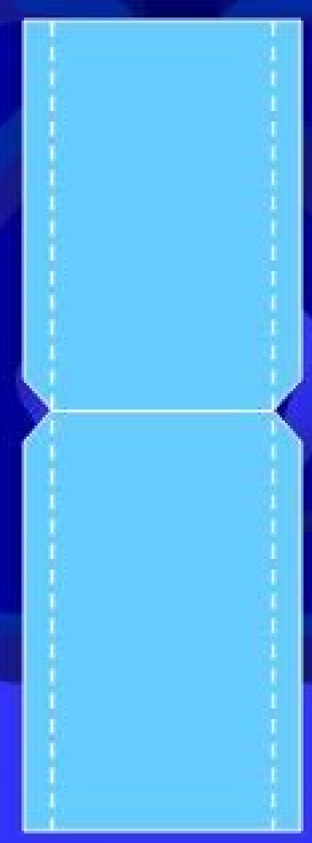
- Position according to standards:
  - 1G
  - 2G
  - 5G
  - 6G

  - 1F
  - 2F
  - 2FR
  - 4F
  - 5F

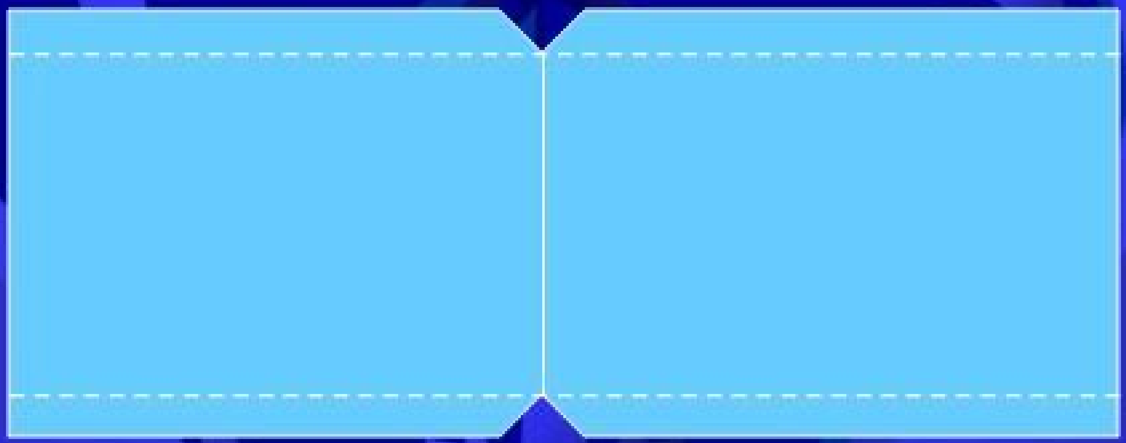
- **Position:**
  - 1G
    - Pipe rotated, Electrode is always at the top
    - Either a split bead or weave technique may be used



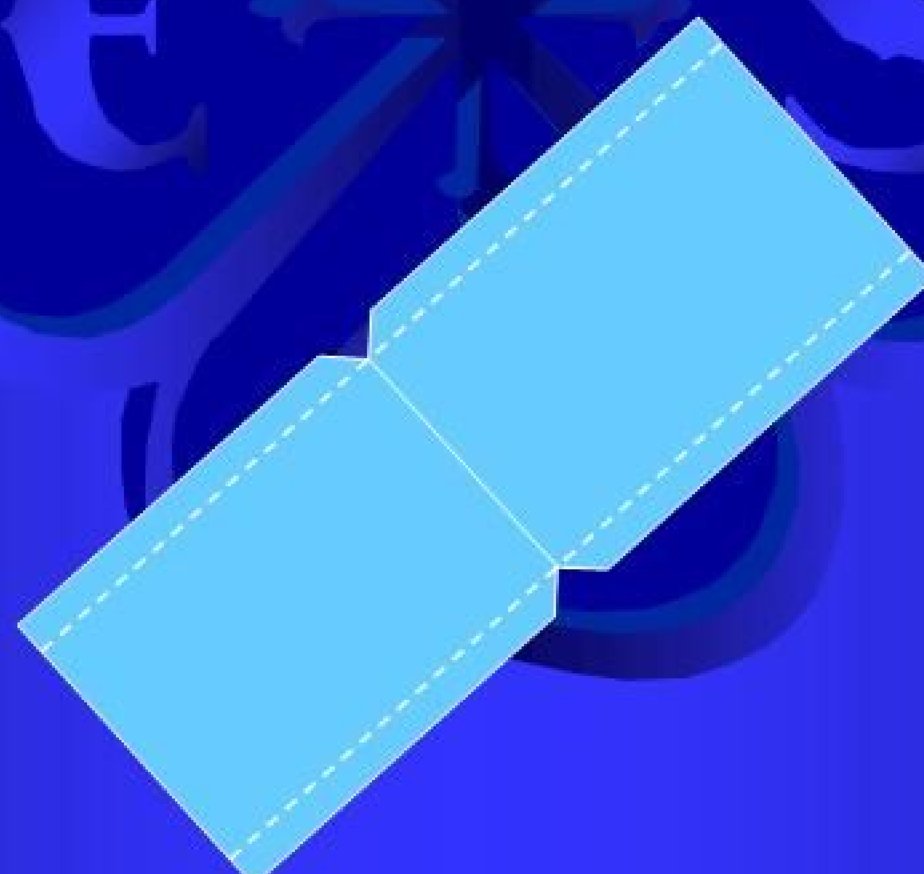
- **Position:**
  - 2G
    - Pipe Axis Vertical, Weld is Horizontal, Pipe is considered in a “fixed” position.
    - Always use a split bead technique
    - Always work from the bottom up.



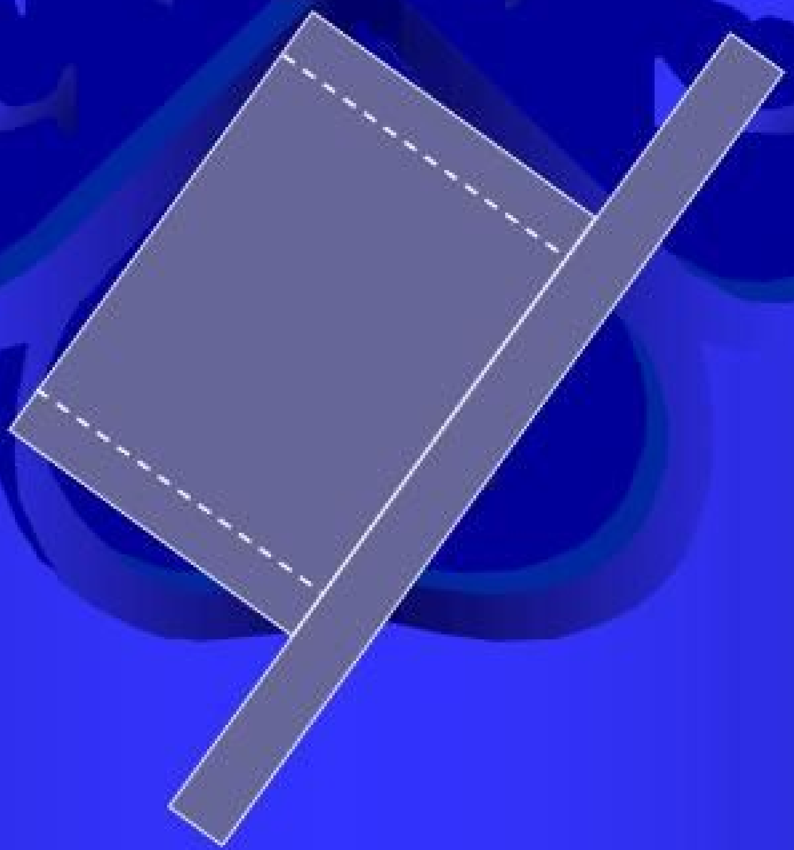
- **Position:**
  - 5G
  - Axis of the Pipe is Horizontal, The weld in vertical.
  - Progression may be up or down.
  - A weave bead is best used.



- **Position:**
  - 6G
    - Pipe axis is fixed in position at a 45 degree incline. The position includes flat, horizontal, vertical, and overhead welds.
    - A split bead technique is best used.

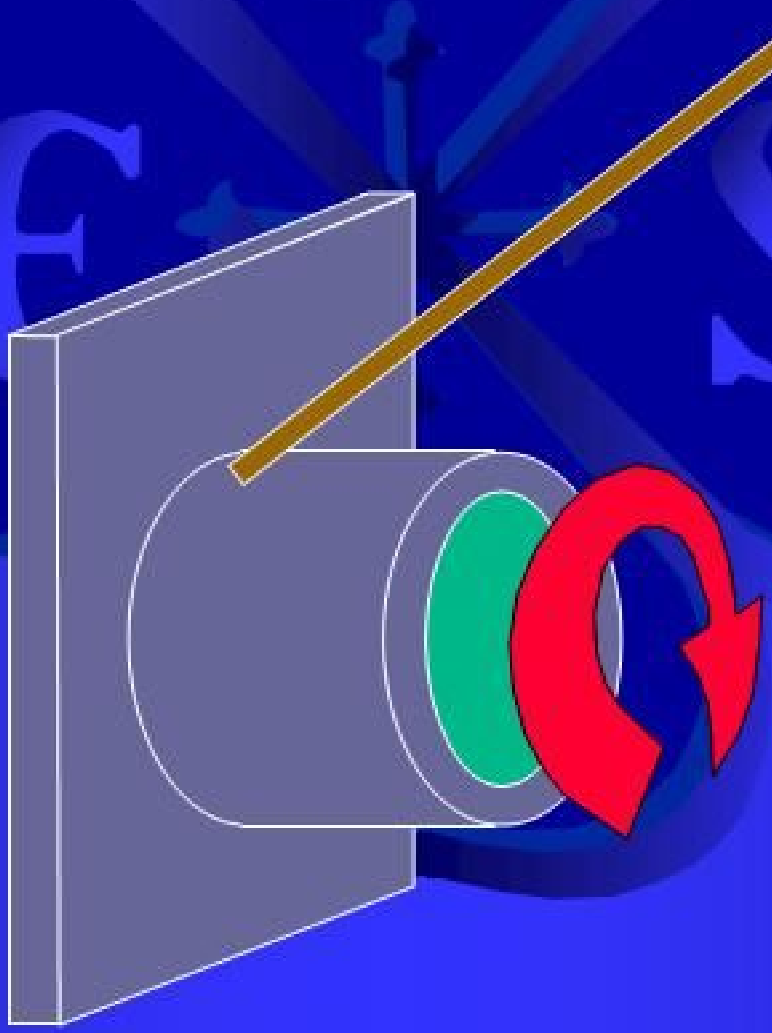


- **Position:**
  - 1F
    - Pipe is rotated. The pipe axis is at a 45 degree incline. Welding is to occur at the top of the pipe.
    - Split bead or weave technique may be used.

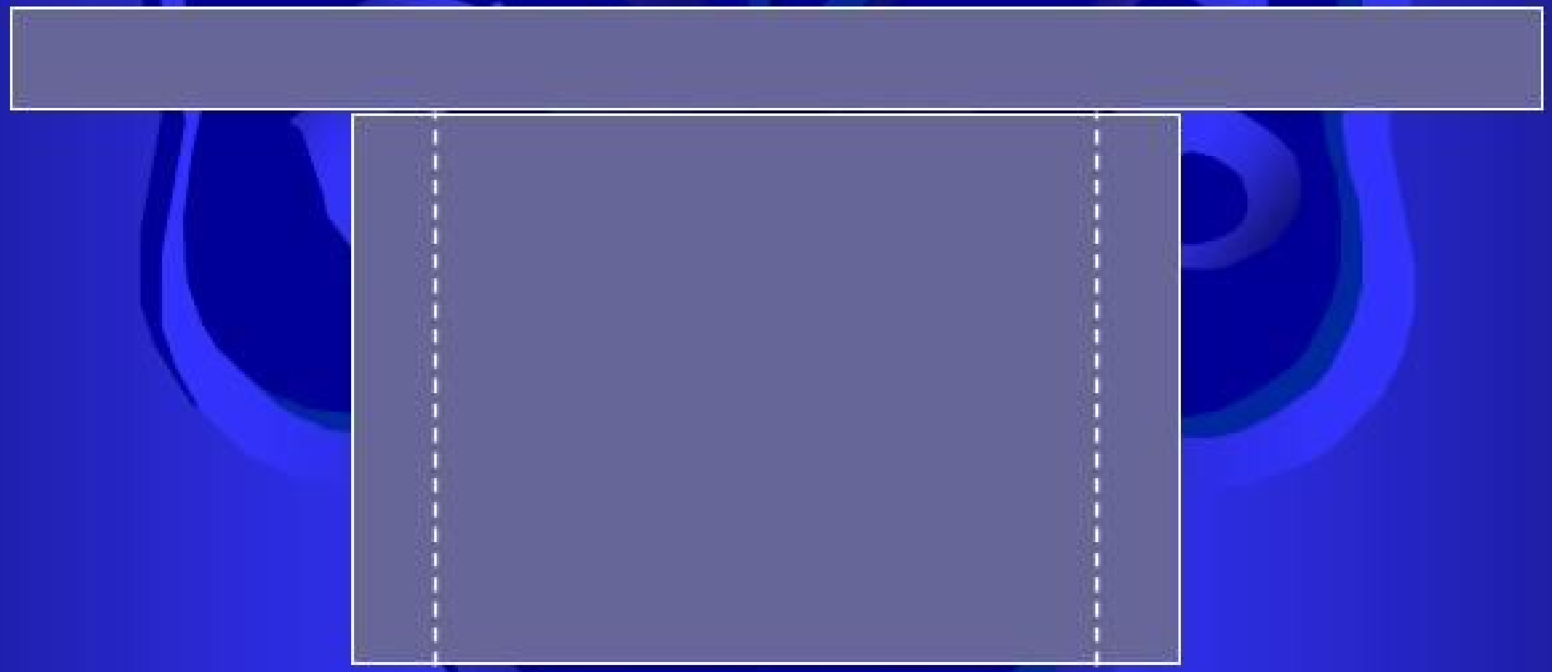


- **Position:**
  - 2F
    - Fixed Position
    - Best to use a split bead technique

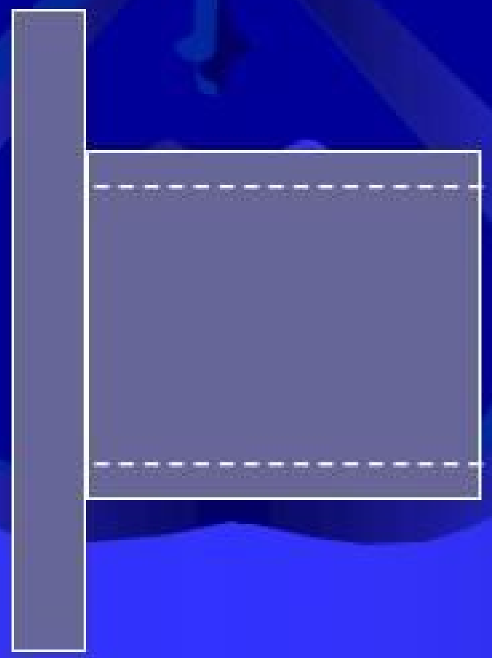
- **Position:**
  - 2FR
  - Rotated
  - A split bead technique is best used.



- **Position:**
  - 4F
  - A split bead technique is best used



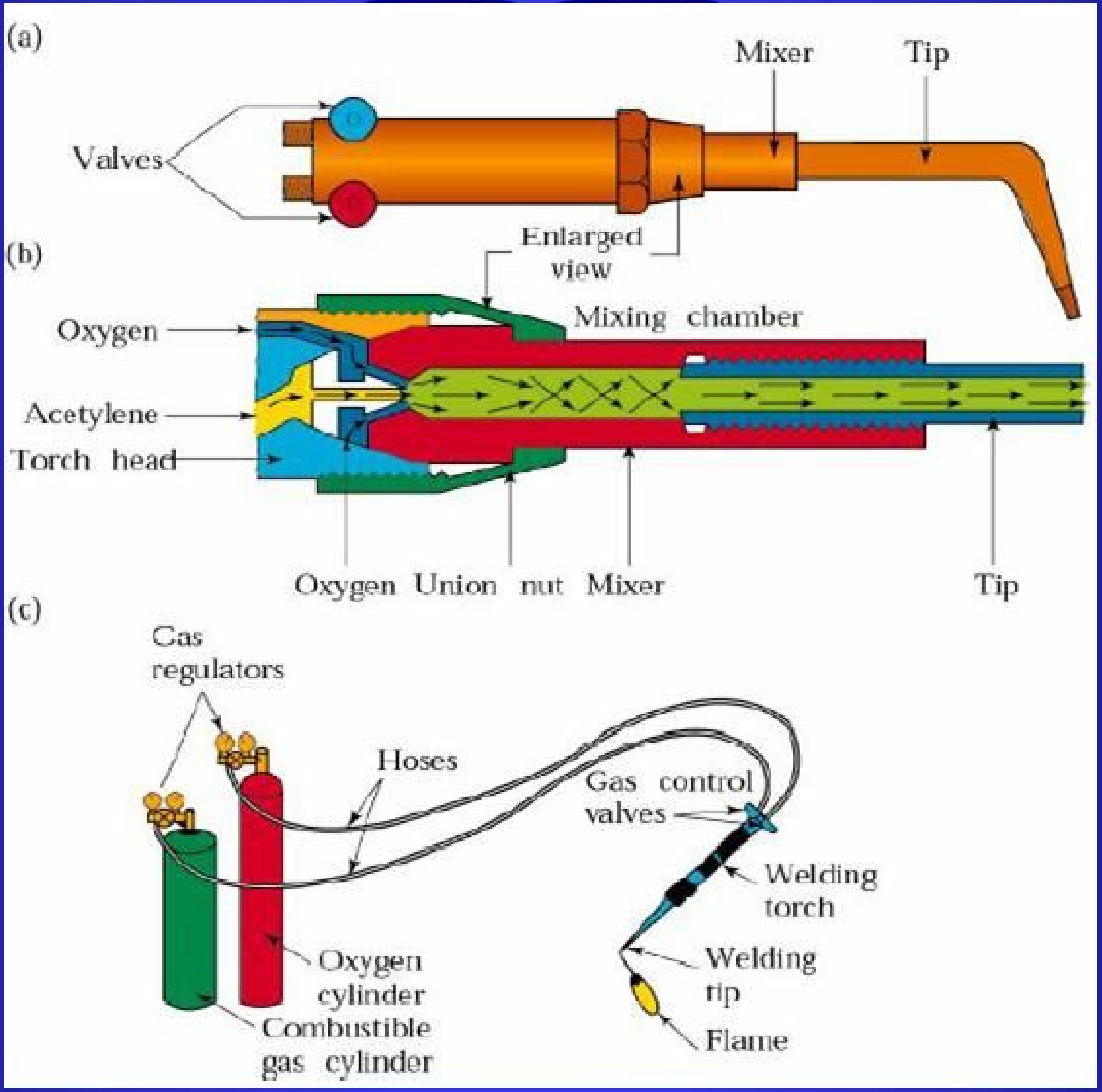
- **Position:**
  - 5F
    - Not Rotated. Progression may be up or down.
    - Split beads or weaves can be used on 5F-up welds, split beads are best used on 5F-down welds.



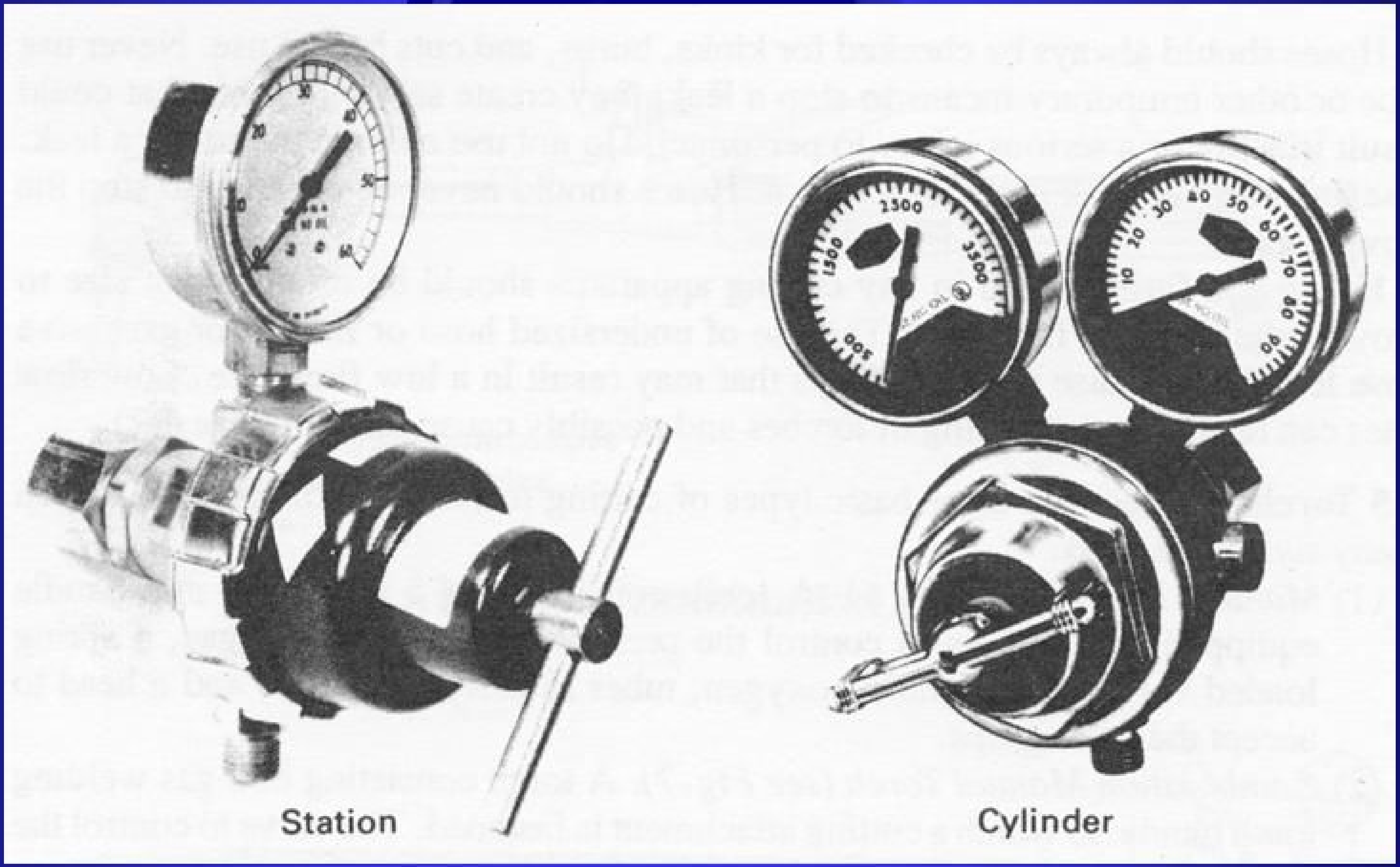
- Type of welding:
  - Oxy-fuel gas welding
  - Arc welding
    - SMAW
    - GTAW

Oxy-fuel gas welding

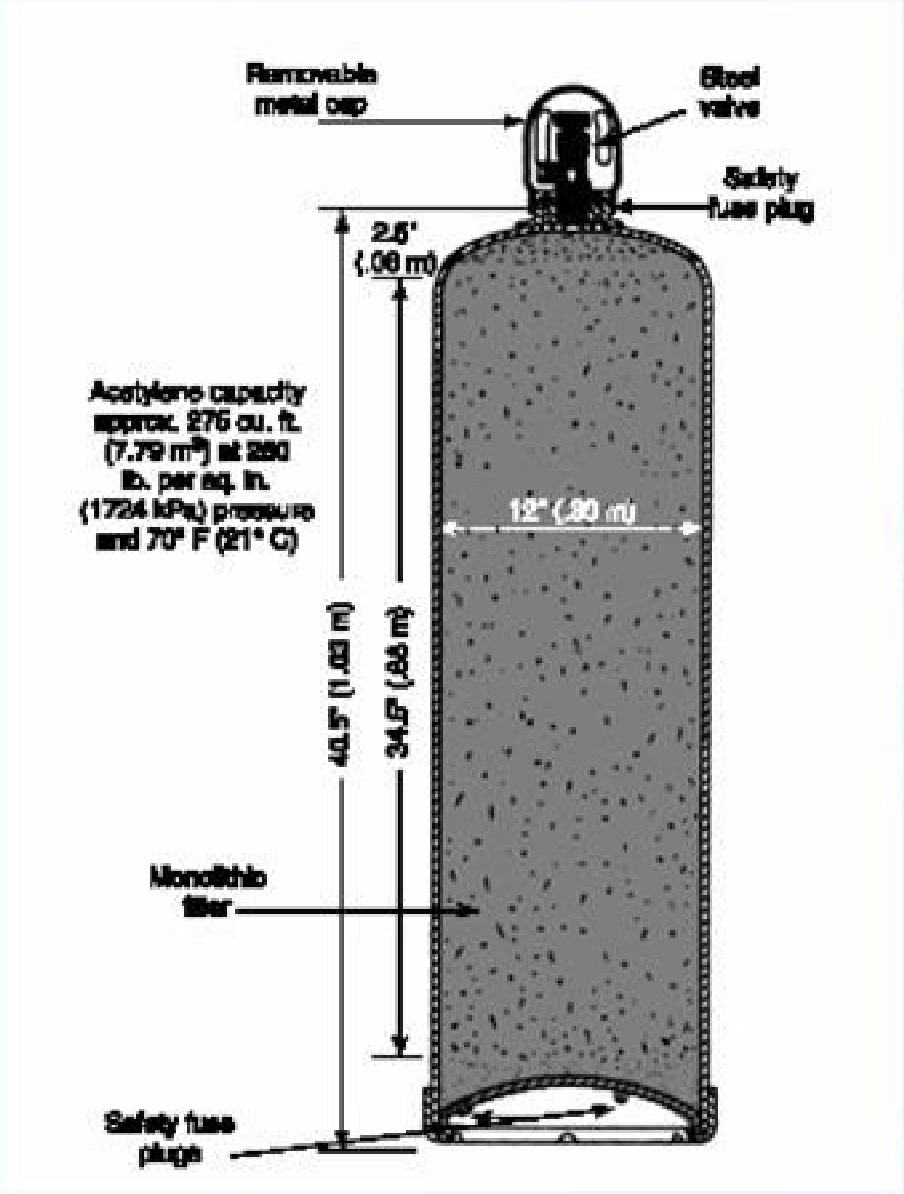
Basic Oxy-fuel Gas Welding Equipment



Pressure Regulators

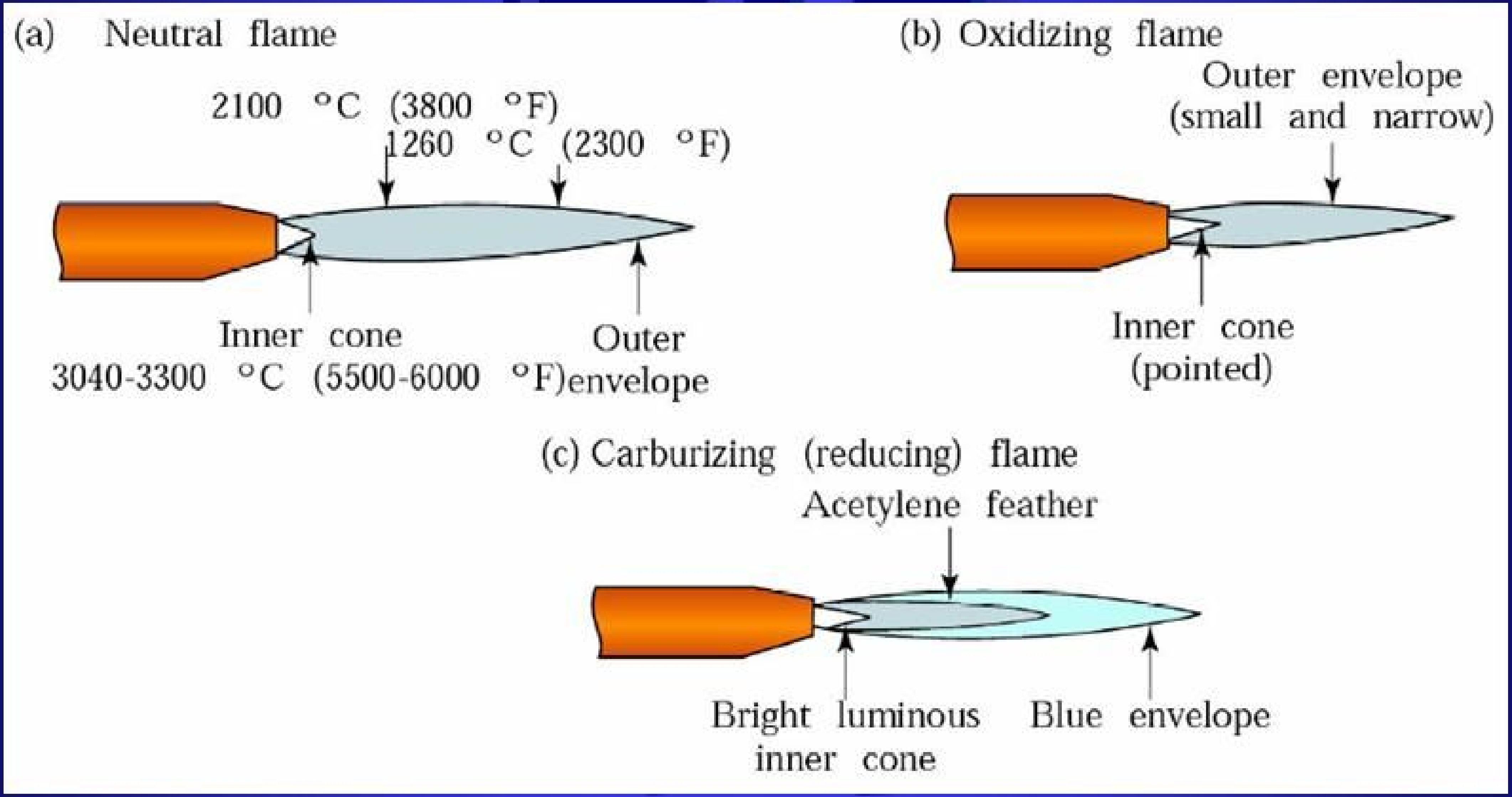


Acetylene and oxygen cylinder



244ft³ (6909L) Capacity Oxygen Cylinder

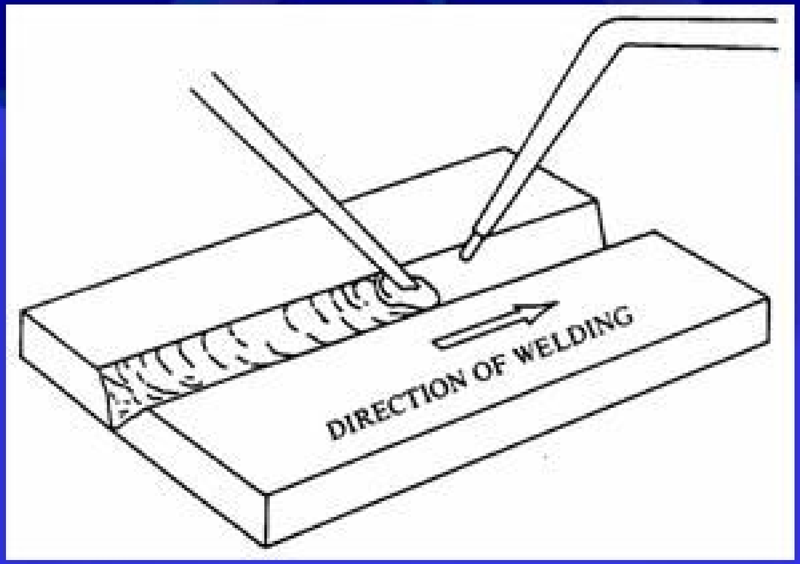
Carburizing, Neutral, and Oxidizing Flames



Applications of Oxy-fuel Gas Welding

- Recommended for material up to 3.2mm (1/8in) Most steels, rolled, wrought or cast

- Root opening
  - Up to 4.8mm (3/16in) square butt O.K.
  - Up to 6.8mm (1/4in) root opening and filler
  - Above 6.8mm parts must be beveled



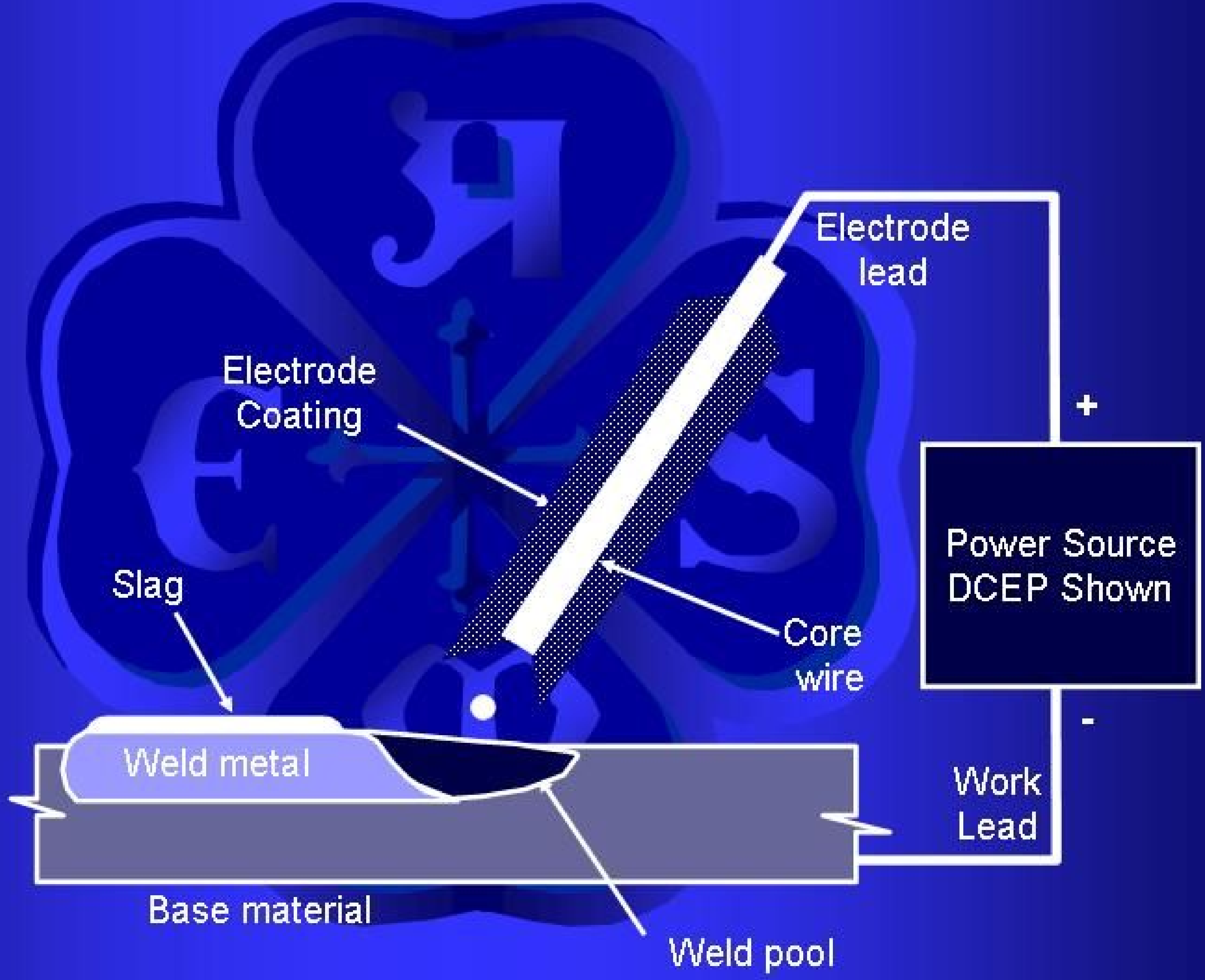
Applications of Oxy-fuel Gas Welding

- Most steels, rolled, wrought or cast
- Aluminum and copper
- No reactive metals
  - titanium, zirconium, hafnium
- No refractory metals
  - tungsten, molybdenum, tantalum, niobium

- Advantages of Oxy-fuel Gas Welding
  - Very portable
  - Low cost
  - Gentle flame
- Disadvantages of Oxy-fuel Gas Weld.
  - Poor air protection
  - Low heat input
  - Safety issues

Shielded Metal-Arc Welding (MMAW, SMAW, Stick welding)

SMAW process:



electrode


CIGWELD
FERROCRAFT 18-1MR
KEEP DRY
CIGWELD
FERROCRAFT 18-NI MR
KEEP DRY

Electrode numbering:

Impact properties (n)
0 = 47J at 0°C
2 = 47J at -20°C
3 = 47J at -30°C
4 = 47J at -40°C

Hydrogen level (H_mR)
H_5 = 5 ml / 100g of WM
R = low moisture

$$E\ \underline{xx}\ \underline{y}\ \underline{z} - n\ \underline{H_m R}$$

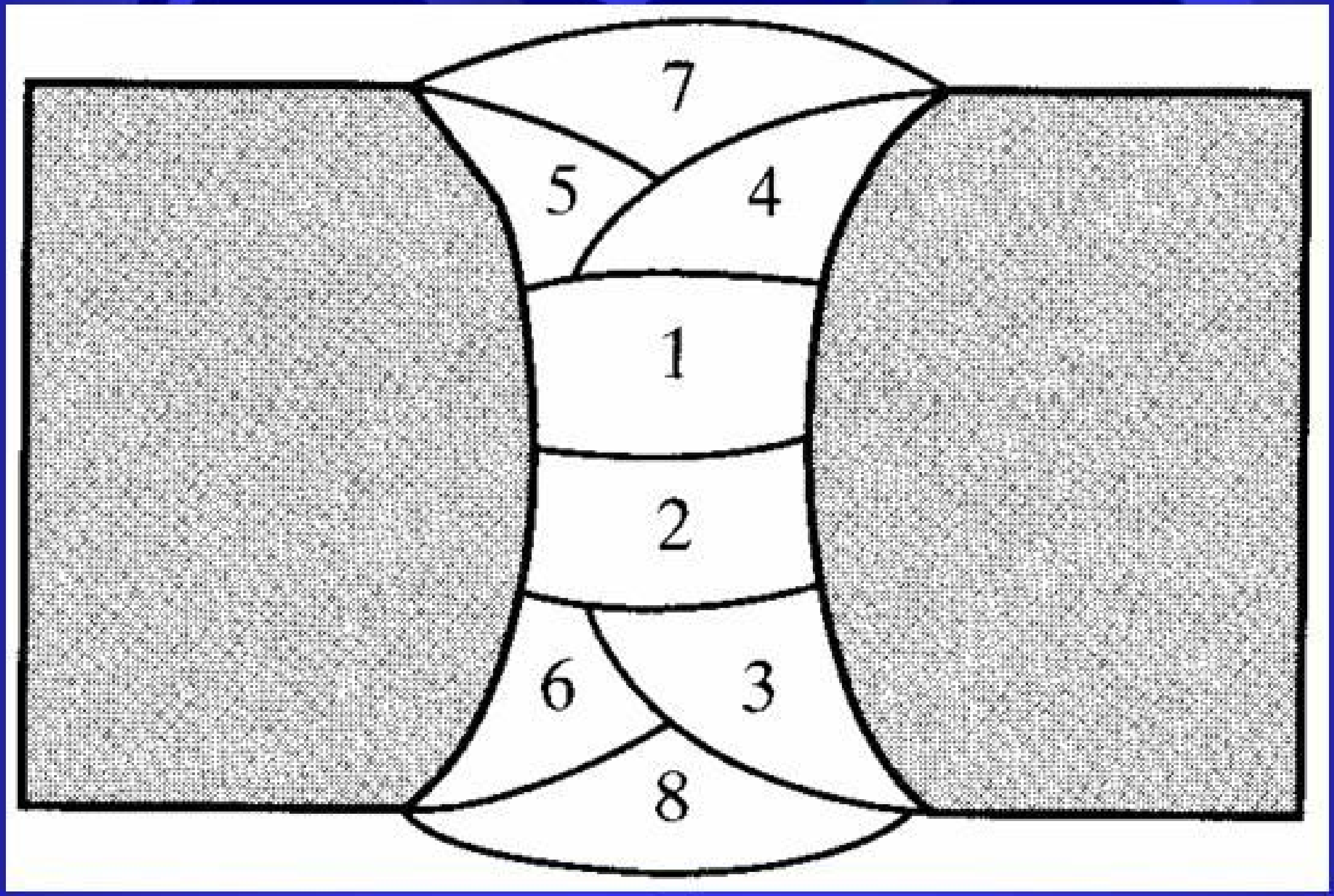
Tensile strength
41 = 410 MPa min
48 = 480 MPa min

positions (y)
1=all positions
2=flat + horizontal
4=vertical down

Flux type (z)
0, 1 = cellulosic
2, 3, 4 = rutile
5, 6, 8 = low hydrogen
7 = iron powder + iron oxide

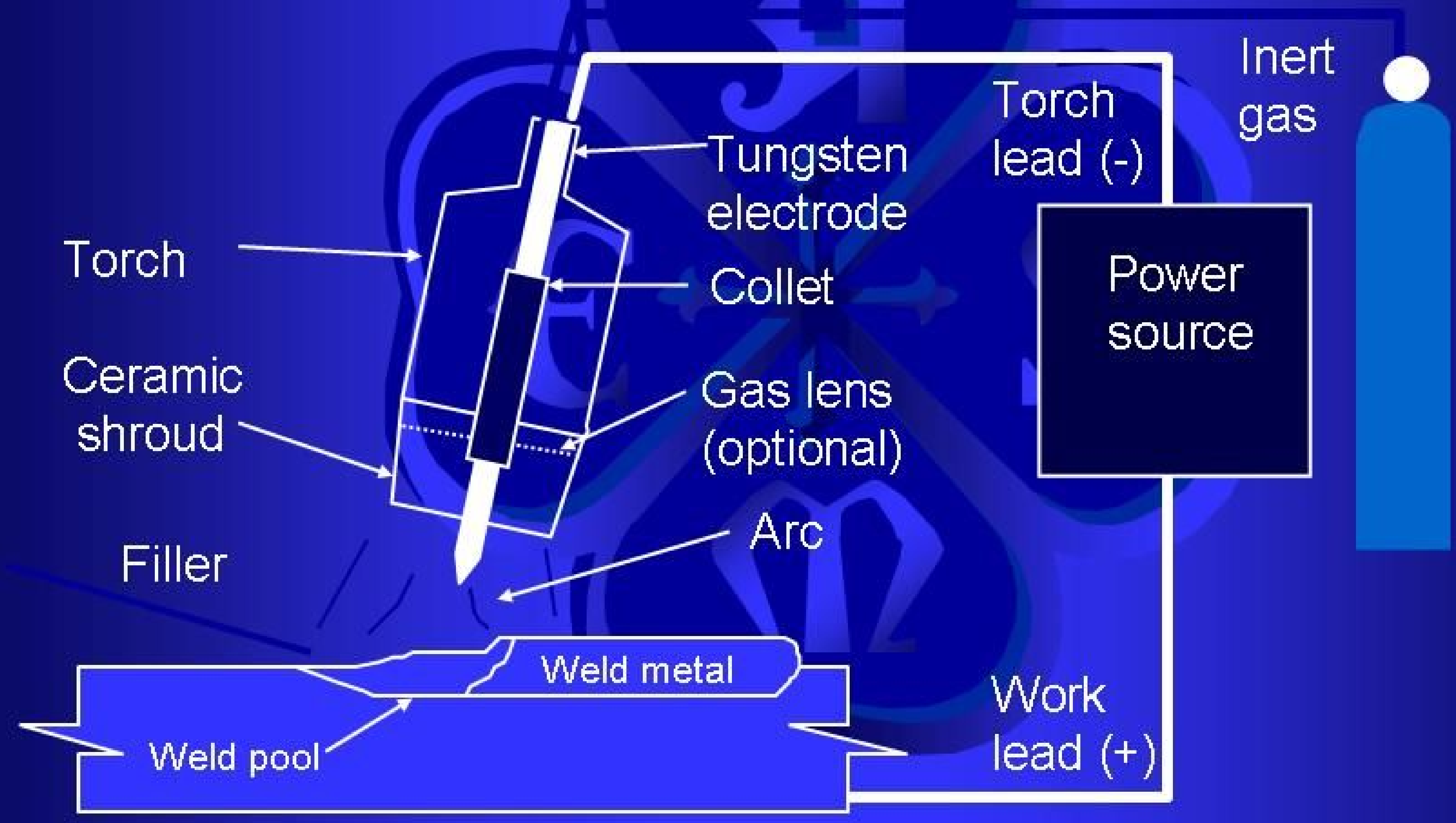
- Advantages
  - Equipment simple, inexpensive, and portable
  - Process can be used in any position
  - Shop repairs, pipelines, building construction
- Disadvantages
  - Limited deposition rate relative to other welding processes due to stubs and slag
  - Weld not well protected form the atmosphere
  - Welds have more inclusions than welds made with other processes

- SMAW usually restricted to metals between 3 to 19mm (1/8 to 3/4 in) thick.
- Typical pass 3mm (1/8 in) thick.



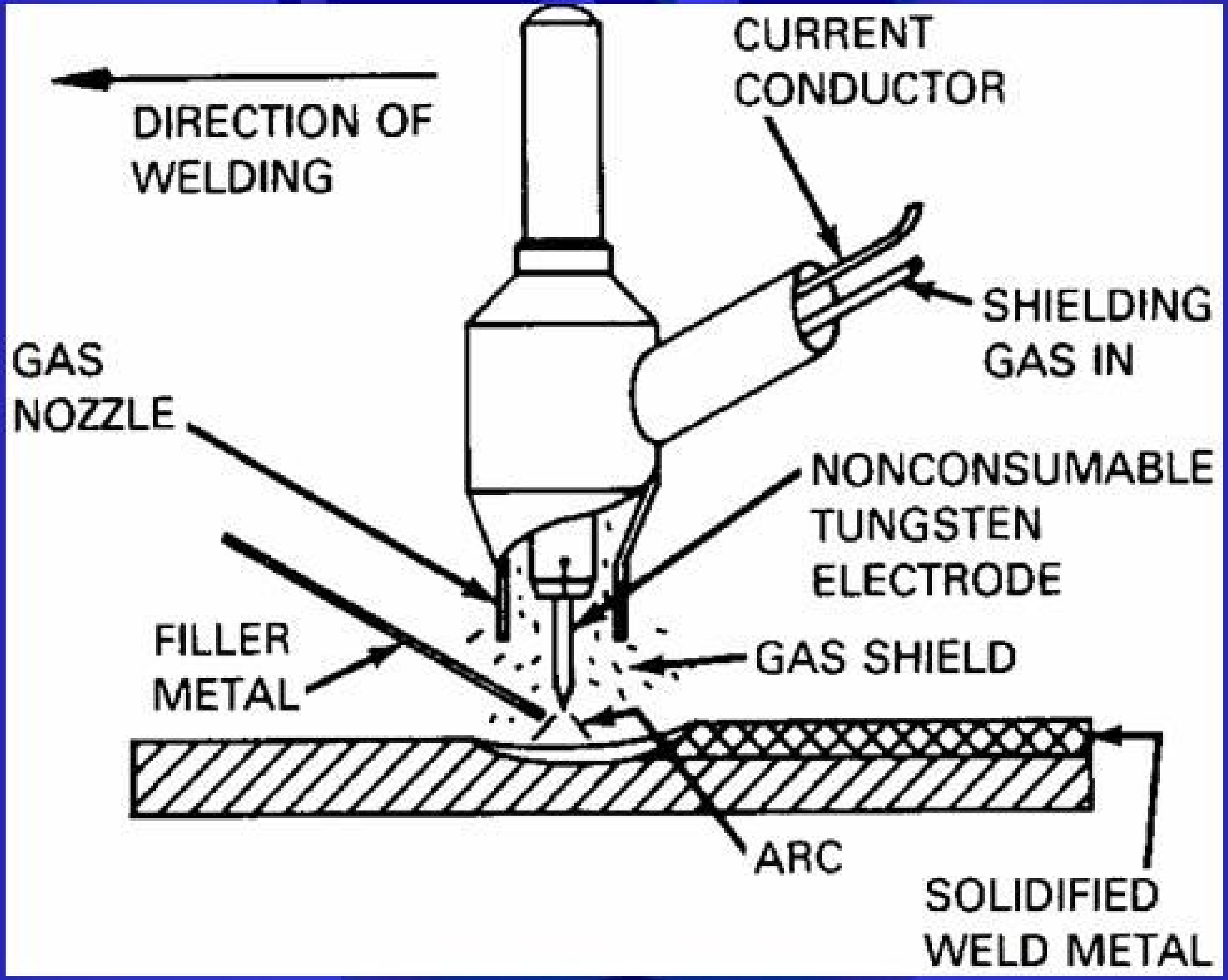
Gas Tungsten Arc Welding

GTAW process:



- SMAW process:

Gas Tungsten Arc Welding



- Shielding gases:
  - Pure argon, Argon-helium, Argon-2% hydrogen
  - Torch gas must not contain oxygen or CO_2
- Backing (or purge) gas
  - Used for all single-sided welds except in carbon steel
- Supplementary shielding
  - Reactive metals: Ti, etc

TIG Process features :

- can also be used to weld dissimilar metals (but not very well)
- Slower and more costly than consumable welding
- Independently added filler
- Used for root, pass runs in pipe or thin sheet
- High quality, Clean process, no slag
- Low oxygen and nitrogen weld metal
- Defect free, excellent profile even for single sided welds

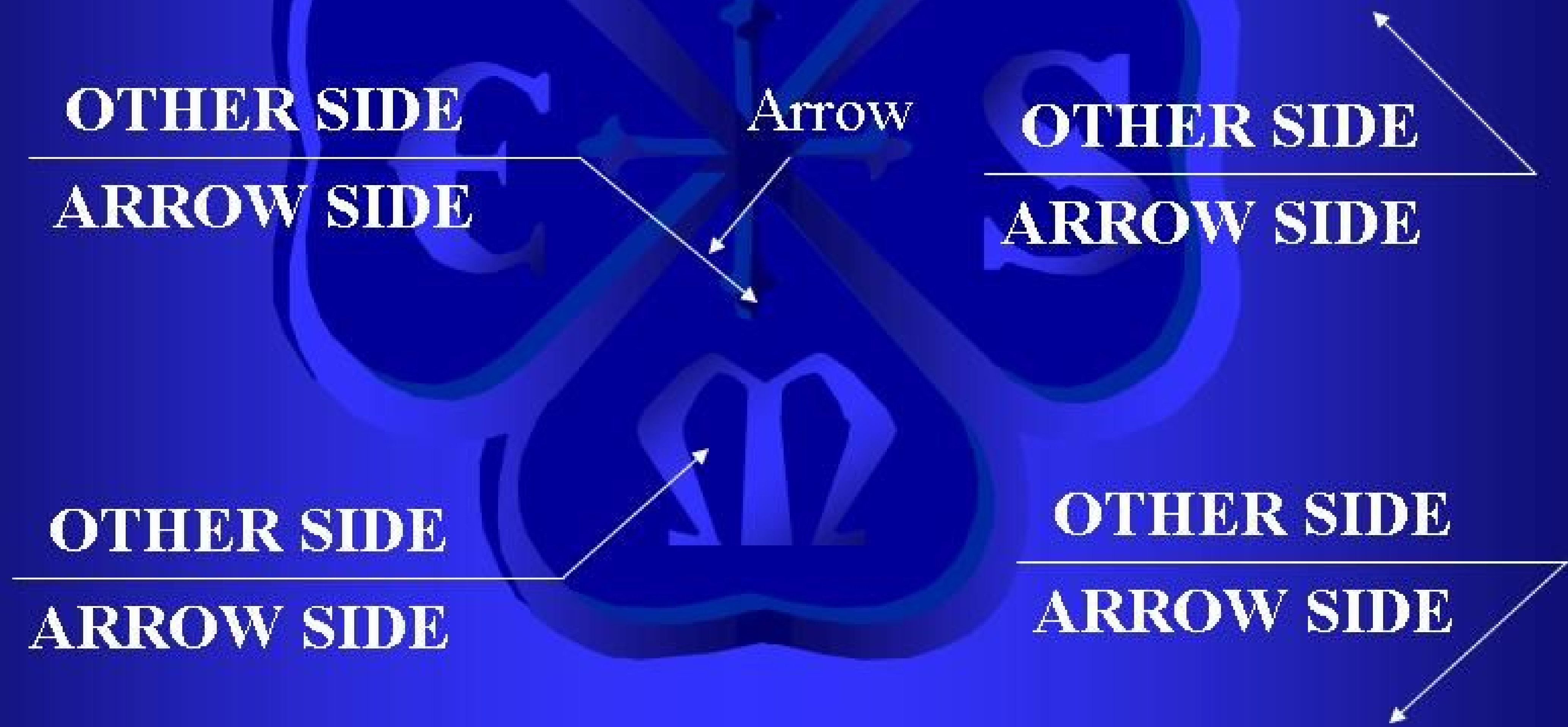
Welding Symbols

Welding symbols:

- The welding symbols devised by the AWS has 8 elements
  - Reference line
  - Arrow
  - Basic weld symbols
  - Dimensions and other data
  - Supplementary symbols
  - Finish symbols
  - Tail
  - Specification or others reference

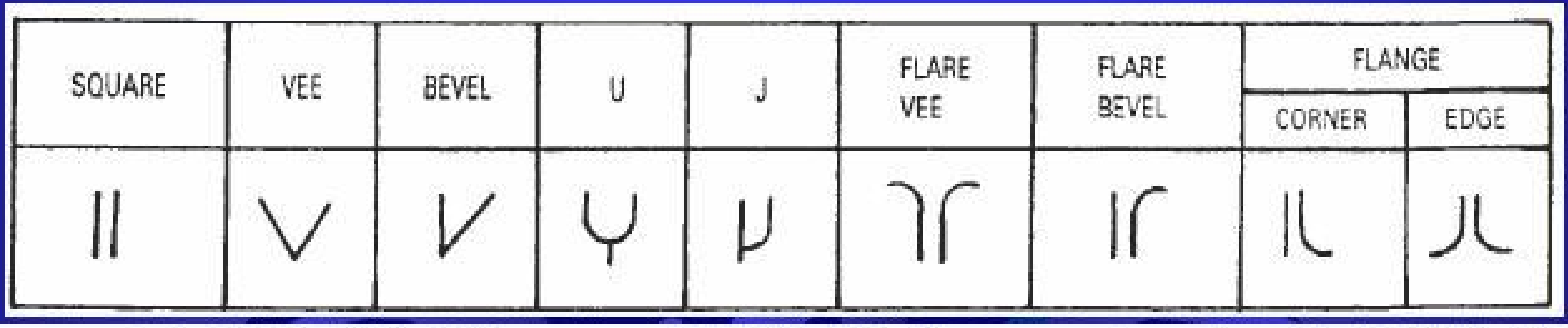
Welding symbols:

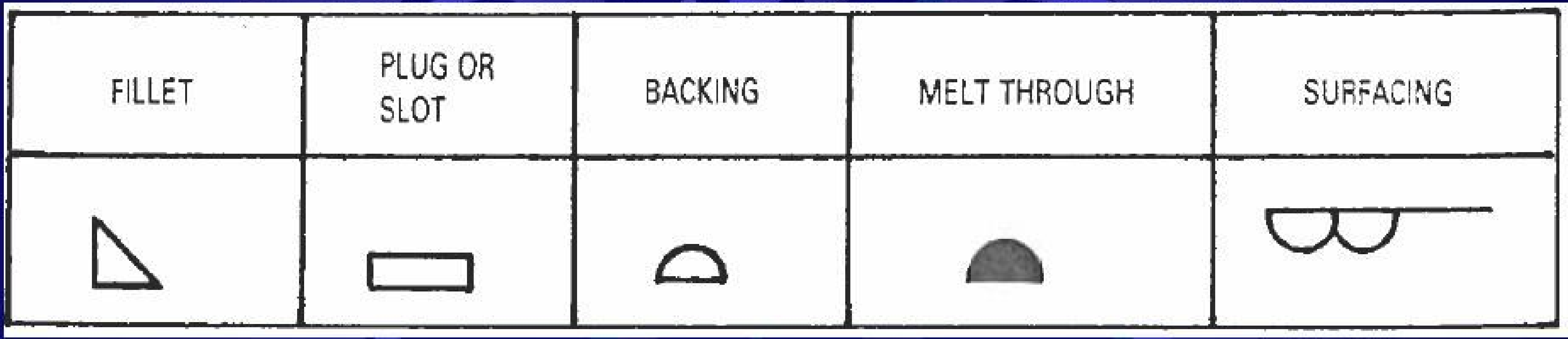
- Reference line and arrow pointing to the joint
- *the reference line has two sides:*
  - *Other side, above the line*
  - *Arrow side, below the side*

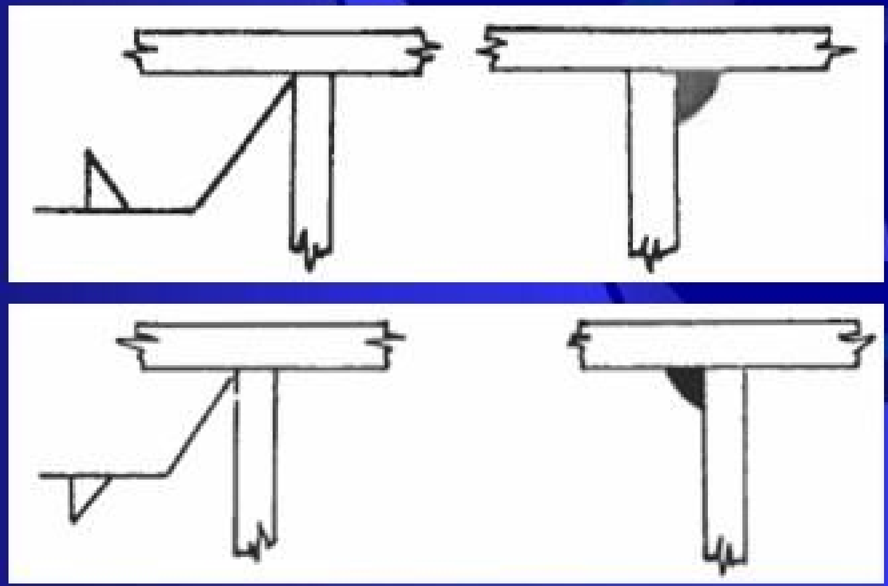


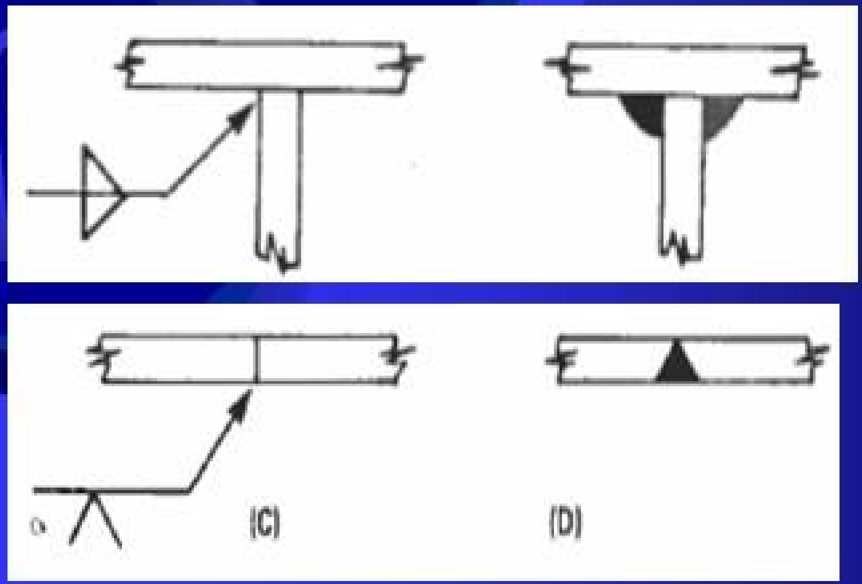
Welding symbols:

- Basic welding symbols

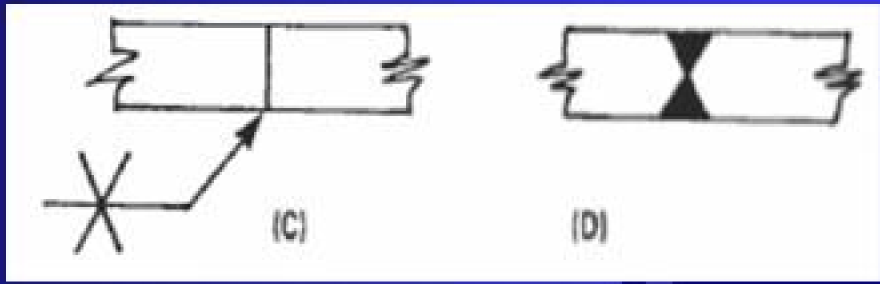


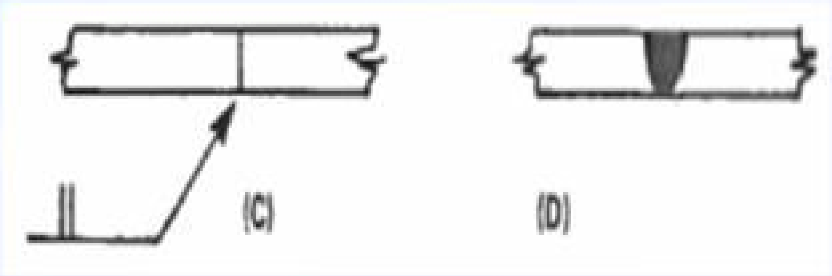


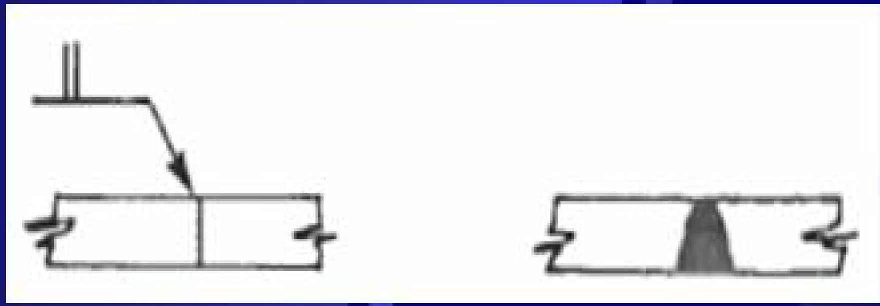




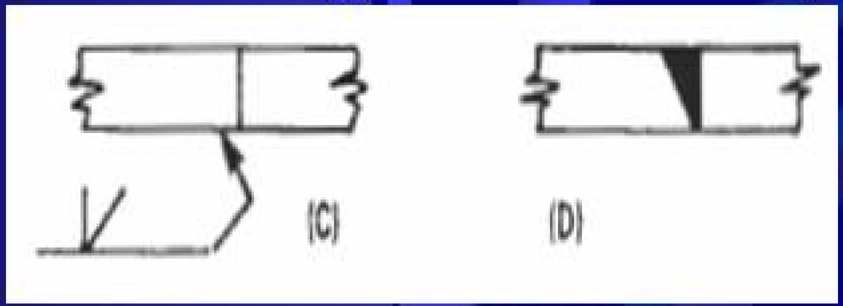
Welding symbols:

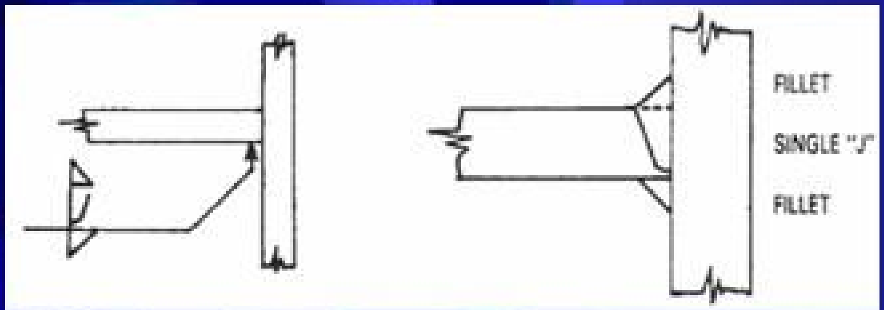






- *If a bevel groove is required the use broken arrow*





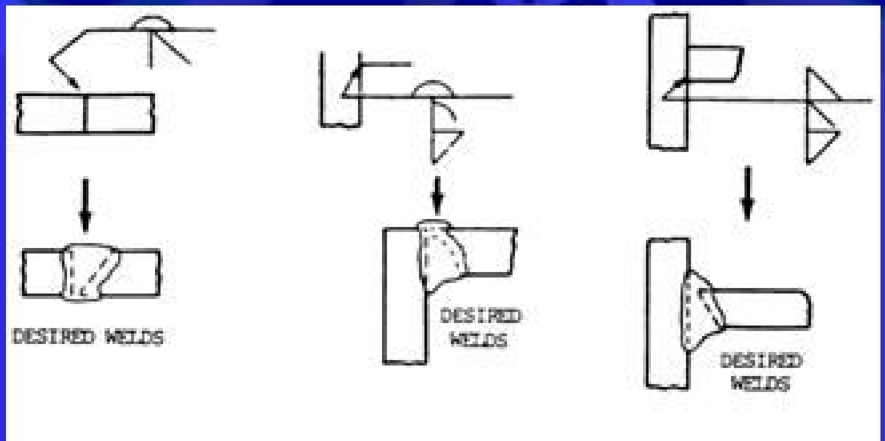
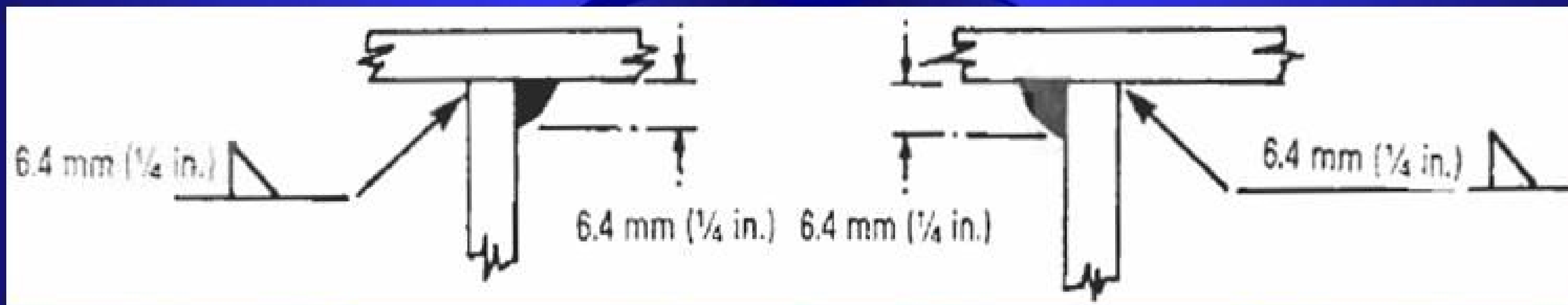
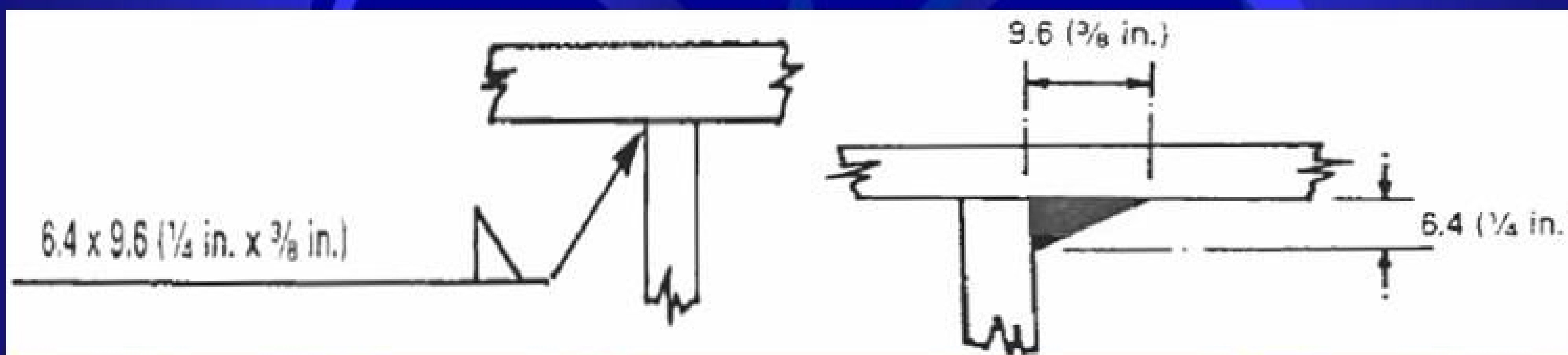
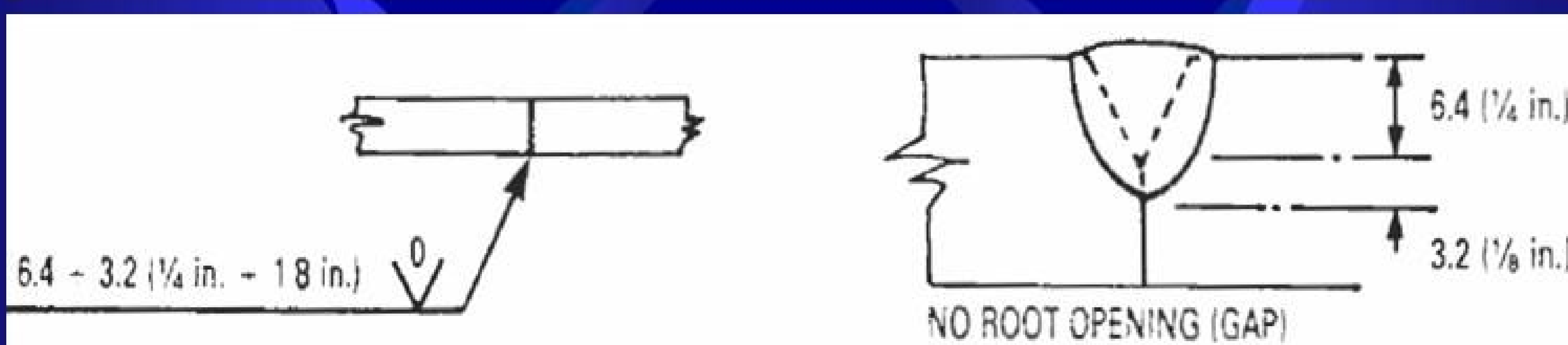


Figure 3-21. Combinations of weld symbols.

Dimensions and other data

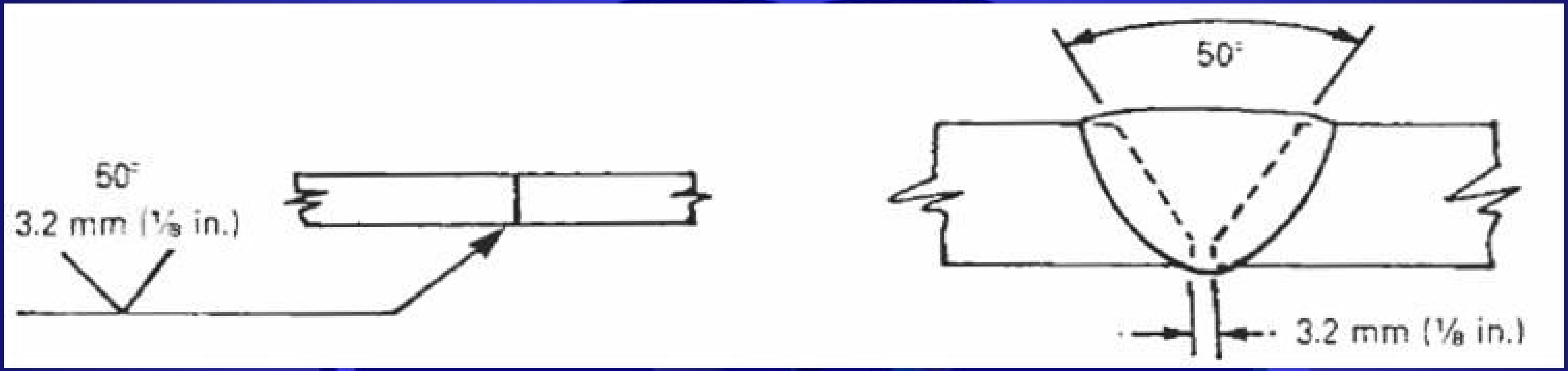


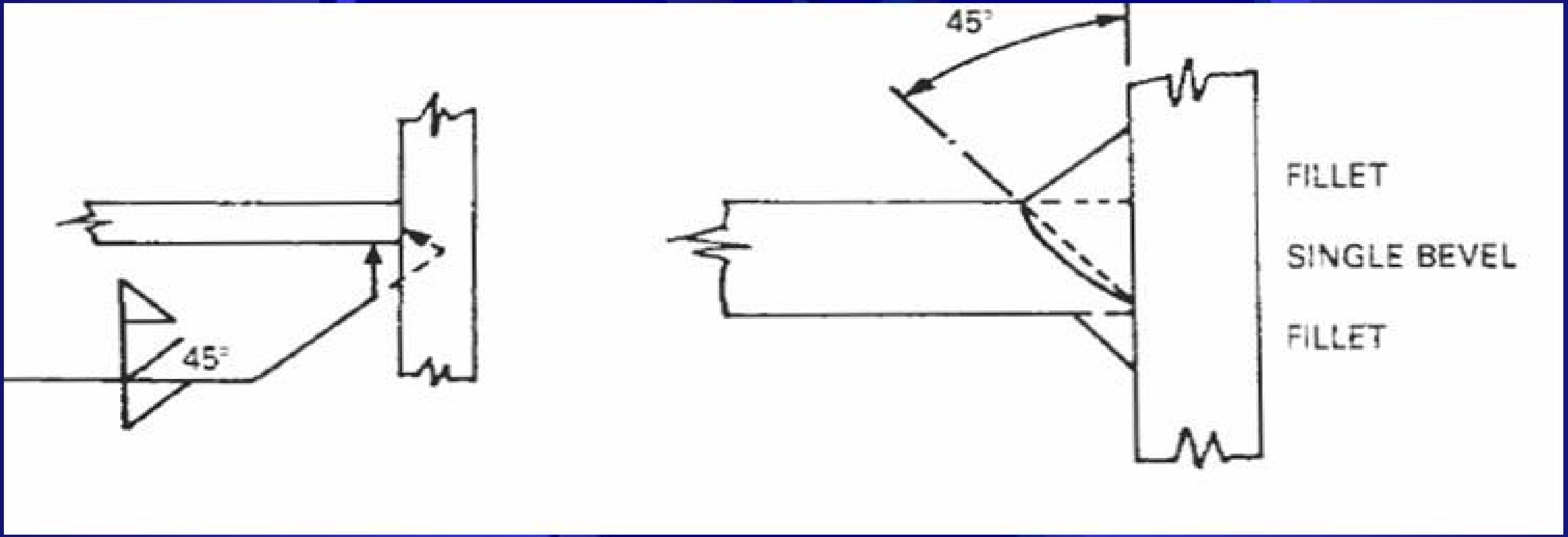




Welding symbols:

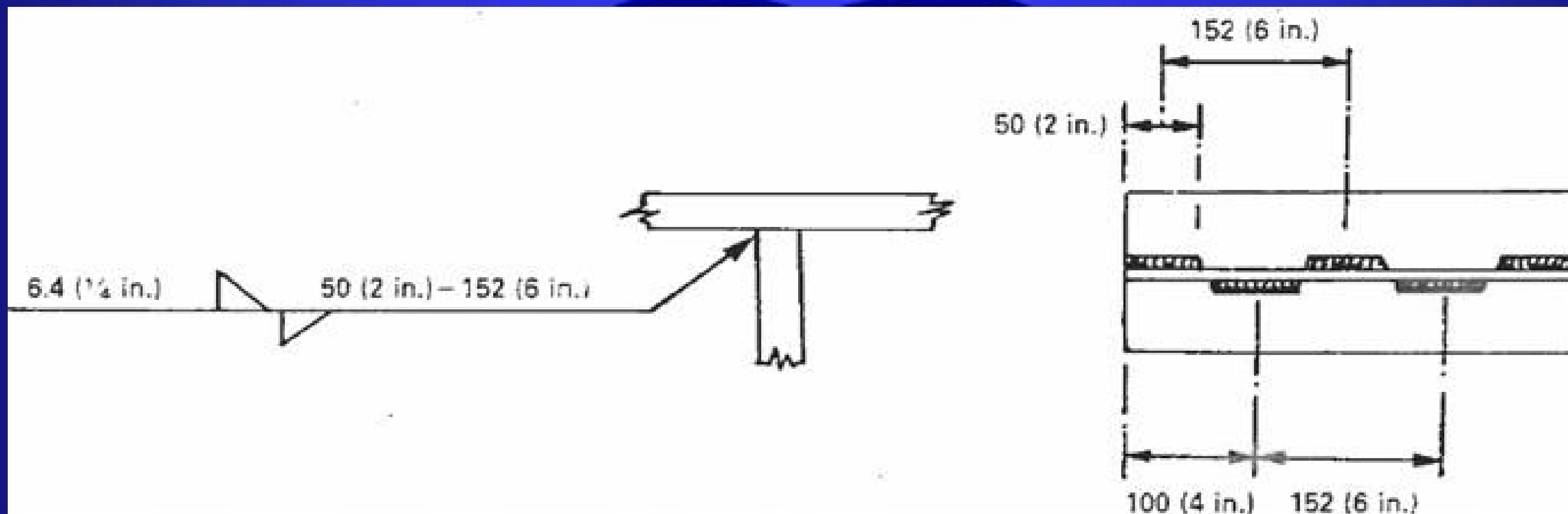
- Dimensions and other data

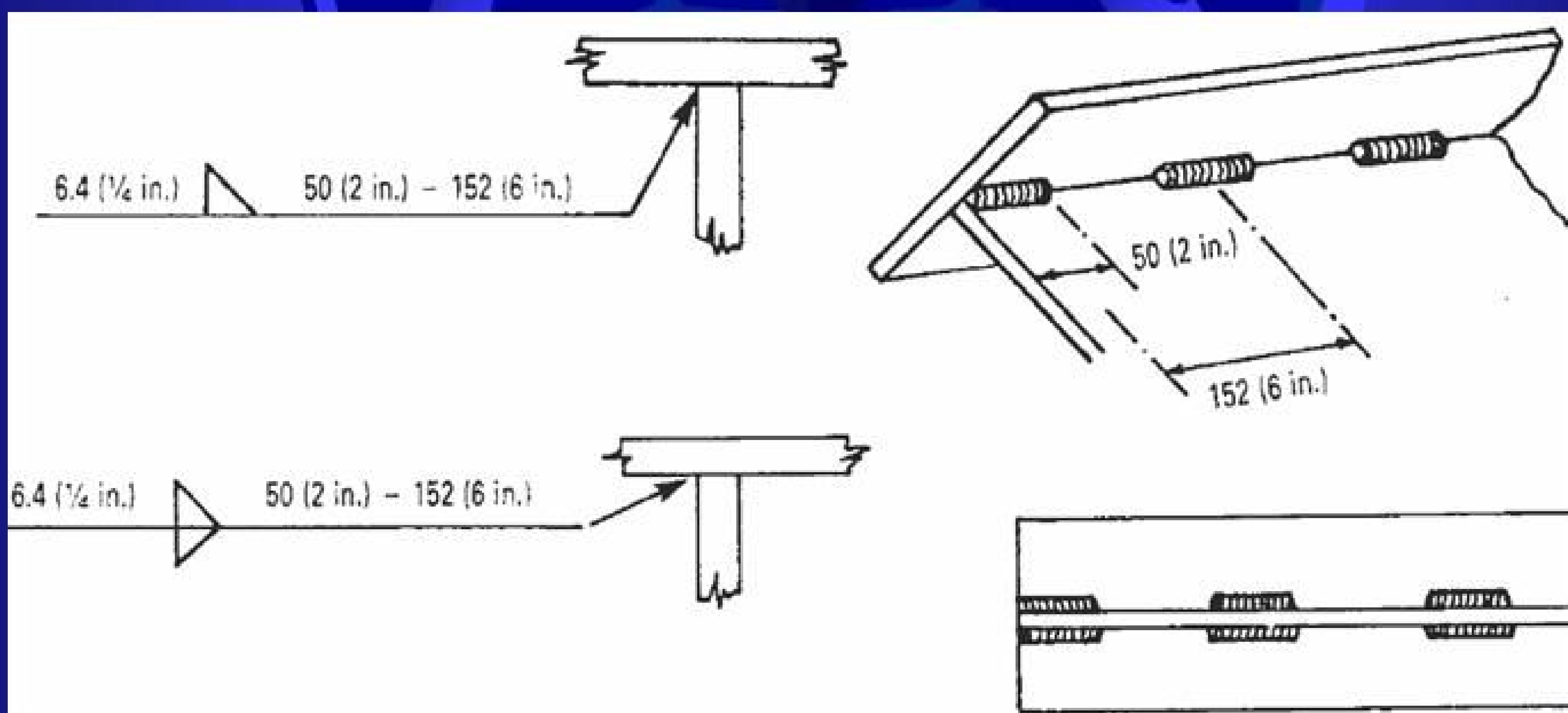




Welding symbols:

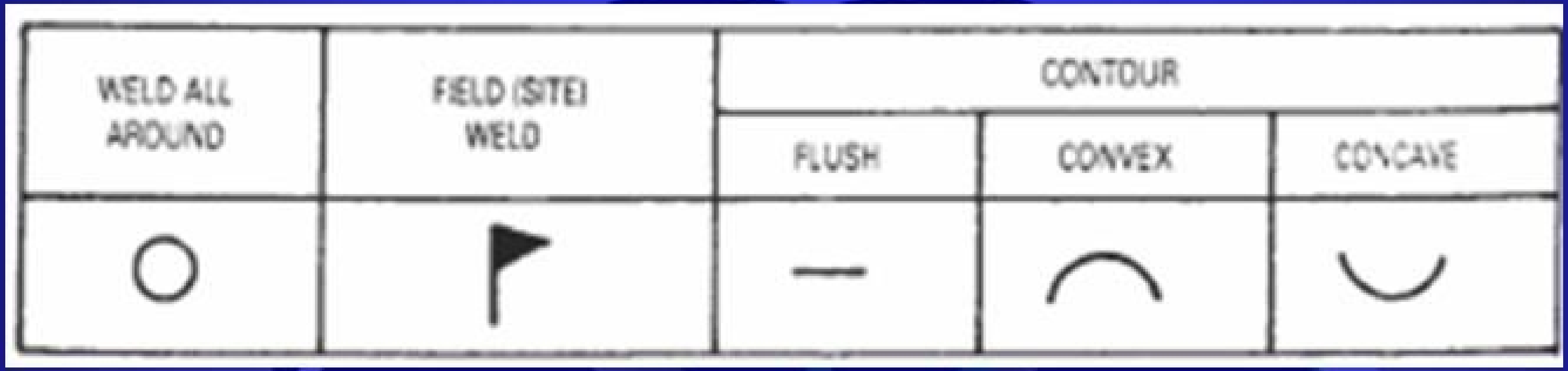
- Dimensions and other data

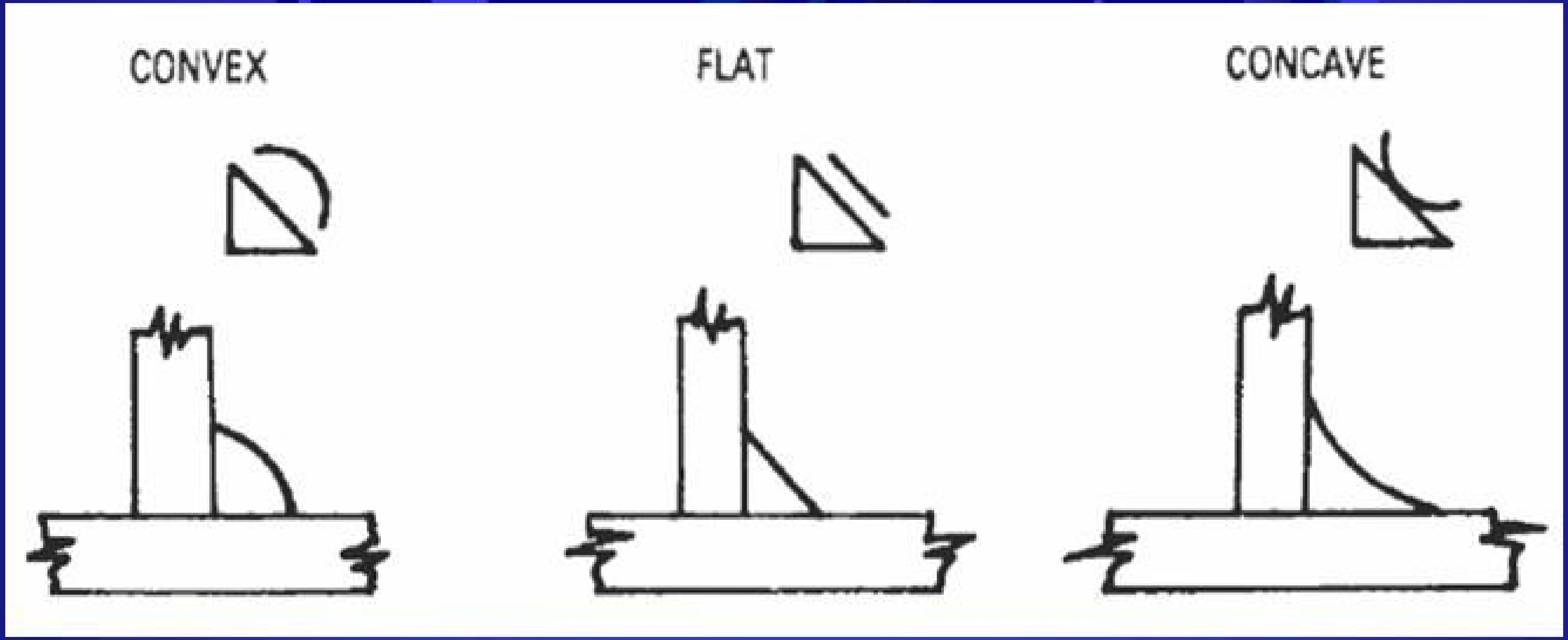




Welding symbols:

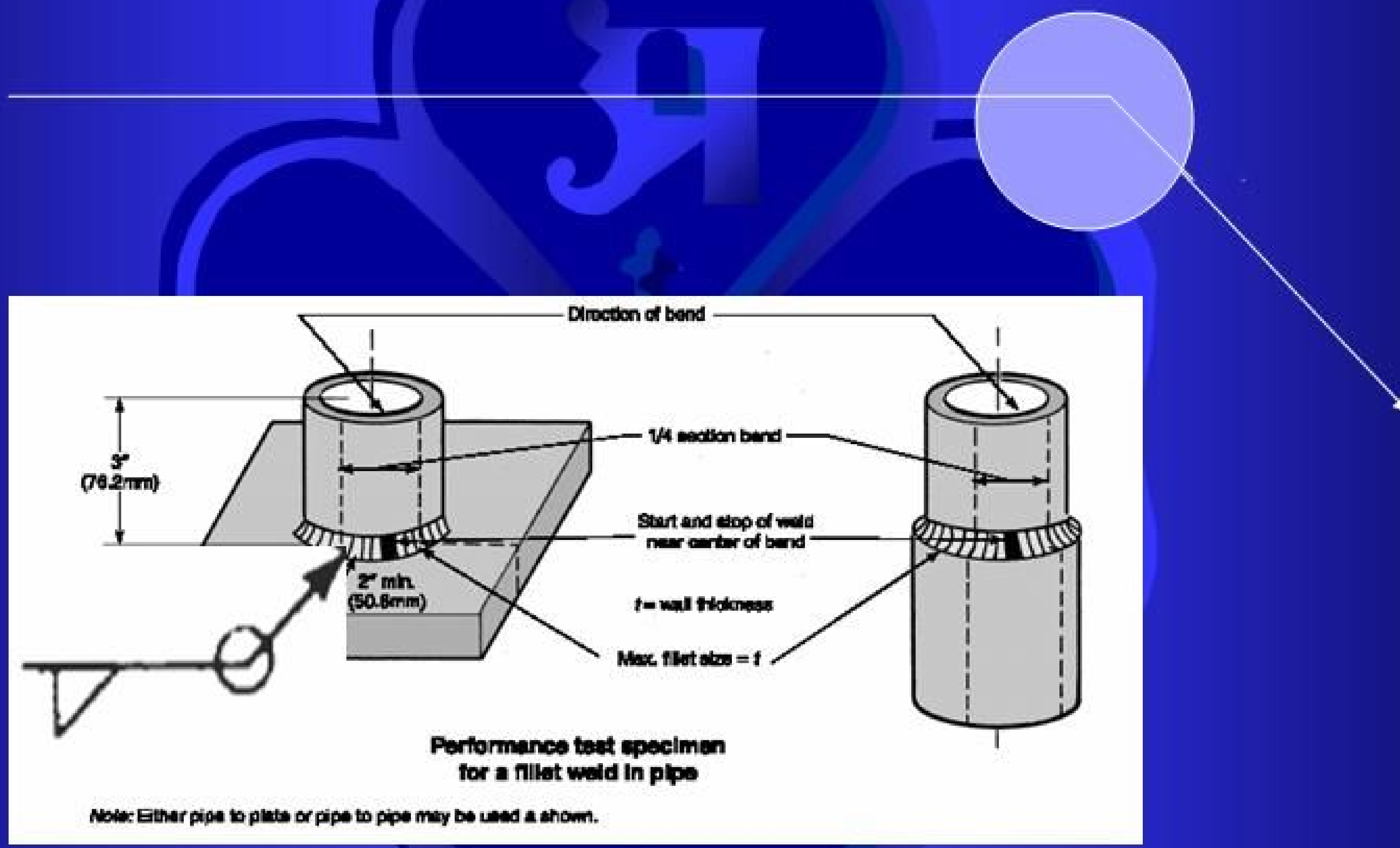
- *Supplementary symbols*





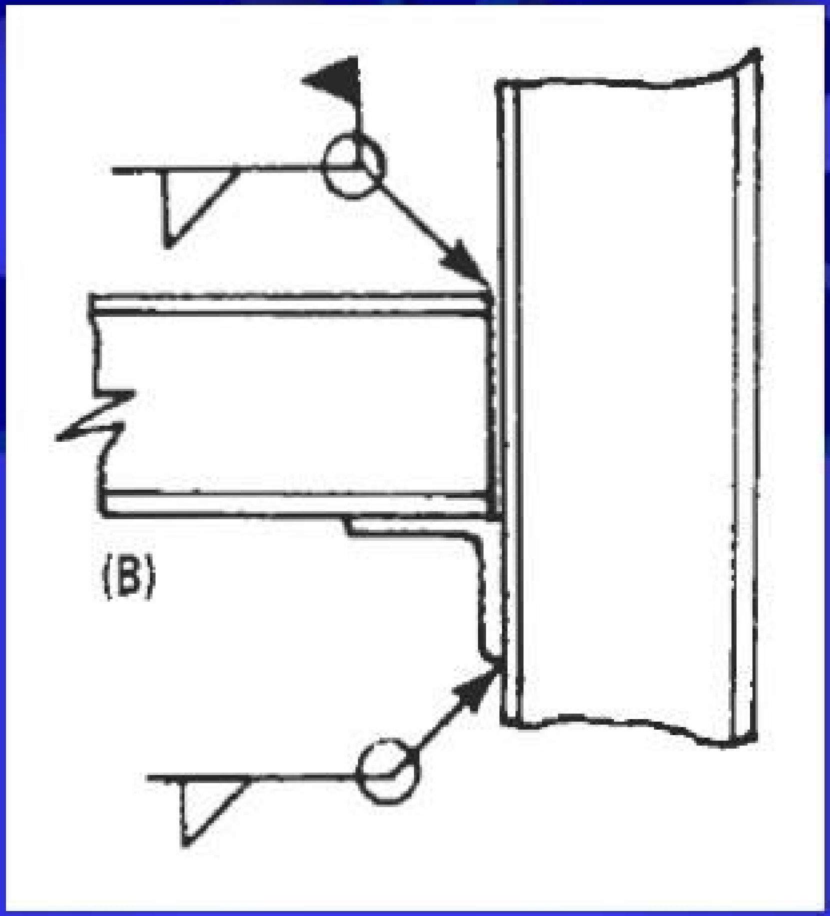
Welding symbols:

- A circle at the tangent of the arrow and the reference line means welding to be all around.



Welding symbols:

- A flag at the tangent of the reference line and arrow means Field Weld.



Tail

- The tail of the welding symbol is used to indicate the welding or cutting processes, as well as the welding specification, procedures, or the supplementary information to be used in making the weld

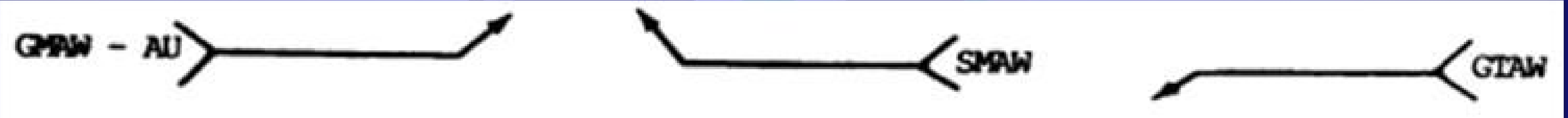


Figure 3-5. Definite process reference.

Welding symbols:

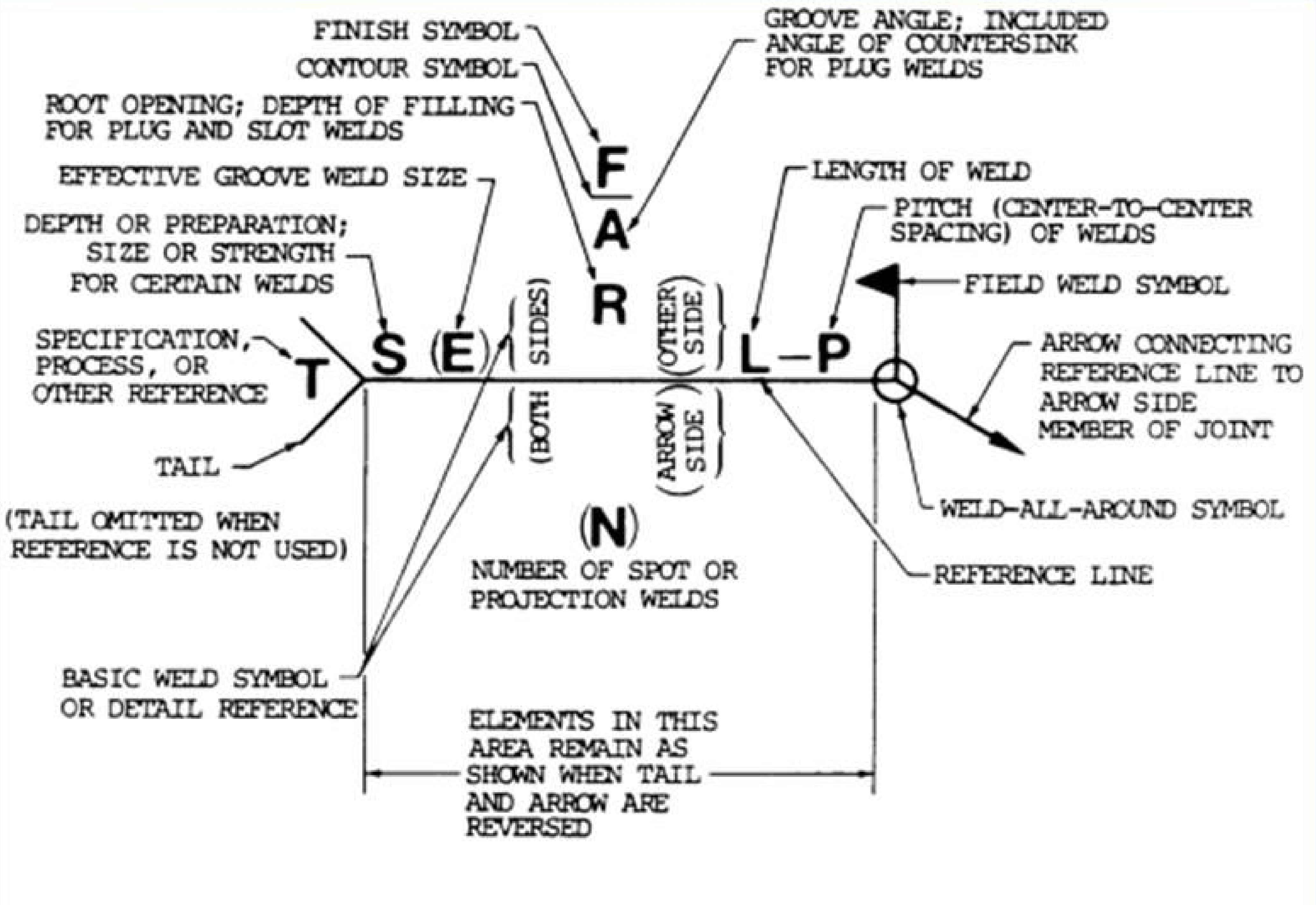
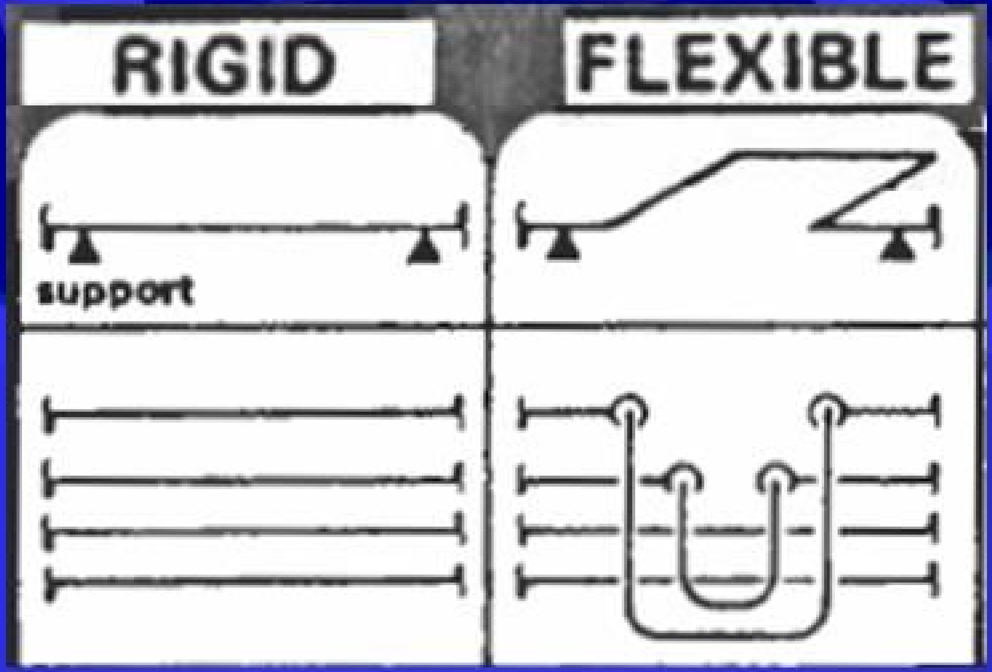


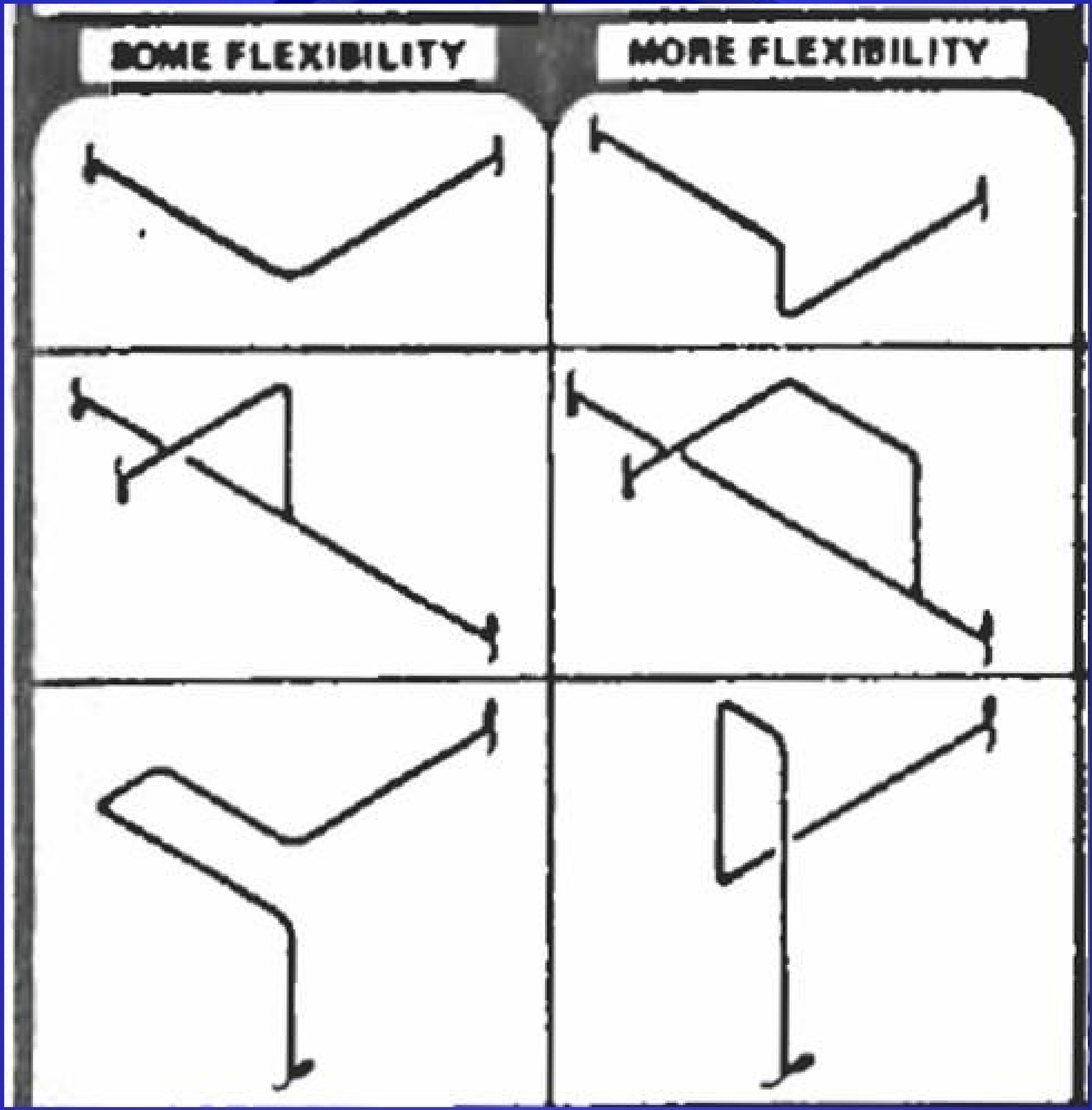
Figure 3-2. Standard locations of elements of a welding symbol.

Arrangement

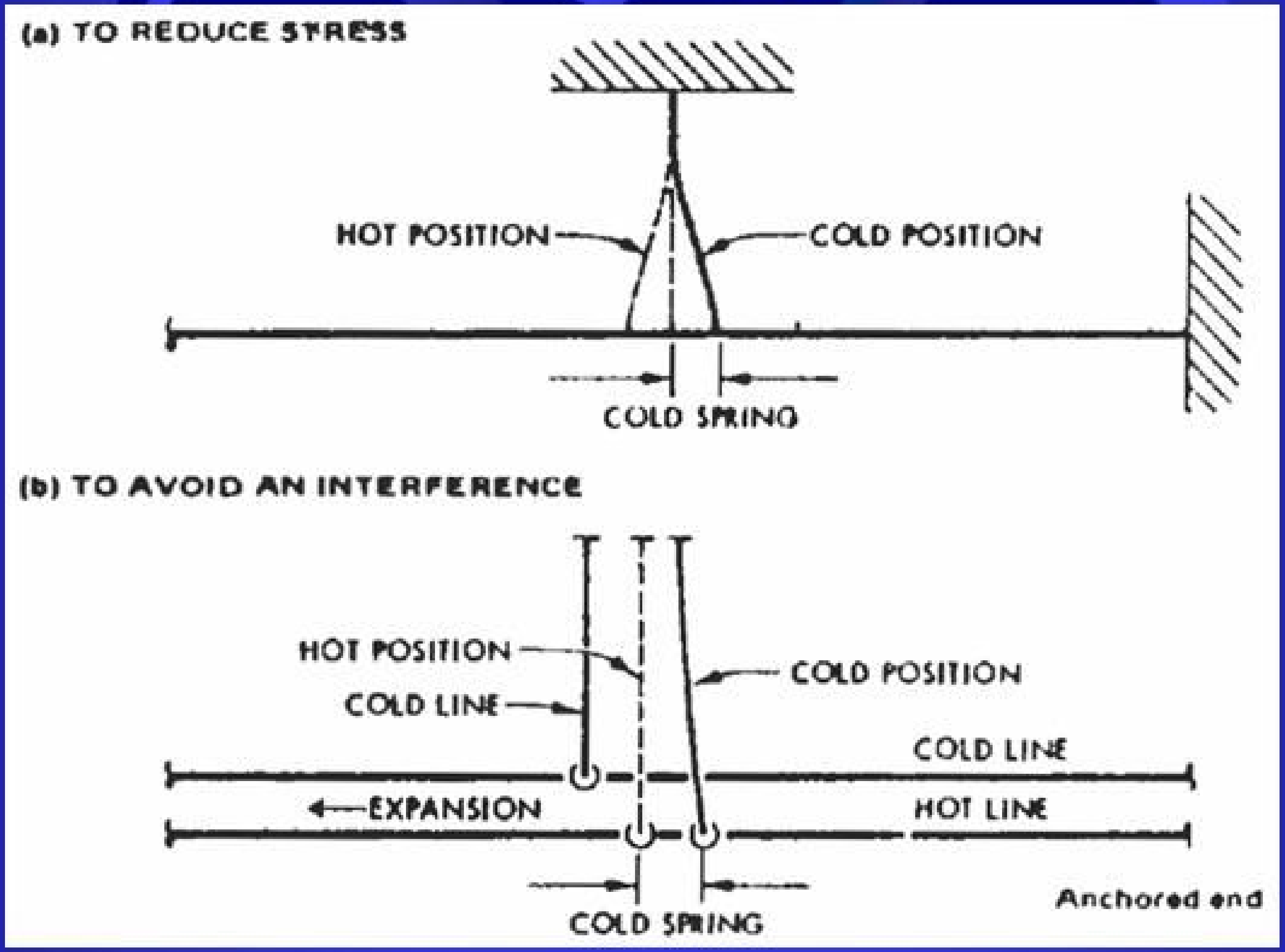
- Design flexible arrangement for piping to reduce
  - thermal stress (induce stress in piping, support and attachment equipment)
  - settlement strain (foundation of large tanks and heavy equipment may settle or tilt slightly in course of time)



Arrangement: Flexibility



- Avoid cold spring of pipe
  - Cold spring used in to manner
    - To reduce stress
    - To avoid an interference

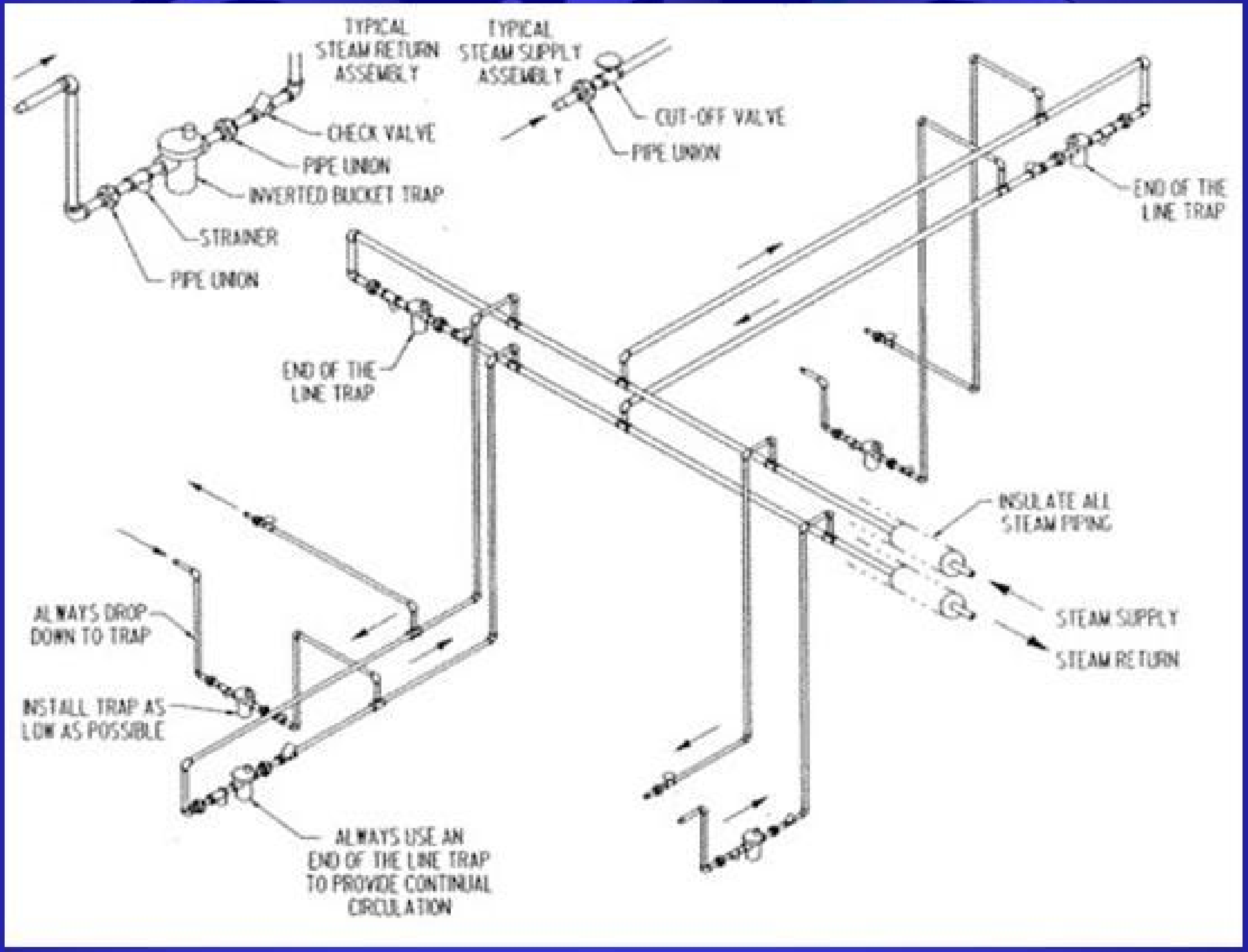


Arrangement: Flexibility

- Flexible pipe connection should have a length of 6 to 10 NPS

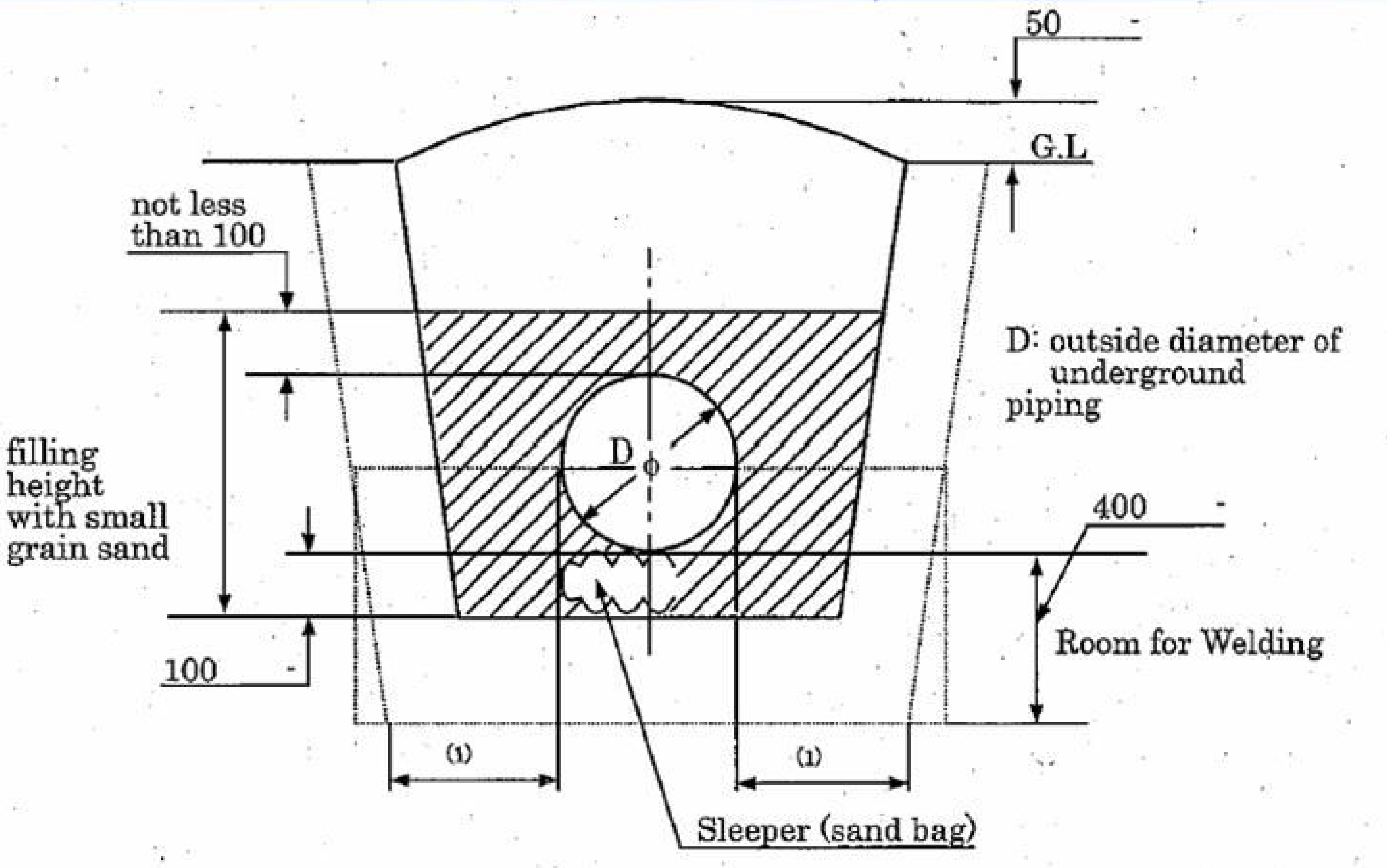
Arrangement:

- Take gas and vapor branch lines from tops of header where it is necessary to reduce the chance of drawing off condensate or sediment which may damage rotating equipment



Arrangement:

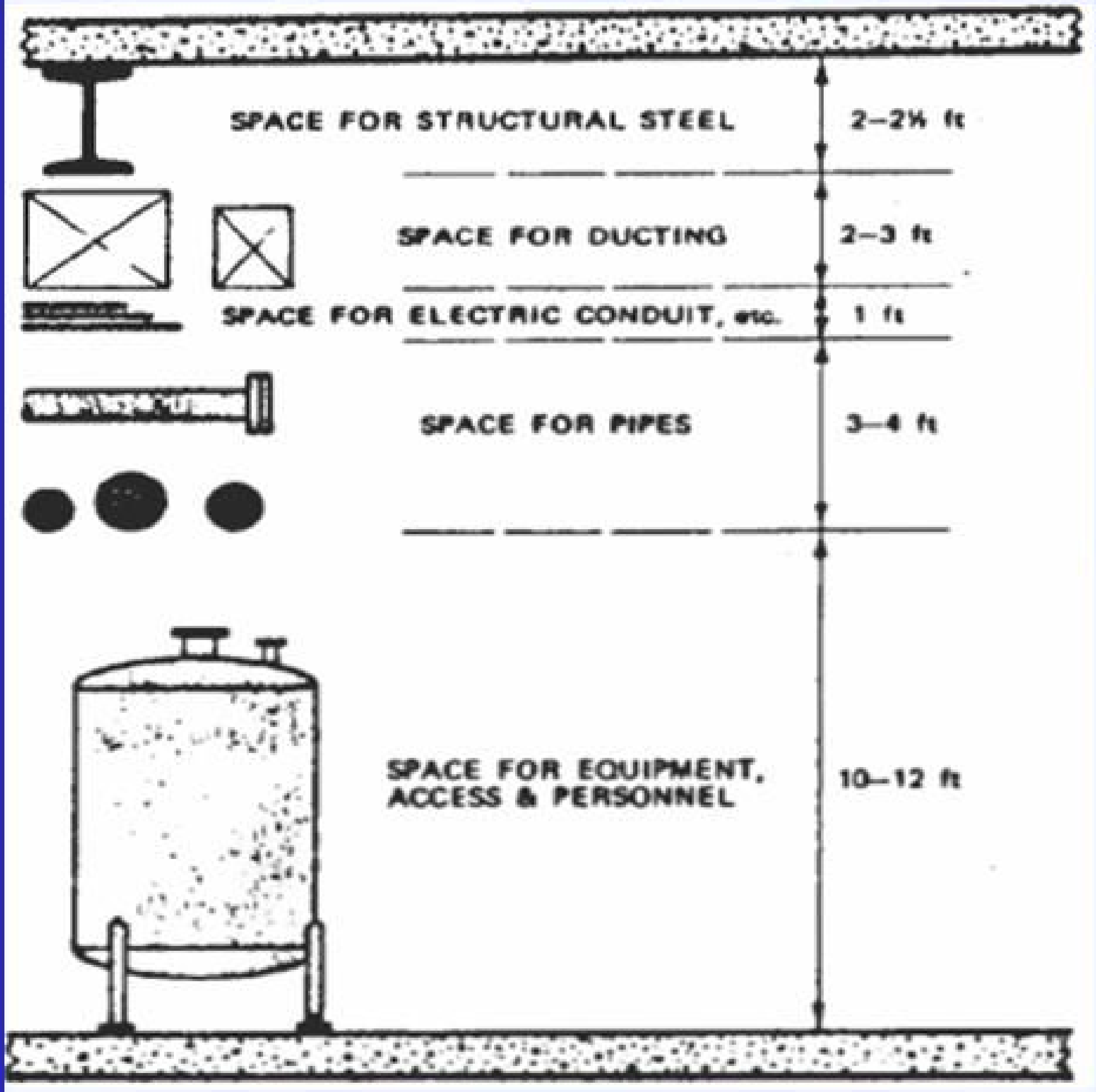
- Allow room for the joint to be made



(1) : Room for Welding 500 - 600 mm

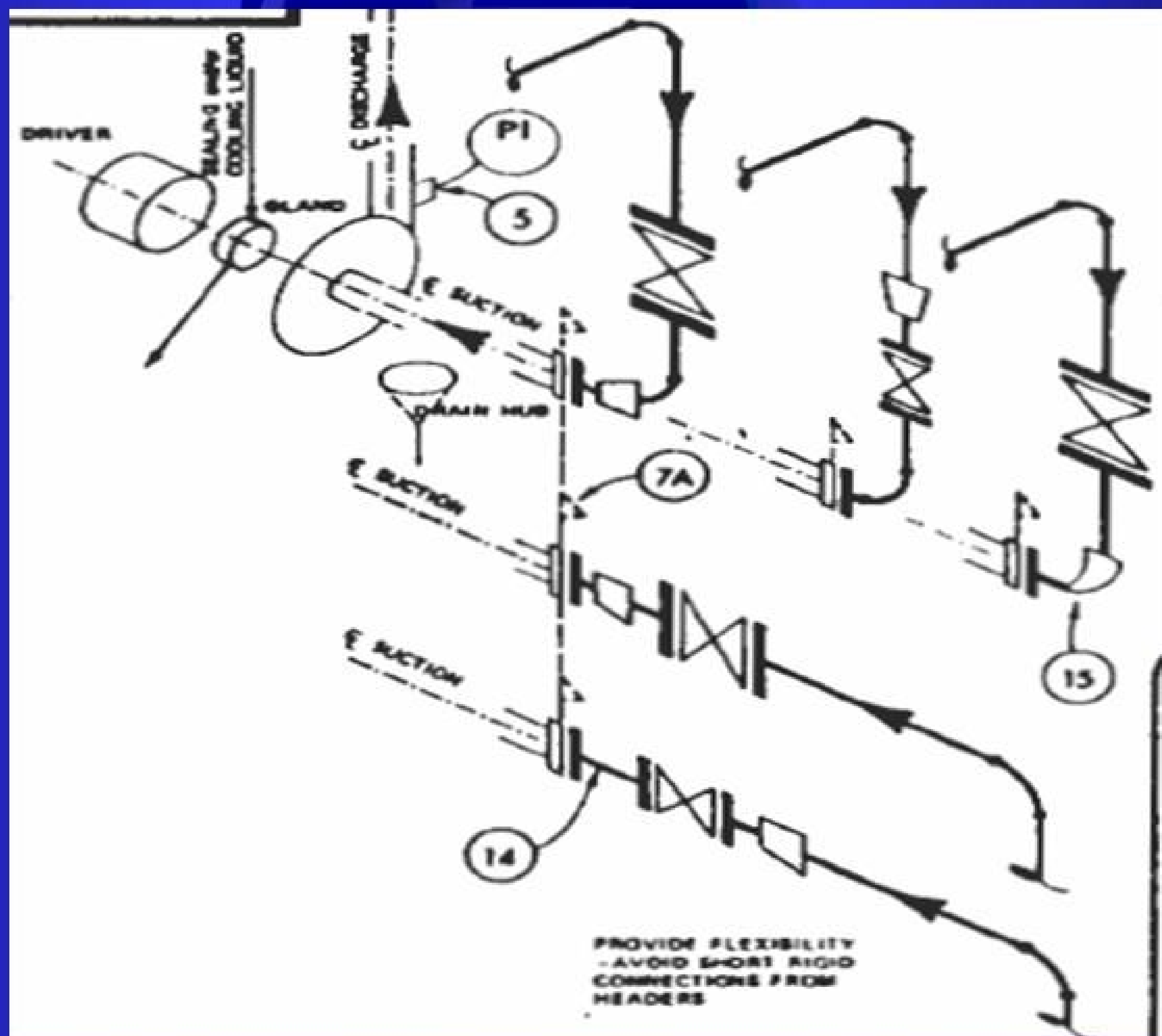
Arrangement:

- Establish sufficient headroom for ductwork, electrical run
- Consider vertical clearance (don't route piping) over pump compressor to permit removal for servicing (maintenance), consider headroom for mobile crane



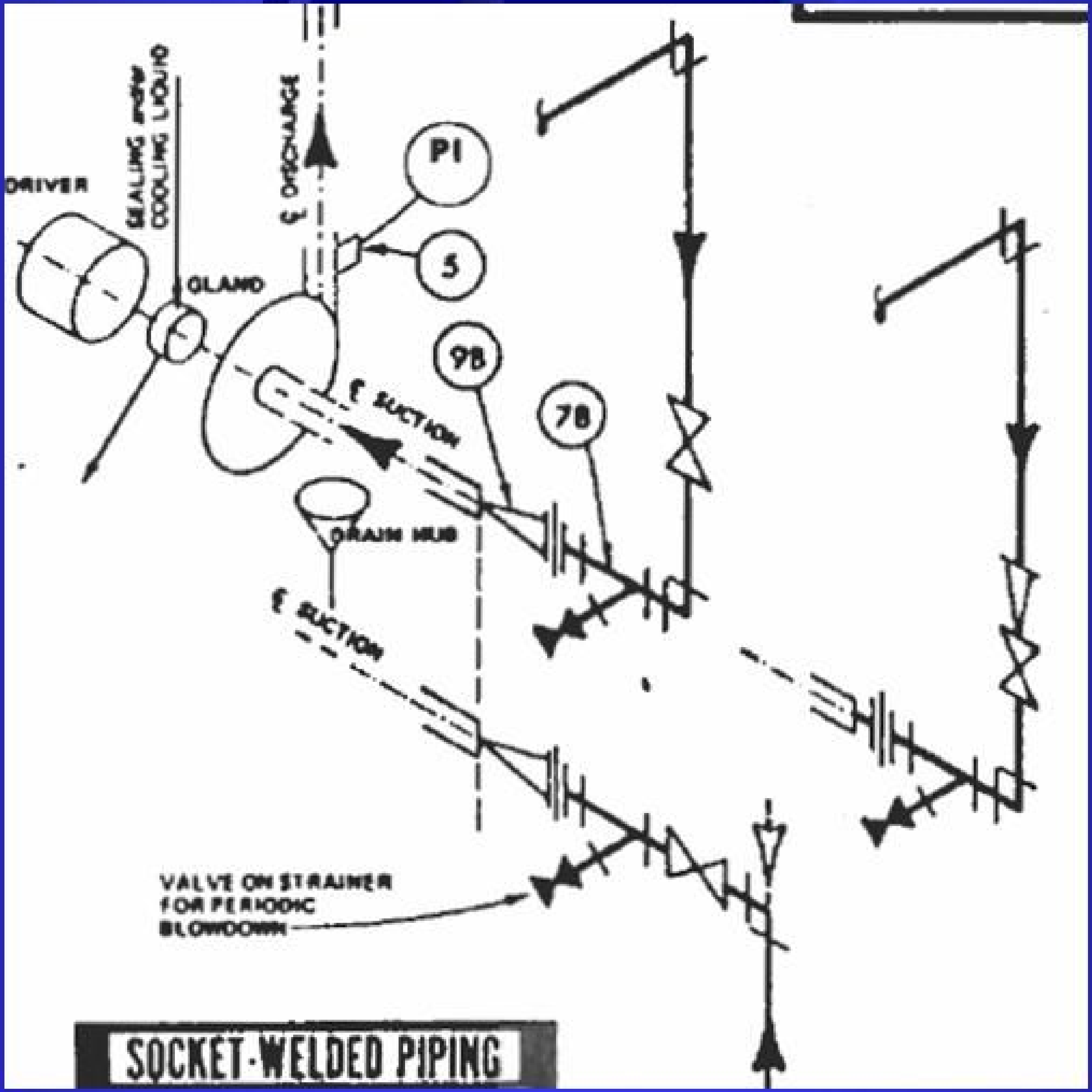
Arrangement:

- Centrifugal Pump arrangement:
  - Suction: eccentric reducer are used in 2½" line and larger

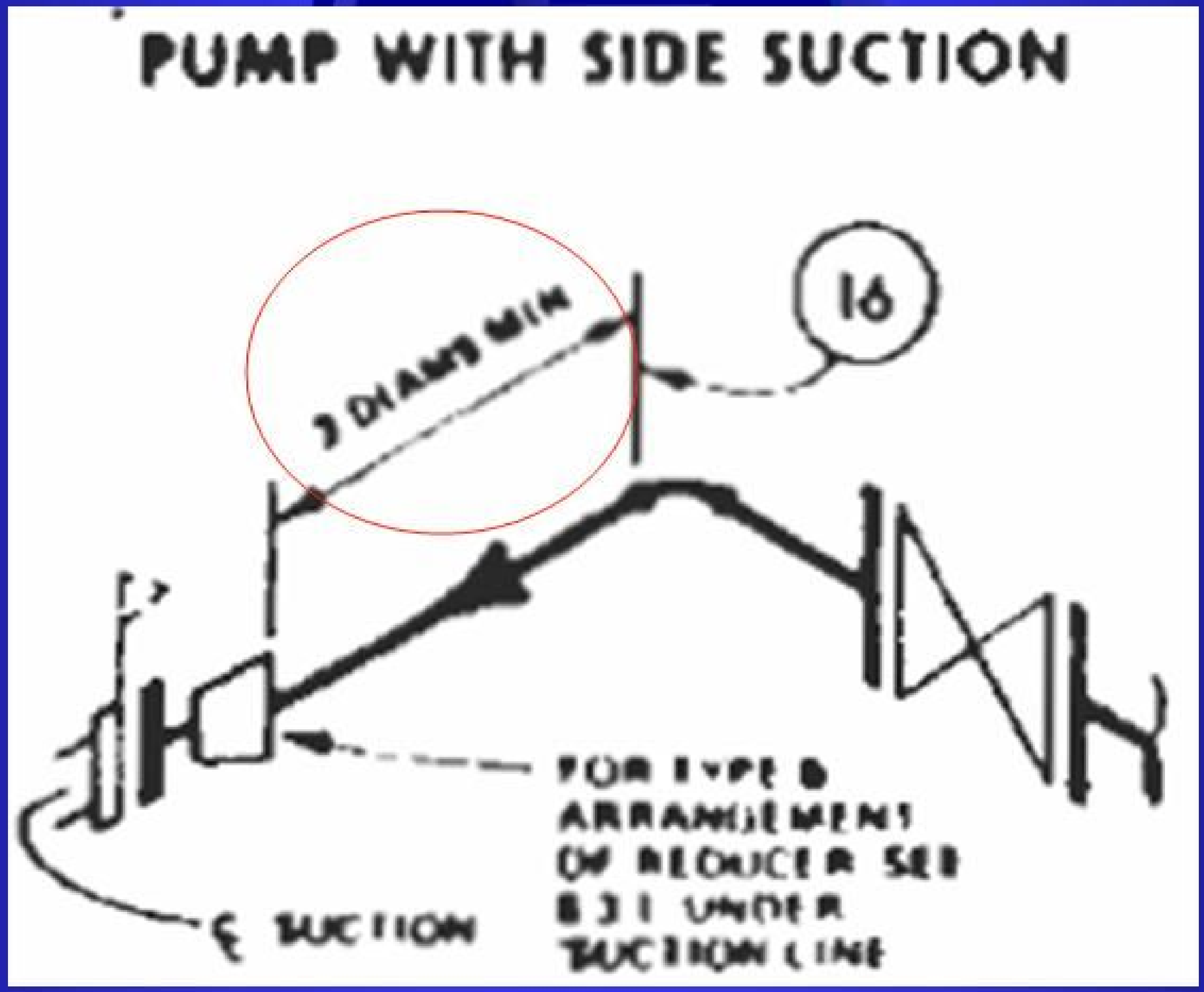


Arrangement:

- Centrifugal Pump arrangement:
  - Suction (socket weld)



- Centrifugal Pump arrangement:
  - Suction arrangement

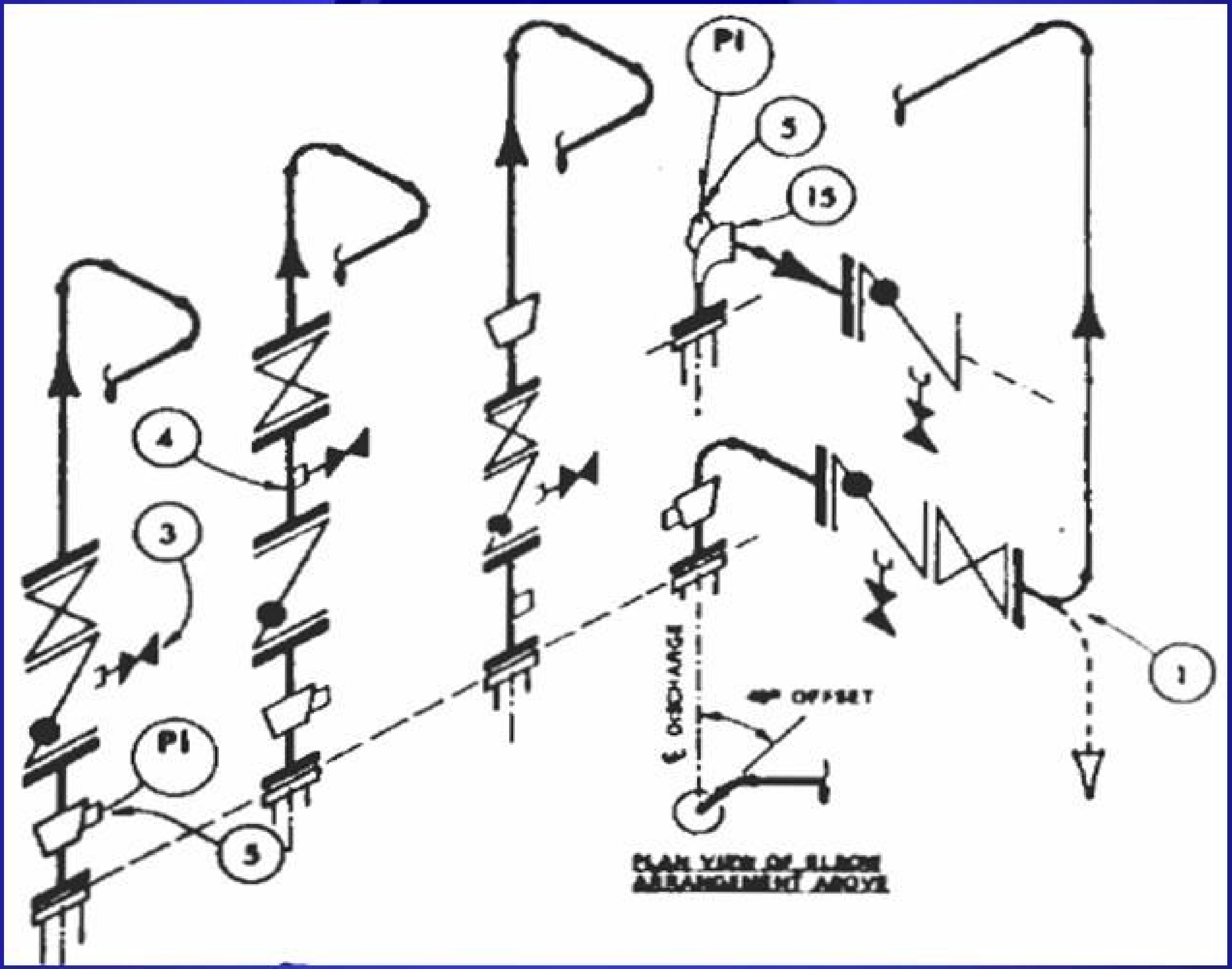


Arrangement:

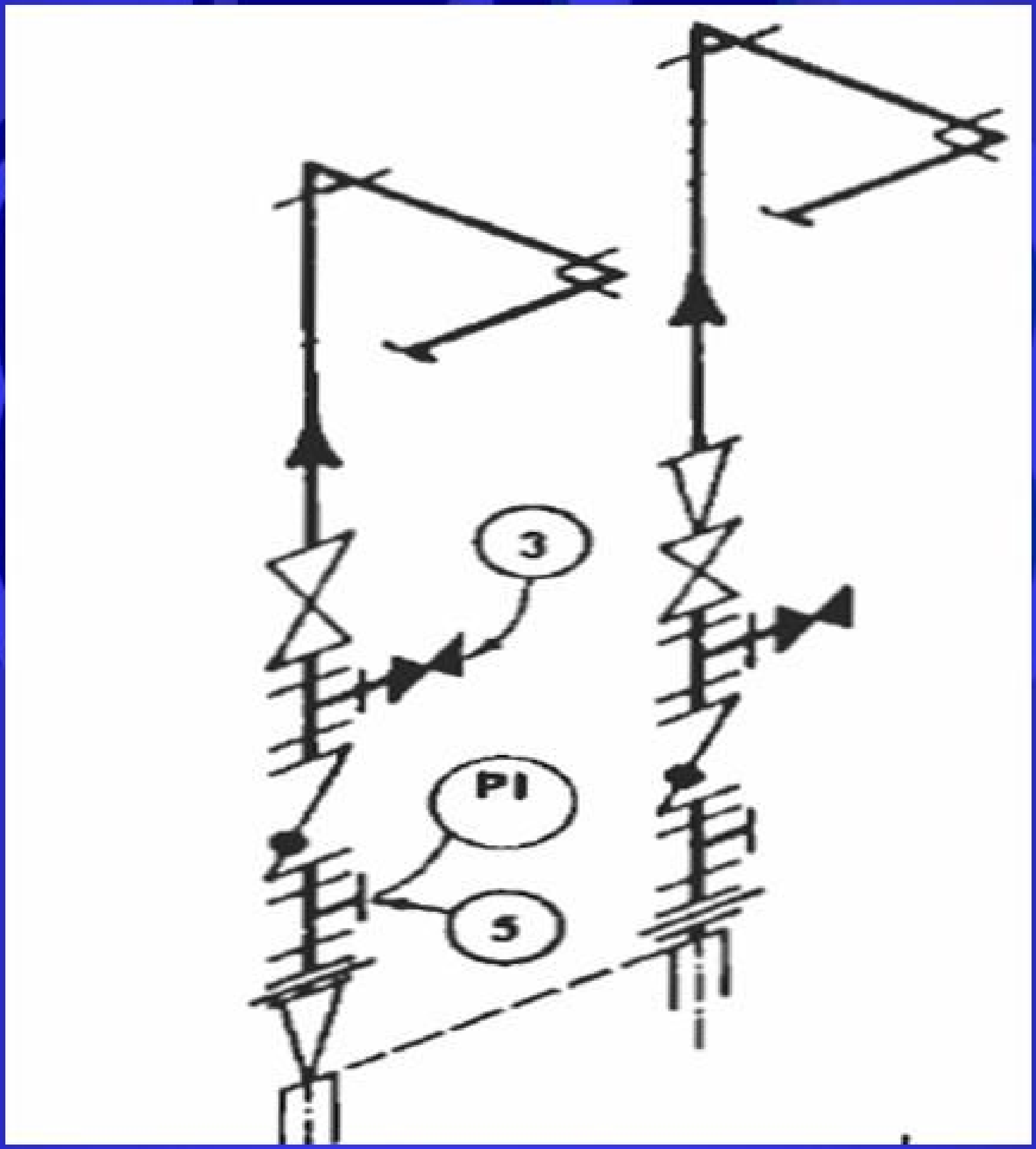
- Don’t use globe valves at suction and discharge for isolating pump
- Route suction line as directly as possible Don’t route piping over the pump, as this interferes with maintenance
- If pump positioned close to supply tanks and are on separate foundations, avoid rigid piping arrangement, for settle of tank in course of time
- Locate the pump as closely as practicable to source of liquid to be pumped from storage tank

Arrangement:

- Centrifugal Pump arrangement:
  - Discharge: Concentric reducers are used in 2" line and smaller

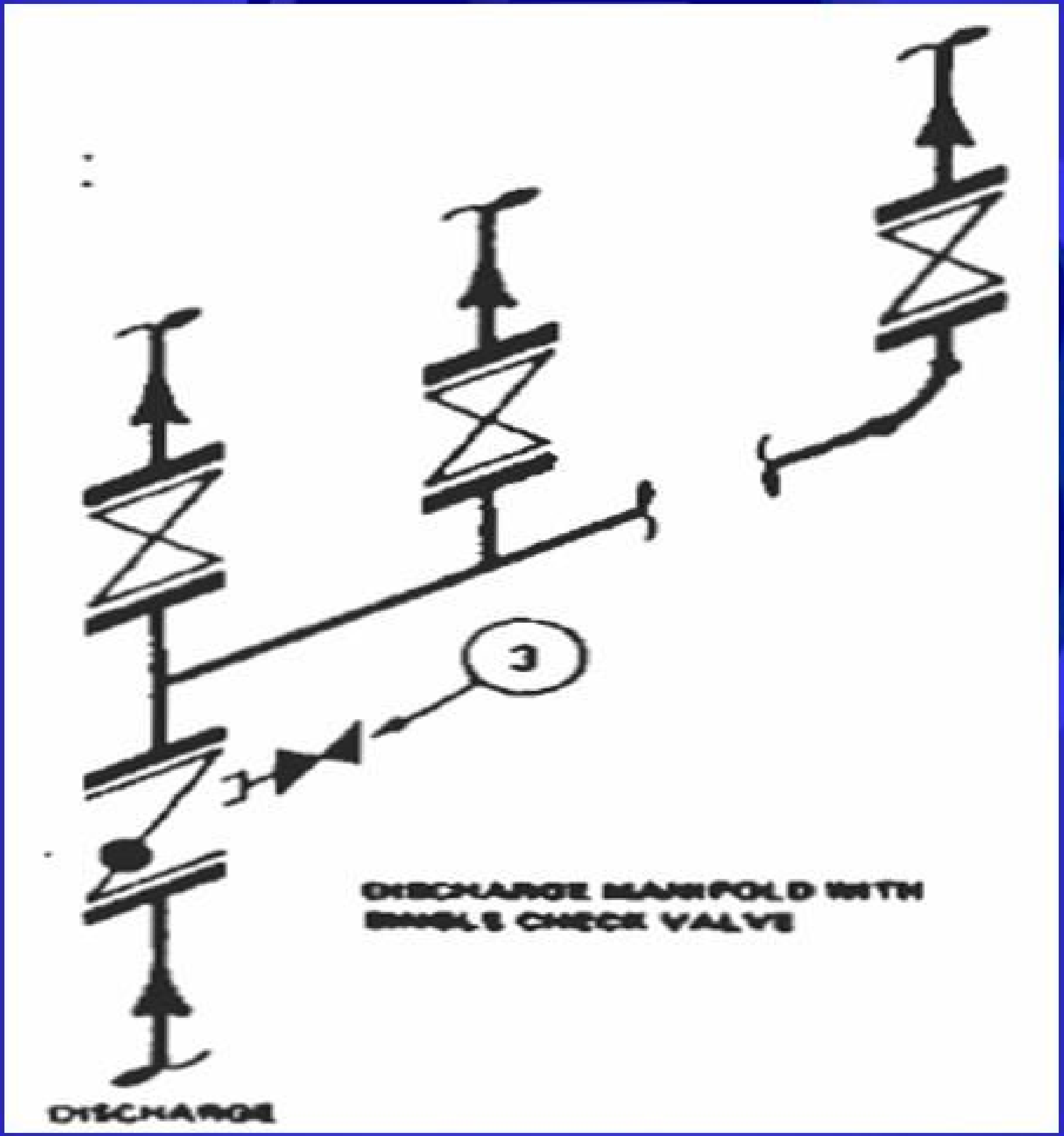


- Centrifugal Pump arrangement:
  - Discharge (socket)



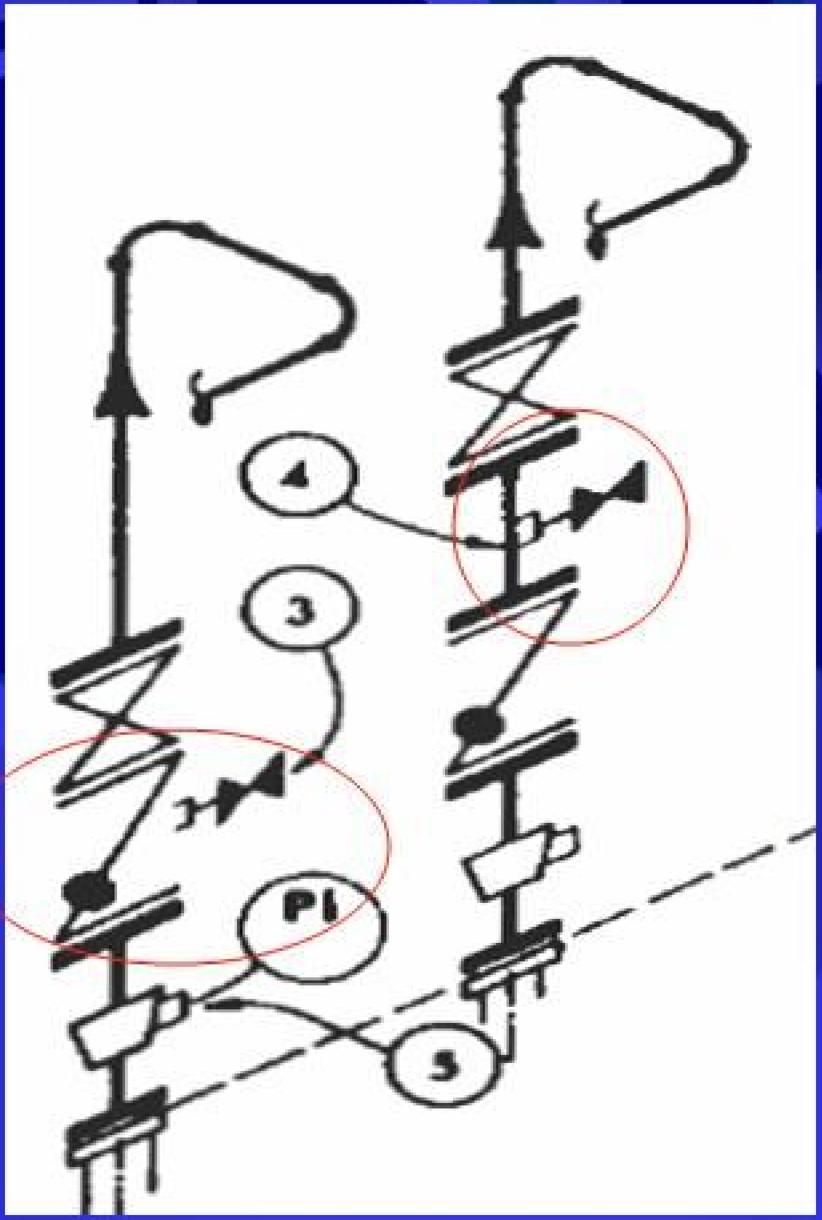
Arrangement:

- Centrifugal Pump arrangement:
  - Discharge (manifold)



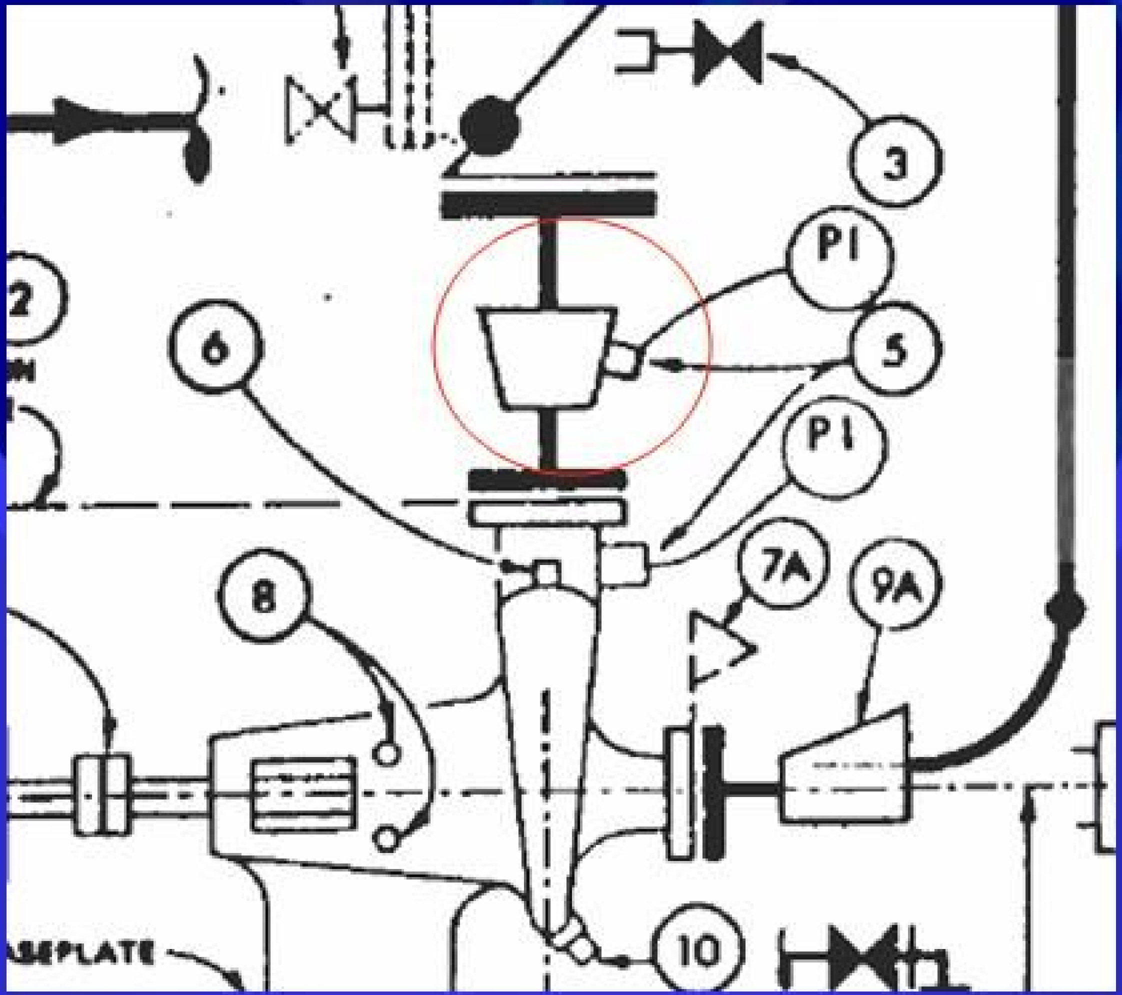
Arrangement:

- Provide ¾" to ½" drain between ball valve and check valve at discharge of pump to drain
- Drain can be provided on above disk of check valve



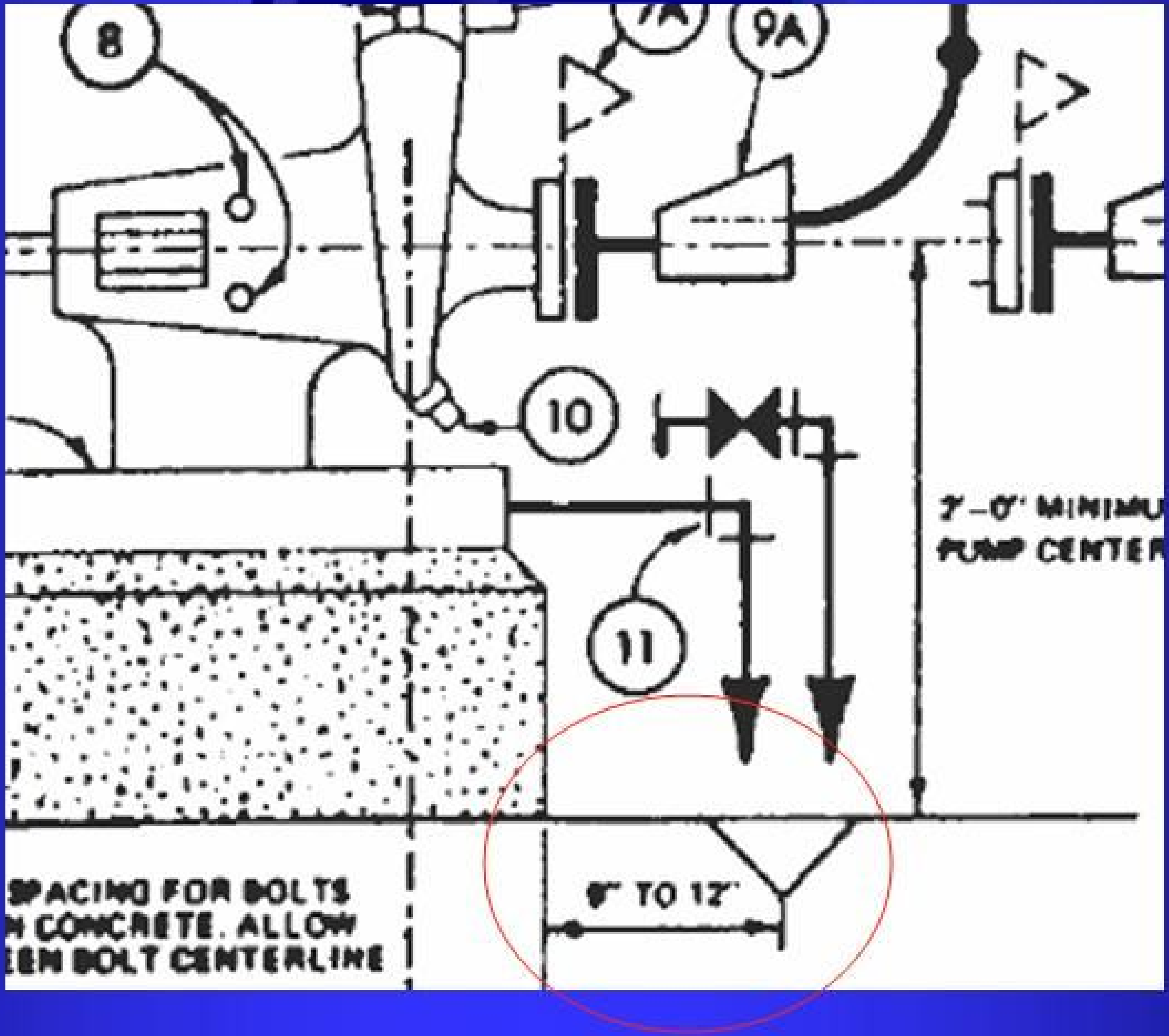
Arrangement:

- The outlet pipe for pump is chosen to be of large bore than the discharge port in order to reduce velocity and equipment pressure drop
- Concentric reducers are used in 2” line and smaller



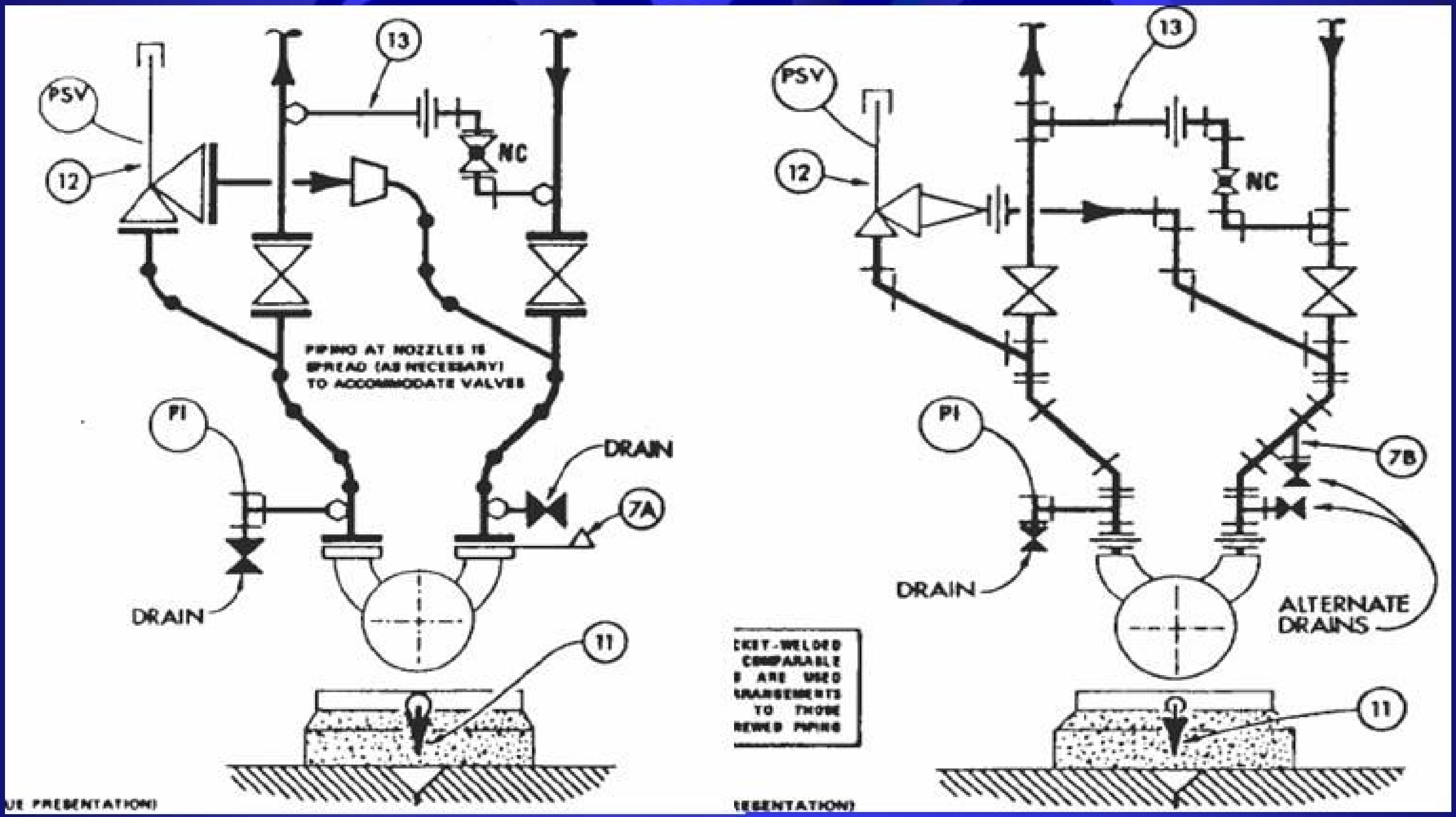
Arrangement:

- Each pump is usually provided with a drain hub 4” to 6” positioned about 9” in front of the pump



Arrangement:

- Positive displacement Pump arrangement:
  - Install PRV at discharge line befor isolating valve
  - pump PDP don't change velocity so, reducer at discharge and suction not used

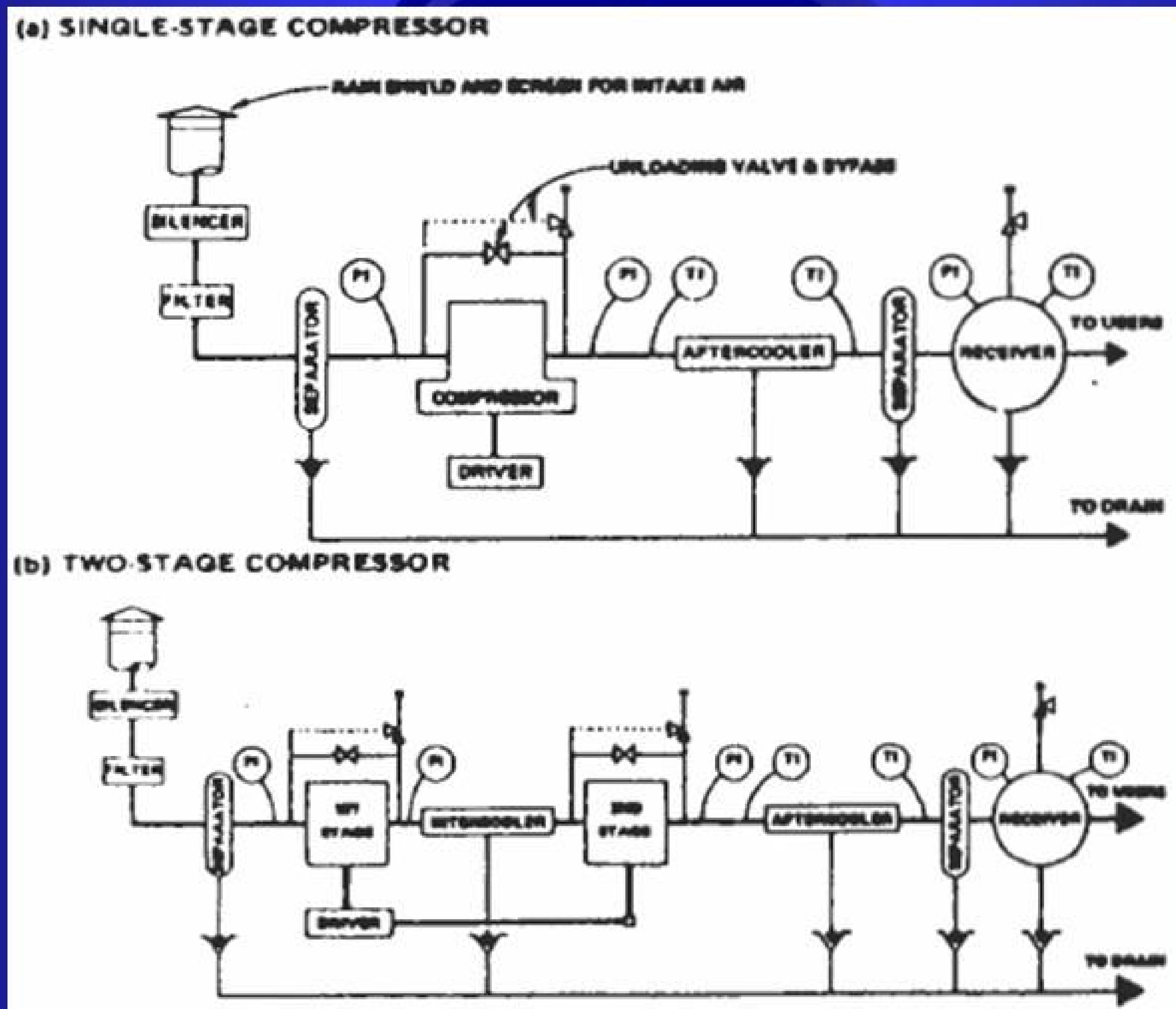


Arrangement:

- PDP have pulsation discharge, so used standpipe (reservoir to damp vibration)

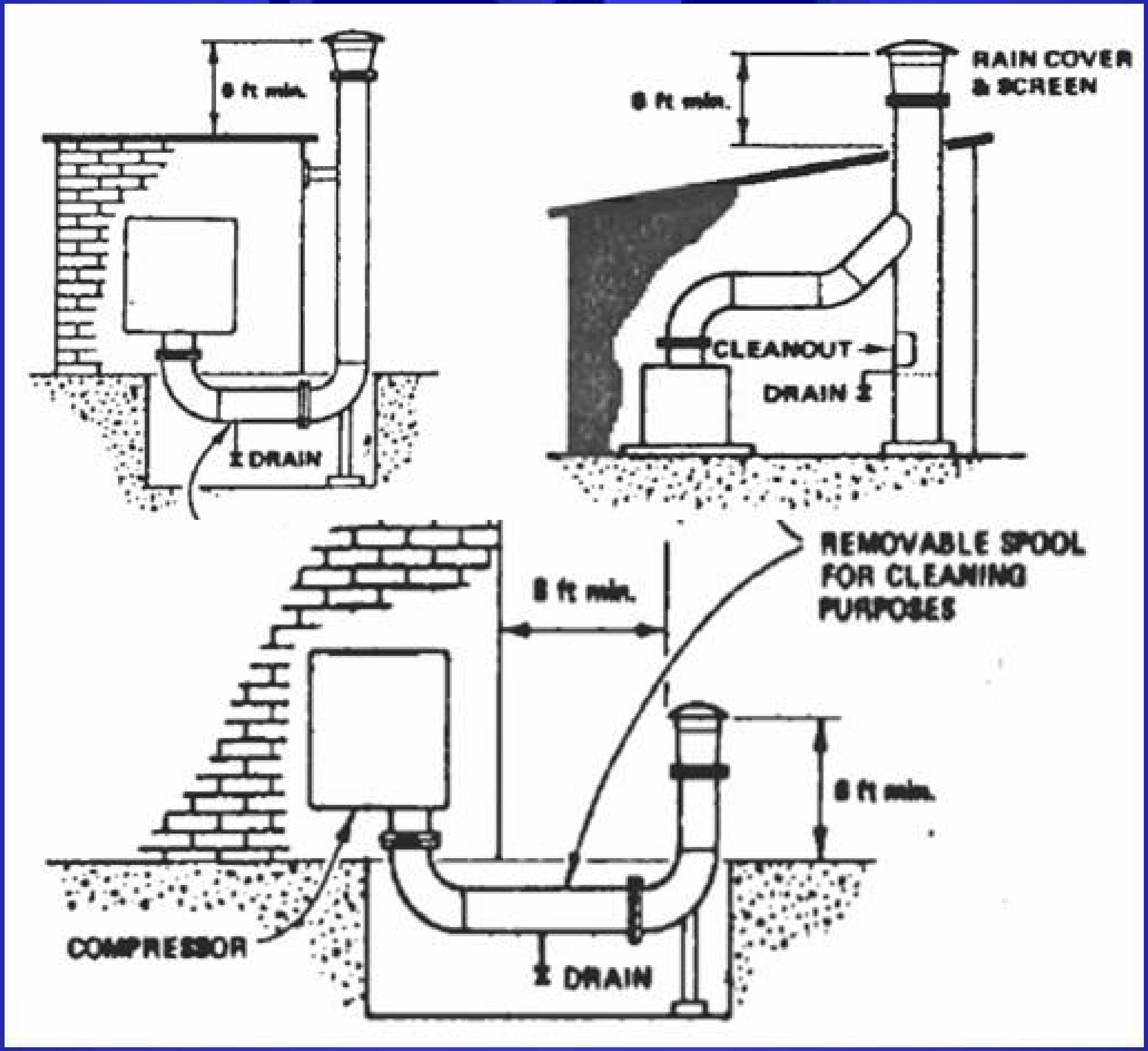
Arrangement:

- Compressor arrangement:



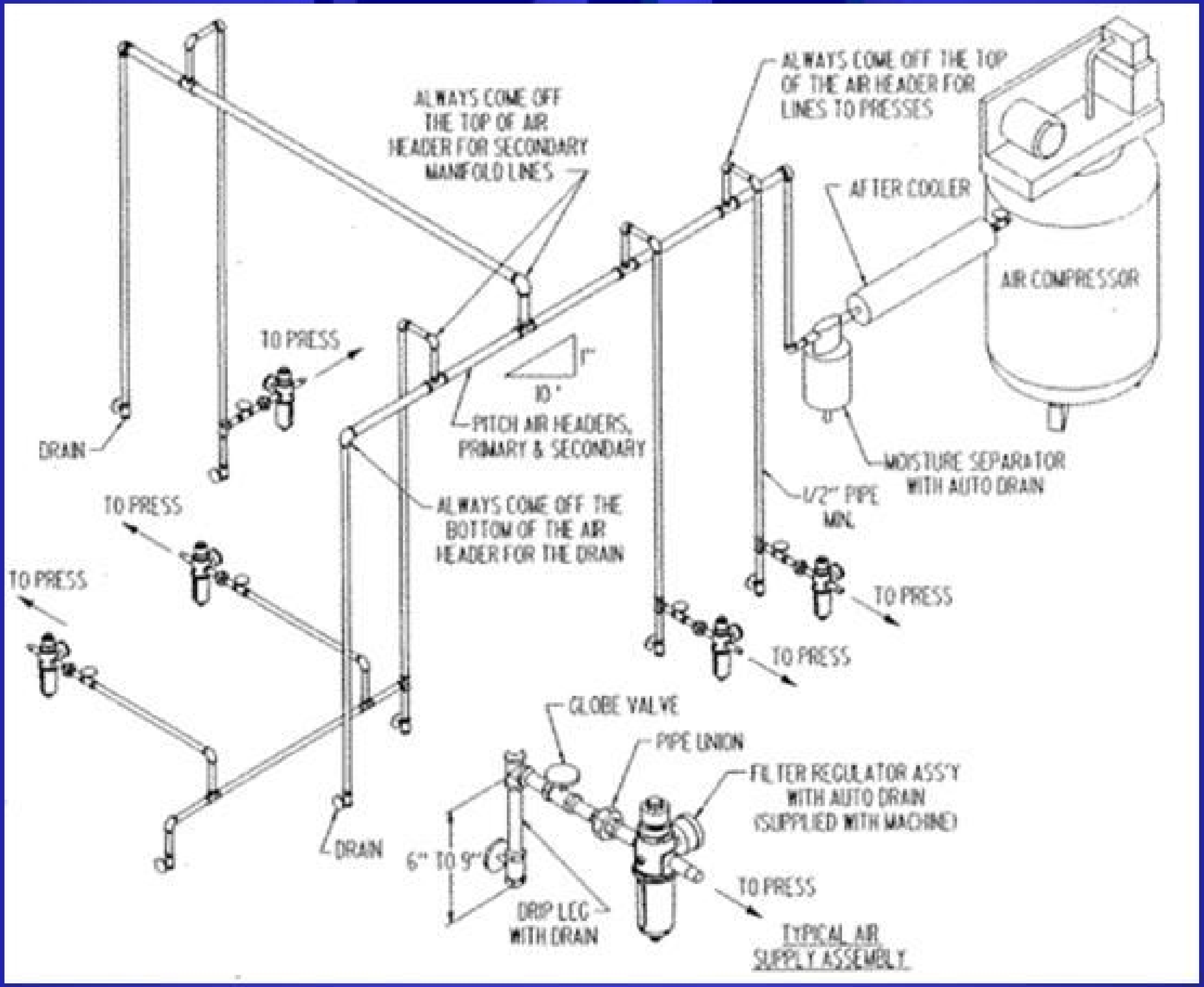
Arrangement:

- Compressor arrangement
  - suction

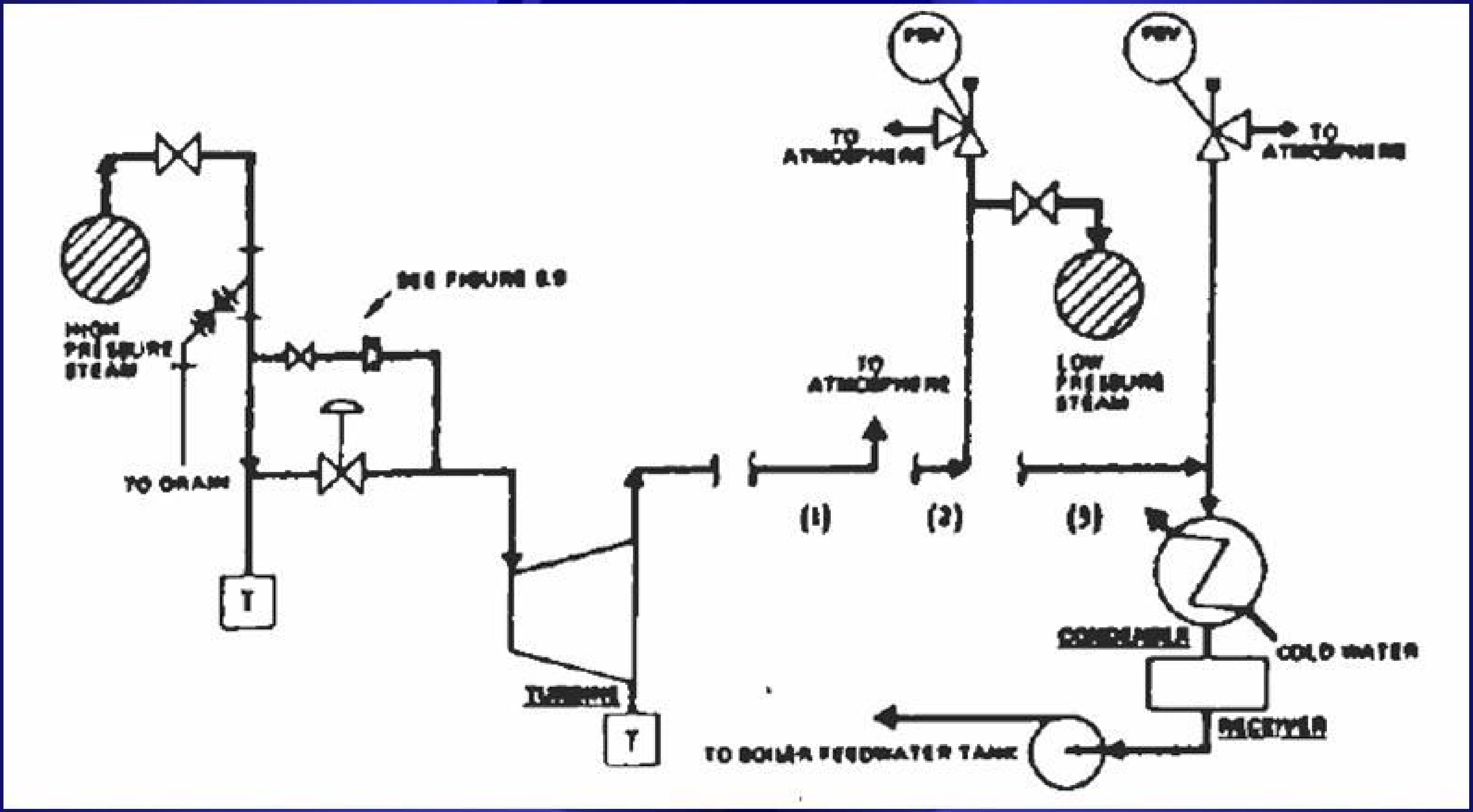


Arrangement:

- Compressor arrangement
  - discharge



- Turbine piping arrangement



Arrangement:

- Piping may have thru concrete floor as walls, inform the civil and architectural to avoid cutting exciting reinforcement
- Don't run piping under foundation
- If there is no possibility of future road or site development, lay piping such as
  - Line to outside storage
  - Loading and receiving facilities

  At grade on pipe sleeper
- Avoiding burying steam line that pocket, due the difficulty to collecting condensate
- Burying line (water, gas, drain) bellow the frost line to avoid freezing water and solutions, save the expense of tracing long horizontal parts of the line

Arrangement:

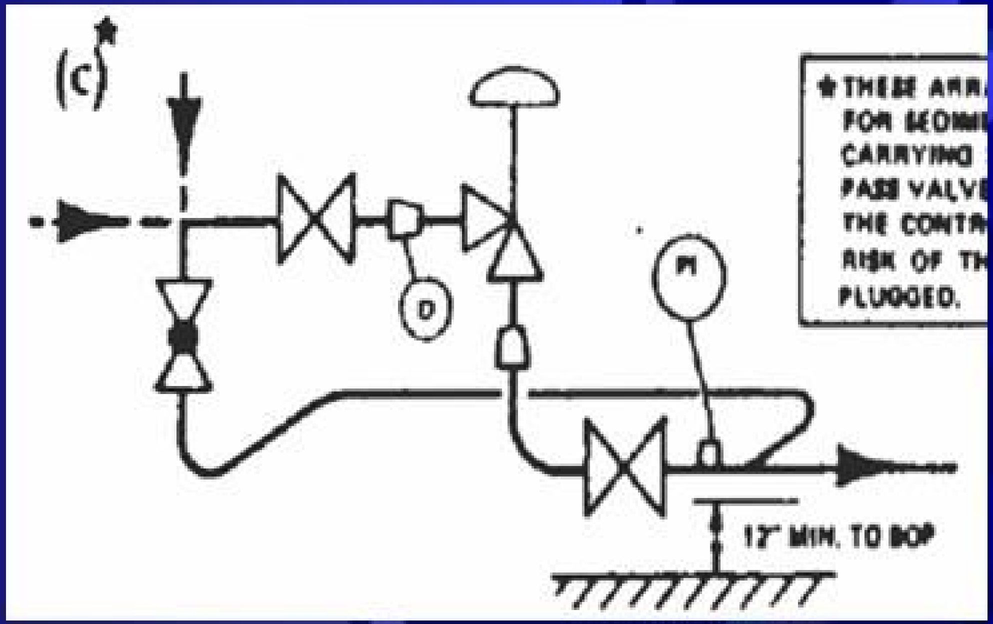
- Vent all high point and drain all low point on lines, place vent and drain valve to permit easily drained or purged during shutdown period (important for reducing cost of winterizing)
- Avoid pocketing lines. Arrange piping lines to drain back into equipment or into lines that can to be drained
- Run piping beneath of platforms, rather than over them.
- If need removing equipment, cleaning line provide
  - Union
  - Flanged
  - Removable spool
  - Cross instead elbows to permit removing solid

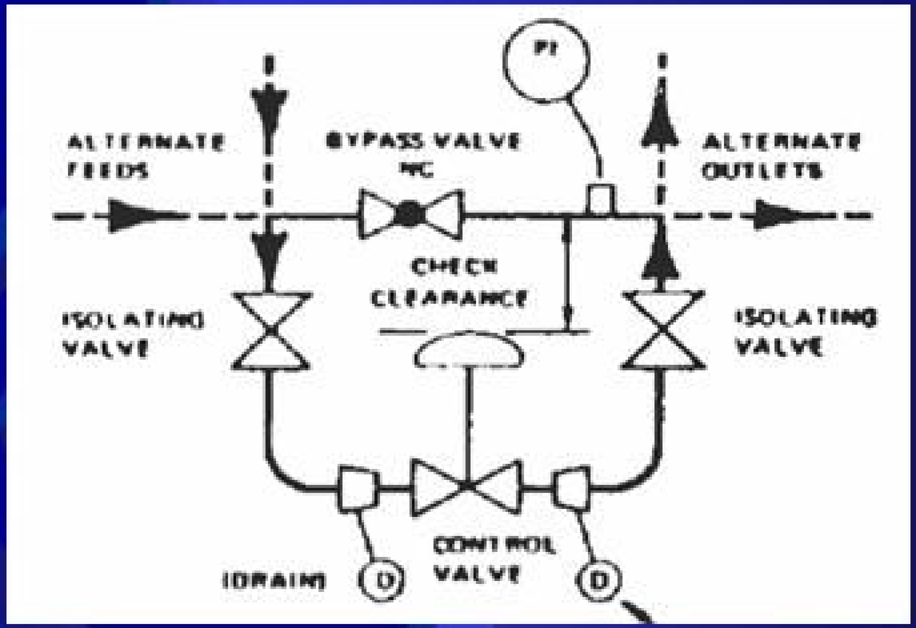
Arrangement:

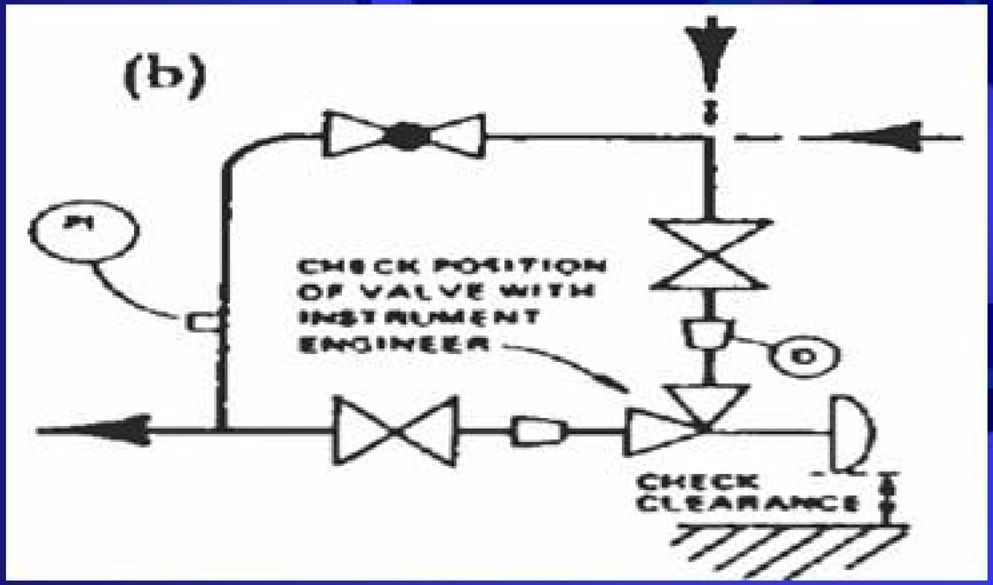
- Don't obstruct access ways (doorways, escape road, …)
- Consider vertical clearance (don't route piping) over pump to permit removal for servicing (maintenance), consider headroom for mobile crane

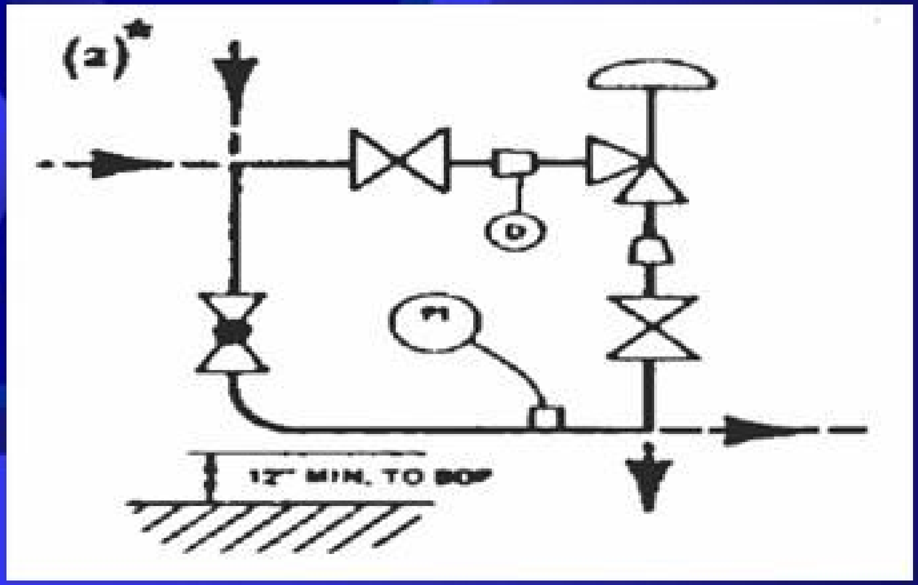
Arrangement:

- Nearly all valve will be line size, one exception is control valve, which are usually one or two size smaller than line size



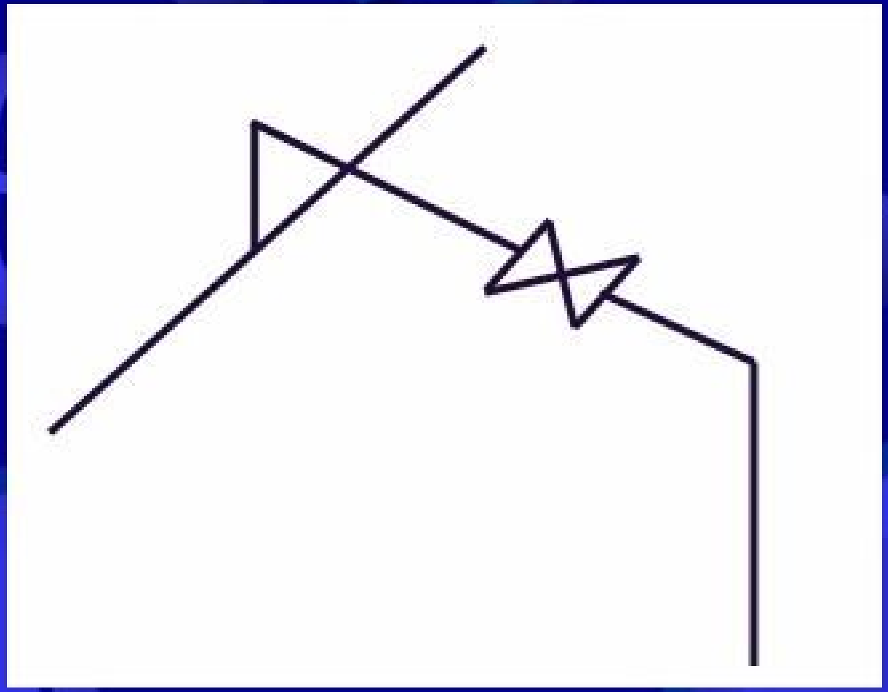






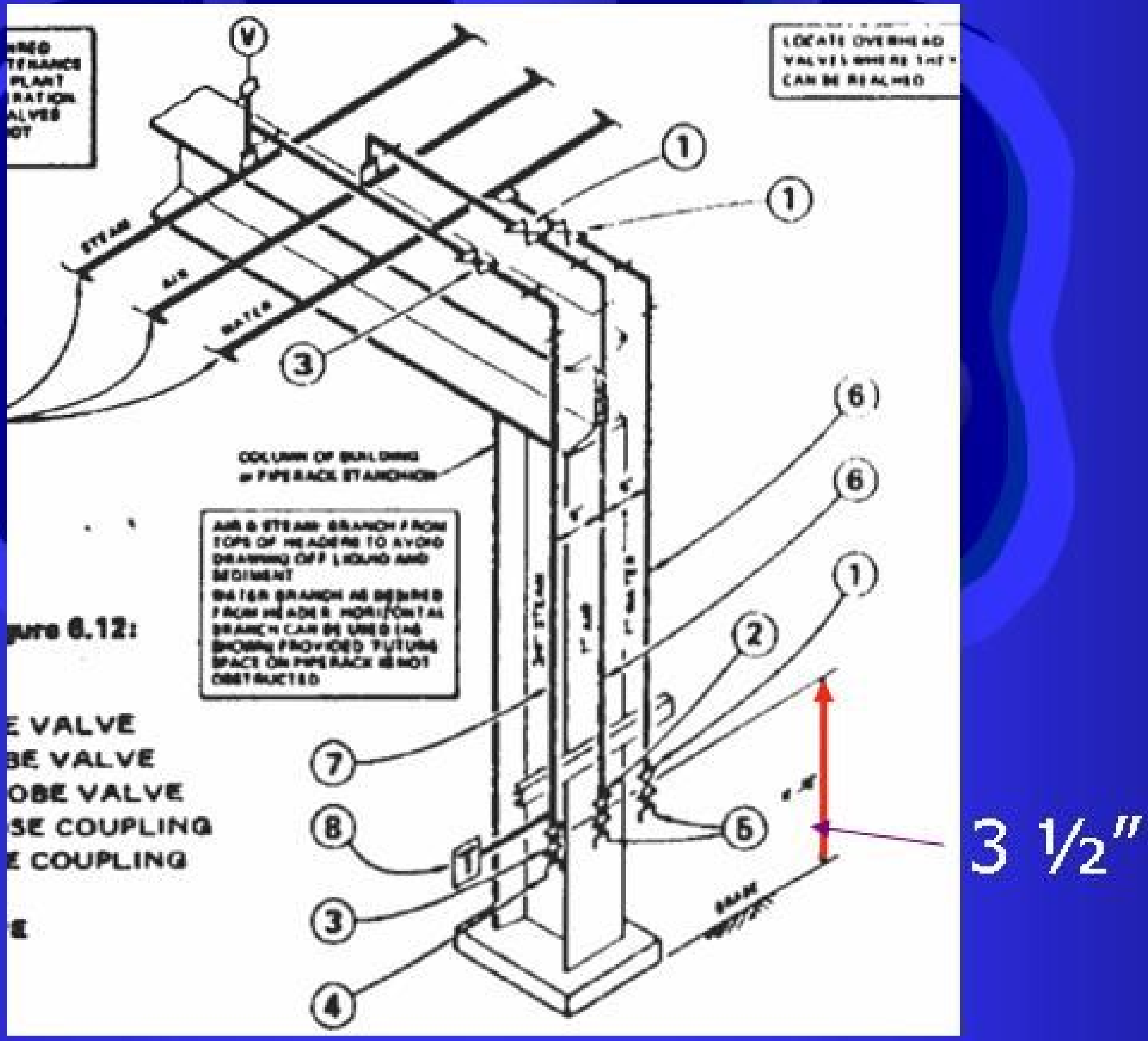
Arrangement:

- Provide isolating valve
  - in all small lines branching from header, place valve in horizontal rather than vertical run, so that lines can drain when the valve are closed
  - At all instrument point for removal of instrument



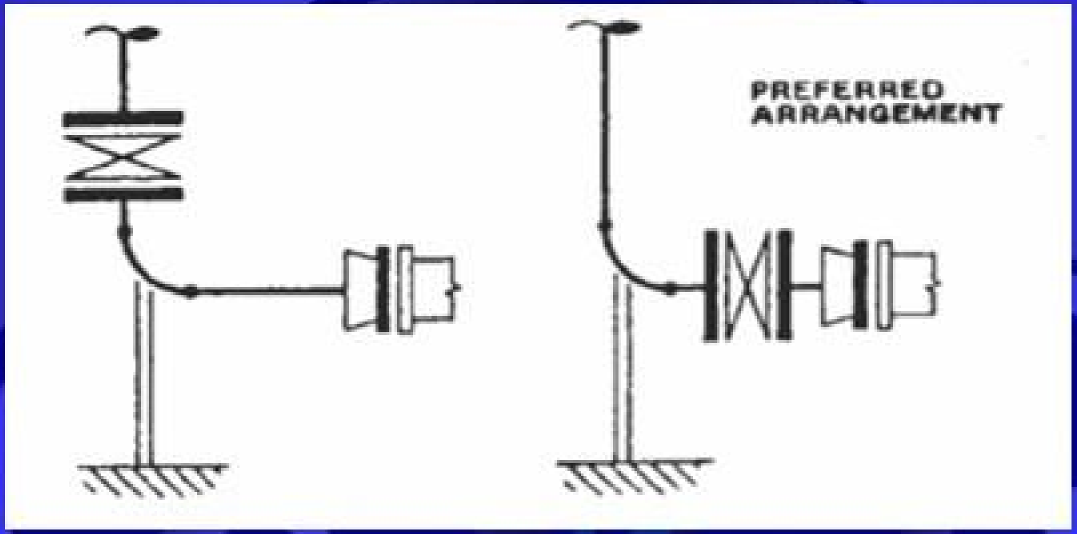
Arrangement:

- Utility station
  - Steam line NPS > ¾", use globe valve
  - Air and water > 1", use gate valve
  - Terminate with house connection

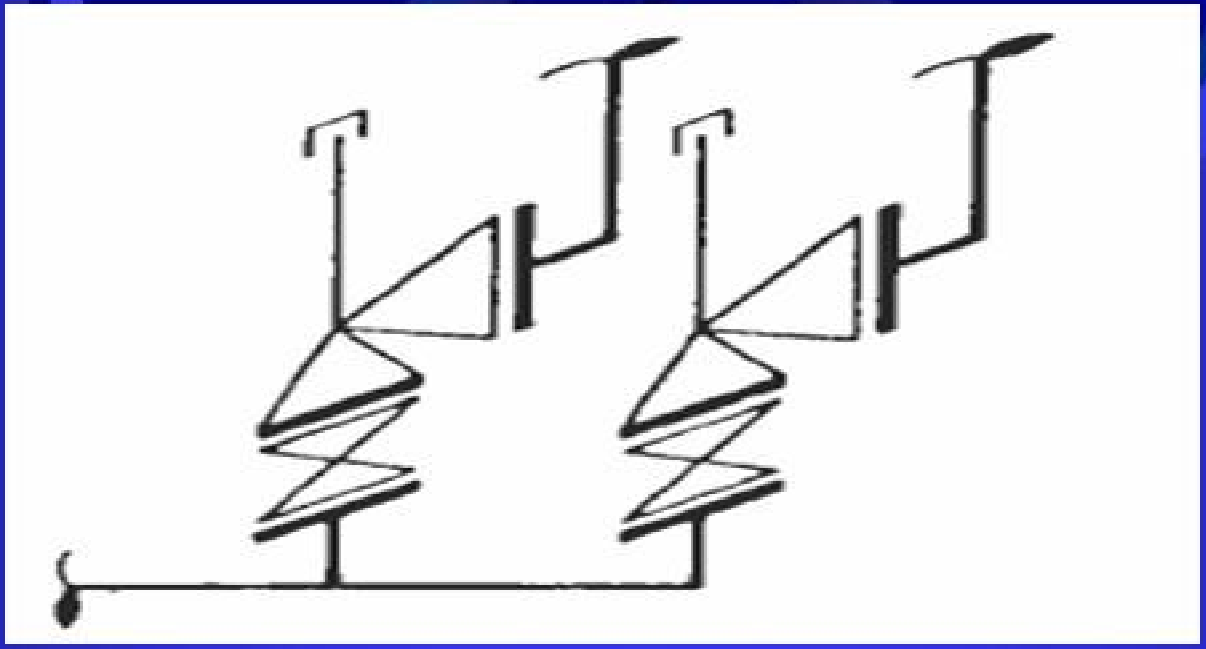


Arrangement:

- Arrange valve so that support will not be on removable spools

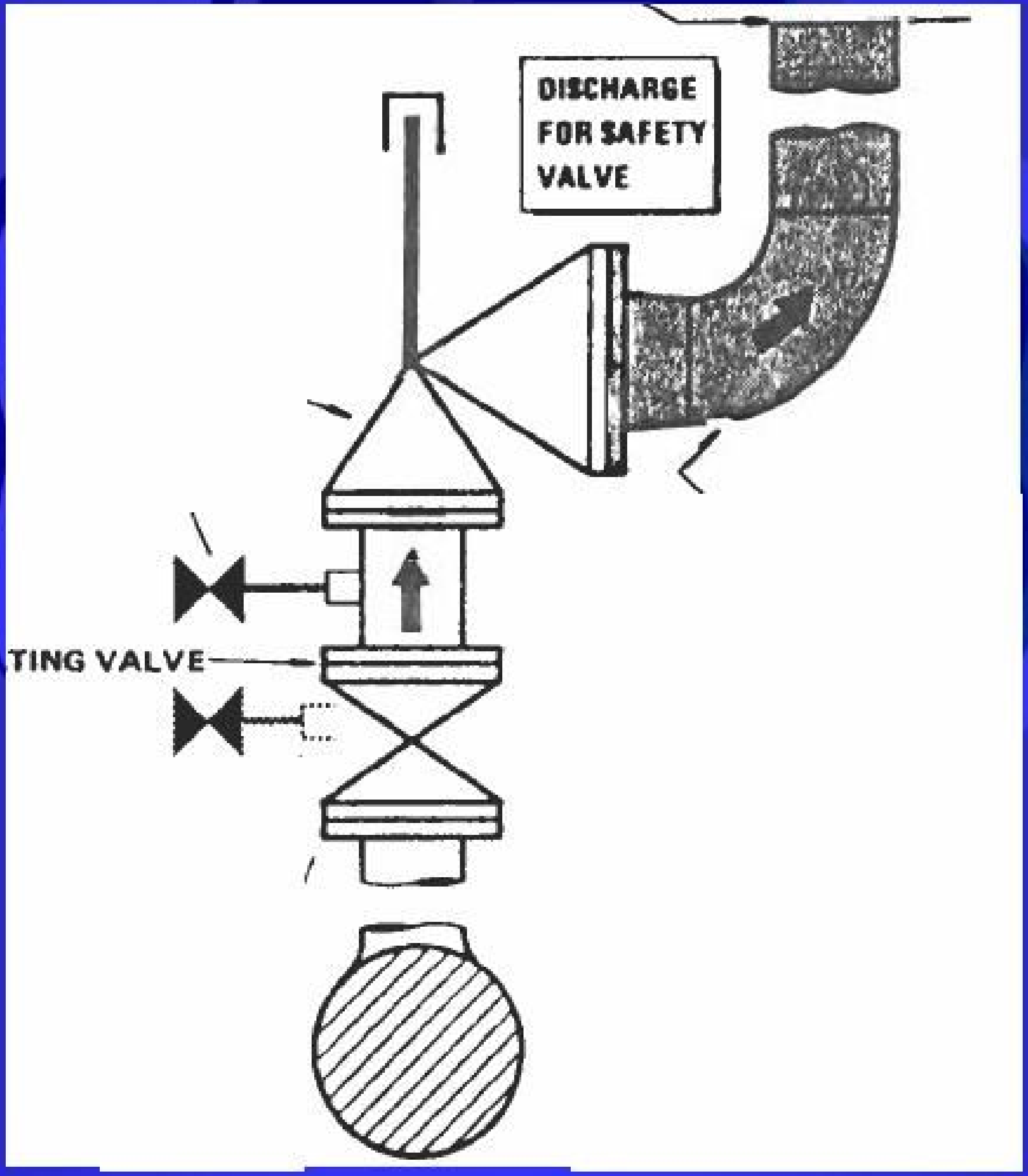


- In critical application, use two pressure relive valve with interlock



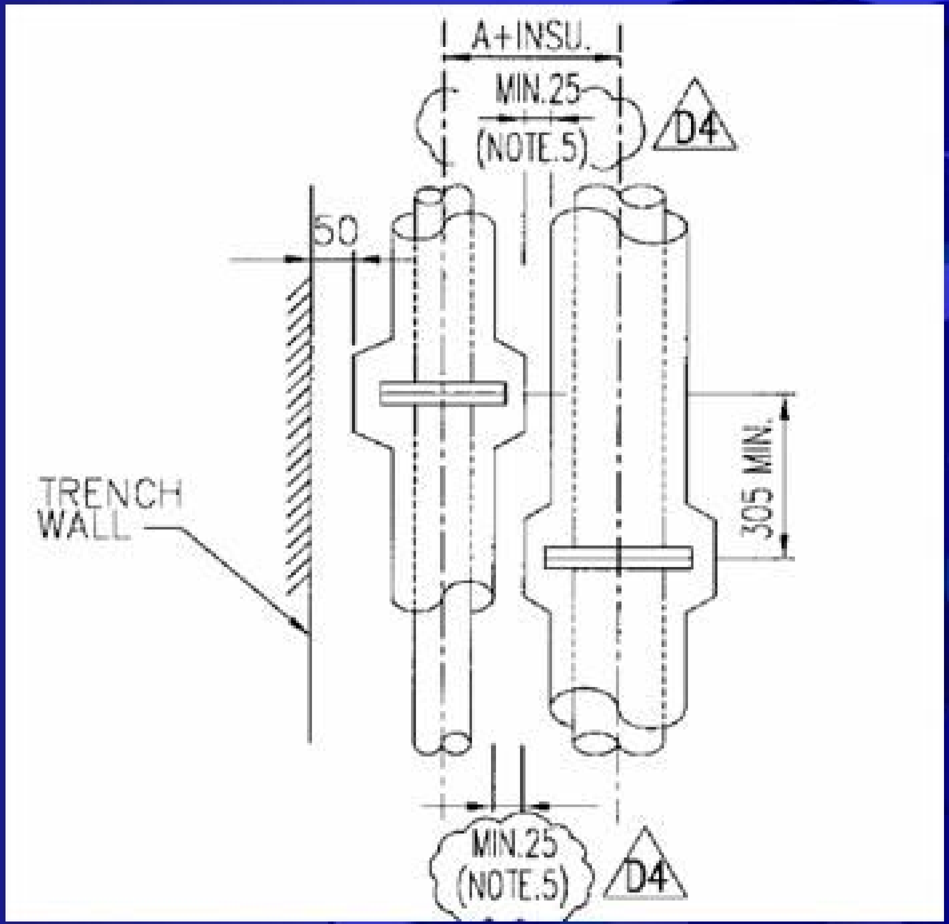
Arrangement:

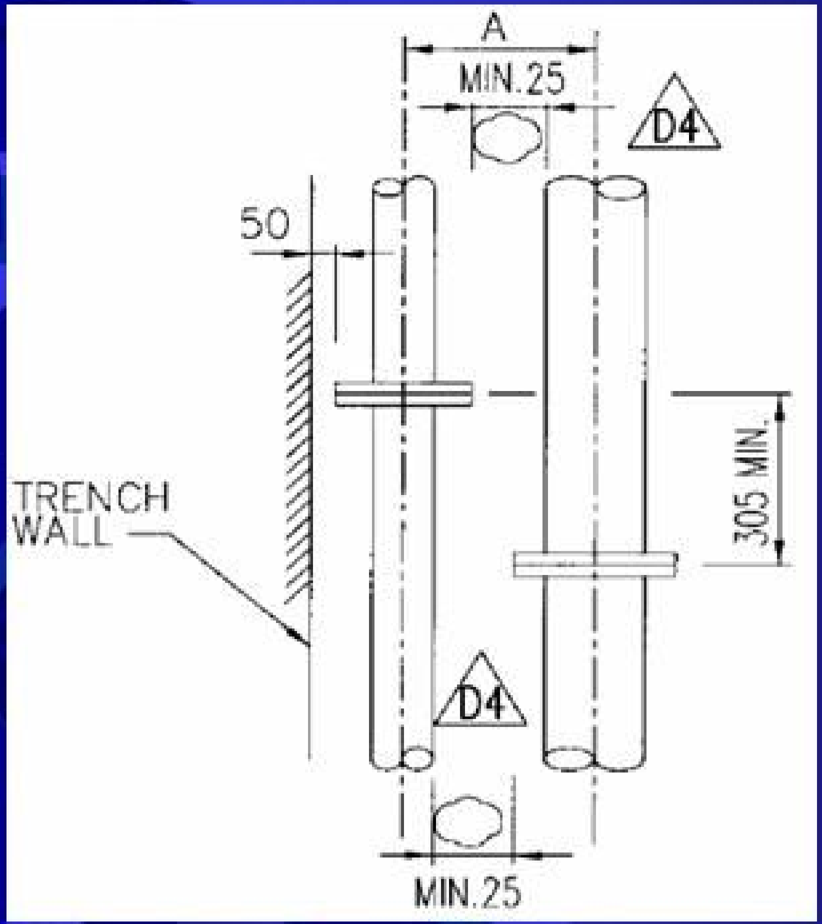
- A relive valve that discharged to into a header should be placed higher than the header in order to drain into it

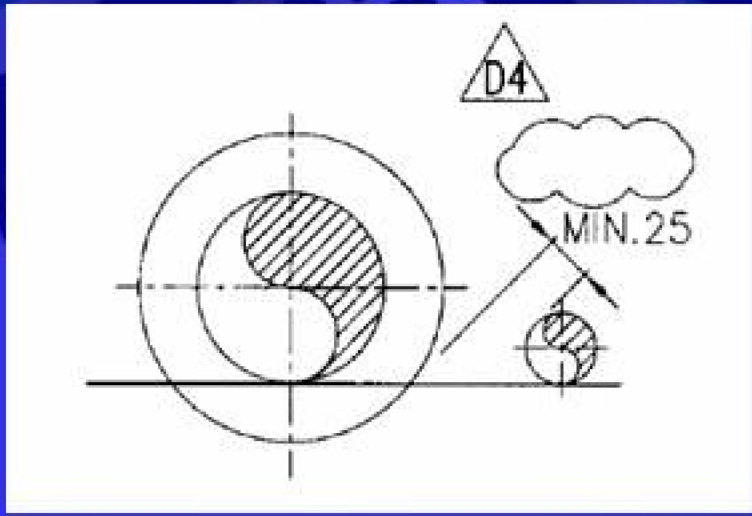


Arrangement:

- Required space between pipes







Pipe Work

- Material work:
  - Fabricate, test, certificate
  - Test (spectrograph), marking
- Storing
  - SS shall be separated from other steels and without any contact to zinc material

- Person who are engaged for
  - Tack welding
  - Welding

    Shall be qualified according to ASME SEC. IX

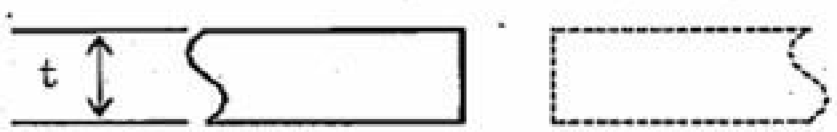
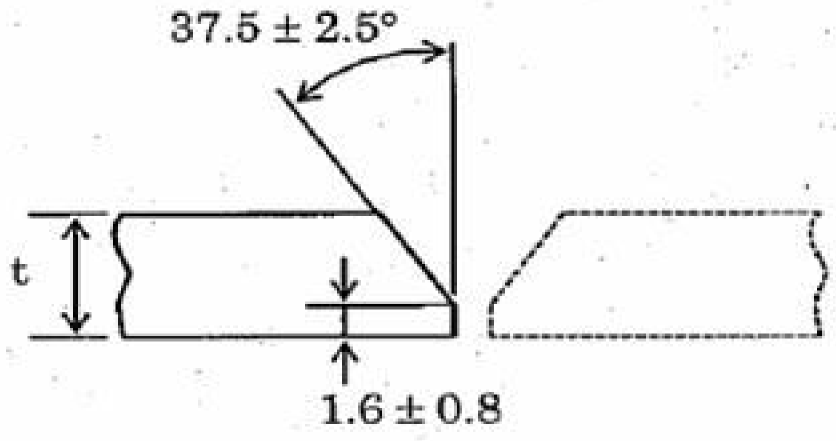
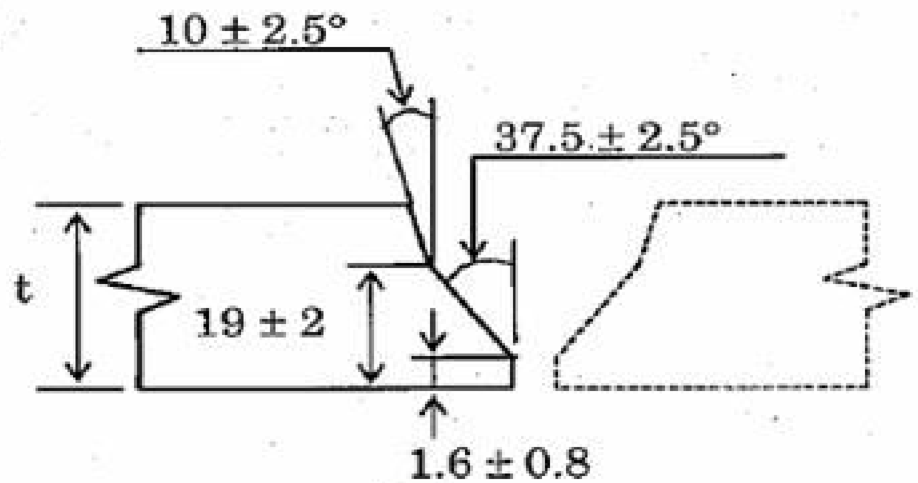
  - Pipe fitting
  - Assembling
  - Erection
  - Control weld temperature

    fully trained and have certificate (license, pass) of employer

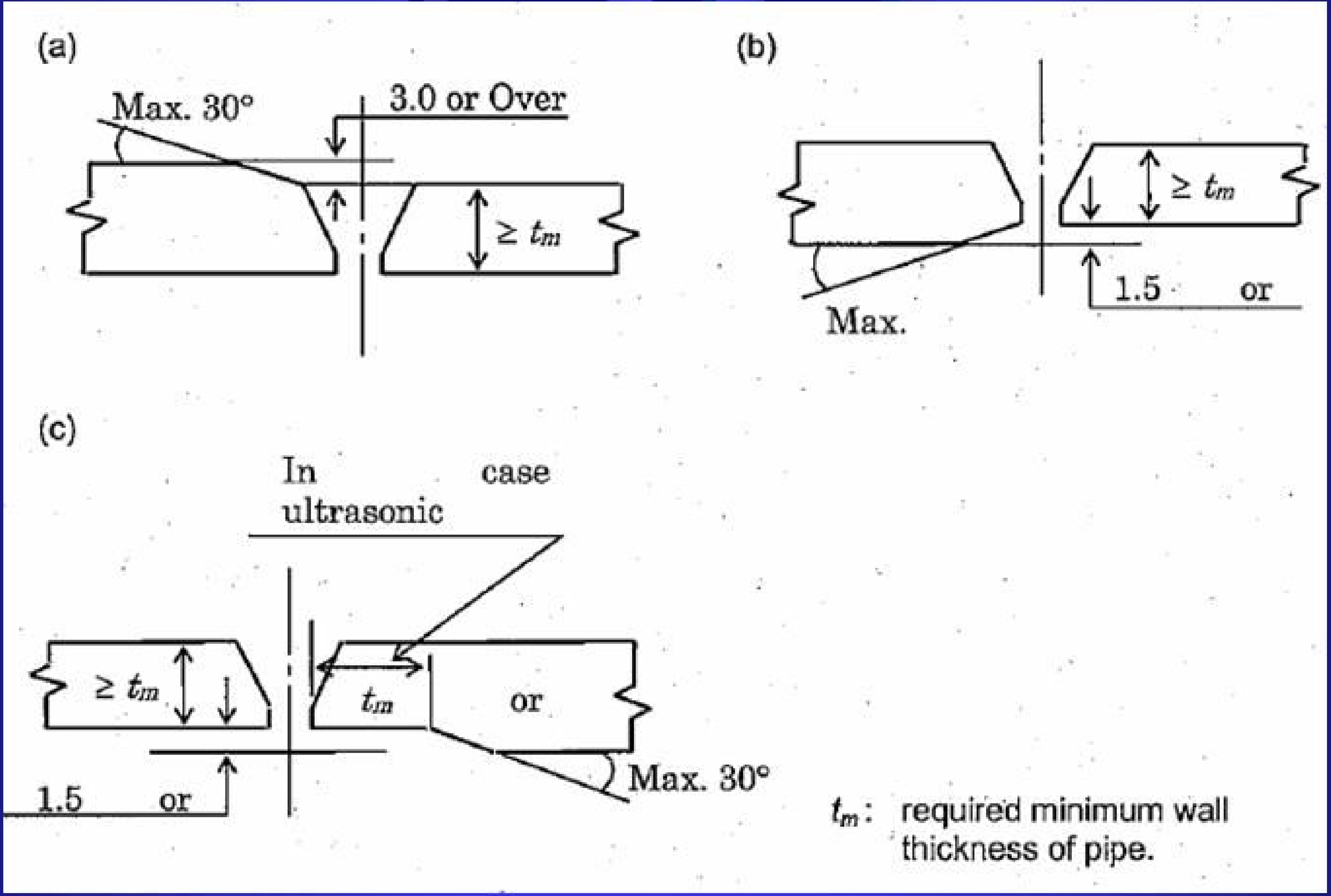
- Cutting method:
  - Shear
  - Milling
  - Planer
  - Flame cutting
  - Flame gouging
  - Arc gouging

- Cutting:
  - In the case of thermal cutting
    - Cutting surface shall be ground to remove any edge and roughness (dross, scale, .. At HAZ) and to be made flush and smooth
    - Cutting slag stuck to the inside of the pipe shall be completely removed
    - After thermal cutting
      - Machining for C.S, SS not require
      - for other material required (3 mm of HAZ)
  - In the abrasive disk case
    - Abrasive disk for SS shall not be used for C.S or vise verse
  - Plasma jet cutting may be applied for SS, etc

- End preparation:
  - According to WPS

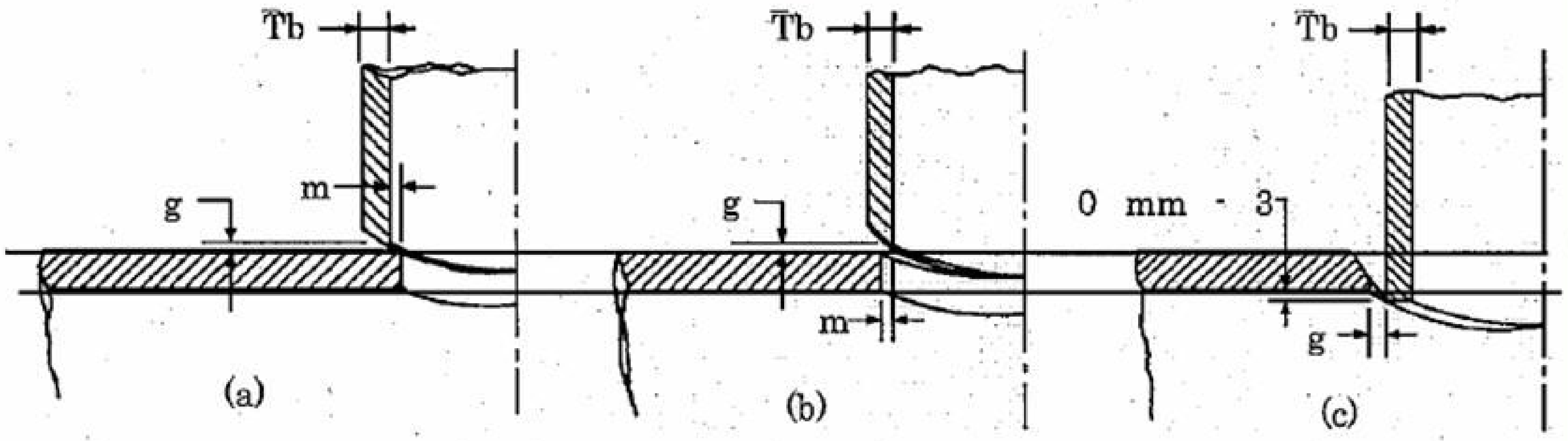
Thickness of Pipe	Type of End	Shape of Groove
t < 3	I	
t ≤ 22	V	
t > 22	Double-V	

- Trimming:
  - When having unequal wall thickness (the difference is more than 3 mm for outer surface and/or 1.5 mm in inner surface



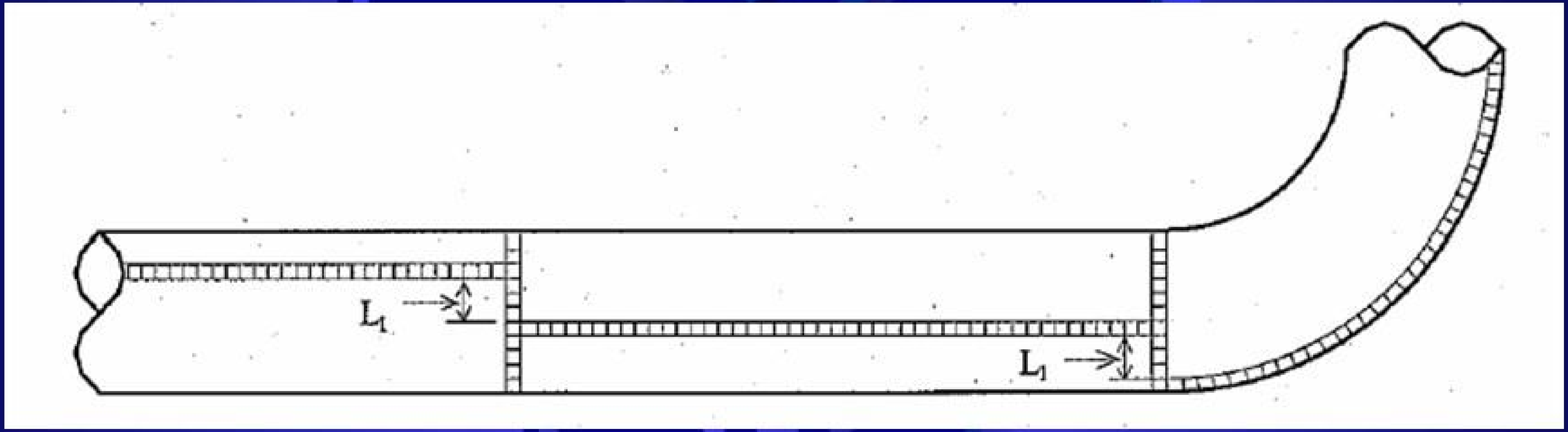
t_m: required minimum wall thickness of pipe.

- Trimming for making branch connection
  - Shall be inserted at least as far as the inside surface of pipe run



g = Root gap per WPS
m = The lesser of 3.2 mm or 0.5 Tb

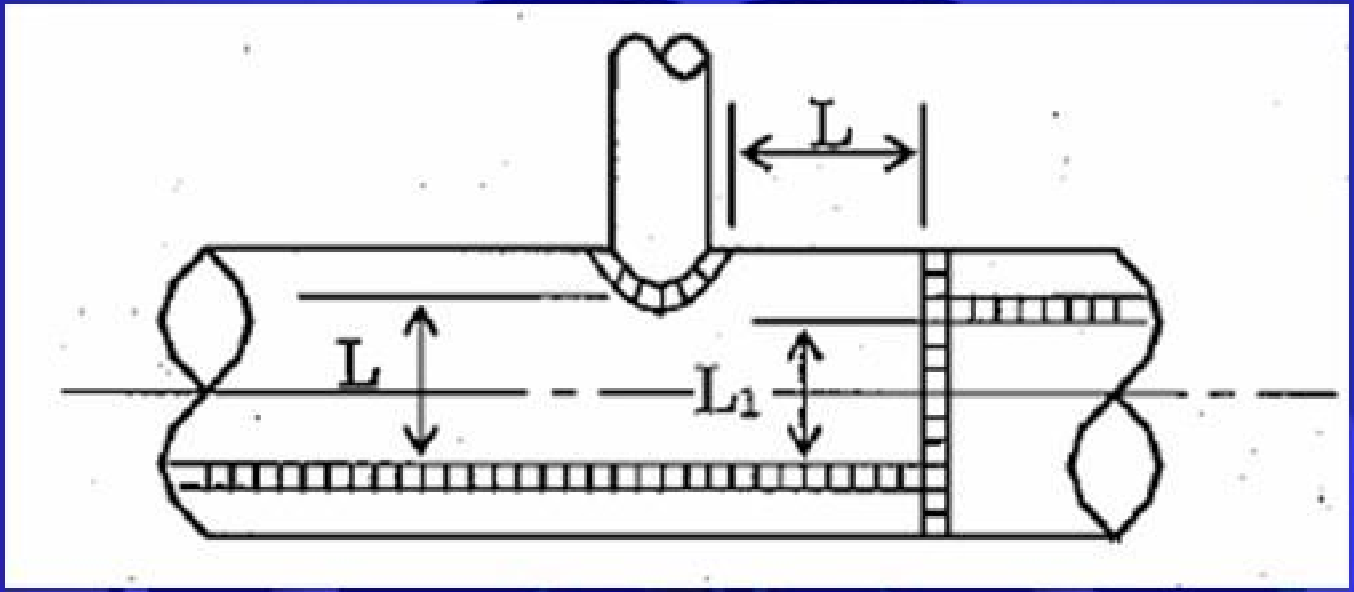
- Alignment:
  - When a pipe having a longitudinal seam is used in a horizontal line, the pipe shall be laid so that the longitudinal weld seam is not on bottom or top of the pipe

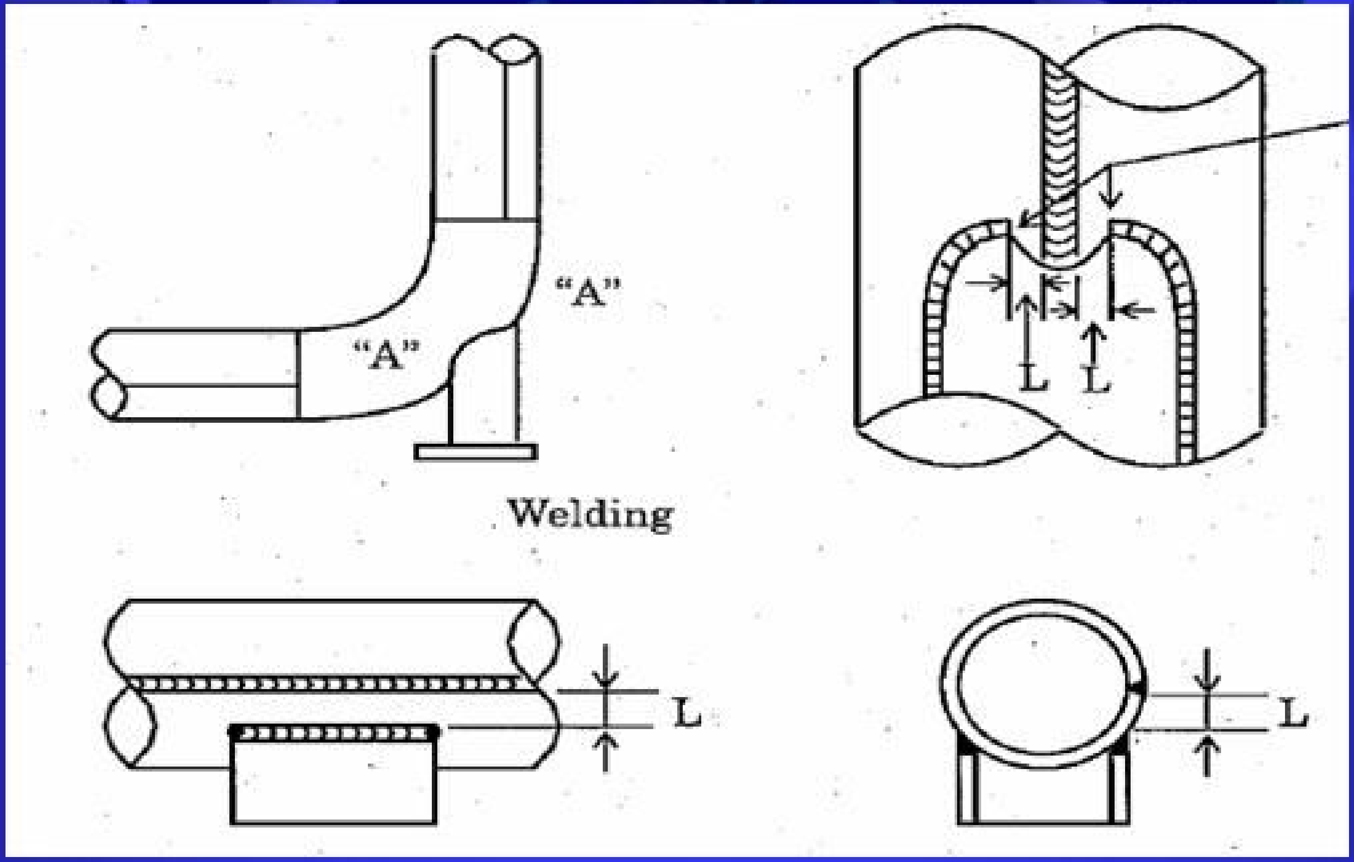


L shall be three times the pipe thickness or over.

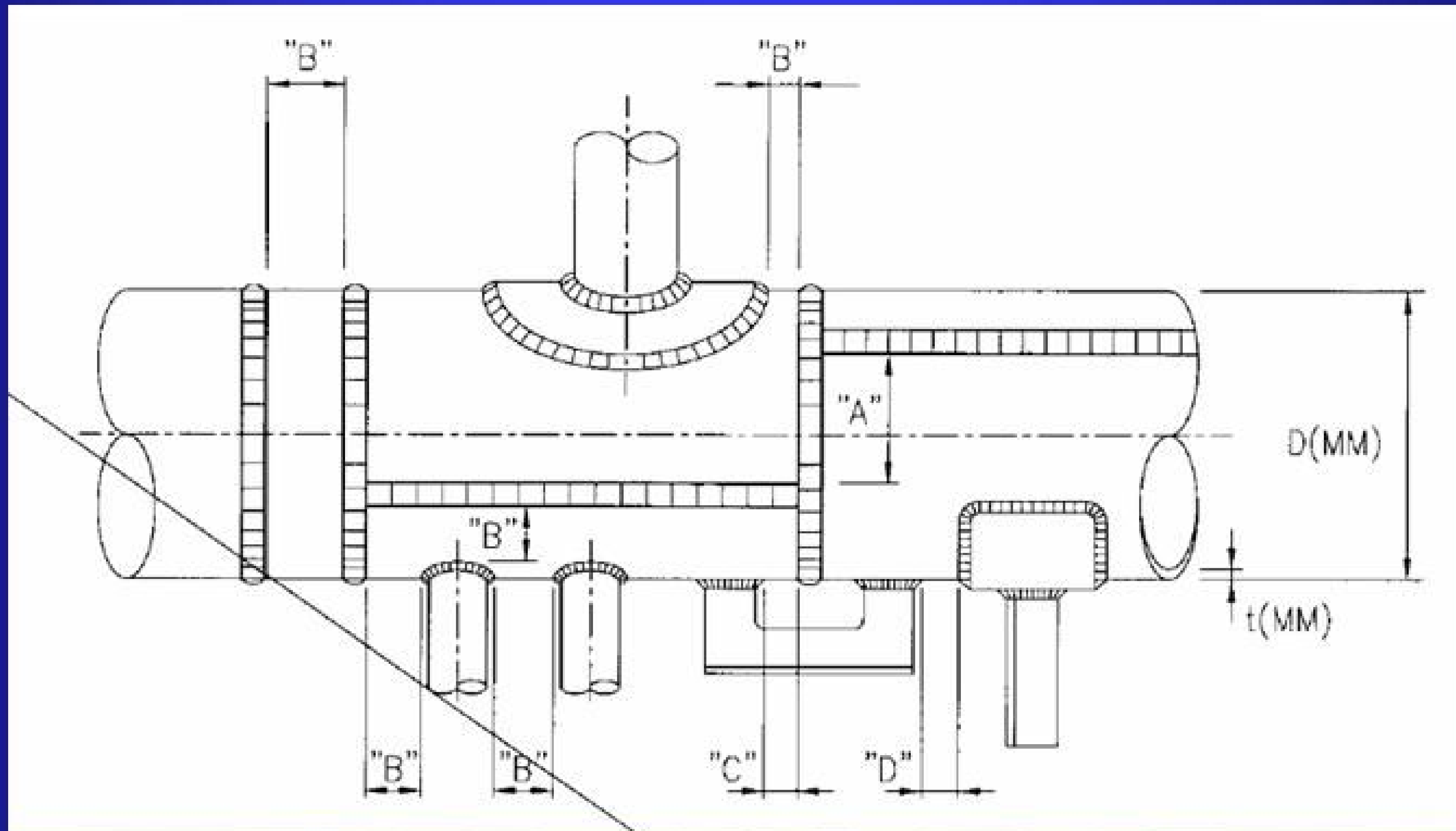
L_1 shall be five times the pipe thickness or over.

Pipe work





Pipe work



DESCRIPTION OF WEDL TYPE	MINIMUM DISTANCE BETWEEN WELD TOES (WHICHEVER IS GREATER)
"A"	120° OR √(DT) OR 5t(1)
"B"	120° OR √(DT) OR 5t(1)
"C"	100MM OR 2t(3)
"D"	50MM OR 2t

- To measure root opening use taper gauge

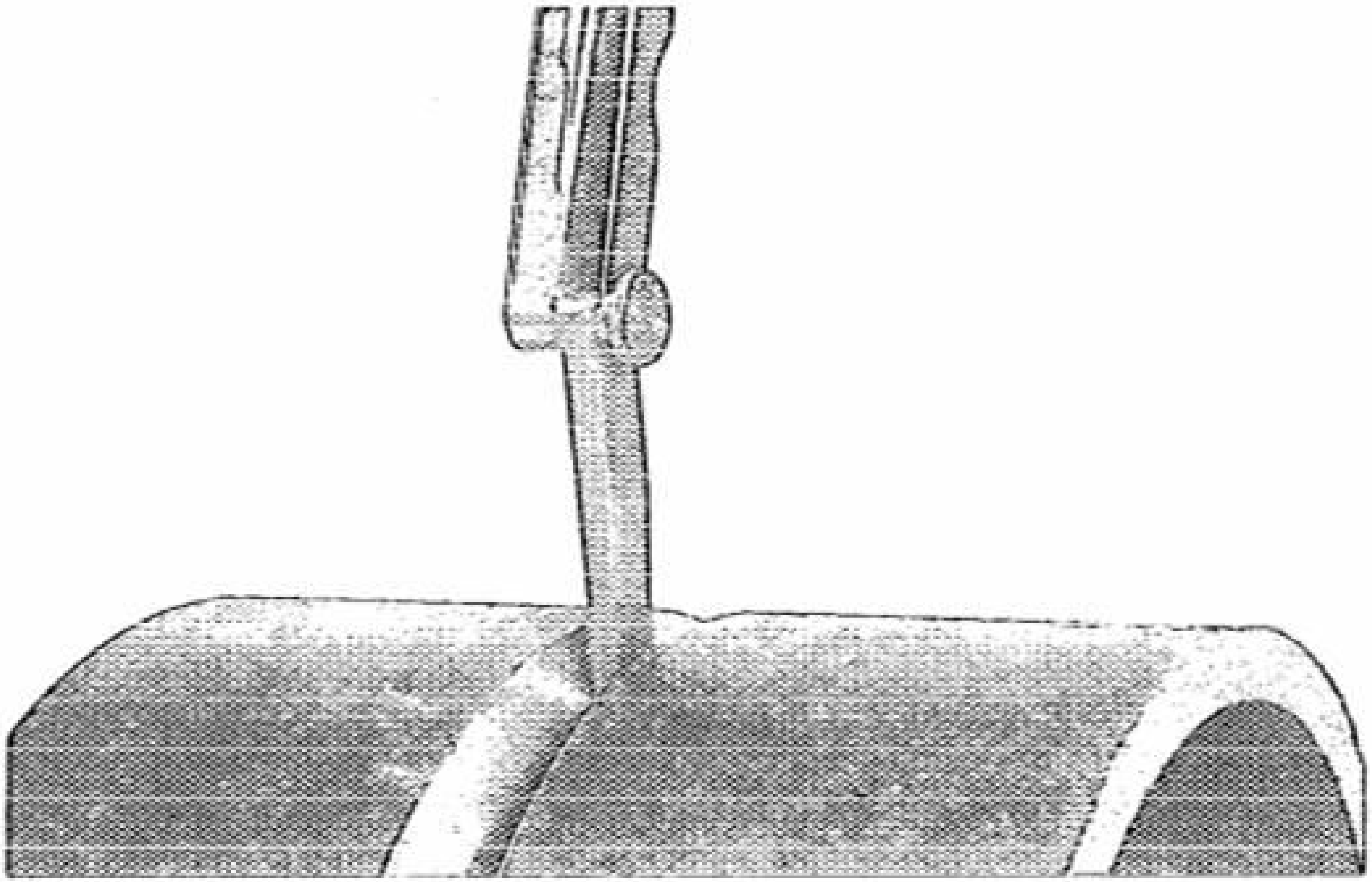


Figure 43 — A Taper Gage

- To measure internal misalignment of joint use hi-low mismatch gauge
  - T > 19 mm, 2.5 mm
  - T < 19 mm, 1.6 mm

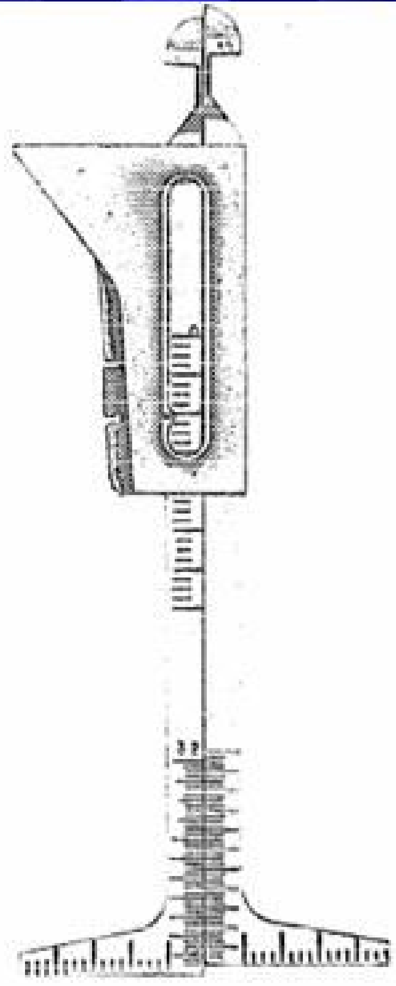
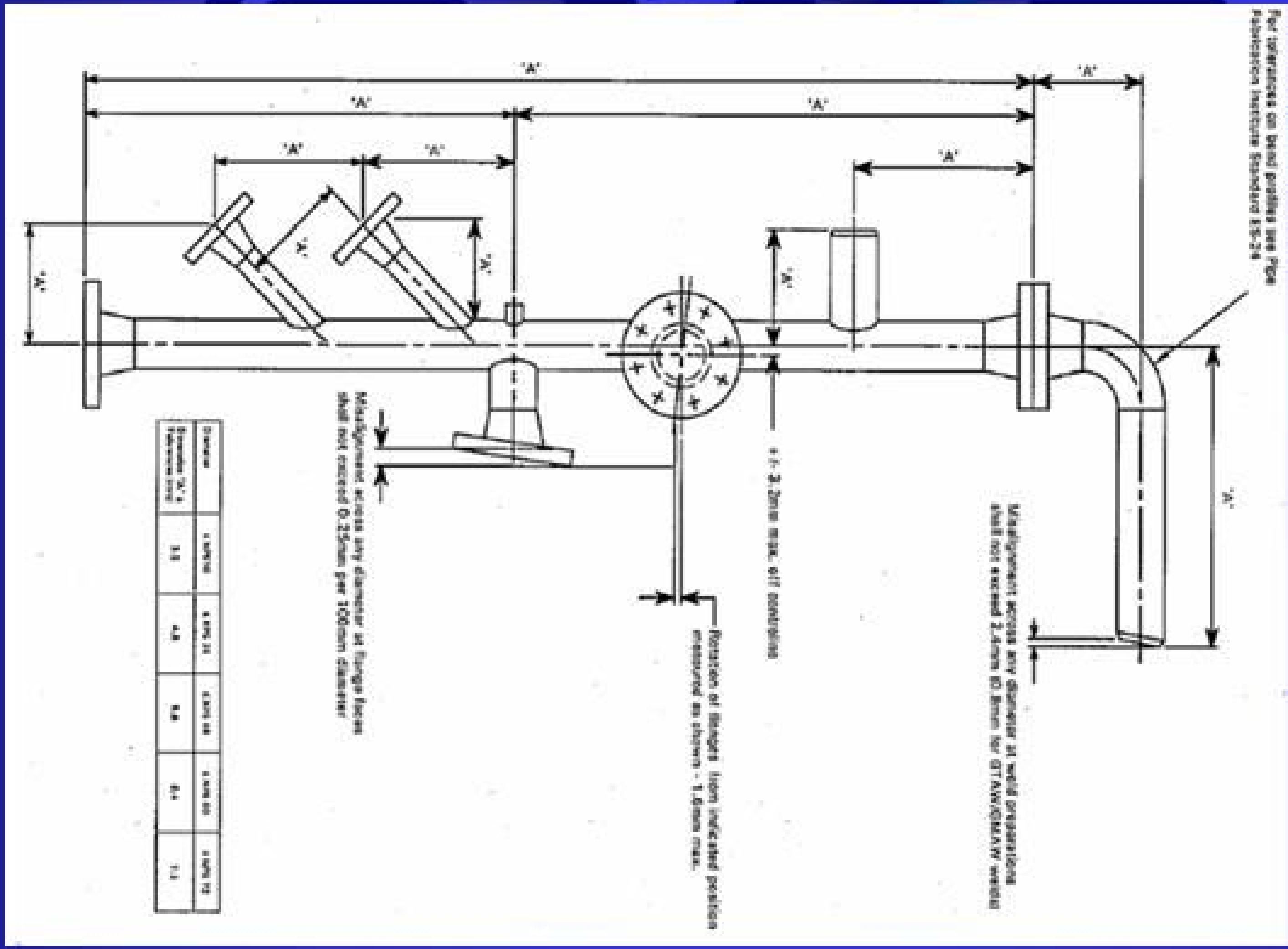


Figure 44 — Hi-Lo Mismatch Gage

Tolerance:

Misalignment across any diameter at weld preparations shall not exceed 2.4mm (0.8mm for GTAW/GMAW welds)

Misalignment across any diameter at flange faces shall not exceed 0.25mm per 100mm diameter



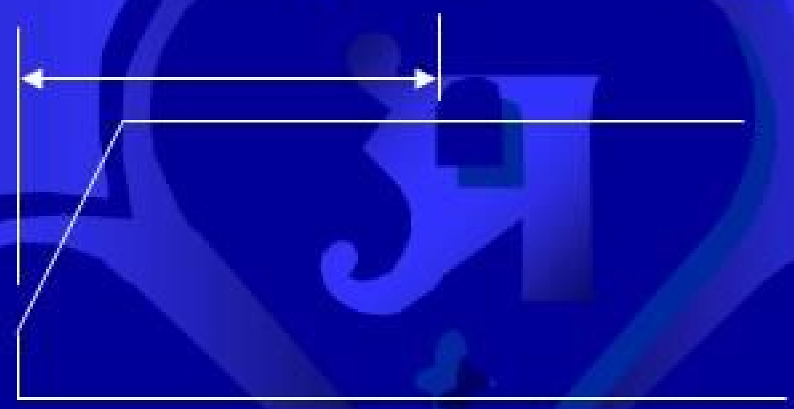
Diameter	≤ NPS10	≤ NPS 36	≤ NPS 48	≤ NPS 60	≤ NPS 72
Dimension 'A' ± Tolerances (mm)	3.2	4.8	5.6	6.4	7.2

- cleaning:
  - The bevel shall be fully clean so that there is no rust, oil, grease, … (50 mm from bevel edge)
    - Solvent:
      - Non-injurious to the material
      - Halide free
  - Material of wire brush shall be properly selected for working CS and SS respectively
    - Iron free
    - Grinding wheel (or disk) shall be organic resin bond

- Preheating:
  - Shall be performed by propane prior to tack welding and welding
  - Valve shall be open during preheating, …
  - Where the ambient temperature is below 5C, preheating temperature = 40 (except Cu-Ni, Ti)

Material Specification		Nominal wall thickness T (mm)	Preheat Temperature (°C)
ASTM	NPS		
API 5L Gr.B A106 Gr.B A333 Gr.6 A671 Gr.B65. CL22 A672 Gr.B60. CL22	ALL	t < 25	Not required (1)
		t ≥ 25	80 and above
A106 Gr. B A333 Gr.6 A671 Gr. B65 CL22	ALL	t < 25	Not required (1)
		t ≥ 25	80 and above
A312.TP. 316L A358.Gr.316L.CL3	ALL	All	Not required (1)
ASTM B466 C70600 90-10CuNi	ALL	All	Not required
TITANIUM	ALL	N/A	N/A

- Preheating:
  - Extend 50 mm or 4T beyond each edge



  - Temperature measure by surface thermometer or crayons

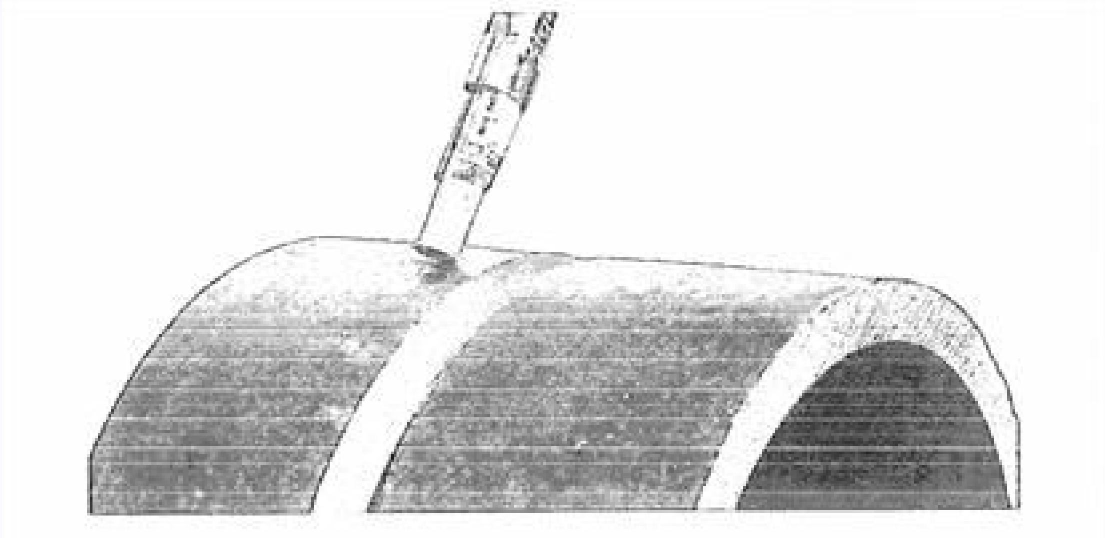


Figure 37 — Temperature Sensitive Crayon

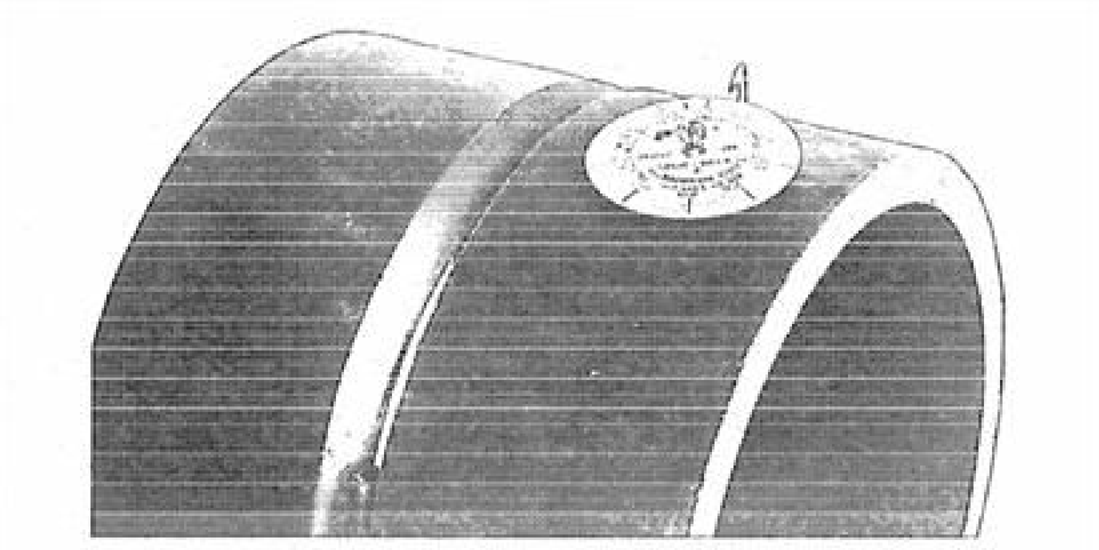
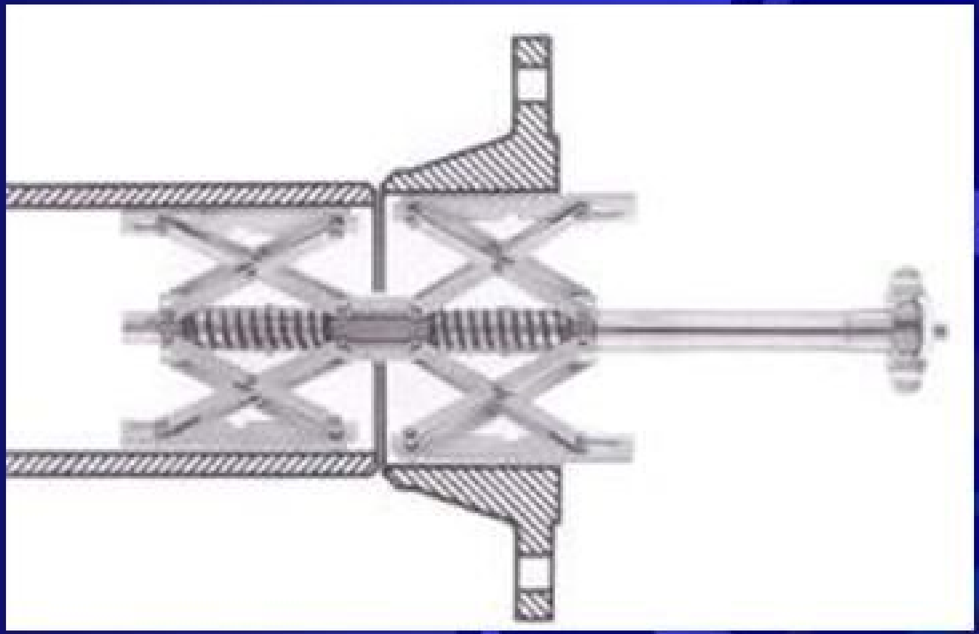
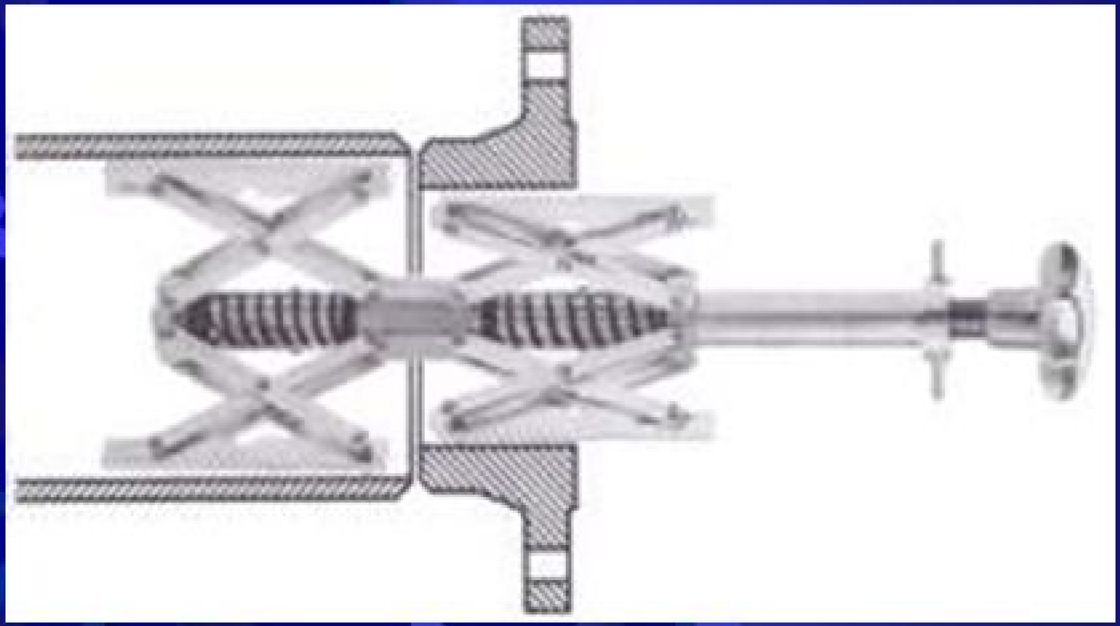


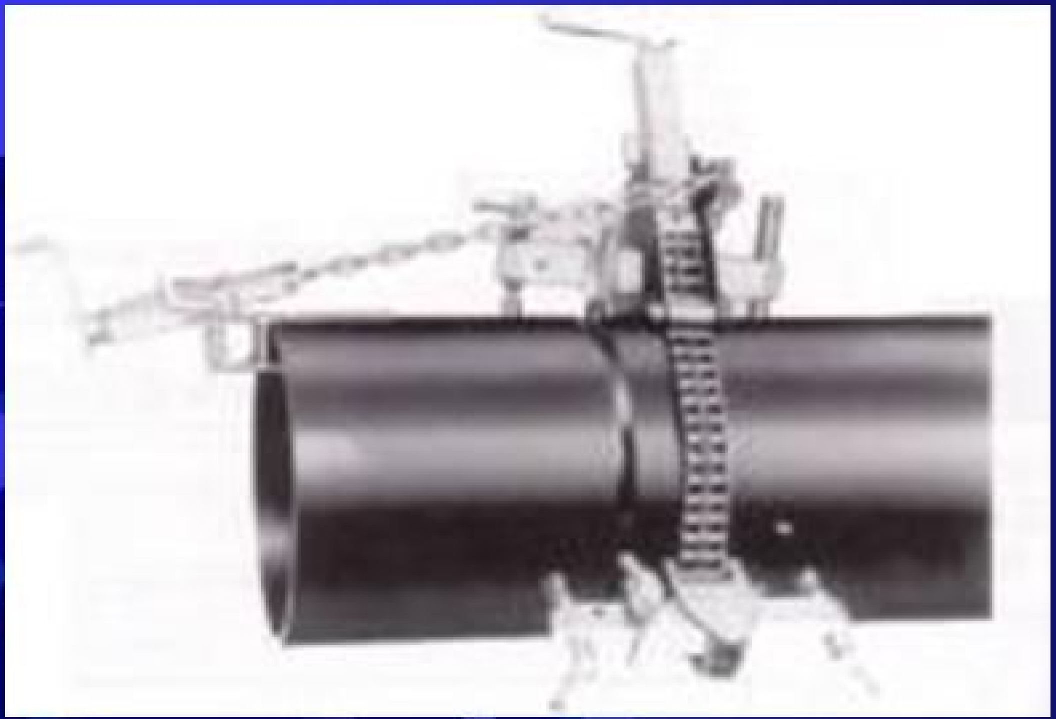
Figure 38 — Surface Contact Thermometers

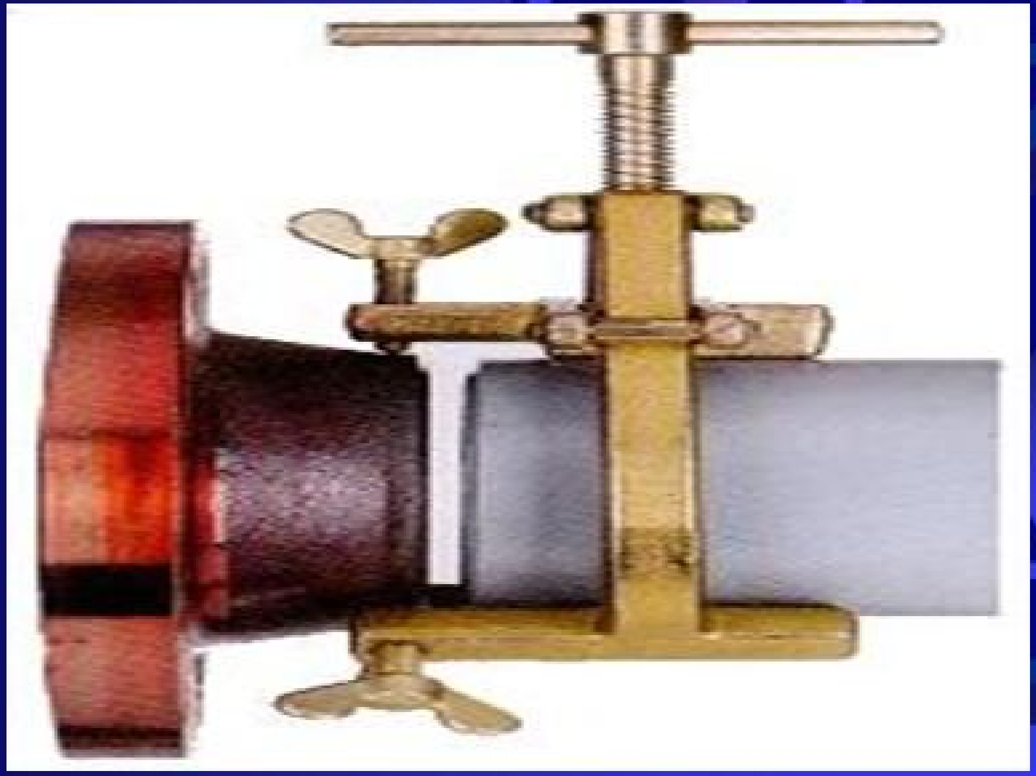
- Preheating:
  - Preheat temperature shall be measured based on 2 minutes per 25 mm thickness

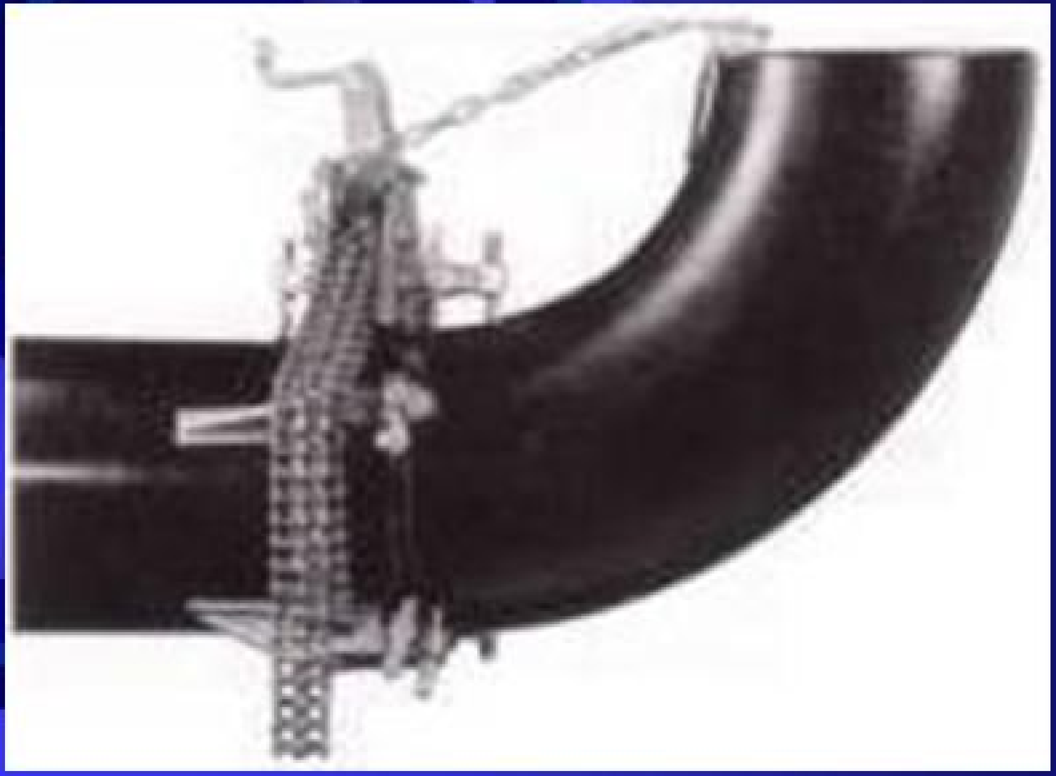
- Tack weld
  - Use internal or external clamps before tack weld

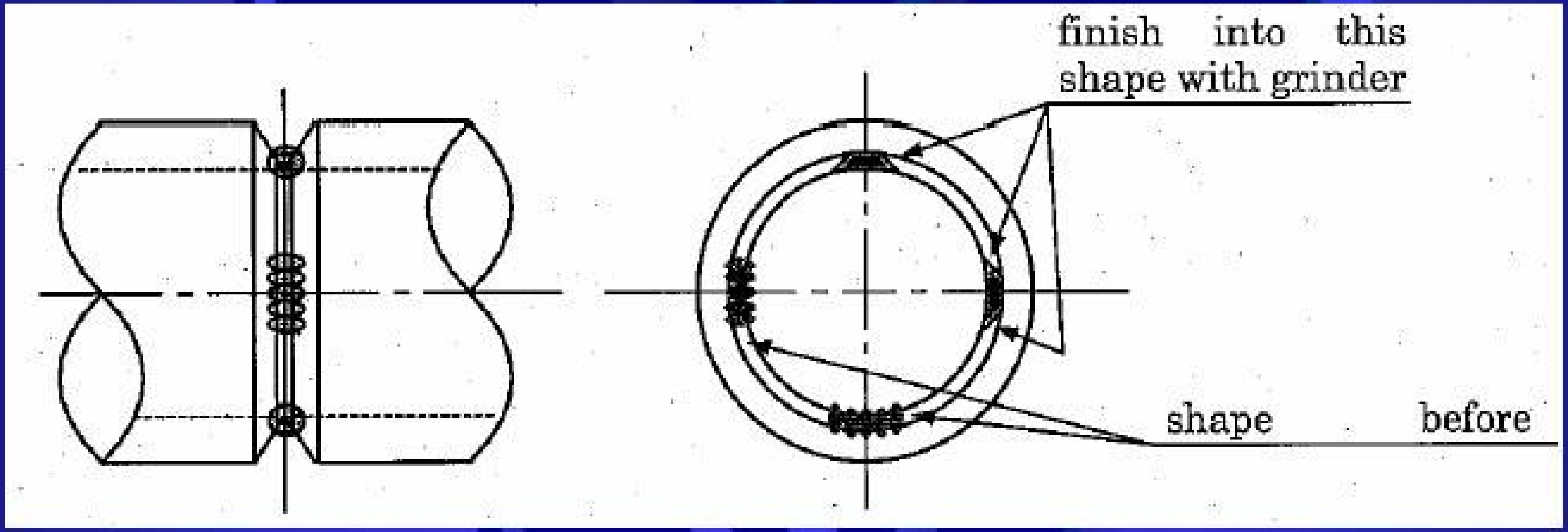

Pipe work







- Tack weld
  - Ensure the contact surface of the clamps are made of same base metal
  - Before welding of the root, both ends of the root tack weld bead shall be prepared with a grinder as shown in the following illustration



  - Type of tack weld
    - Root
    - Bridge (Bridge tack shall never be hammered, removed by grinding or gas cutting)

- Welding:
  - WPS, PQR shall be approved
  - Welder shall be qualified according to ASME SEC. IX
  - All welding processes shall be protected from adverse weather (use shelter)
  - All welding equipment shall be calibrated
  - When preheat is applied, welding shall not be interrupted or stopped until 30% of the final weld has been completed
  - Bolts hole:
    - symmetrically from a vertical center line
    - Symmetrically from plant north

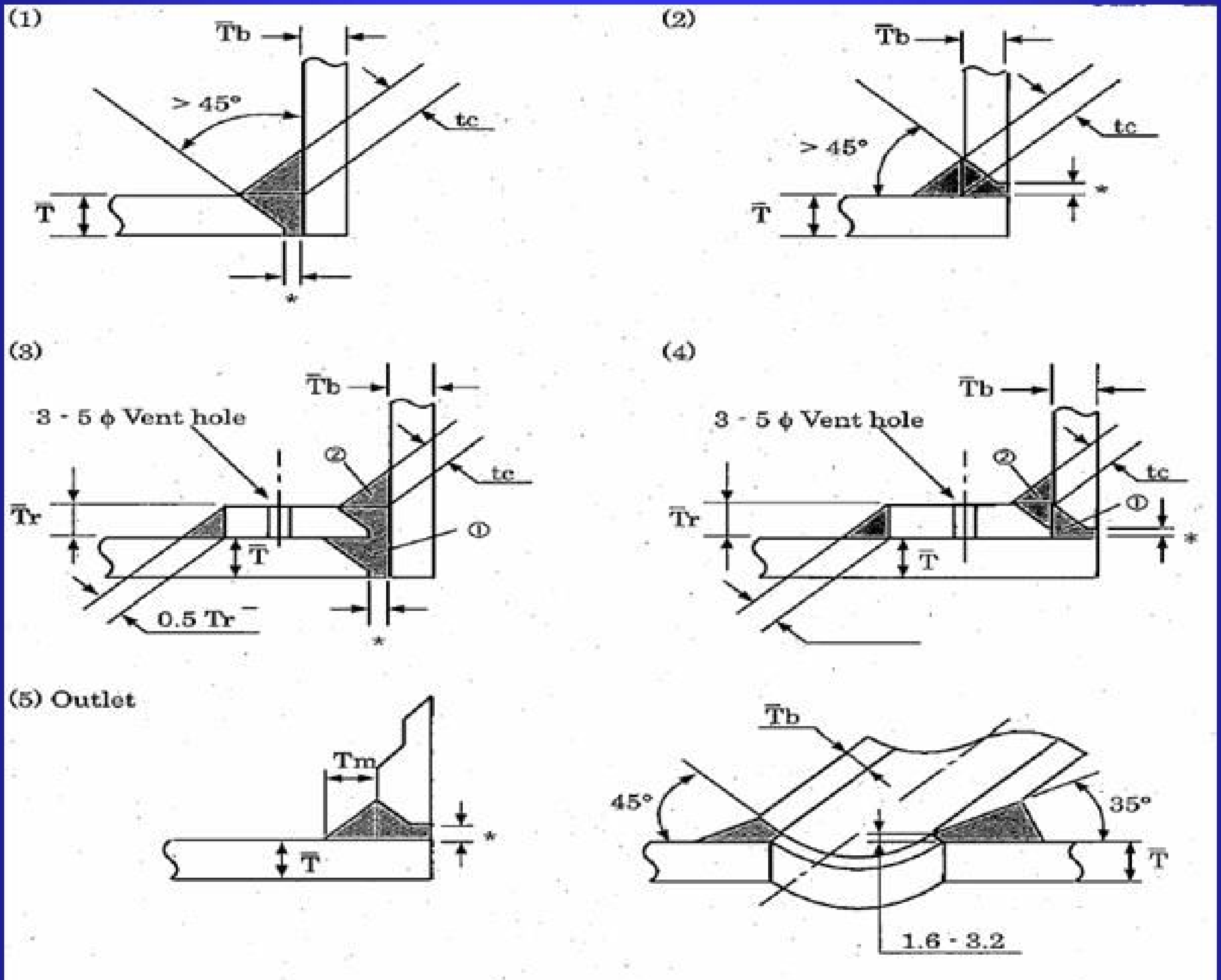
- Welding:
  - Consumable:
    - Consumable manufacture shall be approved by third party
    - Shall be close matching with base metal
    - Control the storage, handling, conditioning
    - Electrode:
      - Low hydrogen electrode stored in oven and don't re-dried more than twice

Materials to be Welded	Carbon Steel	316 L	90-10 Cu-Ni	Titanium
Titanium				D
90-10 Cu-Ni			C	
316 L		B		
Carbon steel	A[5]			

CODE	SMAW	GTAW/GMAW/PAW	SAW	FCAW
A	E60YY[5] E70YY[5]	ER70S-2, -3, -6 [5][6]	F7XX-ELX-EMX [5]	E7XT-X,-XM E70C-3, -6 [5][6]
B	E316L-XX[4]	ER316L[4]	ER316L [4][6]	E316LTX-X [4]
C	ECu-Ni	ERCuNi	ERCuNi	[7]
D	[7]	ERTi2	[7]	[7]

- Welding:
  - Consumable:
    - Purge gas, shielding gas:
      - Check Mixture tolerance, Purity, Dew point
      - moisture < 10 PPM
      - Nitrogen not used for SS
      - Before tack weld and root pass welding monitoring the oxygen content < 5000 PPM
      - Use purge gas for
        - » Thin wall tubing or piping T < 5.5 mm
      - Root pass without backing, single sided for all weld metal

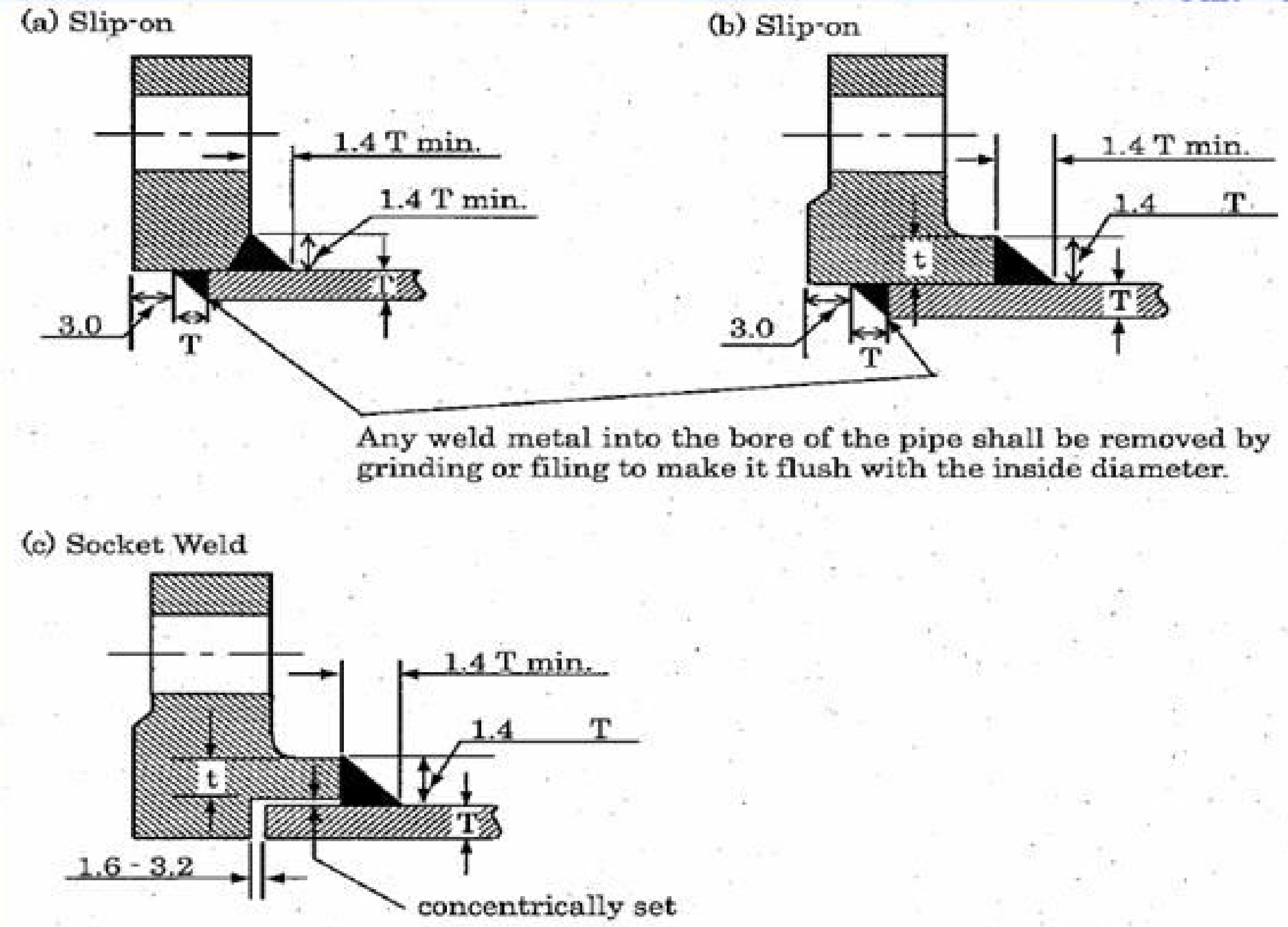
- Use following fitting format:



	Branch Pipe Size	
Tm	≤ 1 ½ NPS	≥ 2 NPS
	≥ 3 mm	≥ 6 mm

* : Specified as per WPS

- Use following fitting format:
  - Perform at least 2 layer weld and end point of weld at each layer shall change



Notes: 1. T: thickness of pipe
t : thickness of flange hub

2. If 1.4 T is larger than t, t shall be taken.

Fig. 5.8.4

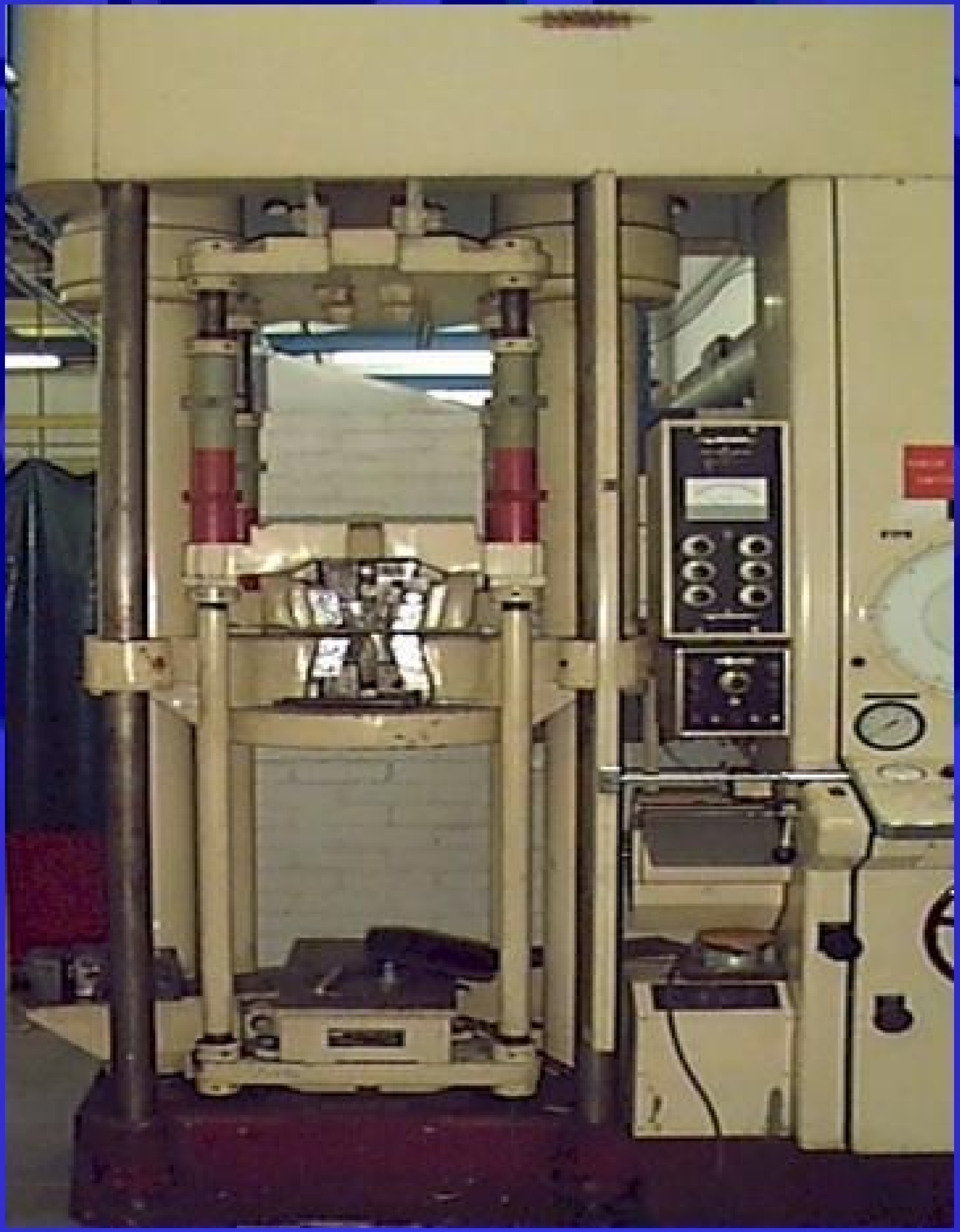
Post Weld Heat Treatment

ASTM Material	Pipe Size (NPS)	Nominal Wall Thickness (1)	Temp (°C)	Holding Period at Temp. (h)	Min Holding Period	Max Heating rate (°C/h) Rh	Max Cooling Rate (°C/H) Rc
API 5L.Gr B A106,Gr B A333 Gr.6 A671 Gr.B65. CL22 A672 Gr.B60. CL22	ALL	> 19mm	593 to 640	2.5min per mm	60min	Rh<220x25/T Max.220 °C/h Min. 55 °C/h	Rc<280 x 25/T Max. 280 °C/h Min. 55 °C/h
A106 Gr,B A333 Gr.6 A671 GR. B65 CL22	ALL	ALL	"	"	"	"	"

D ≤ NPS 4"	• one thermocouple at 12 o'clock position
NPS 4" < D ≤ NPS 12"	• one thermocouple at 12 o'clock position and one at 6 o'clock position
D ≥ NPS 12"	• four thermocouples equally spaced around circumference

- Weld Test include:
  - Tensile
  - Bending
  - Impacting
  - Hardness

- Material is sectioned and edges rounded of to prevent cracking. Punch marks are made to see elongation.

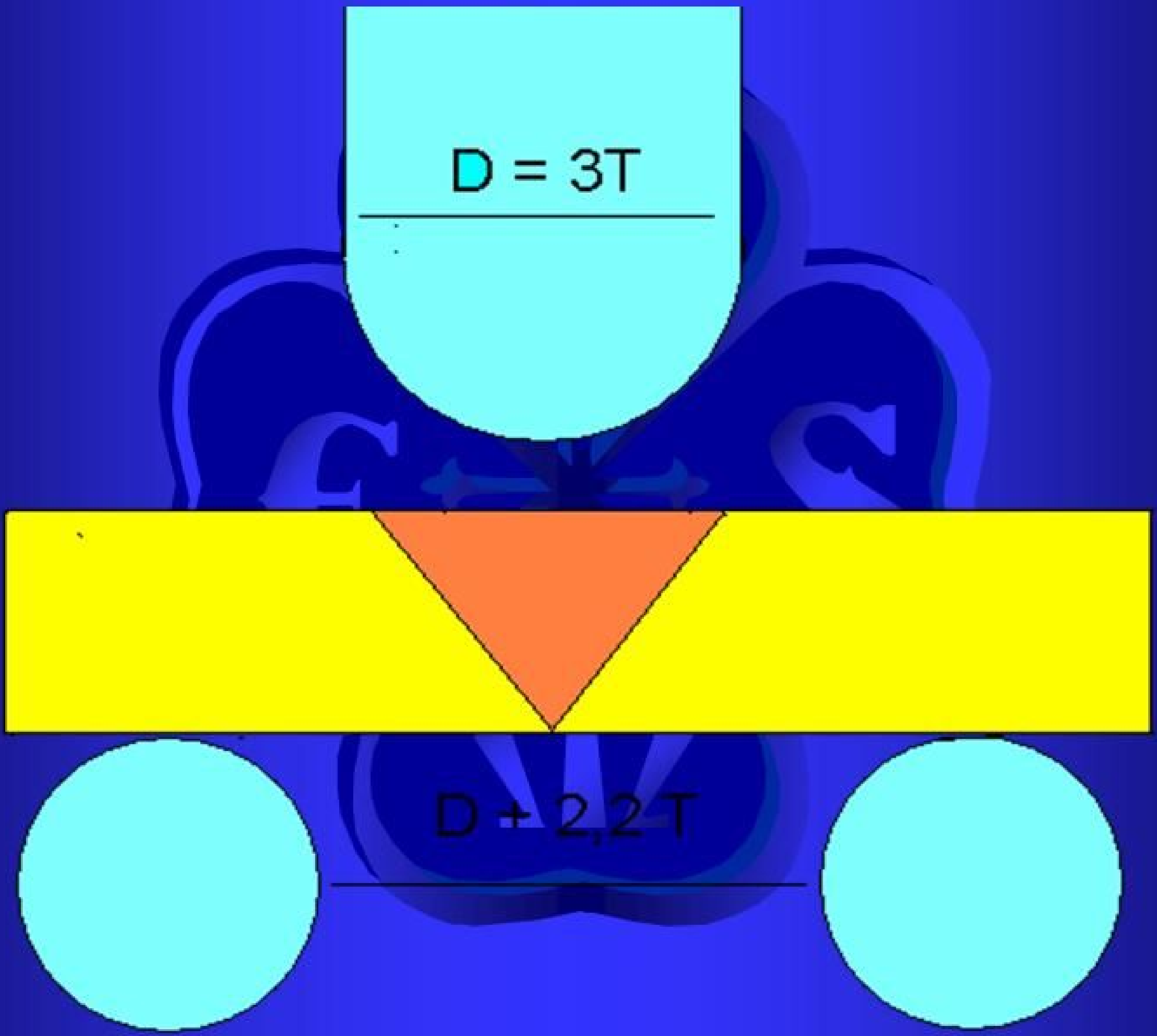


Pipe work: Tensile

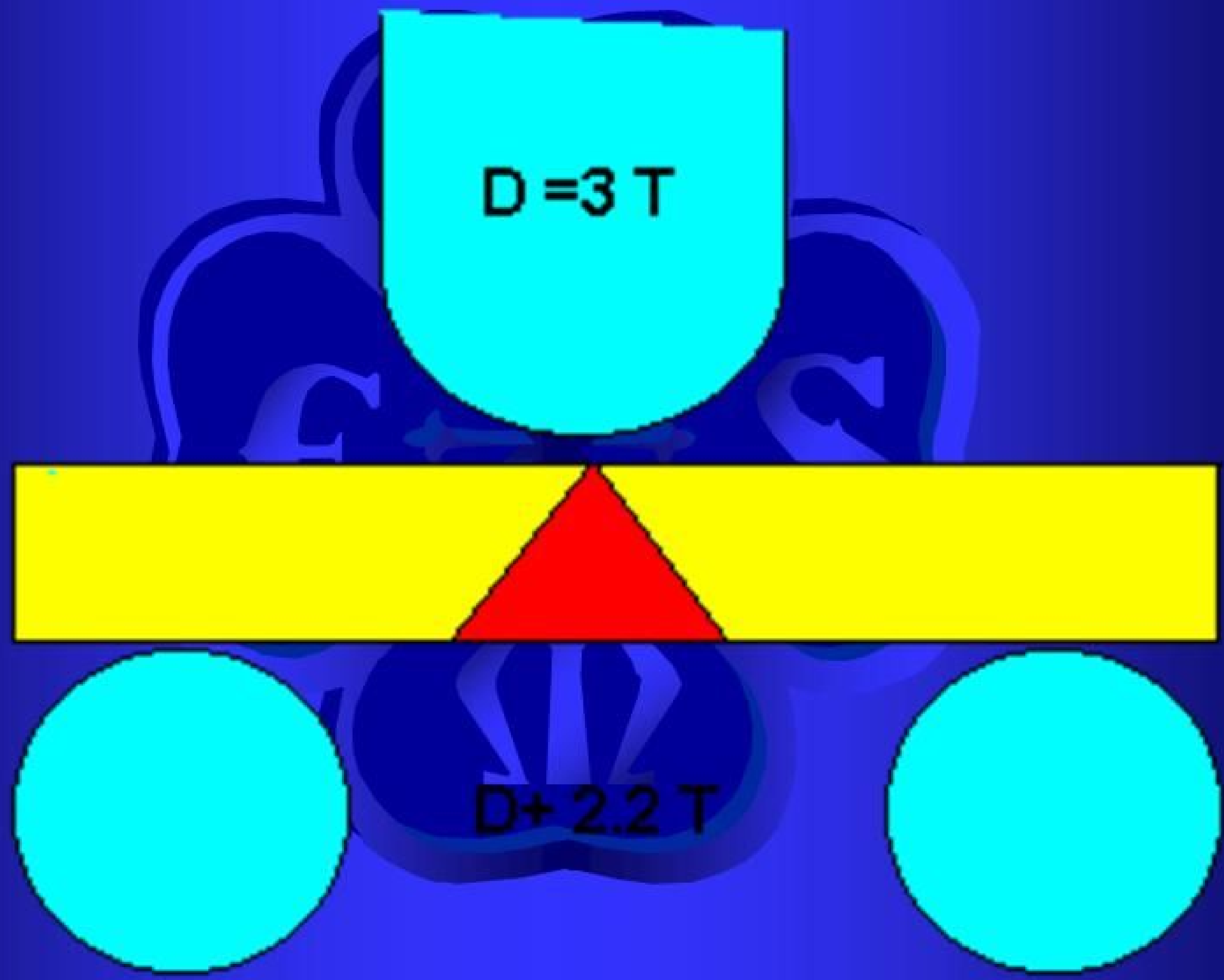
- Shows physical condition of the weld and Determine welds efficiency
  - Tensile strength
  - Ductility
  - Fusion and penetration

- Bend through 180°
- the specimen should be a minimum of 30mm wide
- The fulcrums diameter is 3x thickness of the plate
- The bottom rollers have a distance of the diameter of the former + 2.2 times the thickness of the plate
- Upper and lower surfaces ground or filed flat and edges rounded off.
- the tests should be one against the root -another against the face ,and in some cases a side bend.

Pipe work: Bend test



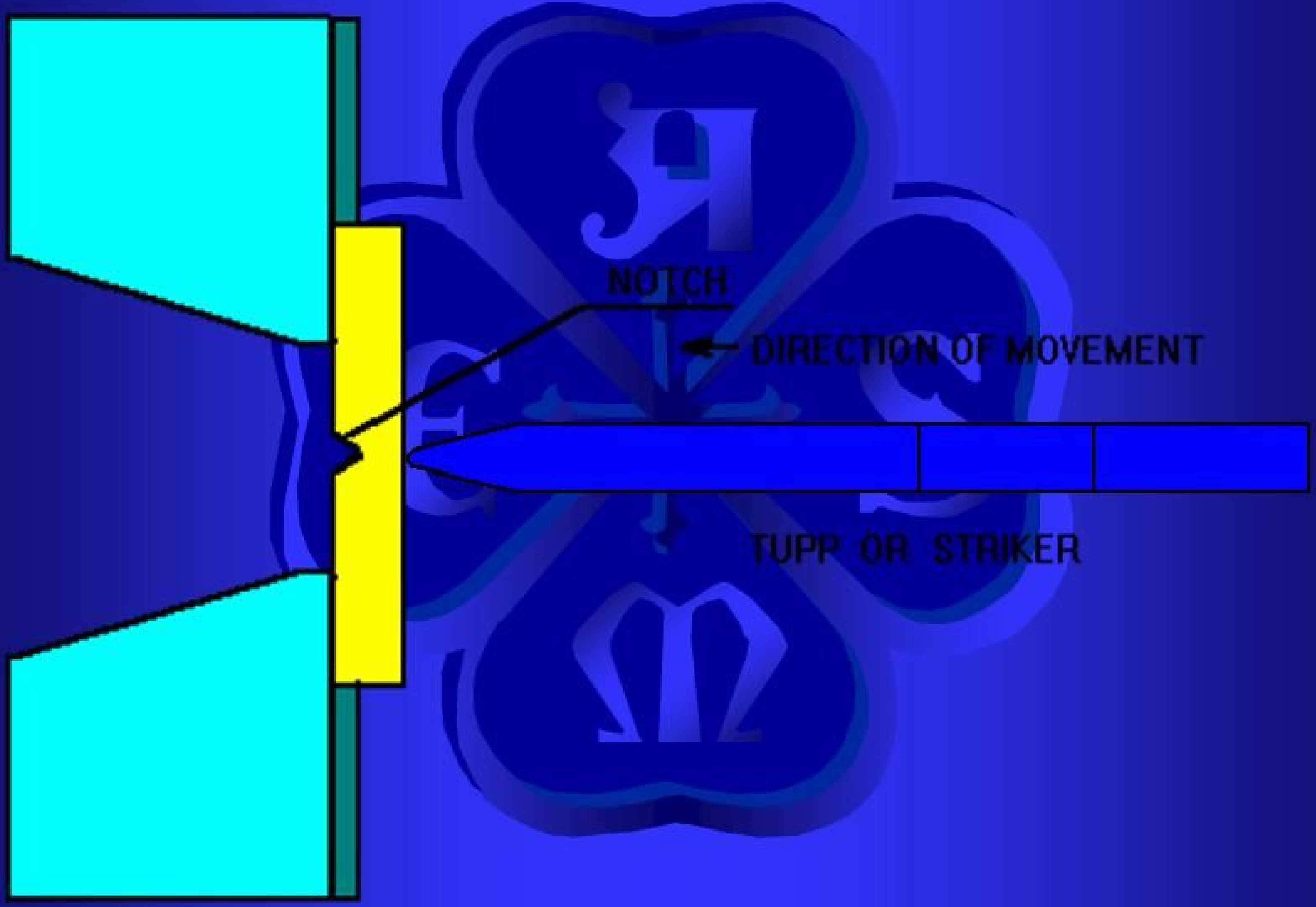
Pipe work: Bend test: face bend



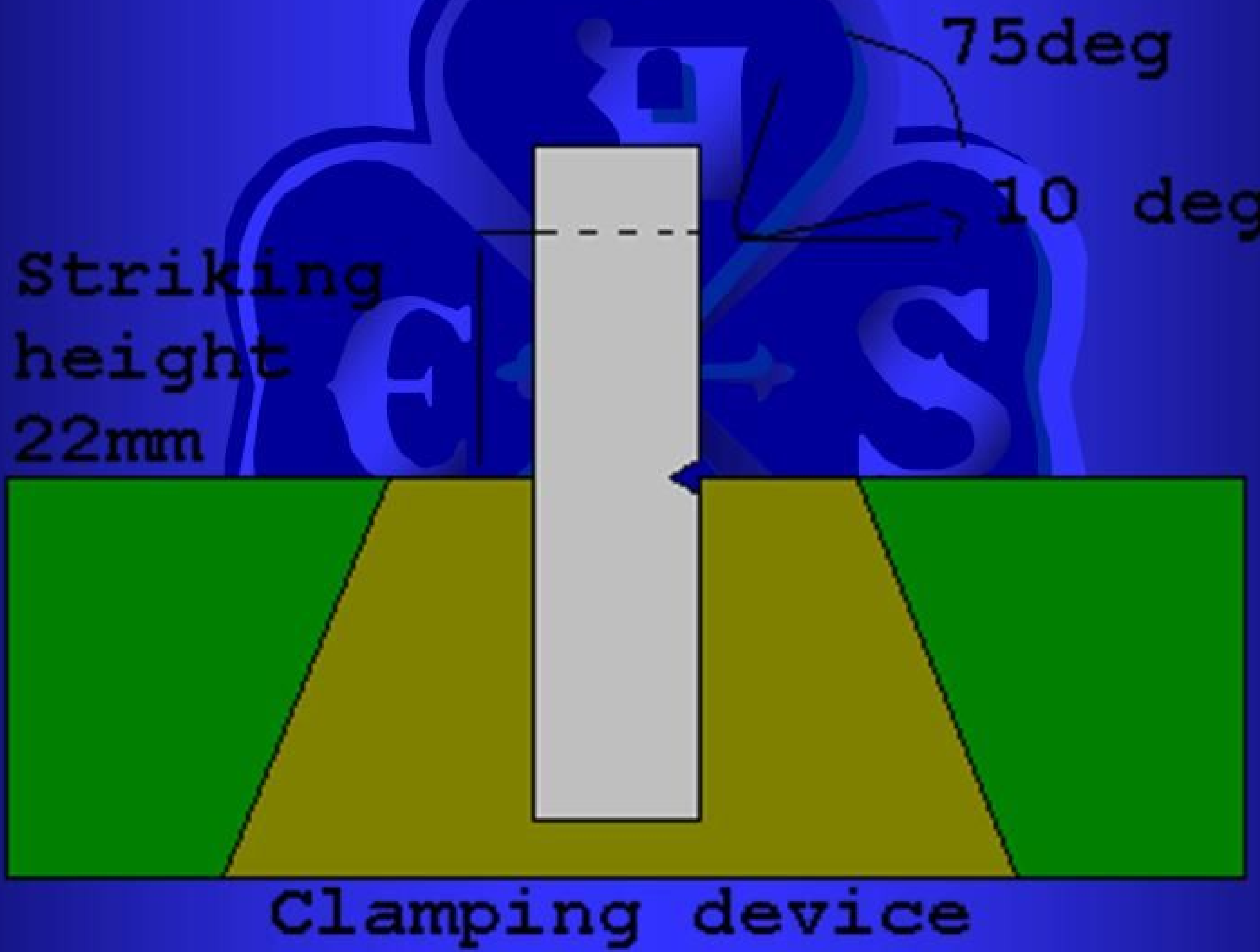
- CHARPY AND IZOD:
  - Gives the toughness and shock loading of the material and weld at varying temperatures with a notch such as under cut
  - The measurement is the energy required to break a specimen with a given notch
  - 2mm depth at a 45° bevel or a “U” notch.

Pipe work: Impact: charpy

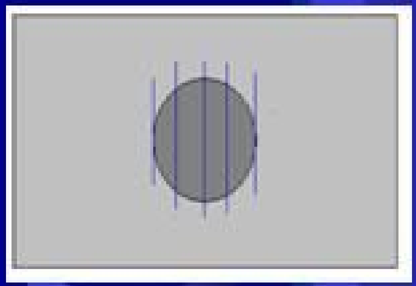
Pipe work: Impact: charpy

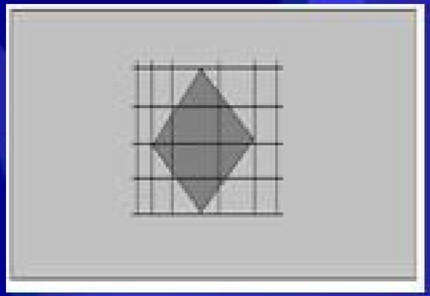


Pipe work: Impact: Izod



- This gives the metals ability to show resistance to indentation which show it's resistance to wear and abrasion.





Design

- **ASME B31.3 provides requirements for:**
  - Design
  - Materials
  - Fabrication
  - Erection
  - Inspection
  - Testing

- **process plants including**
  - Petroleum refineries
  - Chemical plants
  - Pharmaceutical plants
  - Textile plants
  - Paper plants
  - Semiconductor
  - plants
  - Cryogenic plants

- ASME B31.3 applied to piping and piping components of all fluid services:
  - Raw, intermediate, and finished chemicals
  - Petroleum products
  - Gas, steam, air, and water
  - Fluidized solids
  - Refrigerants
  - Cryogenic fluids

ASME B31.3: Scope exclusions specified

- The following are excluded from the scope of ASME B31.3
  - Piping system that design according to BPV and other B31
  - .

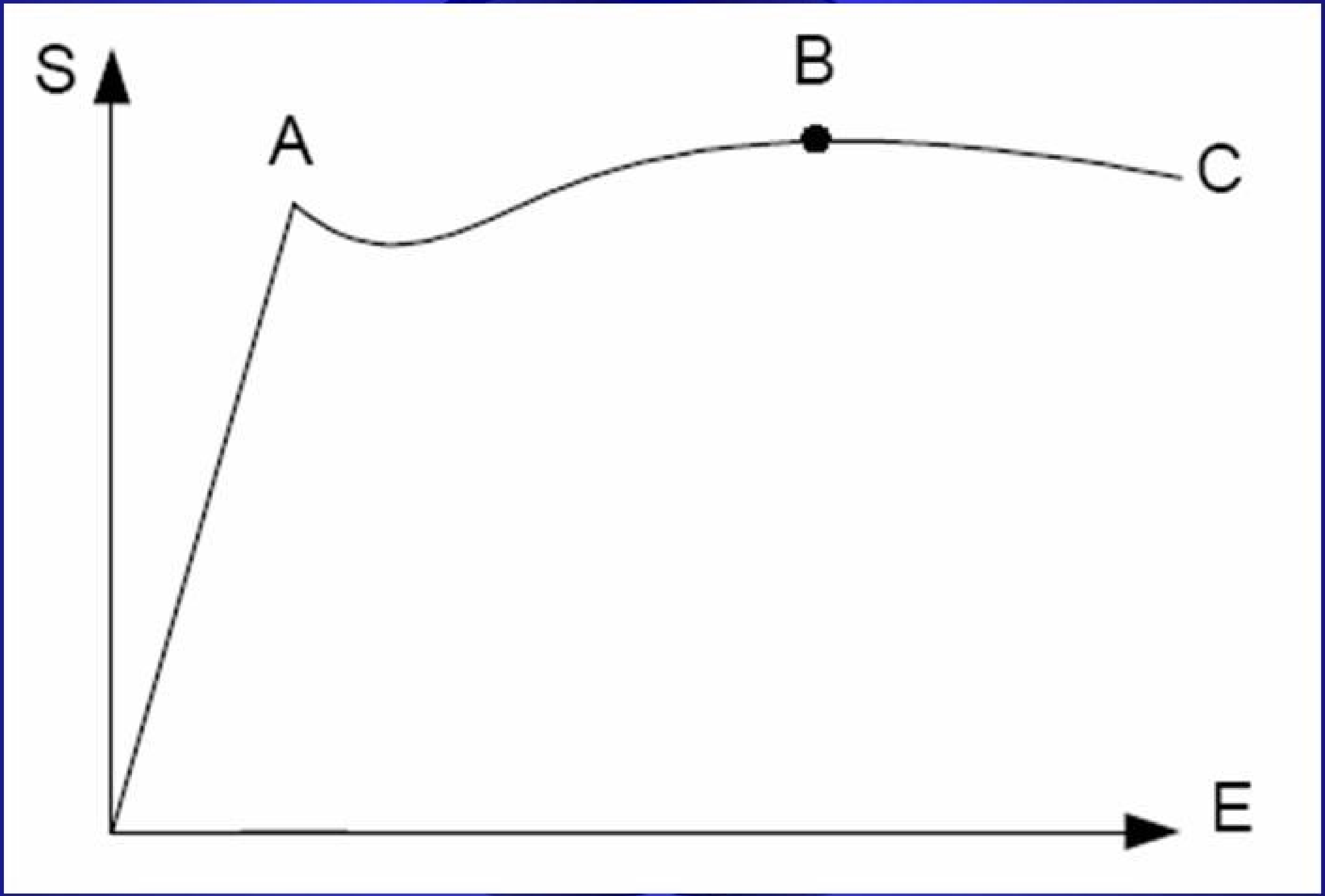
$$\begin{cases} 0 < P_g < 15 \text{ psi} \\ \text{nonflammable} \,\&\, \text{nontoxic} \\ 20\ {}^0\text{F} < T < 366\ {}^0\text{F} \end{cases}$$

This item not exclude vacuum system

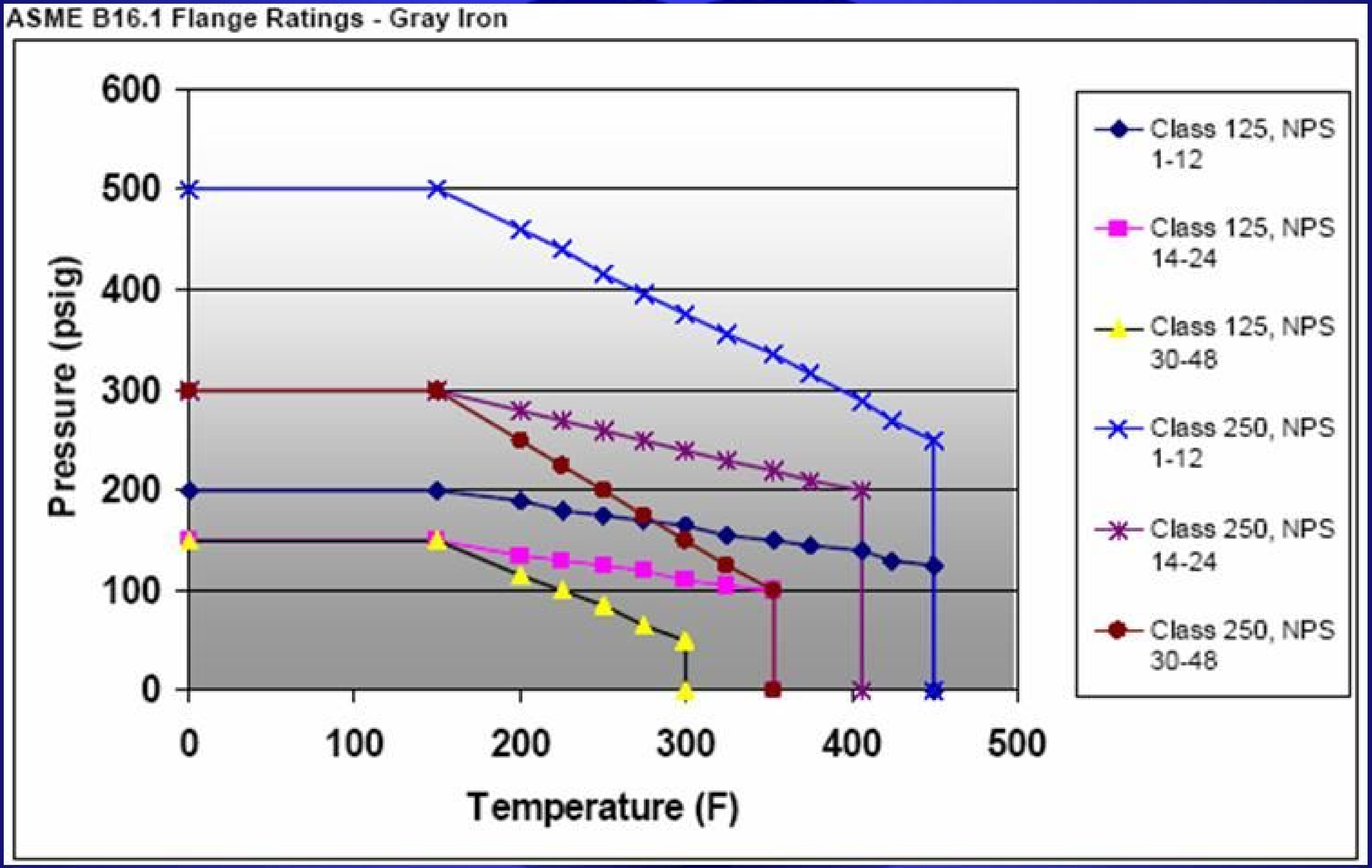
  - Tube, … inside a fire heater
  - Fire protection system (NFPA)
  - Plumbing, sanitary sewer (AWWA)

- The factors that affect piping material selection are:
  - Strength
    - Yield & Tensile strength
    - Creep strength
    - Fatigue strength
  - Corrosion resistance
  - Material fracture toughness
  - Fabricability
  - Availability & cost

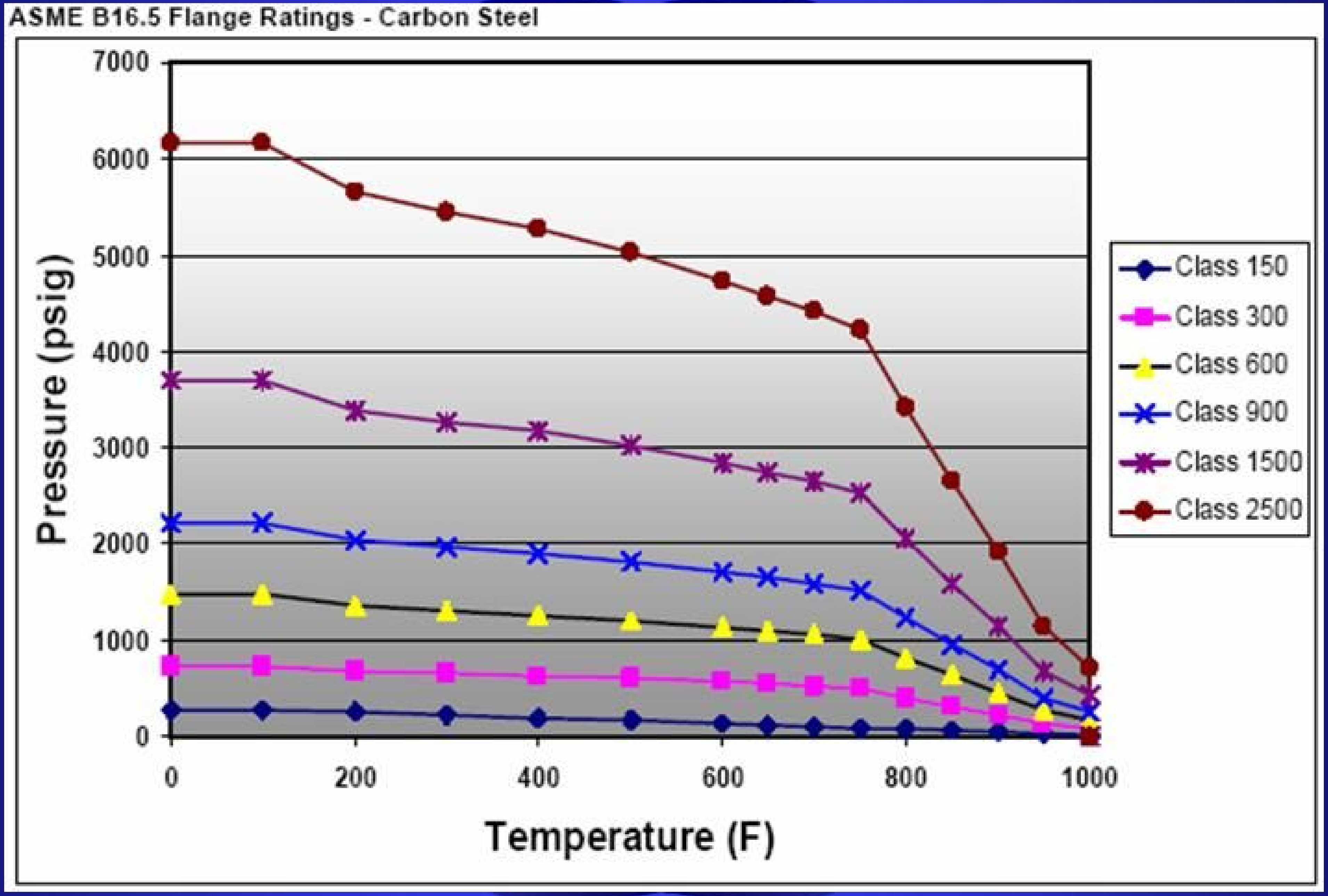
ASME B31.3: Material: *Stress - Strain Diagram*



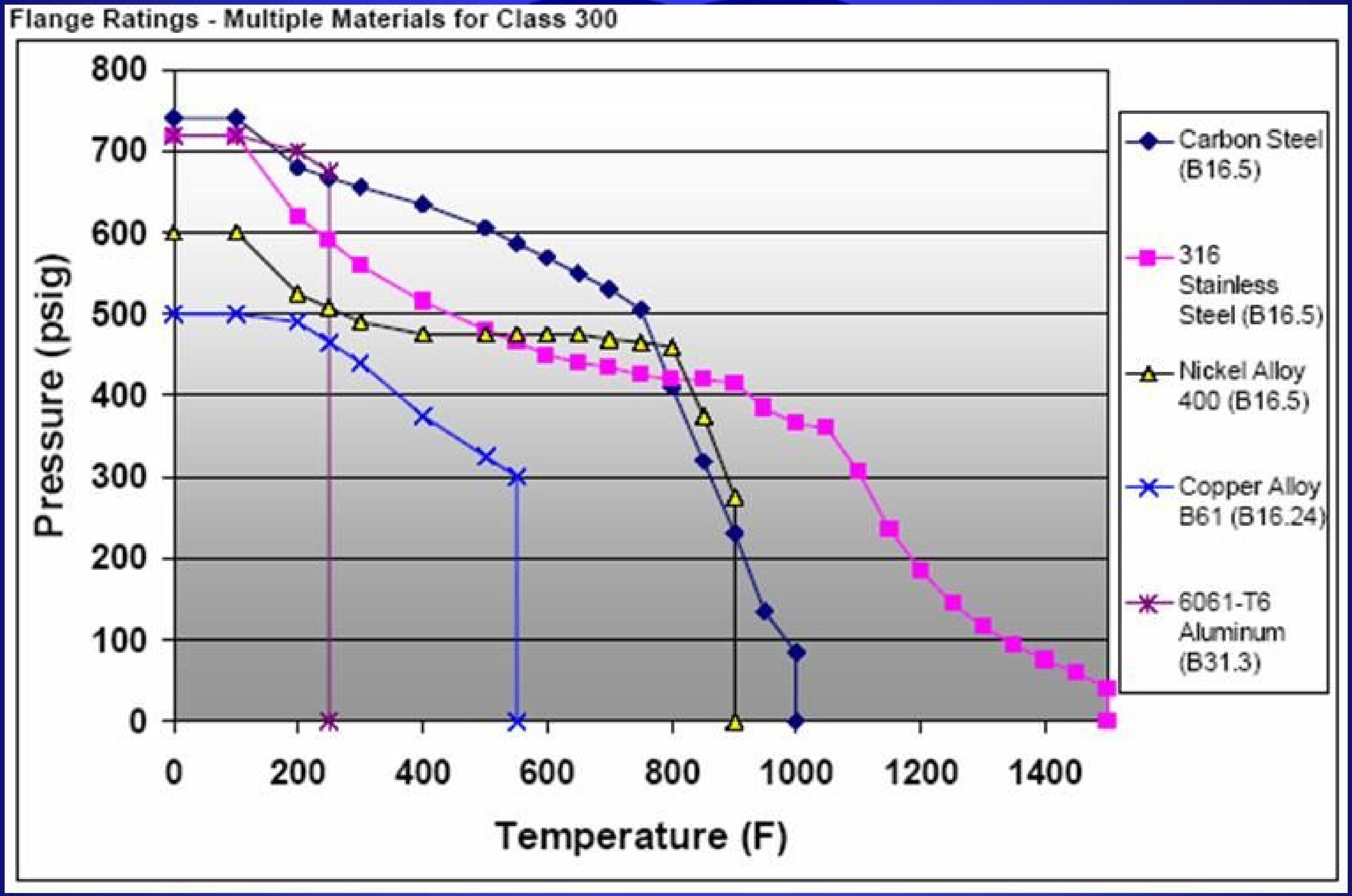
ASME B31.3: Material: *Variation of strength with temperature*



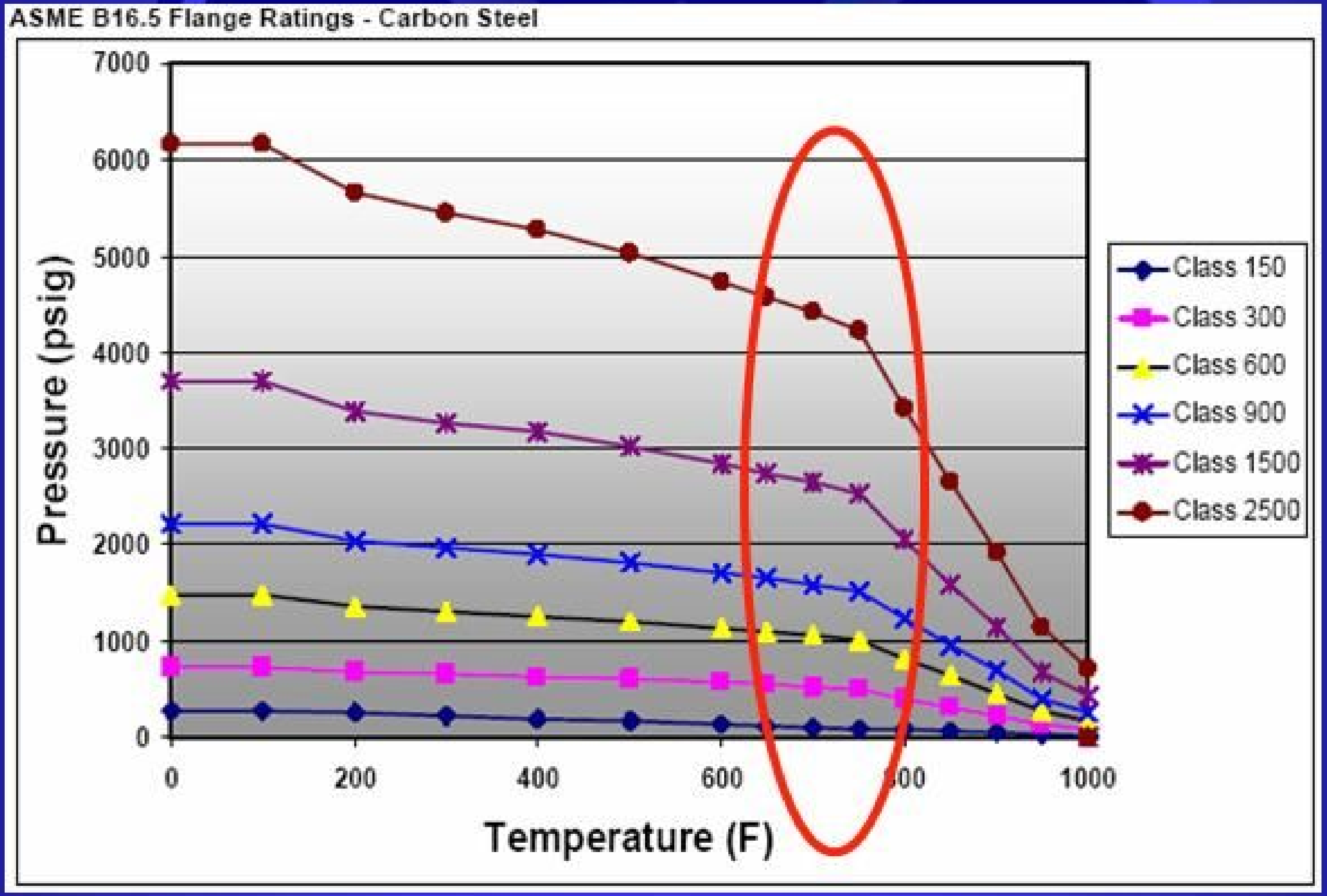
ASME B31.3: Material: *Variation of strength with temperature*



ASME B31.3: Material: *Variation of strength with temperature*



- Below about 750°F for a given stress, the strain in most materials remains constant with time. Above this temperature, even with constant stress, the strain in the material will increase with time. This behavior is known as creep.



- The type of fatigue are:
  - Static:

    specimen breaks under a load that it has previously withstood for a length of time. Examples of static fatigue are: creep fracture and stress corrosion cracking.
  - Cyclic:

    specimen breaks during a load cycle that it has previously withstood several times.

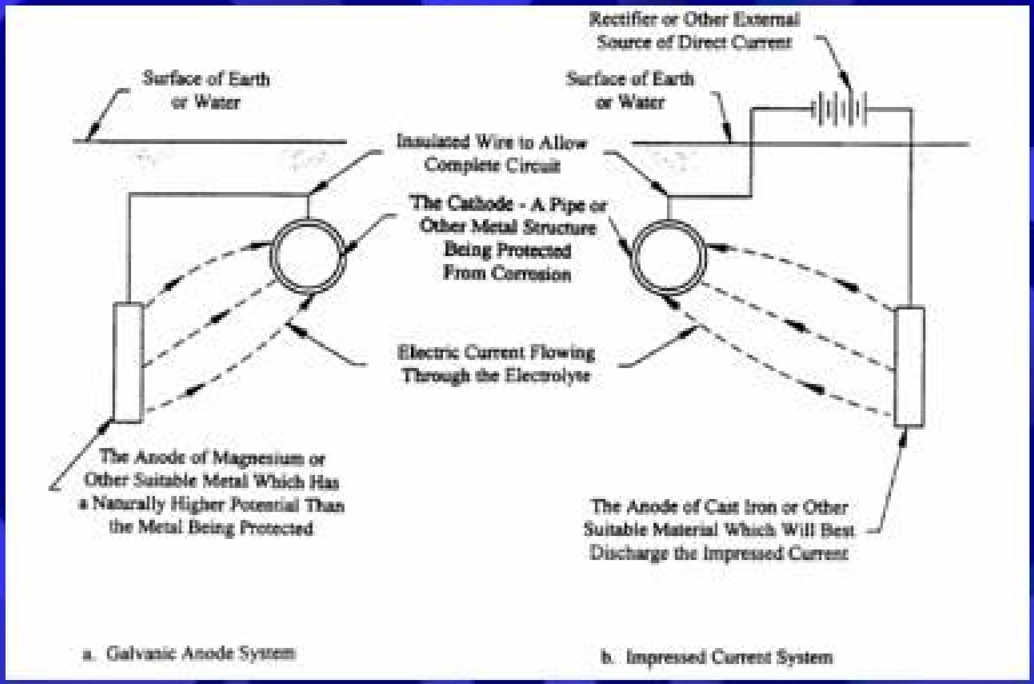
- Corrosion of materials involves deterioration of the metal by chemical or electrochemical attack and include:
  - **General or Uniform Corrosion:**

    Characterized by uniform metal loss over entire surface of material. May be combined with erosion if material is exposed to high-velocity fluids, or moving fluids that contain abrasive materials.
  - **Pitting Corrosion:**

    Form of localized metal loss randomly located on material surface. Occurs most often in stagnant areas or areas of low-flow velocity.

- **Galvanic Corrosion:**

  Occurs when two dissimilar metals contact each other in corrosive electrolytic environment. The anodic metal develops deep pits or grooves as a current flows from it to the cathodic metal.



a. Galvanic Anode System   b. Impressed Current System

- **Crevice Corrosion:**

  Localized corrosion similar to pitting. Occurs at places such as gaskets, lap joints, and bolts, where a crevice can exist.

- **Concentration Cell Corrosion:**

  Occurs when different concentration of either corrosive fluid or dissolved oxygen contacts areas of same metal. Usually associated with stagnant fluid.

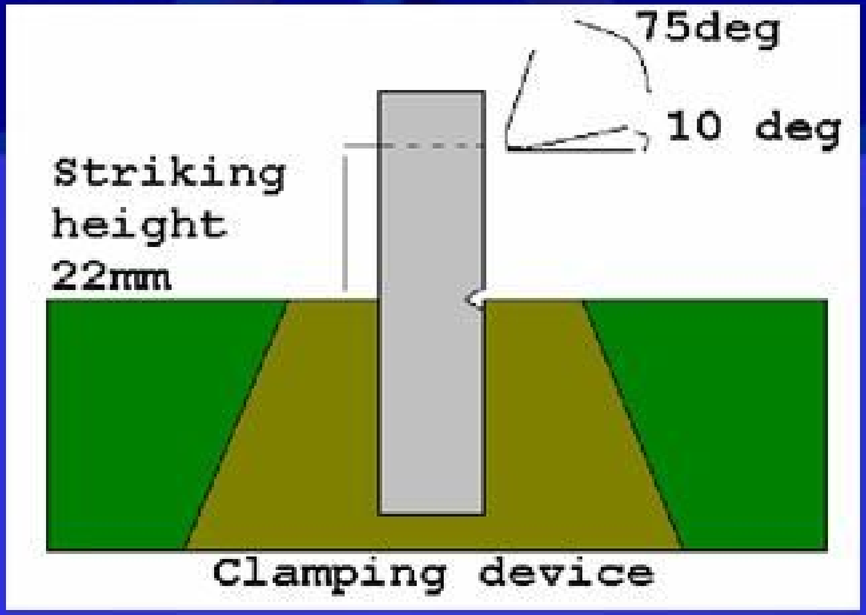
- **Graphitic Corrosion:**

  Occurs in cast iron exposed to salt water or weak acids. Reduces iron in the cast iron and leaves the graphite in place. Result is extremely soft material with no metal loss.

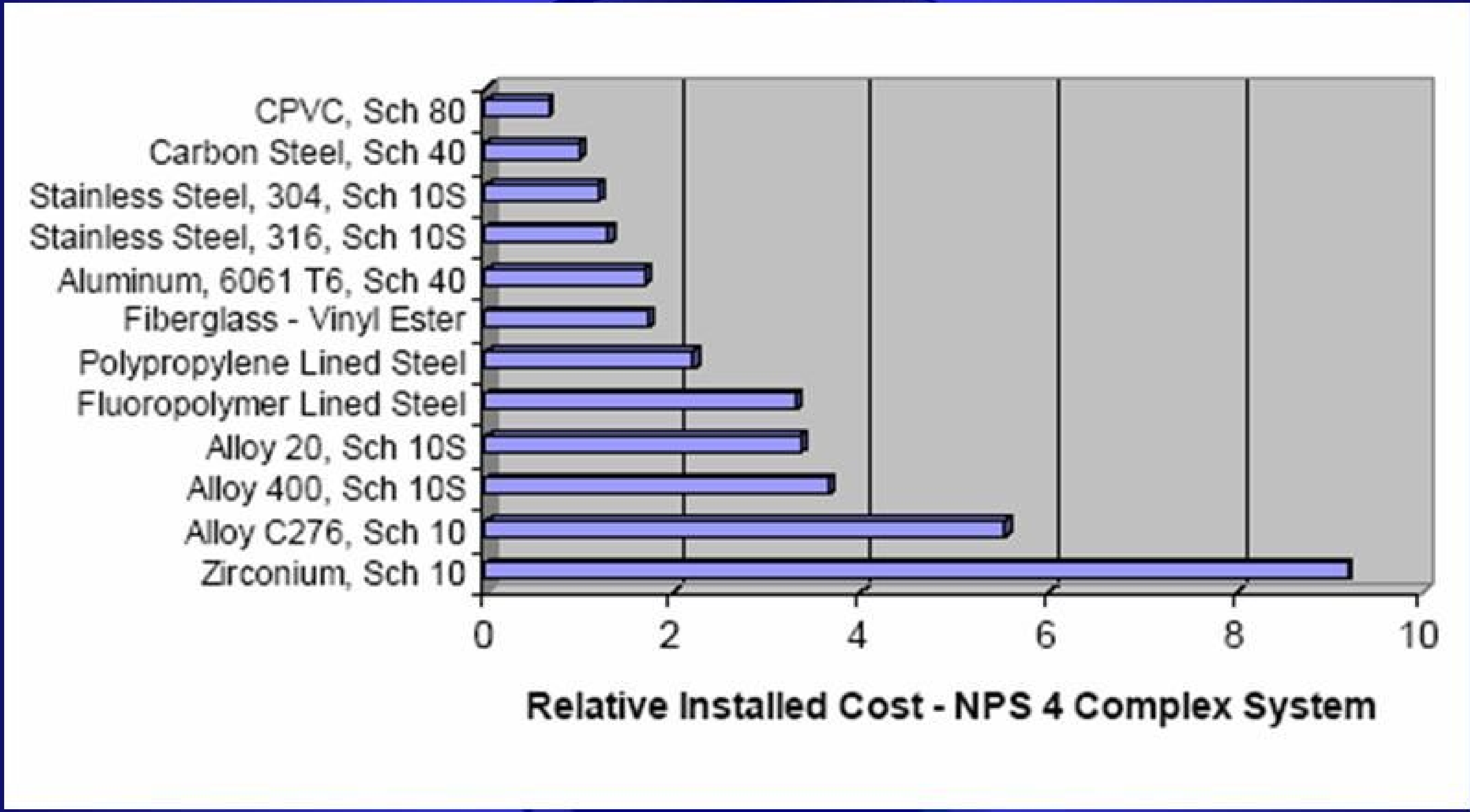
ASME B31.3: Material: *Material fracture toughness*

- It is the amount of energy necessary to initiate and propagate a crack at a given temperature.
  - The addition of manganese or nickel improves fracture toughness.
  - Mostly of concern for carbon steels
  - Generally decreases as temperature decreases
  - Factors affecting fracture toughness include:
    - Chemical composition or alloying elements
    - Heat treatment
    - Grain size
  - The impact energy required to fracture a material sample at a given temperature can be measured by standard Charpy V-notch tests.

ASME B31.3: Material: *Material fracture toughness*



ASME B31.3: Material: Cost



ASME B31.3: Material: Modes of failures

- ***FAILURE BY GERNRAL YIELDING:*** Failure is due to excessive plastic deformation.
  - **Yielding at Sub Elevated temperature:** Body undergoes plastic deformation under slip action of grains.
  - **Yielding at Elevated temperature:** After slippage, material re-crystallizes and hence yielding continues without increasing load. This phenomenon is known as creep.
- ***FAILURE BY FRACTURE:*** Body fails without undergoing yielding.
  - **Brittle fracture:** Occurs in brittle materials.
  - **Fatigue:** Due to cyclic loading initially a small crack is developed which grows after each cycle and results in sudden failure.

ASME B31.3: Material: Modes of failures: Ductile Deformation

ASME B31.3: Material: Modes of failures: Brittle Fracture

- Category D
- Category M
- High Pressure
- Normal

- *Category D:*
  - **The fluid handled is nonflammable, nontoxic and not damaging to human tissue. The design pressure does not exceed 150 psig (1035 kPa). The design temperature is greater than -20°F (-29°C) and does not exceed 366 °F (186°C).**
  - Often characterized as "utility"

- ***Category M:***
  - A fluid service in which the potential for personnel exposure is judged to be significant and in which a single exposure to a very small quantity of a toxic fluid, caused by leakage, can produce serious irreversible harm to persons upon breathing or on bodily contact, even when prompt restorative measures are taken.
  - Often characterized as "lethal"

- ***High Pressure:***
  - A service for which the owner specifies the use of Chapter IX [of B31.3] for piping design and construction… considered to be in excess of Class 2500 (PN 420). Characterized as “high pressure”
- ***Normal:*** Everything else.
  - Often characterized as “process”

- Normal operating conditions:

  Are those expected to occur during normal operation, excluding failure of any operating device, operator error, and the occasional, short-term variations stated in the applicable code.

- Design conditions:

  Are those which govern the design and selection of piping components, and are based on the most severe conditions expected to occur in service.

- *Loading classification*
  - Primary loads: These can be divided into two categories based on the duration of loading.
    - Sustained loads: These loads are expected to be present through out the plant operation. e.g.
      - internal & external pressure
      - weight of system (piping material and operating pressure).
    - Occasional loads: These loads are present at infrequent intervals during plant operation. e.g.
      - Wind, ice and snow load
      - seismic load
      - Dynamic load (pressure surge, water hammer, energy release by pressure relief valve, …
      - Hydrostatic leak test load
      - Wheel load (traffic load)

- **Expansion loads:** These are loads due to displacements of piping. e.g.
  - thermal expansion:
    - are created when the free expansion and contraction of the piping is prevented at its end points by connected equipment, or prevented at intermediate points by supports and/or restraints that are installed. pipe thermal loads can be from the thermal expansion of equipment at pipe-to-equipment nozzle attachment points, causing displacements in the piping system.
  - seismic anchor movements
  - building settlement.

- Principal pipe load types
  - Sustained loads
    - Act on system all or most of time
    - Consist of pressure and total weight load
  - Occasional loads
    - Act for short portion of operating time
    - Seismic and/or dynamic loading
  - Thermal expansion loads
    - Caused by thermal displacements
    - Result from restrained movement

- Primary Stresses: These are developed by the imposed loading and are necessary to satisfy the equilibrium between external and internal forces and moments of the piping system. **Primary stresses are not self-limiting.**
  - Direct
  - Shear
  - Bending

- Secondary stresses: These are developed by the constraint of displacements of a structure. These displacements can be caused either by thermal expansion or by outwardly imposed restraint and anchor point movements. **Secondary stresses are self-limiting**.
  - Act across pipe wall thickness
  - Cause local yielding and minor distortions
  - Not a source of direct failure

- Peak stresses: Unlike loading condition of secondary stress which cause distortion, peak stresses cause no significant distortion. Peak stresses are responsible for causing fatigue failure.
  - More localized
  - Rapidly decrease within short distance of origin
  - Occur where stress concentrations and fatigue failure might occur
  - Significance equivalent to secondary stresses
  - Do not cause significant distortion

ASME B31.3:

Required Wall Thickness for Internal Pressure of Straight Pipe

$$t = \frac{PD}{2(SE + PY)}$$

$$t_m = t + CA$$

$$t_{nom} = \frac{t_m}{0.875}$$

- t = Required thickness for internal pressure, in.
- P = Internal design pressure, psig
- S = Allowable stress in tension, psi
- E = Longitudinal-joint quality factor
- Y = Wall thickness correction factor
- tm = Total minimum required wall thickness, in.
- tnom = Minimum required nominal pipe wall thickness, in.

ASME B31.3: Allowable Stresses

- Function of
  - Material properties
  - Temperature
  - Safety factors

Material	Spec. No/Grade		Basic Allowable Stress *S*, ksi. At Metal Temperature, °F.														
			100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Carbon Steel	A 106	B	20.0	20.0	20.0	20.0	18.9	17.3	16.5	10.8	6.5	2.5	1.0				
C - ½Mo	A 335	P1	18.3	18.3	17.5	16.9	16.3	15.7	15.1	13.5	12.7	4.	2.4				
1¼ - ½Mo	A 335	P11	20.0	18.7	18.0	17.5	17.2	16.7	15.6	15.0	12.8	6.3	2.8	1.2			
18Cr - 8Ni pipe	A 312	TP304	20.0	20.0	20.0	18.7	17.5	16.4	16.0	15.2	14.6	13.8	9.7	6.0	3.7	2.3	1.4
16Cr - 12Ni-2Mo pipe	A 312	TP316	20.0	20.0	20.0	19.3	17.9	17.0	16.3	15.9	15.5	15.3	12.4	7.4	4.1	2.3	1.3

ASME B31.3: Wall thickness correction factor

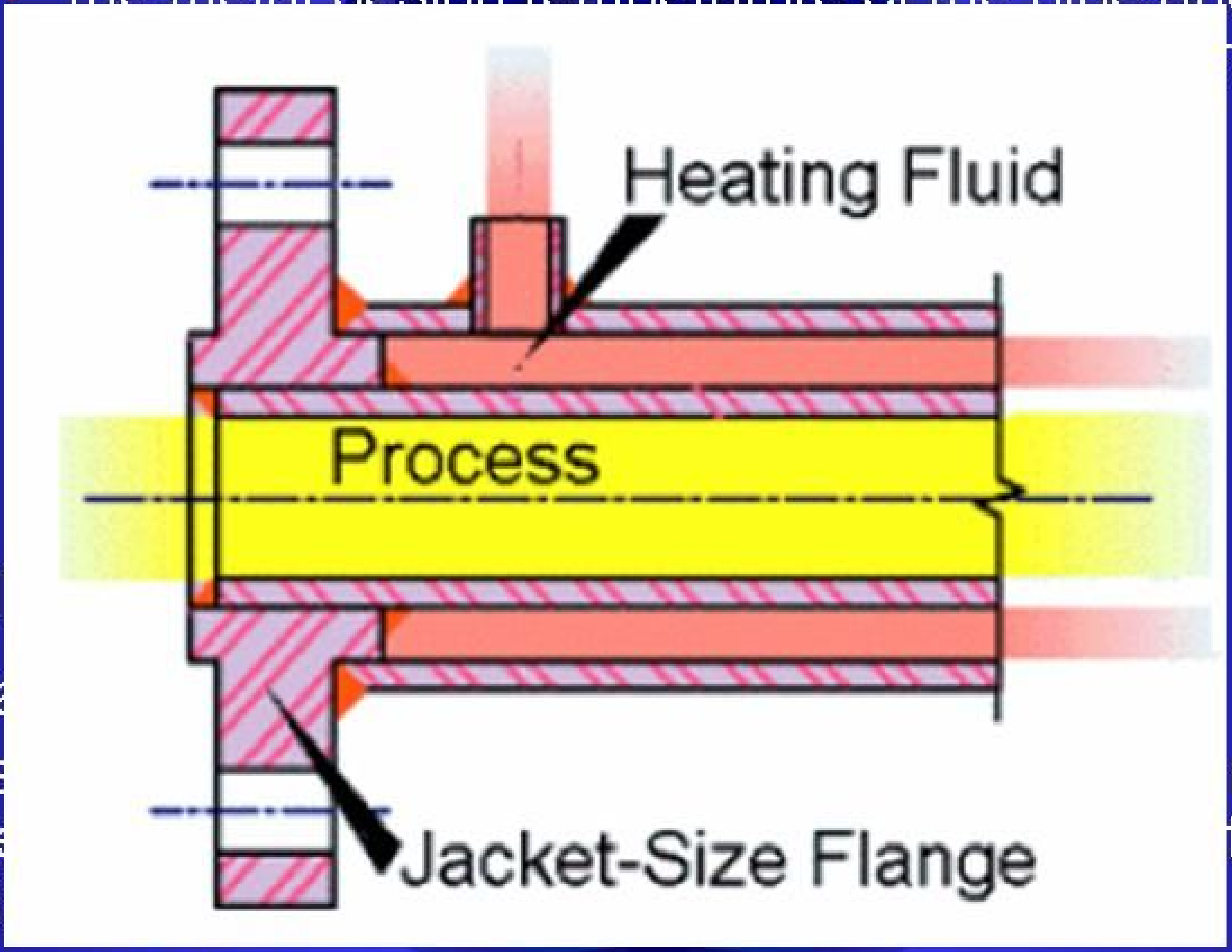
Spec. No.	Class (or Type)	Description	E_j
		Carbon Steel	
API 5L	. . .	Seamless pipe	1.00
	. . .	Electric resistance welded pipe	0.85
	. . .	Electric fusion welded pipe, double butt, straight or spiral seam	0.95
		Furnace butt welded	
A 53	Type S	Seamless pipe	1.00
	Type E	Electric resistance welded pipe	0.85
	Type F	Furnace butt welded pipe	0.60
A 106	. . .	Seamless pipe	1.00
		Low and Intermediate Alloy Steel	
A 333	. . .	Seamless pipe	1.00
	. . .	Electric resistance welded pipe	0.85
A 335	. . .	Seamless pipe	1.00
		Stainless Steel	
A 312	. . .	Seamless pipe	1.00
	. . .	Electric fusion welded pipe, double butt seam	0.85
	. . .	Electric fusion welded pipe, single butt seam	0.80
A 358	1, 3, 4	Electric fusion welded pipe, 100% radiographed	1.00
	5	Electric fusion welded pipe, spot radiographed	0.90
	2	Electric fusion welded pipe, double butt seam	0.85
		Nickel and Nickel Alloy	
B 161	. . .	Seamless pipe and tube	1.00
B 514	. . .	Welded pipe	0.80
B 675	All	Welded pipe	0.80

ASME B31.3: Wall thickness correction factor

	Temperature, °F					
Materials	900 & lower	950	1000	1050	1100	1150 & up
Ferritic Steels	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic Steels	0.4	0.4	0.4	0.4	0.5	0.7
Other Ductile Metals	0.4	0.4	0.4	0.4	0.4	0.4
Cast iron	0.0	...	...	...	...	...

ASME B31.3: Design temperature

- Uninsulated component:
  - T < 150F:
    - the metal design temperature of the pipe and component
    - ... radiation or
  - T > ...
- External...
  - Meta...
  - Whe... r jacketing, the e... the metal desi...
- Internally insulated:
  - Require heat transfer calculation



ASME B31.3: Design pressure

- The design pressure of a piping system is the pressure at the most severe condition of coincident internal or external pressure and temperature expected during service. *unless all of the following criteria are met.*
  - *The piping system have no pressure containing components of cast iron or other non ductile metal.*
  - *Nominal pressure stresses shall not exceed the yield strength, Sy data in [ASME] BPV Code, Section II, Part D, Table Y-1).*
  - *The total number of pressure-temperature variations shall not exceed 1000 during the life of the piping system.*
  - *Increased pressure shall not exceed the test pressure*

ASME B31.3: Design pressure

- Occasional variations above design conditions shall remain within one of the following limits for pressure design.
  - Subject to the owner's approval, it is permissible to exceed the pressure rating or the allowable stress for pressure design at the temperature of the increased condition by not more than:
    - 33% for no more than 10 hour at any one time and no more than 100 hour per year; or
    - 20% for no more than 50 hour at any one time and no more than 500 hour per year.
  - When the variation is self-limiting (e.g., due to a pressure relieving event), 20% for no more than 50 hour at any one time and no more than 500 hour per year.

- *The combined effects of the sustained and cyclic variations shall have been evaluated.*
- *Temperature variations below the minimum temperature shown in Appendix A [of ASME B31.3] are not permitted.*
- *The application of pressures exceeding pressure-temperature ratings of valves may cause loss of seat tightness or difficulty of operation. The differential pressure on the valve closure element should not exceed the maximum differential pressure rating established by the valve manufacturer.*

- For buried piping, dead weight is not a factor. However, a sustained load that is analyzed is the load from the earth above the buried piping. The earth load on rigid piping may be calculated using the following formula.

$$F_E = \frac{\omega H}{a}$$

where:

F_E = earth load, kPa (psi)

ω= soil weight, kg/m^3 (lb/ft^3); typically 1,922 kg/m^3 (120 lb/ft^3)

H = height of cover, m (ft)

a = conversion factor, 102 $kg/m^2/kPa$ (144 $lb/ft^2/psi$).

- *Wheel load*

$$F_W = \frac{C\,R\,P\,F}{b\,D_o}$$

F_W = wheel load, kPa (psi)
C = surface load factor, see AWWA C150, Table 10.6M/10.6
R = reduction factor for a AASHTO H20 truck on an unpaved or flexible paved road, see AWWA C150, Table 10.4M/10.4
P = wheel weight, kg (lb); typically 7,257 kg (16,000 lb)
F = impact factor; typically 1.5
b = conversion factor, 0.031 kg/m/kPa (12 lb/ft/psi)
D_o = pipe outside diameter, mm (in).

- *Wind load:*
  - Wind load can cause other loads, such as vibratory loads, due to reaction from a deflection caused by the wind. The design wind speed is determined from ASCE 7

$$F_W = C_{W1} V_W^2 C_D D_o$$

where:

F_W = design wind load per projected pipe length, N/m (lb/ft)
V_W = design wind speed, m/s (miles/hr)
C_D = drag coefficient, dimension less
D_o = pipe (and insulation) outside diameter, mm (in)
C_{W1} = constant, 2.543×10^{-6} (N/m)/[mm(m/s)] (2.13×10^{-4} (lb/ft)/[in(mile/hr)]).

$$R_e = C_{W2} V_W D_o$$

where:

R_e = Reynolds Number
V_W = design wind speed, m/s (miles/hr)
D_o = pipe (and insulation) outside diameter, mm (in)
C_{W2} = constant, 6.87 s/mm-m (780 hr/in-mile).

- *Snow load (ANSI A58.1)*
  - Assuming that snow laying on a pipe will take the approximate shape of an equilateral triangle with the base equal to the pipe diameter.
  - For most heavy snow climates, a minimum snow load of 1.2 kpa (25 psf) is used in the design.

$$W_S = \tfrac{1}{2}\, n\, D_o\, S_L$$

where:

W_S = design snow load acting on the piping, N/m (lb/ft)
D_o = pipe (and insulation) outside diameter, mm (in)
S_L = snow load, Pa (lb/ft^2)
n = conversion factor, 10^{-3} m/mm (0.083 ft/in).

ASME B31.3: Load

- *Ice load:*
  - Unless local or regional data suggests assumption of 50 to 75 mm (2 to 3 in) maximum ice accumulation to calculate an ice *loading*

$$W_I = \pi \; n_3 \; S_I \; t_I \; (D_o + t_I)$$

where:

W_I = design ice load, N/m (lbs/ft)
S_I = specific weight of ice, 8820 N/m^3 (56.1 lbs/ft^3)
t_I = thickness of ice, mm (in)
D_o = pipe (and insulation) outside diameter, mm (in)
n_3 = conversion factor, 10^{-6} m^2/mm^2 (6.9 x 10^{-3} ft^2/in^2).