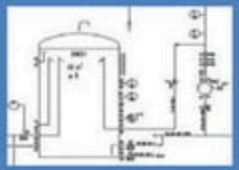
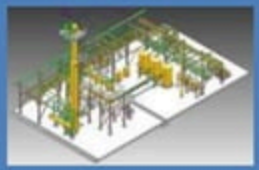
Fundamentals of Process Plant Design

Goals and Objectives

- Understand the basic fundamentals of an EPC role in Process Plant Engineering.
- Help / Guide you in your job to try and apply some thought, where can you add value to the industry we serve.
- Presentation where we can learn about Plant Design.
- Does not cover all aspects of Plant Design.
- Does not cover all industries
- Not about making you a Piping Designer

Plant Design Workflow

Concept Selection (Pre-FEED)

Front-End Engineering and Design (FEED)

Process Simulations

Preliminary GAs

Process Flow Diagrams

Preliminary Layouts

Preliminary P&IDs

CAPEX +/- 30%

Concept Selected

Instrument & Electrical Schematics

Data Sheets

Process and Utility P&IDs

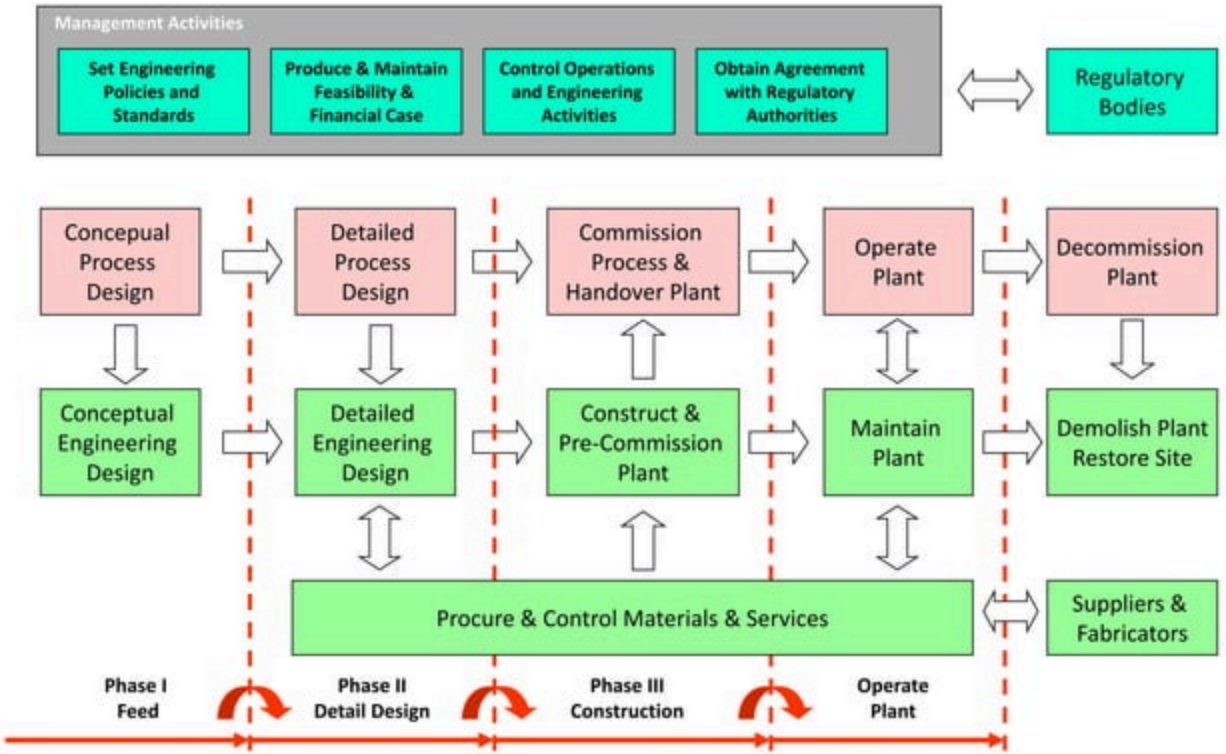
HAZOP / Safety Reviews

Feed Defined

Initiate 3D Plant Design

CAPEX +/- 15%

Process Plant Activity Model



Process department and its role

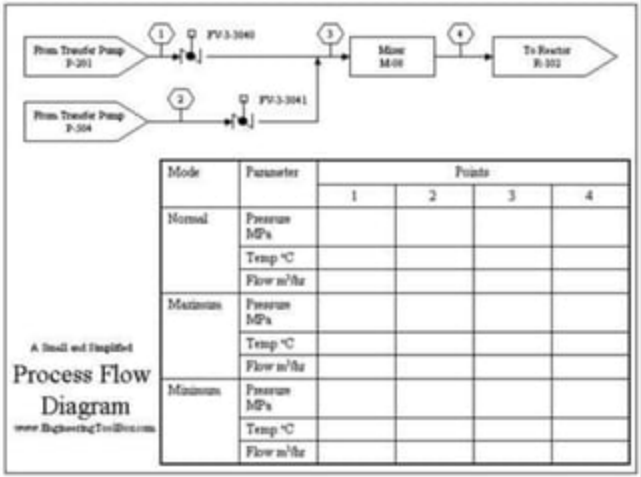
- Process Engineering focuses on Design, Operation, Control and Optimisation of Chemical, Physical and Biological processes
- Translate a customer needs into a production facility – Safely & Productive
- Block Diagram
- FEED (Front End Engineering and Design)
- PFD (Process Flow Diagram)

PFD (Process Flow Diagram)

This figure depicts a small and simplified PFD:

System Flow Diagrams ***should not include***:

- pipe class
- pipe line numbers
- minor bypass lines
- isolation and shutoff valves
- maintenance vents and drains
- relief and safety valve
- code class information
- seismic class information



PFD (Process Flow Diagram)

A PFD should include:

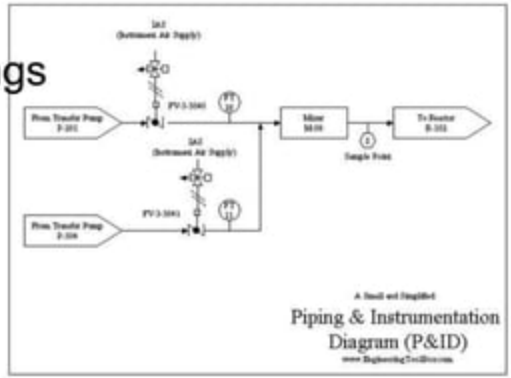
- Process Piping
- Major equipment symbols, names and identification numbers
- Control, valves and valves that affect operation of the system
- Interconnection with other systems
- Major bypass and recirculation lines
- System ratings and operational values as minimum, normal and maximum flow, temperature and pressure
- Composition of fluids

P&ID (Piping & Instrumentation Diagram)

This figure depicts a very small and simplified P&ID:

A P&ID ***should not include***:

- Instrument root valves
- control relays
- manual switches
- equipment rating or capacity
- primary instrument tubing and valves
- pressure temperature and flow data
- elbow, tees and similar standard fittings
- extensive explanatory notes

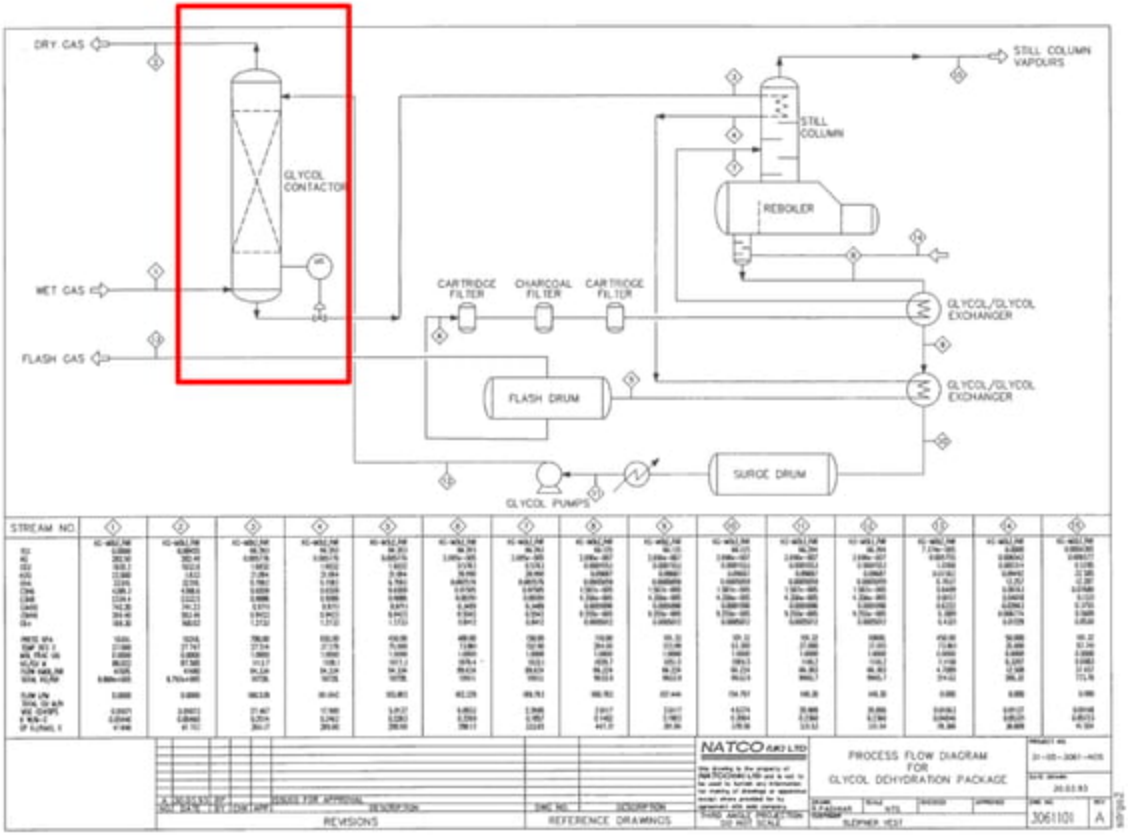


P&ID (Piping & Instrumentation Diagram)

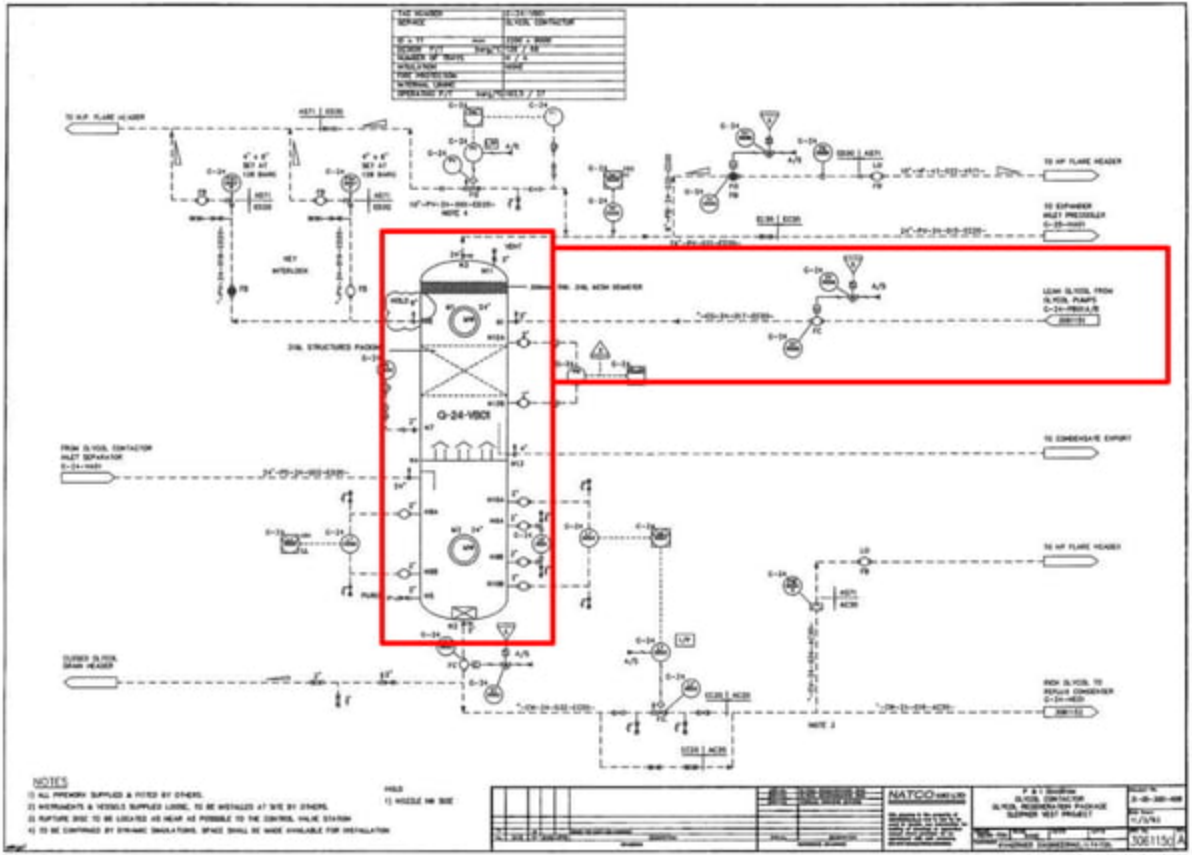
A P&ID should include:

- 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, increasers and swaggers
- Permanent start-up and flush lines
- Flow directions
- Interconnections references
- Interfaces for class changes
- Computer control system input
- Vendor and contractor interfaces
- Identification of components and subsystems delivered by others
- Intended physical sequence of the equipment

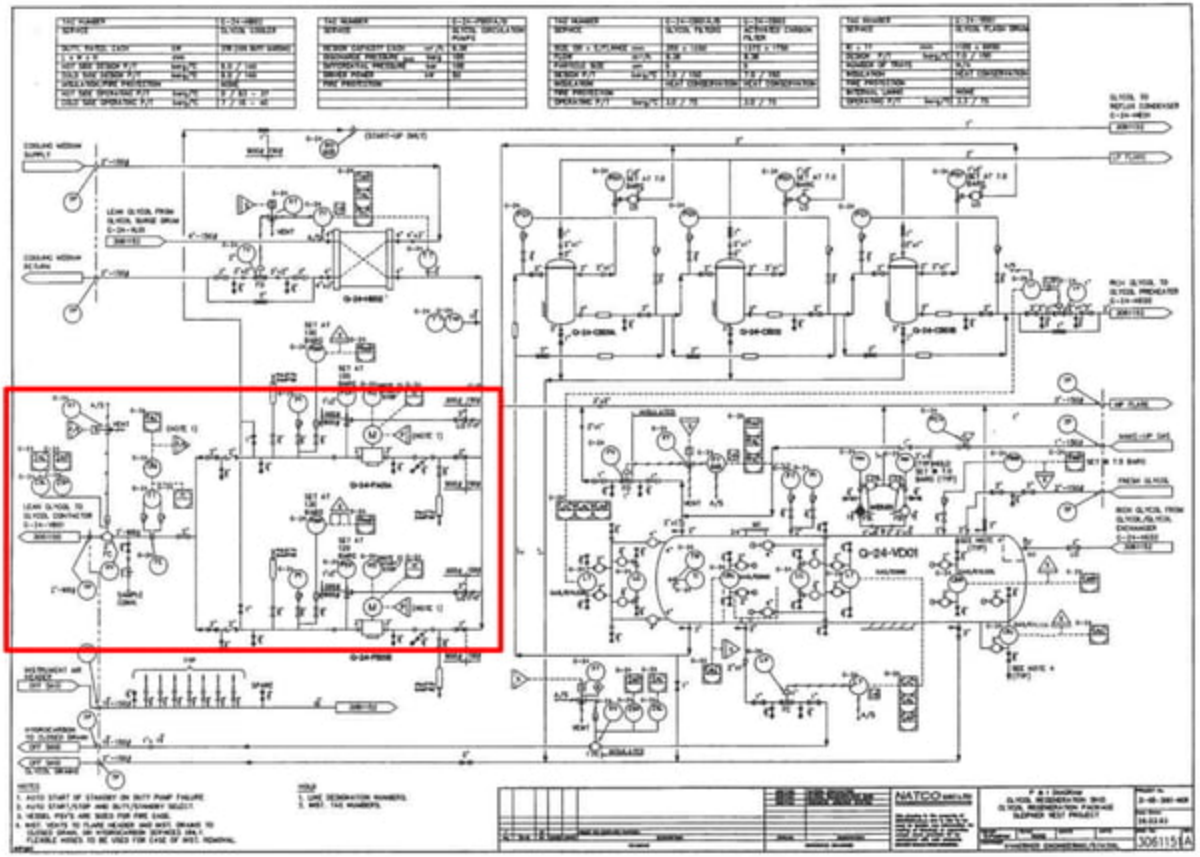
PFD (Process Flow Diagram)



P&ID (Piping and Instrumentation Diagram)

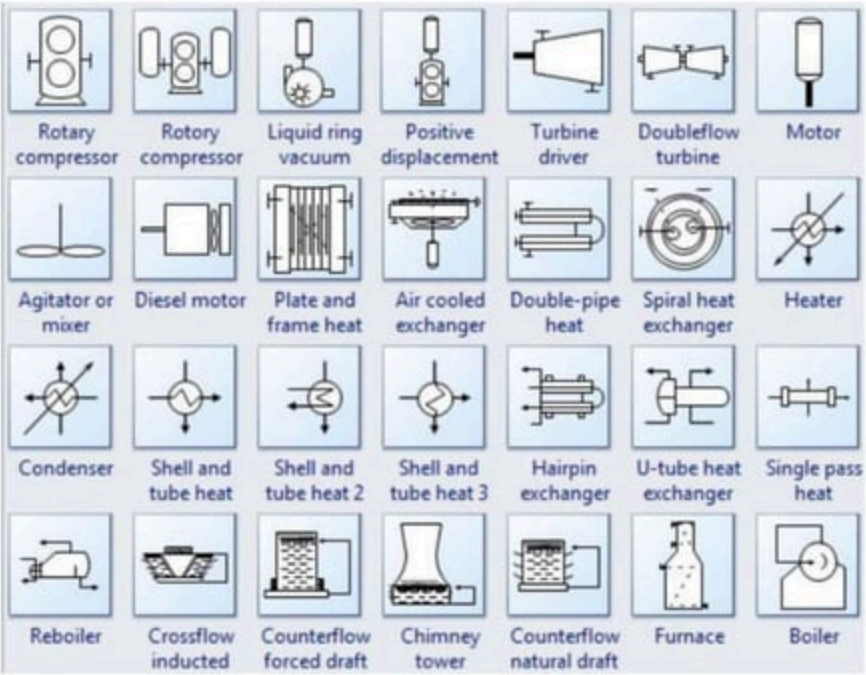


P&ID (Piping and Instrumentation Diagram)



P&ID / Project deliverables Symbology

P&ID / Project deliverables Symbology



P&ID / Project deliverables Symbology

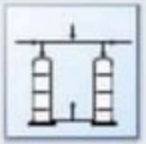

Oil burner


Automatic stoker


Evaporative condenser


Plate tower


Packed tower


Hydrocracki...


Hydrodesu...


Reformer


Fluid catalytic


Fluid coking


Tubular


Fluidized reactor


Mixing reactor


Alkylation


Boom loader


Screw conveyor


Scraper conveyor

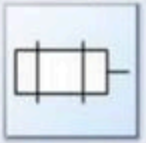

Elevator 1


Elevator 2


Skip hoist

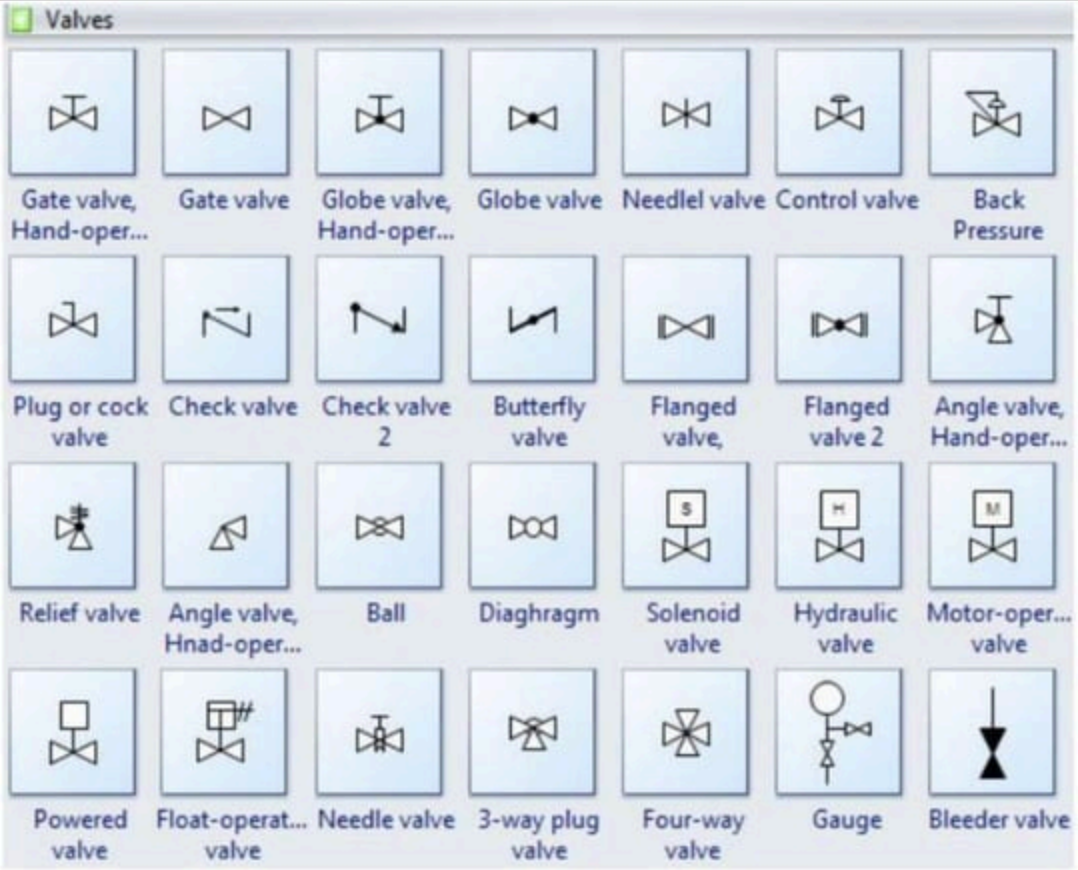

Overhead conveyor


Hoists

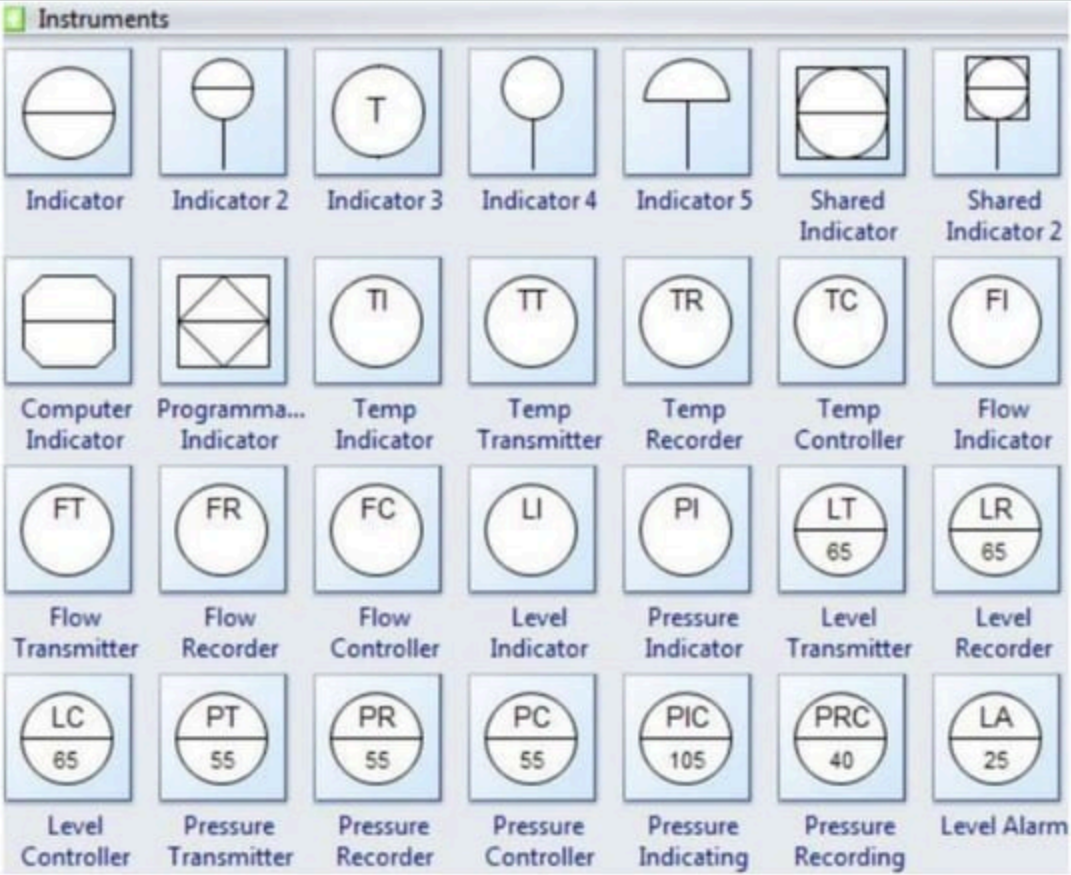

Electric motor


Conveyor

P&ID / Project deliverables Symbology



P&ID / Project deliverables Symbology



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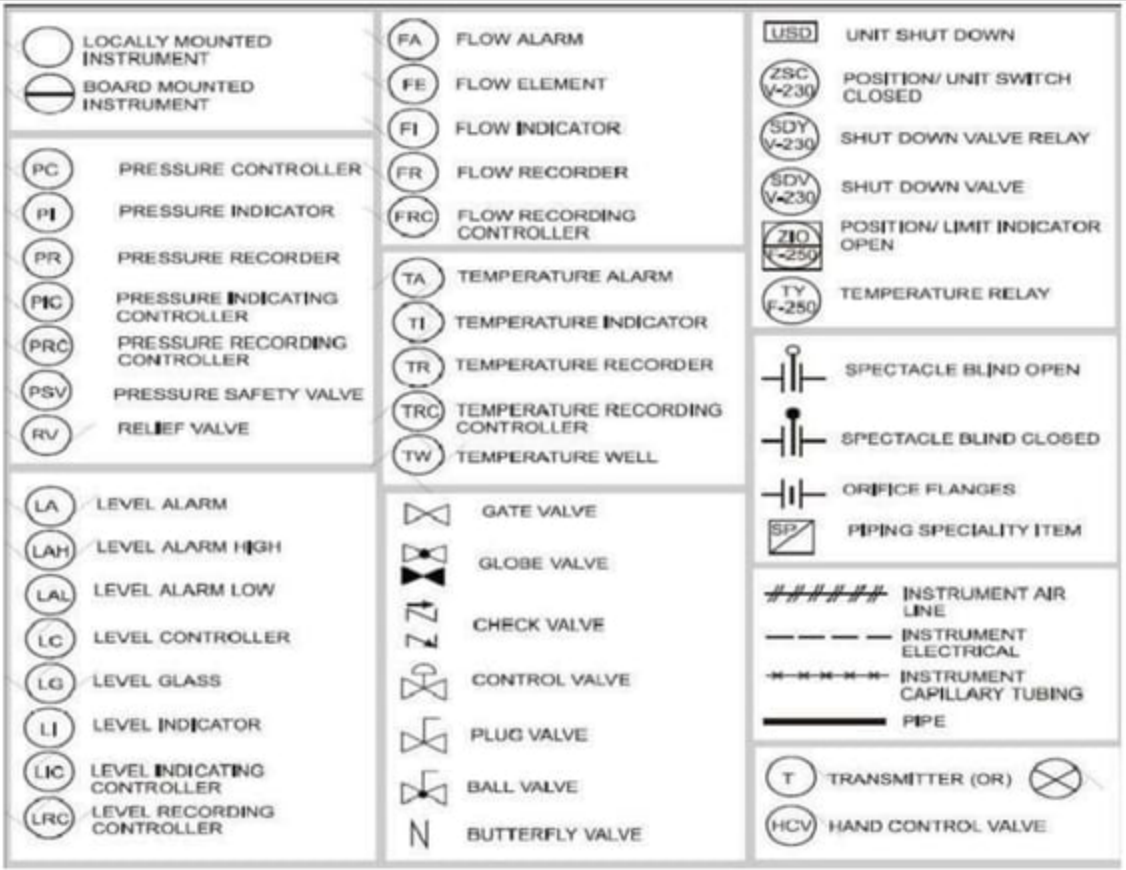
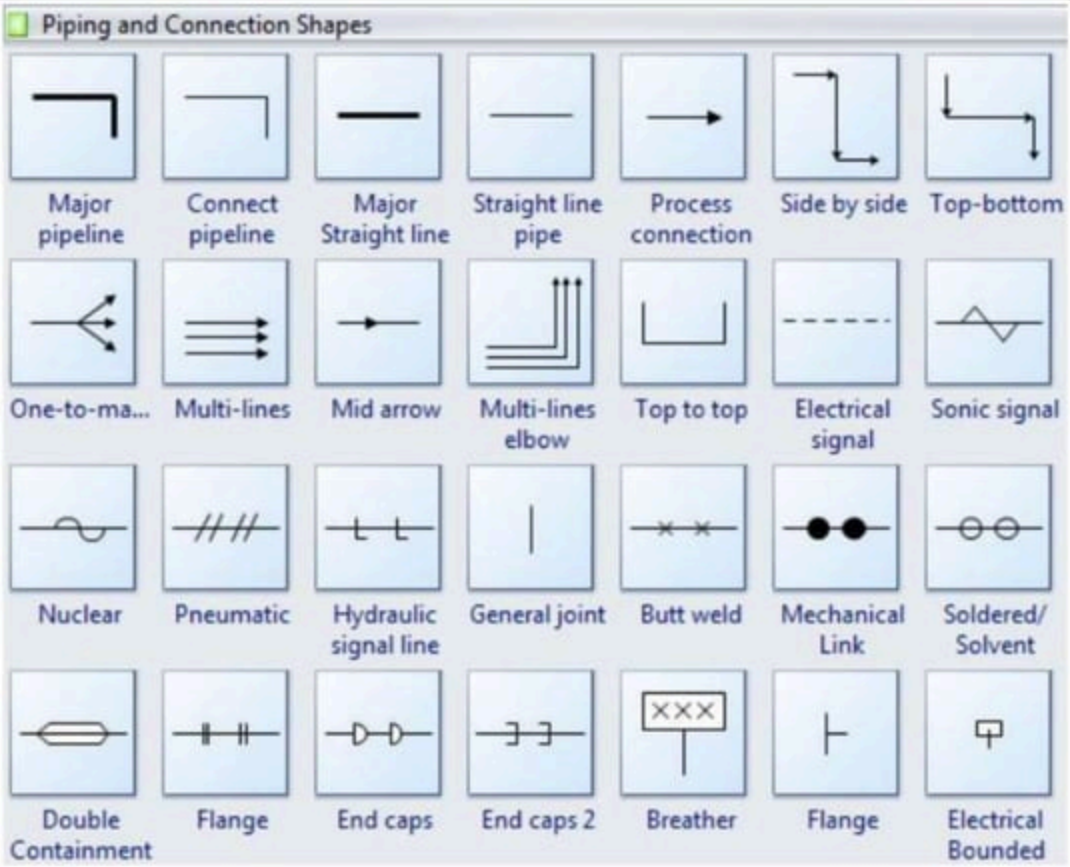


P&ID / Project deliverables Symbology

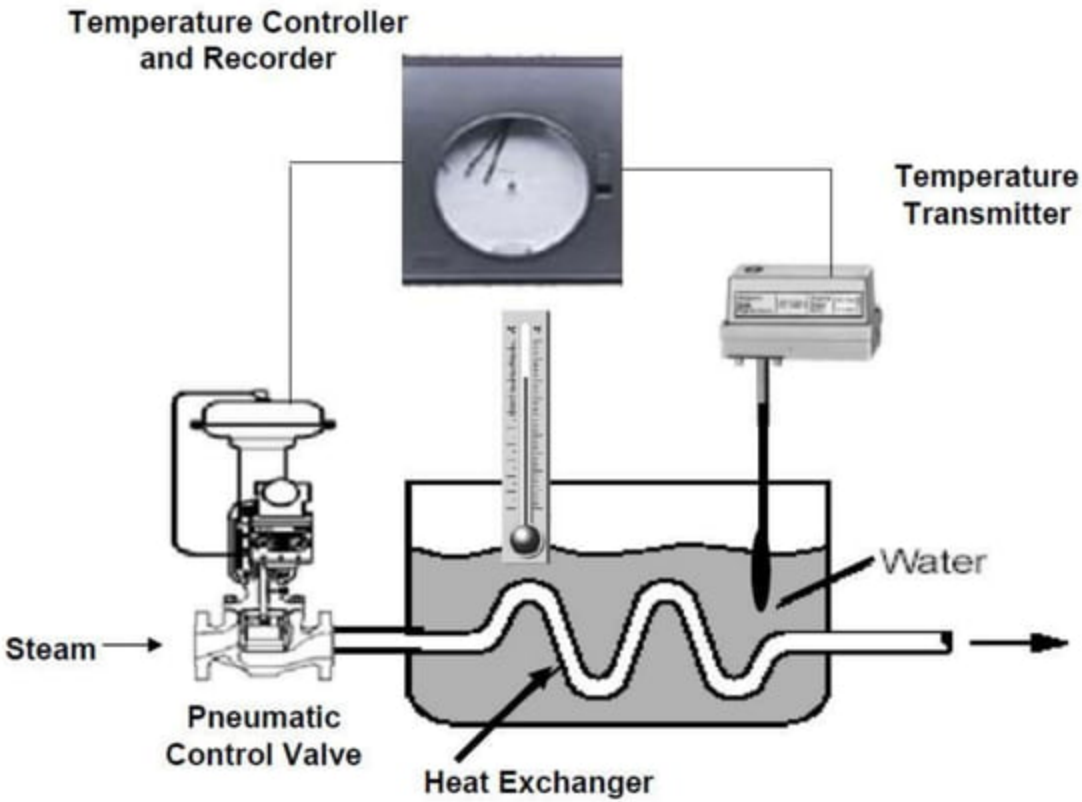


Piping and Instrumentation Diagrams or simply “P&IDs” are the “Schematics” used in the field or Instrumentation and Control (Automation).

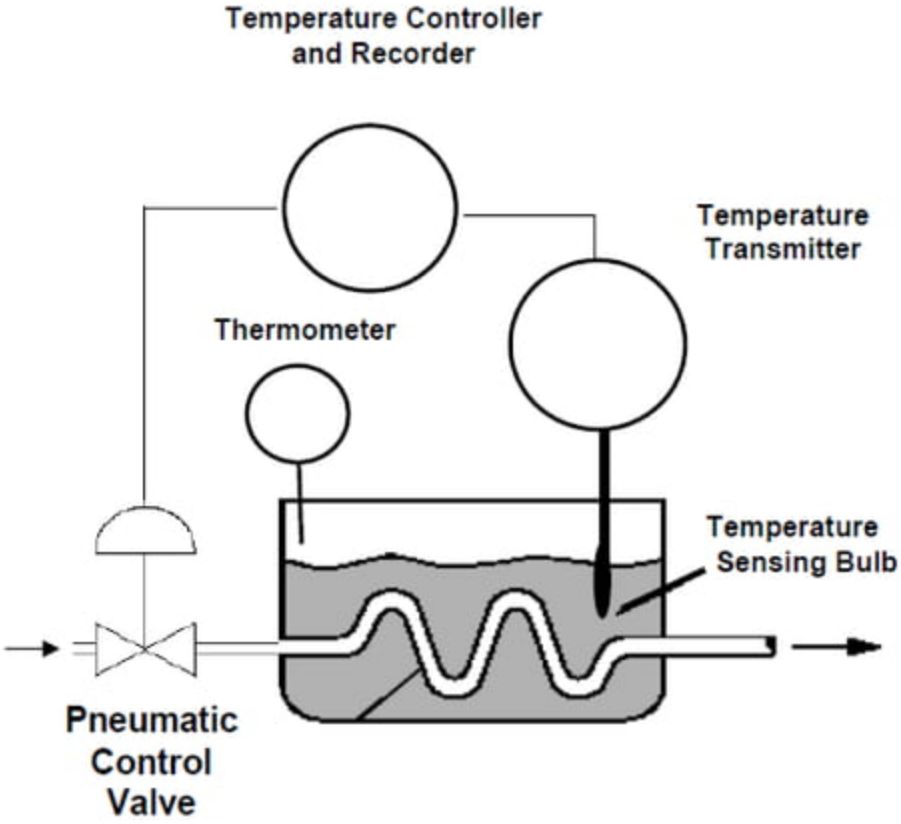
The P&ID is used by the field technicians, engineers and operators to better understand the process and how the instrumentation is interconnected, ensuring the plant is operating efficiently.

Most industries have standardised the symbols according to the ISA Standards S5.1 Instrumentation Symbol Specification

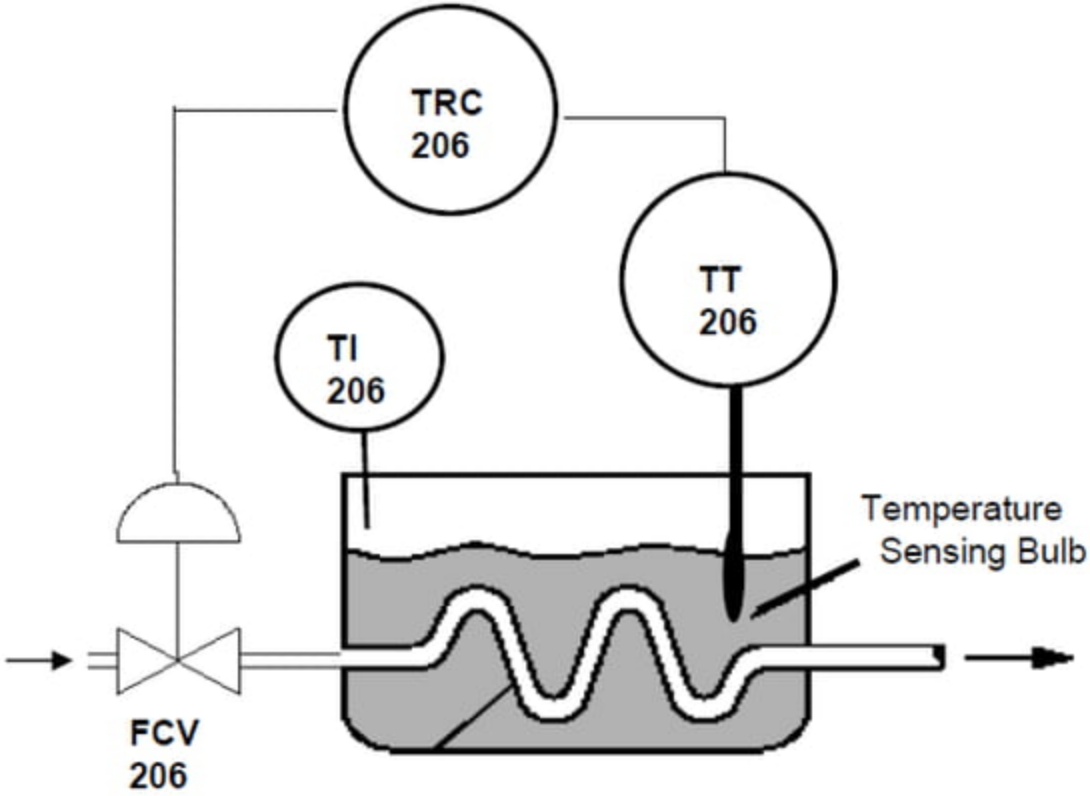
Temperature Process / Loop Diagram



Tag Numbers in a Loop



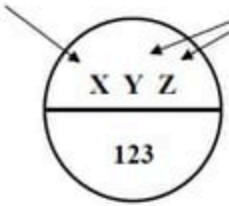
Tag Numbers



Tag Descriptors

*The first letter is used to designate the **measured variable***

*The succeeding letter(s) are used to designate the **function** of the component, or to **modify** the meaning of the first letter.*



Pressure

Level

Flow

Temperature

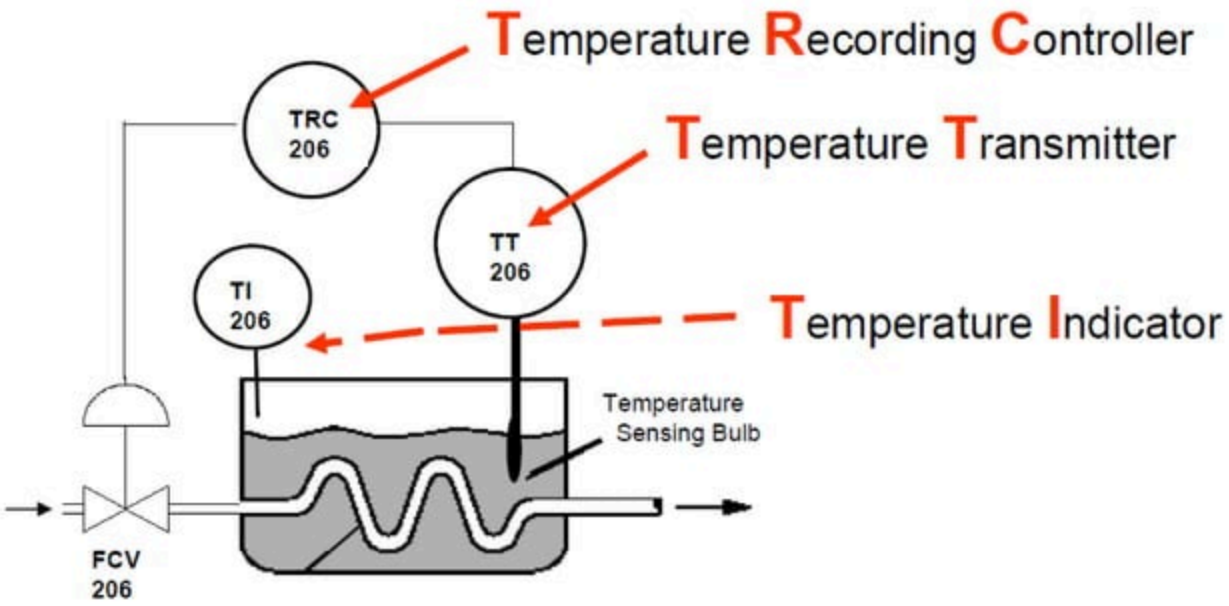
Indicator

Recorder

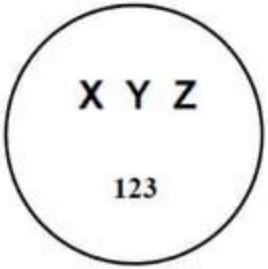
Controller

Transmitter

Tag Descriptors

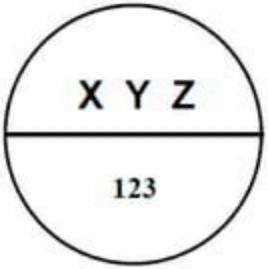


Instrumentation Location



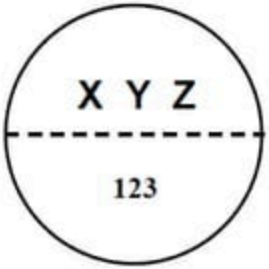
No Line

The instrument is mounted in the field near the process, (close to the operator)



Solid Line

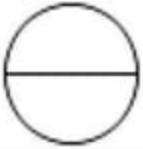
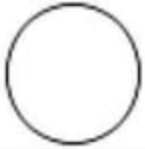
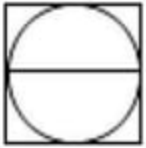
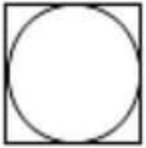
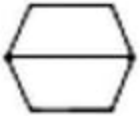
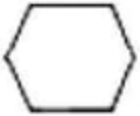
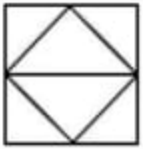
The instrument is mounted in the control room (accessible to the operator)



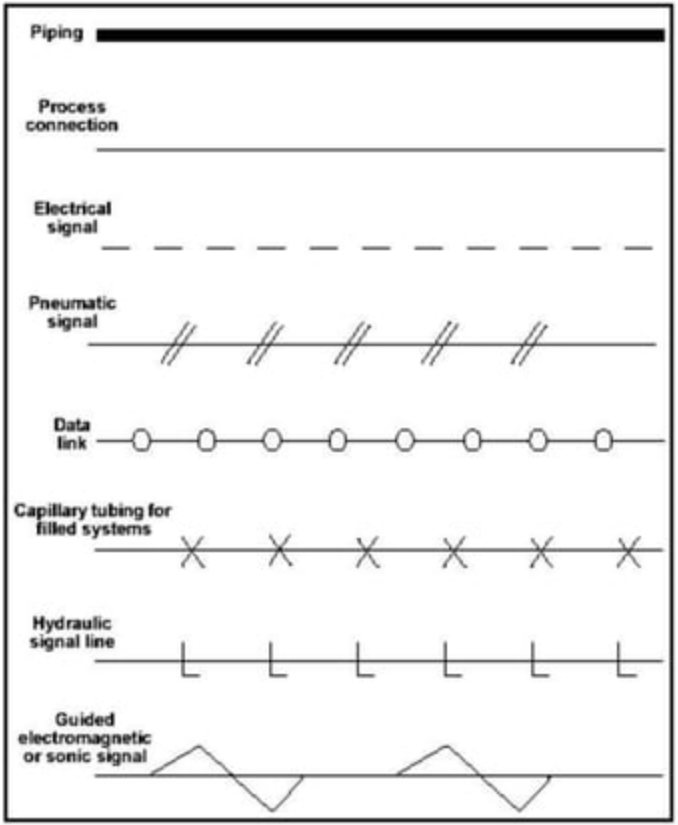
No Line

The instrument is mounted out of sight (not accessible to the operator)

Summary of Instrument type & location

	Accessible to the Operator; Primary Location on the Main Control Panel	Mounted in the Field	Not Normally Accessible to Operator, Behind the Panel
Distinct Elements			
Shared Display Shared Control in Distributed Control System			
Computer Logic Function			
Programmable Logic Control			

Piping and Connection Symbols



Piping and Connection Symbols

Instrument Valve Symbols


Gate Valve, Hand-operated


Globe Valve, Hand-operated


Plug or Cock Valve, Hand-operated


Check Valve


Butterfly Valve


Angle Valve, Hand-operated


Control Valve

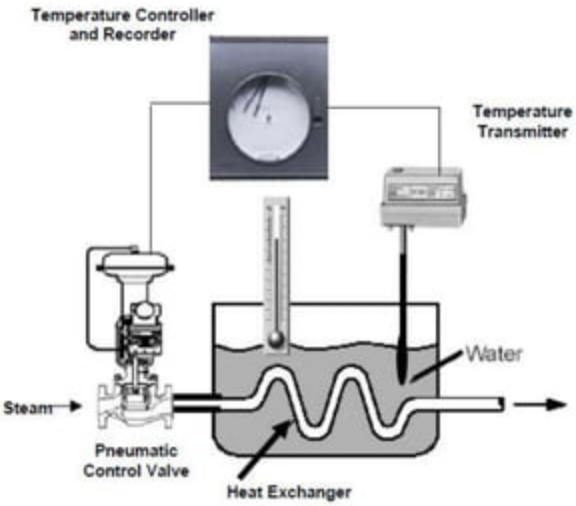
Solenoid Valve

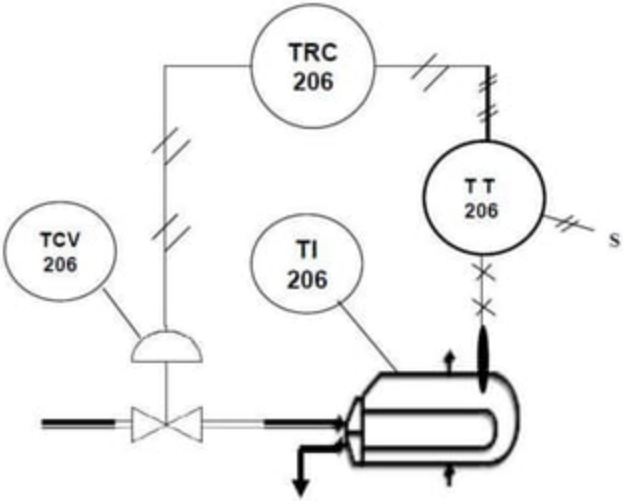
Motor-operated


Piston-operated

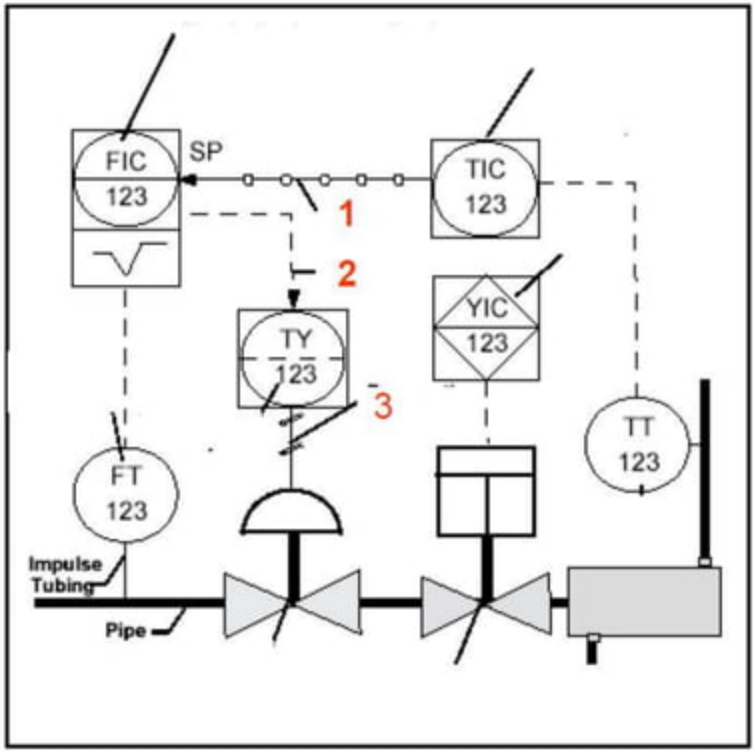

Safety Valve or Relief Valve

P&ID Example of a Instrument Loop





P&ID Exercise



FIC

TIC

YIC

TY

FT

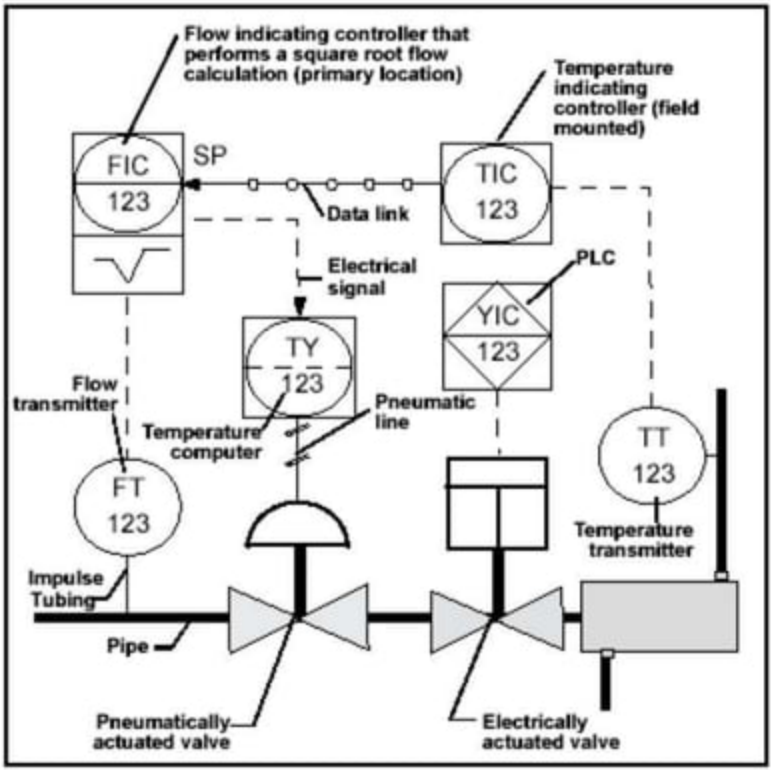
TT

1

2

3

P&ID Exercise (Completed)



FIC –
Flow Indicating Controller

TIC
Temperature Indicating Cont.

YIC
PLC Indicating Controller

TY
Temperature Computer Output

FT
Flow Transmitter

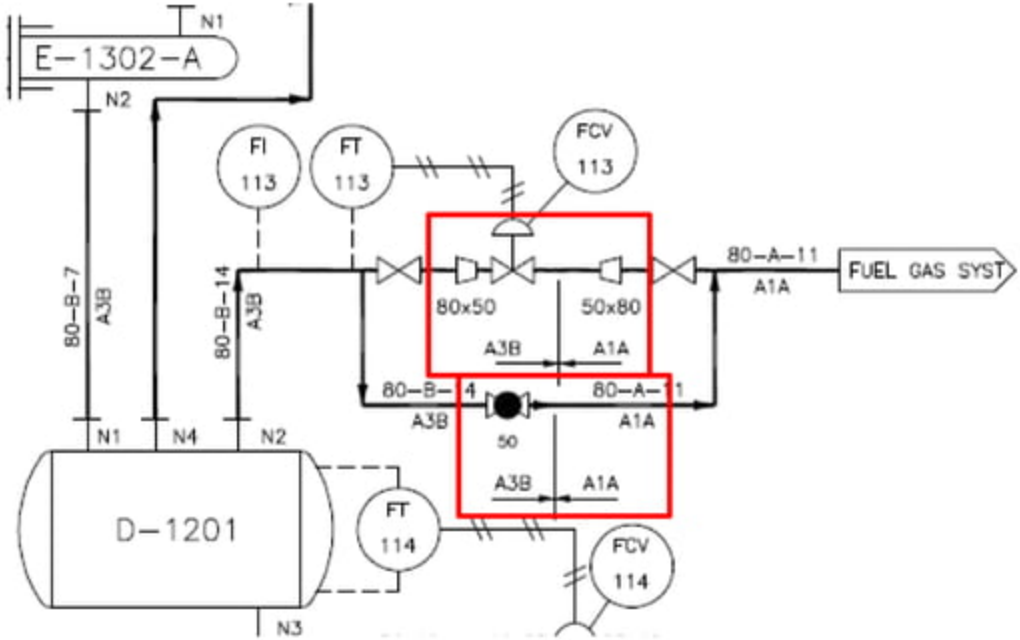
TT
Temperature Transmitter

Pipeline Naming

150-PV-20-2002-AD20XS-03-050-N

150 – Line Size Nominal Dia
PV – Service Code
20 – System
2002 – Sequence Number
AD20XS – Pipe Class
03 – Insulation Class
050 – Insulation Thickness
N – Heat Tracing

Pipe Spec Breaks



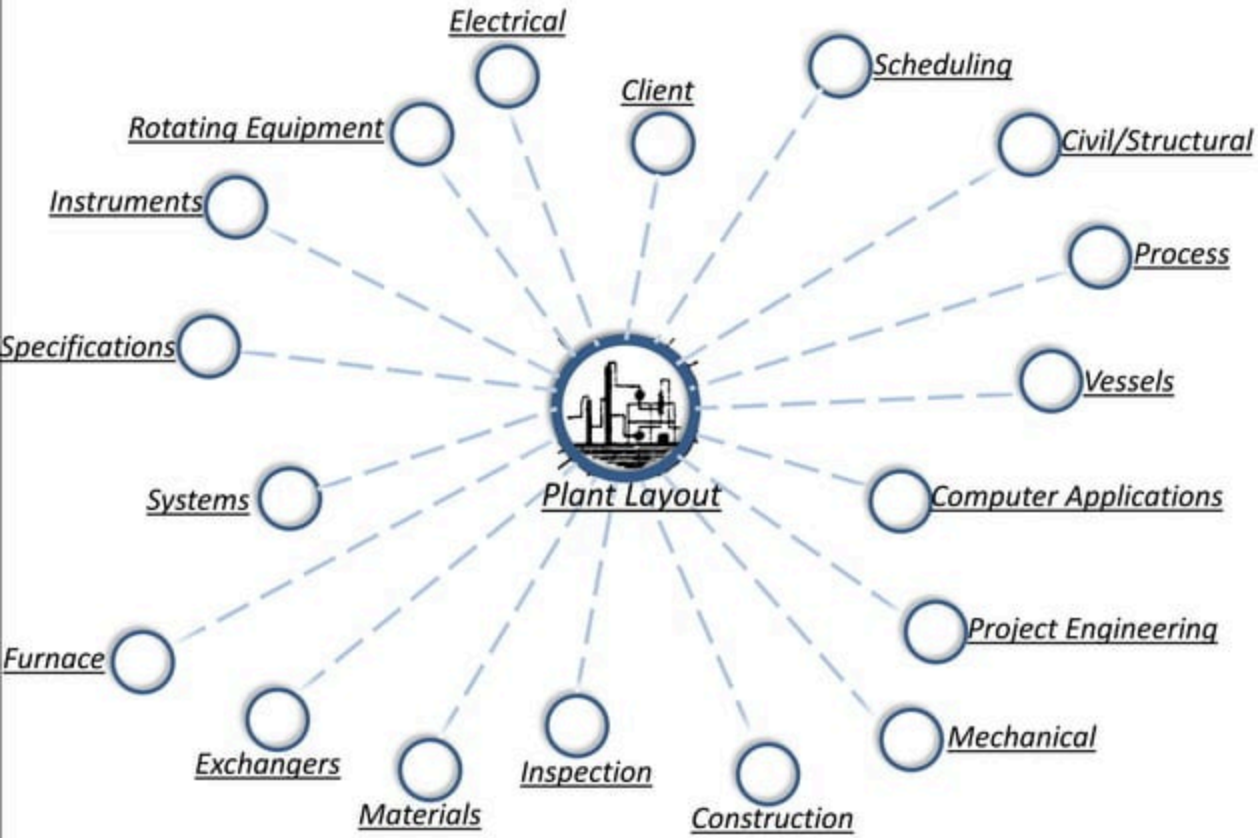
Bulk MTO / Estimates

20 NB SS LINES																	
Line No	Pipe	Gate Valves	90 Elbow	45 Elbow	Tee	Flange	Gasket	Nut/Bolt	CRed 20x15	RedT 20x15	Steam Trap	GlobE Valve	Control Valve	Flush Bot Valve	Strainer	RedT 20x15	Plug
20-MET-05-SS	3000		1	1		2	2	8						1			
20-MET-06-SS	4920	1	3	1		3	3	12									
20-MET-07-SS	11515	2	4		2	10	10	40				1	1				
20-MET-09/10-SS	8265	1	3			6	6	24									
20-BIO-12-SS	3000		1	1		4	5	20						1			
20-BIO-13-SS	6260	1	2	2	1	3	3	12									
20-BIO-14-SS	29570	2	8		2	9	9	36				1	1				
20-BIO-15-SS	7860	1	7			2	3	12									
20-BIO-14-SS(OP)	7545		1		1	1	1	4									
20-BIO-15-SS(OP)	6545		3		1	1	1	4									
20-BIO-28-SS(OP)	9120		6			2	2	8									
20-BIO-29-SS(OP)	5420		3			2	2	8									
20-BIO-30-SS(OP)	14540	3	4		3	3	3	12									
	117560	11	46	5	10	48	50	200				2	2	2			

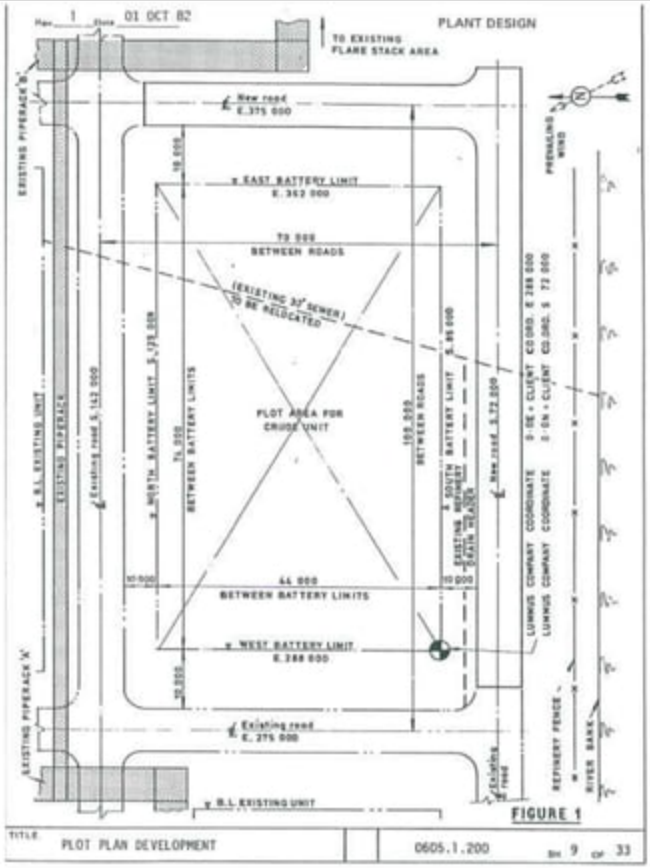
Piping Engineering

A Major phase in the life of process plants

Basics of Plant Layout Design



Plot Plan Development



Plot Plan Development

- Indicate all Major equipment items
- Building outlines
- Battery Limits
- Area Limits of responsibility
- Piping Entry and Exit Points
- Access ways
- Roadways
- Main Structure – Stairways
- Piperacks
- Dimensions kept to a minimum
- Show all Easting/Northings – Elevations
- True North
- Plot Plans supplied by Clients (FEED Specifications)

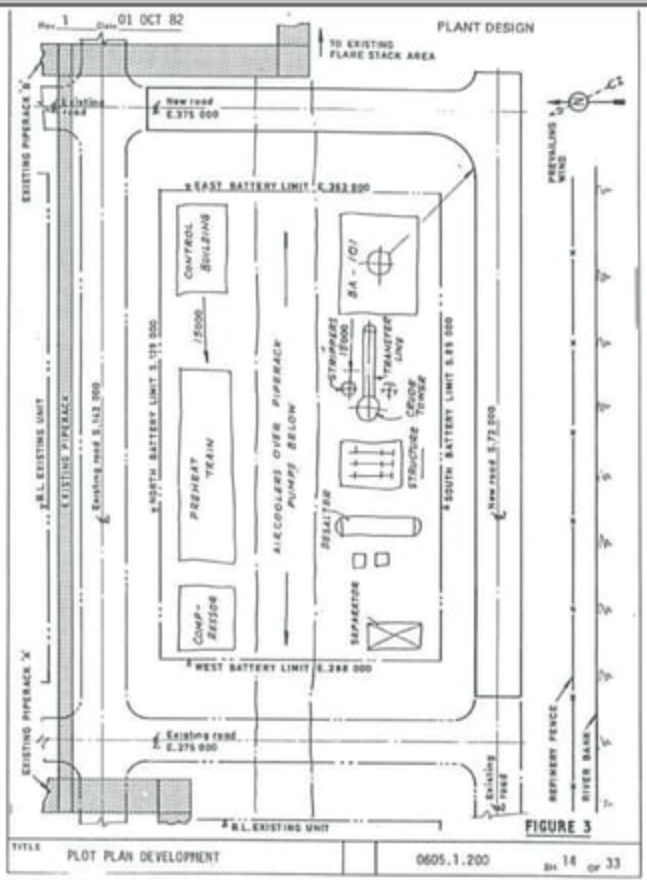
Plot Plan Development – General Information Required

- Site Plans
- Project Design Information – Client Standards
- Equipment List
- PFD and P&ID
- Utility conditions – Cooling Water, Steam, etc
- Preferred locations of exit and entry piping points
- Electrical Cables entry points
- Client / EPC Standards for safely distances
- Client / EPC Standards for specific equipment locations
- Grade levels of unit area and plant in general
- Details of existing roadways, railroad or accessways
- Plant North
- Battery Limits
- Firefighting data

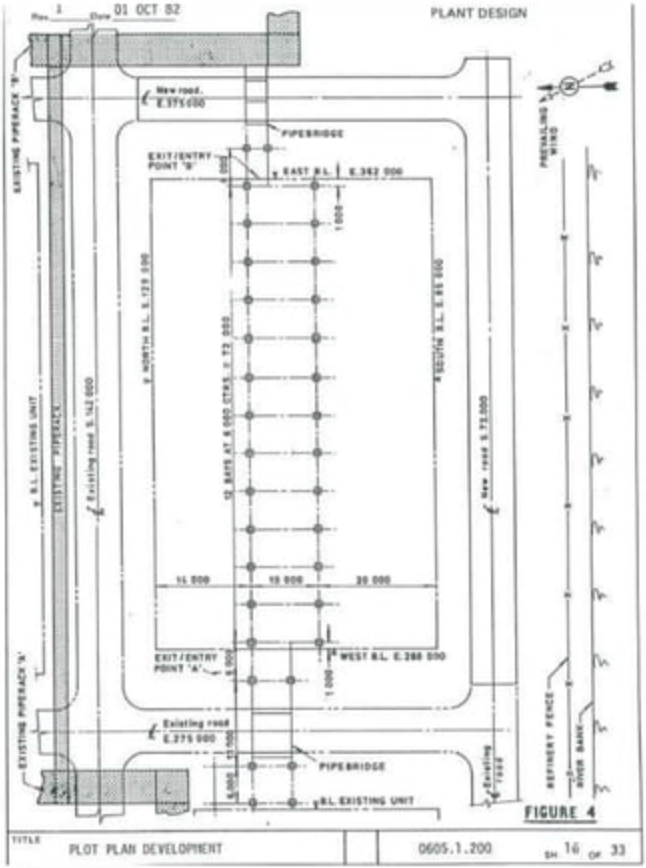
Plot Plan Development – General Information Required

- Storage tanks – diameter and capacity
- Heaters – diameter of shell and height
- Compressors – size of base plate area – type
- Specialist equipment – eg skids, size and area
- Towers/Drums– Diameter and tan line minimum heights
- Critical elevations for all equipment
- Exchangers tube length and diameter

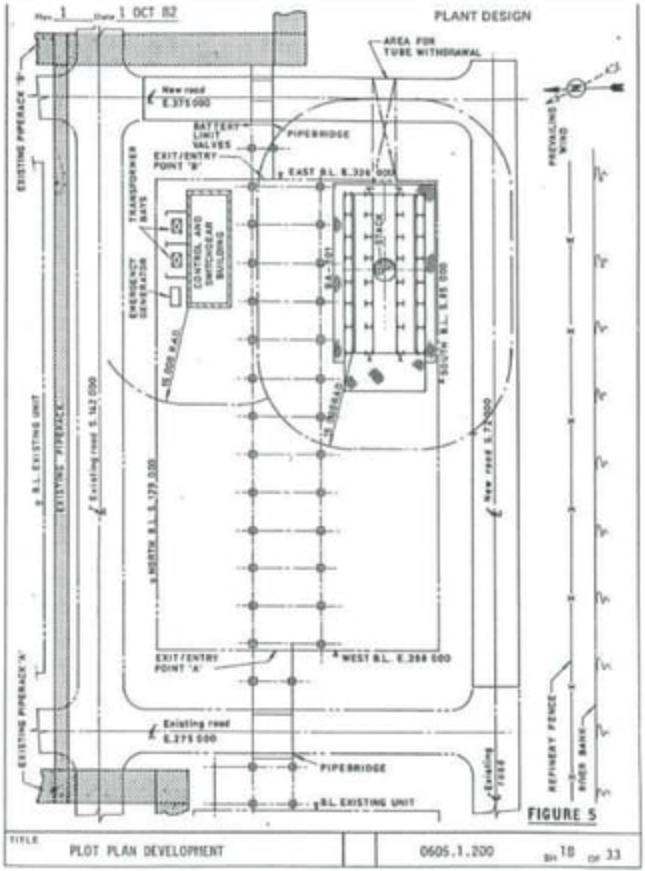
Plot Plan Development



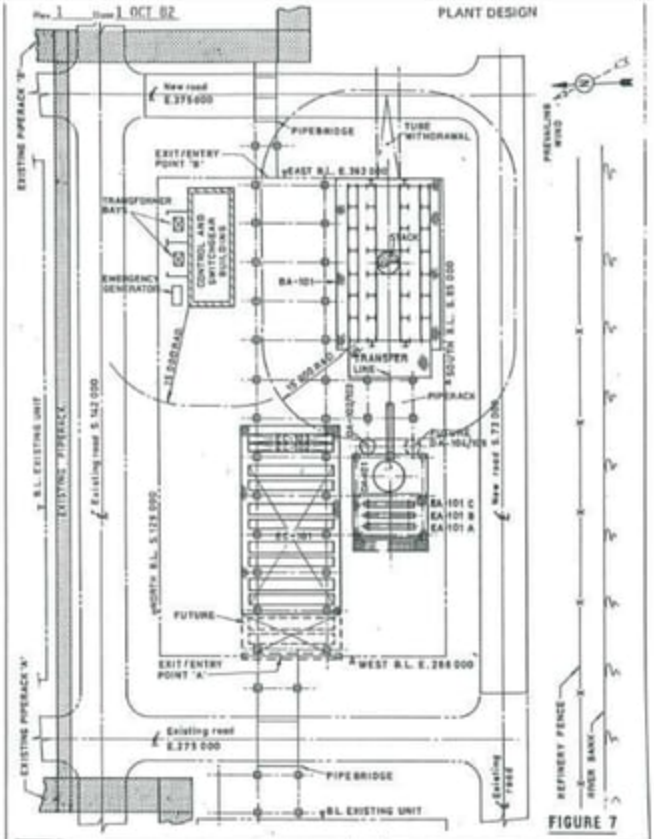
Plot Plan Development



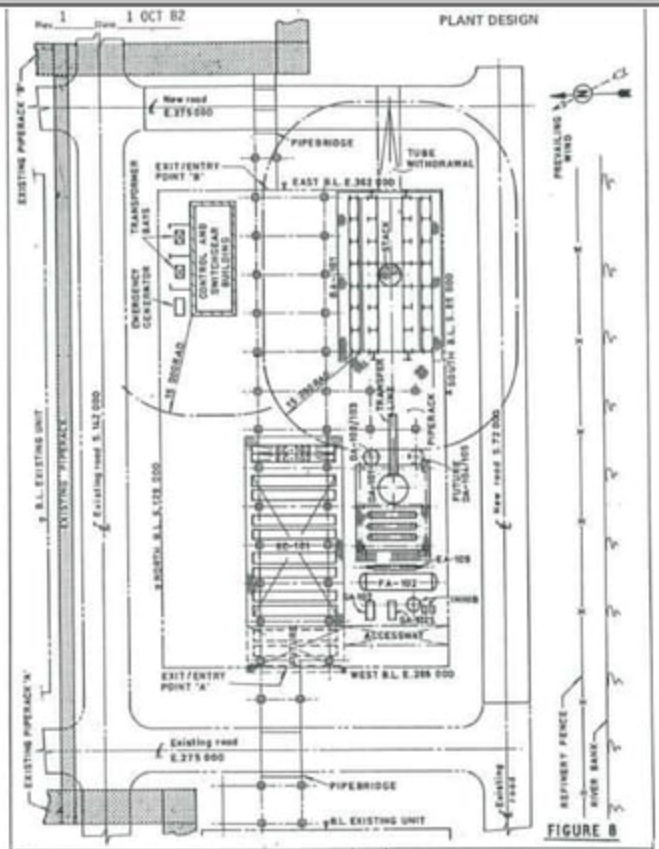
Plot Plan Development



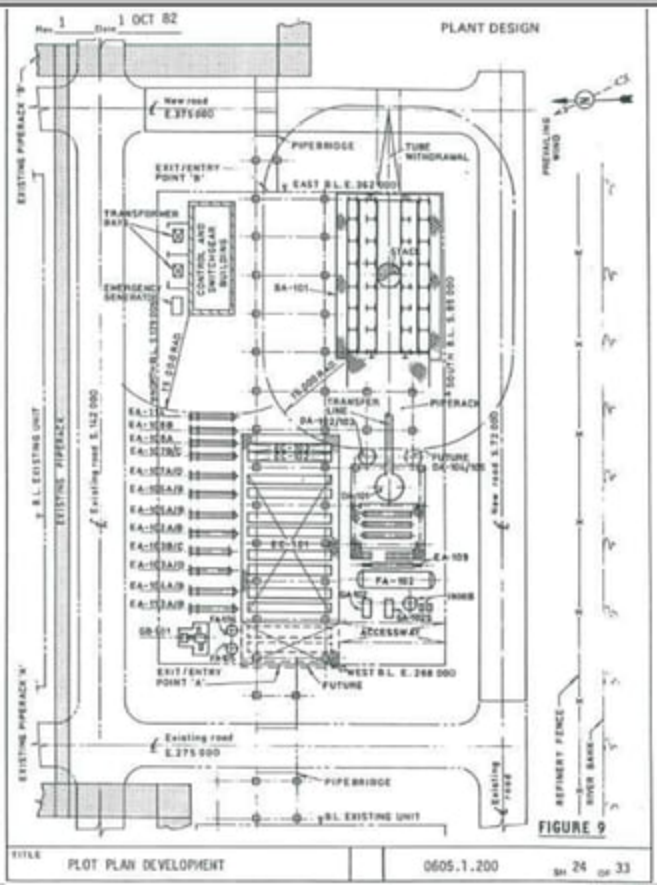
Plot Plan Development



Plot Plan Development



Plot Plan Development



Plot Plan Development

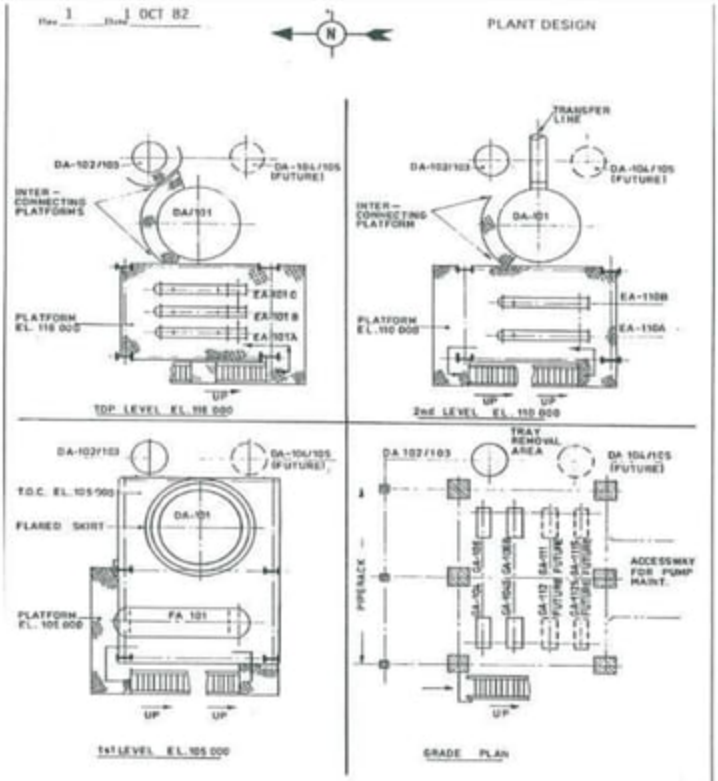
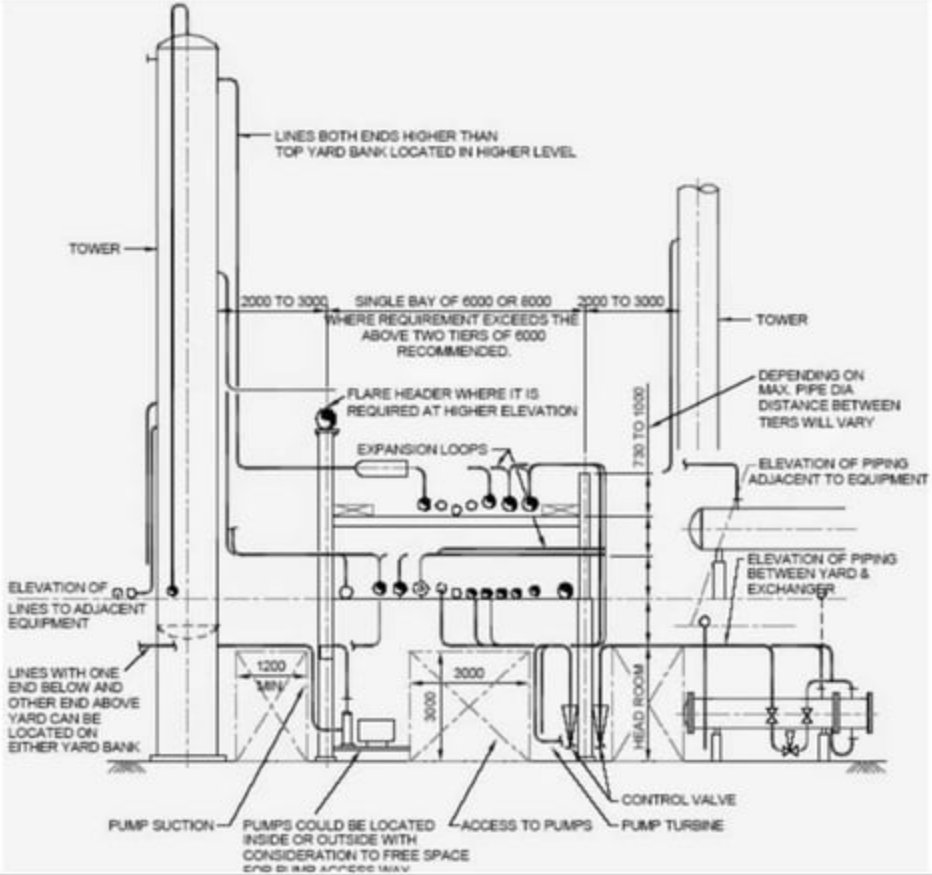


FIG. 12
PROPOSED PLOT PLAN

TITLE		
PLOT PLAN DEVELOPMENT	0603.1.200	SH 31 OF 33

Piping Study



Plot Plan Development

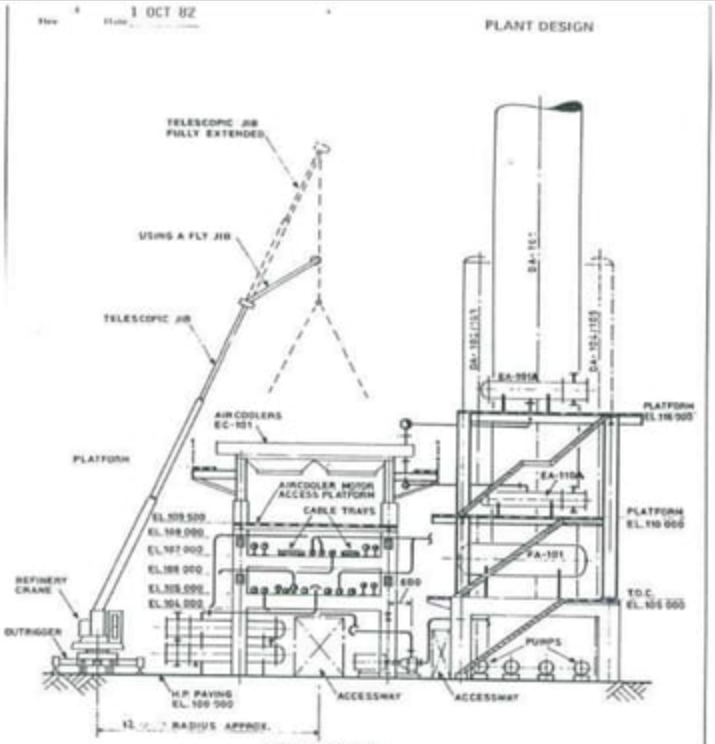
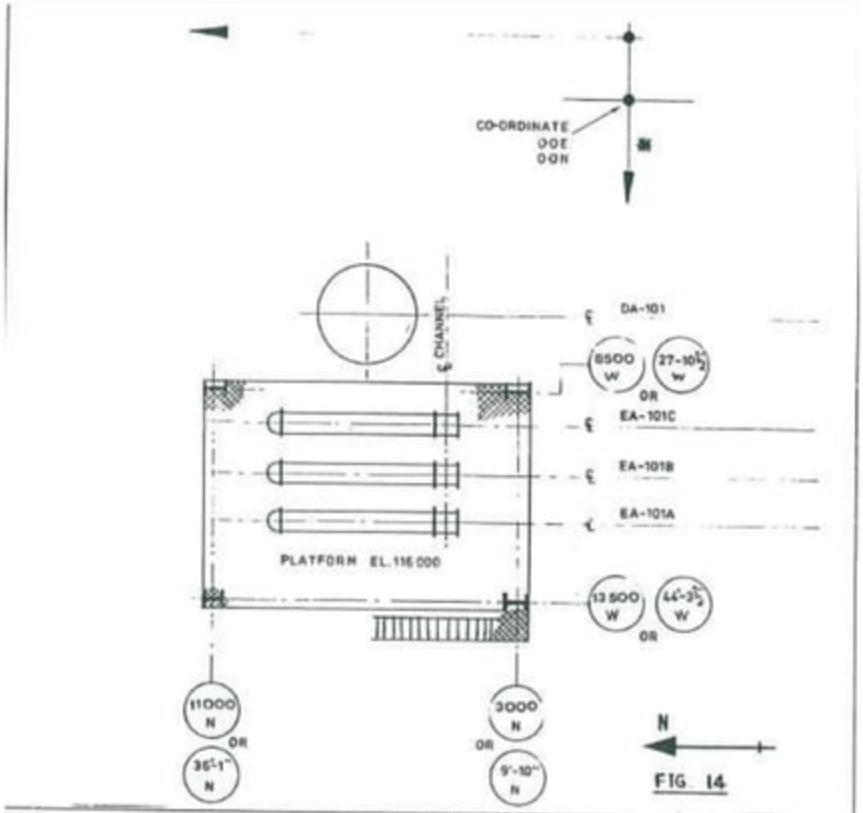


FIG. 1.3
PROPOSED PLOT PLAN

TITLE		
PLOT PLAN DEVELOPMENT	0605.1.200	SH 32 OF 33

Plot Plan Development



Plot Plan Development

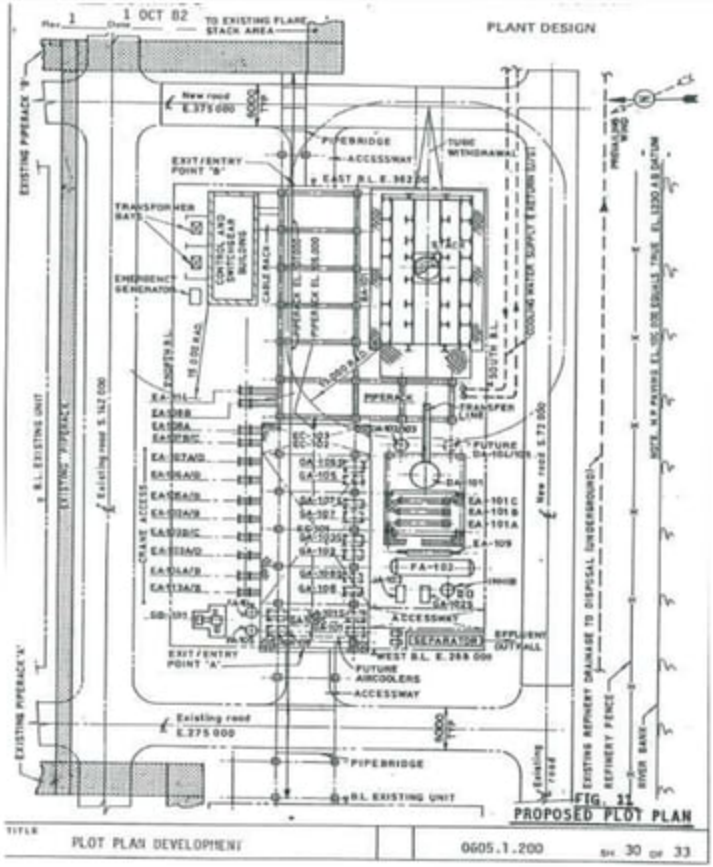


FIG. 11

Piping - Fundamentals

The Goal of Piping Engineering is:

To Ensure a connected Piping is……

- *Specified and Designed*
- *Fabricated and Erected*
- *Inspected and Tested*
- *Operated and Maintained*

In other words….

To perform reliably and safely in all expected conditions, for its design life.

Why is Piping Engineering so important?

- Pipes are supported at point locations
- Weight of the Pipe may change
- Temperature will vary – ambient to operating
- Thermal expansion
- Connected to equipment
- Pipe are welded to components
- Different components within a piping system
- Etc.....

MAJOR ORGANIZATION FOR STANDARDS

Sr. No. Abbreviation	County	Organization	
1.	USA	American National Standard Institute	ANSI
2.	Canada	Canadian Standard Association	CSA
3.	France	Francaise	AFNOR
4.	United Kingdom	British Standards Institute	BSI
5.	Europe	European Community for standardization	CEN
6.	Germany	Deutsches Institute for Normung	DIN
7.	Japan	Japanese Industrial	JIS
8.	India	Bureau of Indian	BIS Standards

Piping - Standards

Organization	ID	Title
ASME	B31.1	Power Piping
ASME	B31.4	Liquid Petroleum Transportation Piping Systems
ASME	B31.5	Refrigeration Piping
ASME	B31.8	Gas Transmission and Distribution Piping Systems
ASME	B31.9	Building Services Piping
ASME	B31.11	Slurry Transportation Piping Systems
ANSI/AGA	Z223.1	National Fuel Gas Code (same as NFPA 54)
AWWA	C 100	Cast-Iron Pipe, Fittings
AWWA	C 200	Steel Pipe
AWWA	C 300	Concrete Pipe
AWWA	C 400	Asbestos Cement Pipe
AWWA	C 500	Valves and Hydrants
AWWA	C 600	Pipe Laying
AWWA	C 900	PVC Pressure Pipe
AWWA	M9	Concrete Pressure Pipe
AWWA	M11	Steel Pipe-Guide for Design and Installation
NFPA	Multiple	Fire Protection Systems

Acronyms and Definitions

The following acronyms and definitions are applicable to this Guide. They may either appear in this Guide, or in various vendor valve catalogues.
Understanding of these acronyms and what they mean may be necessary to proper valve selection.

- ASME: The American Society of Mechanical Engineers.
- ANSI: American National Standards Institute.
- API: The American Petroleum Institute.

Process Pipe

Pipe is specified by its Nominal Bore, its outside diameter.
Pipe is identified by its Wall Thickness, referred to as “Schedule”, eg Sch 40, 80, XS, etc

Piping Specification Revision Control Page

Piping Specification	Title	Revision	Description of Revision	Pages
PS-101	Class 150 Carbon Steel	0	Original Issue	1
PS-102	Carbon Steel (B16.3)	0	Original Issue	1
PS-103	Class 300 Carbon Steel	0	Original Issue	1
PS-104	Class 400 Carbon Steel	0	Original Issue	1
PS-105	Class 600 Carbon Steel	0	Original Issue	1
PS-106	Rating 1000 psi, Carbon Steel	0	Original Issue	1
PS-107	Class 1500, Carbon Steel	0	Original Issue	1
PS-108	Class 2500, Carbon Steel	0	Original Issue	1
PS-109	Victaulic Zero-flex, Carbon Steel	0	Original Issue	1
PS-200	Class 150 304L Stainless Steel	0	Original Issue	1
PS-201	Class 150 316L Stainless Steel	0	Original Issue	1
PS-202	Class 300 304L Stainless Steel	0	Original Issue	1
PS-203	Class 300 316L Stainless Steel	0	Original Issue	1
PS-204	304L Stainless Steel Tubing	0	Original Issue	1
PS-205	304L Stainless Steel Tubing	0	Original Issue	1
PS-206	316L Stainless Steel Tubing	0	Original Issue	1
PS-207	316L Stainless Steel Tubing	0	Original Issue	1
PS-208	Class 400 304L Stainless Steel	0	Original Issue	1
PS-209	Class 600 304L Stainless Steel	0	Original Issue	1
PS-210	Rating 600 psi, 304L Seamless	0	Original Issue	1
PS-211	Rating 600 psi, 316L Seamless	0	Original Issue	1
PS-212	Rating 1225 psi, 304L Seamless	0	Original Issue	1
PS-213	Class 1500, 304L Seamless	0	Original Issue	1
PS-214	Class 2500, 304L Seamless	0	Original Issue	1
PS-215	Victaulic Zero-flex, 316L 10S	0	Original Issue	1
PS-300	Class 150 Hastelloy C276	0	Original Issue	1
PS-301	Class 300 Hastelloy C276	0	Original Issue	1
PS-302	Class 150 Alloy 20	0	Original Issue	1
PS-303	Class 300 Alloy 20	0	Original Issue	1

Piping - Specifications

Piping Specification 101	Date: March 16, 2009	Revision: 0	Page 1 of 1

Design Parameters

P-Spec	PS-101(A, B, C, D)						
Design Pressure (psig)	285	260	230	200	170	140	125
Design Temperature (°F)	100	200	300	400	500	600	650
Minimum Temperature (°F)	-20	-20	-20	-20	-20	-20	-20
Minimum Test Pressure (psig)	430	390	345	300	270	245	220
Maximum Test Pressure (psig)	820						

Calculation Reference:	00-00-CALC-M-0004-R0
Code of Reference:	B31.3 - 2002
Fluid Service:	Normal
Material:	Carbon Steel
Pressure Rating:	Class 150
External Pressure Rating:	15 psi

General Notes

Refer to General Notes 1-12.

Allowable Pipe Materials

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Piping	¼ - 24	Schedule Tables	ASME B36.10M	ASTM A53	B	ERW – Type E/Seamless
Piping	¼ - 24	Schedule Tables	ASME B36.10	ASTM A106	B	Seamless

Required Schedules for Non-Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6	8	10	12	14	16	18	20	24
A	0.000	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
B	0.031	Schedule	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
C	0.063	Schedule	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD
D	0.125	Schedule	-	XXS	160	160	160	80	80	80	STD	STD	STD	STD	STD	STD	STD	STD	STD	STD

Required Schedules for Threaded Pipe

P-Spec	Corrosion Allowance	Pipe Size	¼	½	¾	1	1 ½	2	2 ½	3	4	6
A	0.000	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
B	0.031	Schedule	80	80	80	80	80	STD	STD	STD	STD	STD
C	0.063	Schedule	-	80	80	80	80	80	80	80	STD	STD
D	0.125	Schedule	-	XXS	160	160	160	160	160	80	80	80

Piping - Specifications

Fittings

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Fittings	¼ - 4	2000#, 3000#	ASME B16.11	ASTM A105	WP	Use 3000# for PS101-D
Socket-Weld Fittings	¼ - 2	3000#, 6000#	ASME B16.11	ASTM A105	WP	Use 6000# for PS101-D
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Buttweld Fittings	½ - 24	Schedule Tables	ASME B16.28	ASTM A234	WPB	

Flanges

Component	Size	Rating	Standard	Material	Material Grade	Additional Requirements
Threaded Flange	½ - 6	Class 150	ASME B16.5	ASTM A105	N/A	
Socket-Weld Flange	½ - 2	Class 150	ASME B16.5	ASTM A105	N/A	
Weldneck Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Slip-on Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Blind Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	
Backup Flange	½ - 24	Class 150	ASME B16.5	ASTM A105	N/A	

Mechanical Fasteners

Component	Size	Standard	Material	Material Grade	Additional Requirements
Fasteners	½ - 1 ¼	ASME B18.2.1	ASTM A193	B7-HH	See General Note 10.
Nuts	½ - 1 ¼	ASME B18.2.2	ASTM A194	2H-HH	

VALVES

The valve ID numbering system is defined in Appendix D.

	Feature	Feature Specifications
Required Specification Features	1) Acceptable Standard	CV Code Valve
	2) Material	2-Bronze, 4-Carbon Steel (1), 5-Stainless Steel 304(L) (2), 6-Stainless Steel 316(L) (3)
	3) Pressure Class	1-150, P-Pressure Rated
	4) End Connection (4)	1-Flanged, 2-Socket Weld, 3-Butt Weld, 4-Threaded
	5) Type of Valve	BL-Ball, CB-Ball Check, GW-Solid Wedge Gate, TN-Needle Globe, TS-Standard Globe
Optional Specification Features	6) Valve Size	Specified as shown in the Example Valve ID Number by NPS
	7) Disc Material	A-Chromium (11-13%), C-Bronze, D-Stainless Steel
	8) Seat Material	A-Chromium (11-13%), D-Stainless Steel, O-Viton, P-EPDM
	9) Stem Material	A-Chromium (11-13%), B-Carbon Steel, C-Bronze, D-Stainless Steel
	10) Packing Material	A-Graphite, B-Teflon, D-Nylon, G-Viton, H-EPDM
	11) Body Gasket	B-Teflon, D-Nylon, G-Viton, H-EPDM

NOTES

1) ASTM A216WCB or A105
2) CF3, CF8, F304, or F304L
3) CF3M, CF8M, F316, F316L
4) Non welded end stainless steel valves pressure rating is based on the high carbon (non L) grade.

Table D-1 Standards for Valves

Standard	Title
ASME B16.34	Valves - Flanged, Threaded, and Welding End
API 594	Wafer Check Valves
API 599	Steel and Ductile Iron Plug Valves
API 600	Steel Gate Valves, Flanged and Buttwelding Ends
API 602	Compact Steel Gate Valves
API 603	Class 150 Cast, Corrosion-Resistant, Flanged-End Gate Valves
API 608	Metal Ball valves - Flanged and Buttwelding Ends
API 609	Butterfly Valves, Lug-Type and Wafer-Type
AWWA C500	Gate Valves, 3 inch through 48 inch, for Water and Sewage Systems
AWWA C504	Rubber Seated Butterfly Valves
MSS SP-42 (Note 1)	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
MSS SP-67 (Note 1)	Butterfly Valves
MSS SP-70	Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	Ball Valves with Flanged or Butt-Welding Ends for general Service
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-81	Stainless Steel, Bonnetless, Flanged Knife Gate Valves
MSS SP-85	Cast Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-88	Diaphragm Type Valves

Note 1: These valves are acceptable even though not listed in Table 326.1 of ASME B31.3. They are listed in Table 126.1 of ASME B31.1. The additional requirements of ASME B31.1 must be met in that "only valves designed such that the valve stem is retained by an assembly which functions independently of the stem seal retainer shall be used" (refer to paragraph 107.1(D) of ASME B31.1).

Table D-2 Valve Selection

Service	Description of Service	Recommended Valve
Contamination	Control of fluids which may cause contamination buildup, a valve with minimum obstruction to flow is needed	Ball, Gate, Globe, or Pinch
High Pressure	Control of flow at high pressures - selection of a valve to be used in a high pressure application, particularly pneumatic, should be approached with caution	Ball or Globe, Poppet Valves are occasionally used
High Temperature	Control of flow at high temperatures	Ball or Globe, Poppet Valves are occasionally used
Low Leakage	Control of flow with very low seat leakage in the closed position	Ball, Gate, Globe, or Plug
Shutoff	Normal on-off control	Ball, Gate, Globe, or Plug - Ball and Plug Valves normally operate faster
Steam Service	Control of steam under pressure	Ball or Globe
Throttling	Control the amount of flow by varying the valve position	Globe - Ball and gate valves tend to vibrate under flow, and erosion is a concern when using gate valves

Table D-3 Valve Selection

Valve	Type	Mode of Flow Regulation			Fluid				
						Solids in Suspension			
		On-Off	Throttling	Diverting	Free of Solid	Non-Abrasive	Abrasive	Sticky	Sanitary
Globe	Straight Pattern	Yes	Yes		Yes				
	Angle Pattern	Yes	Yes		Yes	Special	Special		
	Oblique Pattern	Yes	Yes		Yes	Special			
	Multi-Port			Yes	Yes				
	Piston	Yes	Yes		Yes	Yes			
Parallel Gate	Conventional	Yes			Yes				
	Conduit	Yes			Yes	Yes	Yes		
	Knife	Yes	Special		Yes	Yes	Yes		
Wedge Gate	With bottom Cavity	Yes			Yes				
	Without Bottom Cavity (rubber seated)	Yes	Moderate		Yes	Yes			
Plug	Non-lubricated	Yes	Moderate	Yes	Yes	Yes			
	Lubricated	Yes		Yes	Yes	Yes	Yes		Yes
	Eccentric Plug	Yes	Moderate	Yes	Yes	Yes		Yes	
	Lift Plug	Yes		Yes	Yes	Yes		Yes	
Ball	---	Yes	Moderate	Yes	Yes	Yes			
Butterfly	---	Yes	Yes	Special	Yes	Yes			Yes
Pinch	---	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Diaphragm	Weir Type	Yes	Yes		Yes	Yes		Yes	Yes
	Straight Through	Yes	Moderate		Yes	Yes		Yes	Yes

Piping – Fittings and Components

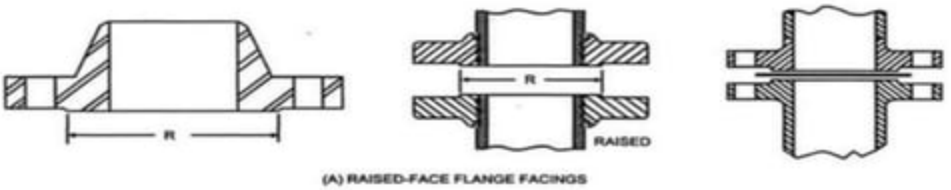
Screwed stainless steel and butt weld mild steel fittings

Piping – Fittings and Components

- Fittings are used in pipe systems to connect straight pipe or where change is direction is required.
- Ends are already prepared.
- To adapt to different sizes, to branch out or re-direct the process (flow).
- To provide a joint if 2 dissimilar materials are used in one system.
- Fittings for pipe most often made from the same base material as the pipe being
- connected, e.g., carbon steel, stainless steel, copper or plastic.
- Any material that is allowed by code may be used, but must be compatible with the other
- materials in the system, the fluids being transported, and the temperatures and
- pressures inside and outside of the system.
- Lines below 50mm NB are normally screwed or socket weld.
- Line 50mm and above are butt welded.

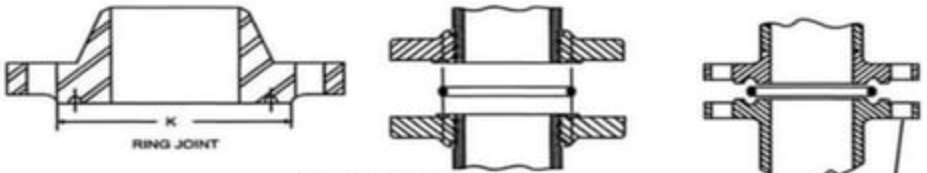
Piping - Flanges

Piping - Flanges



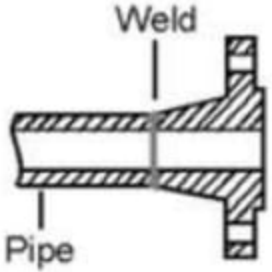
(A) RAISED-FACE FLANGE FACINGS

(B) FLAT-FACE FLANGE FACINGS



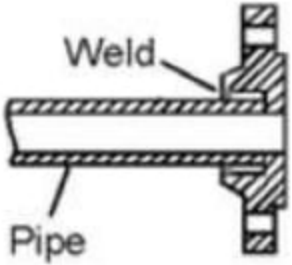
(C) RING-JOINT FLANGE FACINGS

(D) LAP-JOINT FLANGE FACINGS



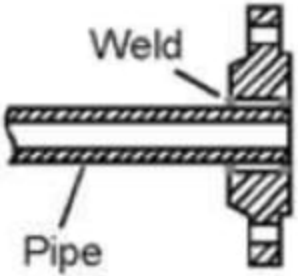
Weld Neck

Weld Neck flanges are used in critical applications. These are circumferentially welded onto the system at their necks which means that the integrity of the butt-welded area can easily be examined by X-ray radiography.
The bores of both pipe and flange match thus reducing turbulence and erosion.



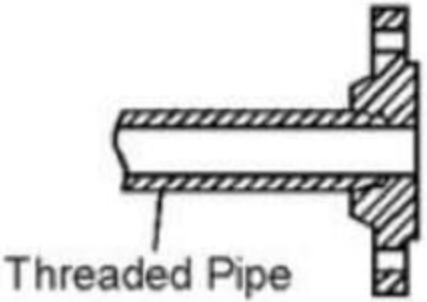
Socket Weld

Socket Weld Flange is counter-bored to accept the pipe, which is then fillet welded.
The bore of both the pipe and the flange are the same to ensure good flows.

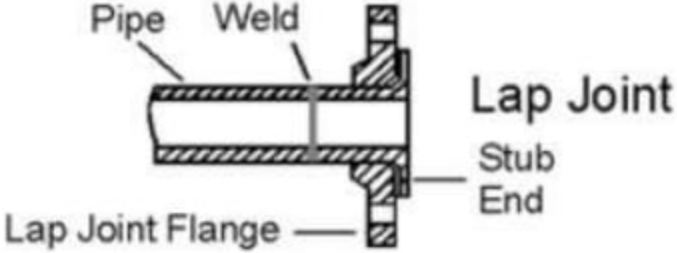


Slip On

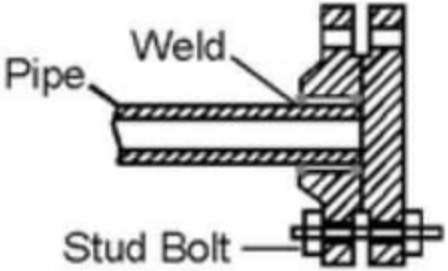
Slip-on Flange is slipped over the pipe and then fillet welded. Easy to use in fabricated applications.



Screwed or Threaded Flange requires no welding and is used to connect other threaded components in low pressure non-critical applications.



Lap Flange (or **Backing Flange**) are used with a stub end which is butt-welded to the pipe with the lap flange acting as a loose collar behind it. Thus the stub end always provides the sealing face. This type of joint is easily assembled and aligned, and it is favoured in low pressure applications.



Blind Flange or sometimes called a **Blanking Flange**, this is used for blanking off pipelines, valves and pumps and as an inspection cover.

Piping - Valves

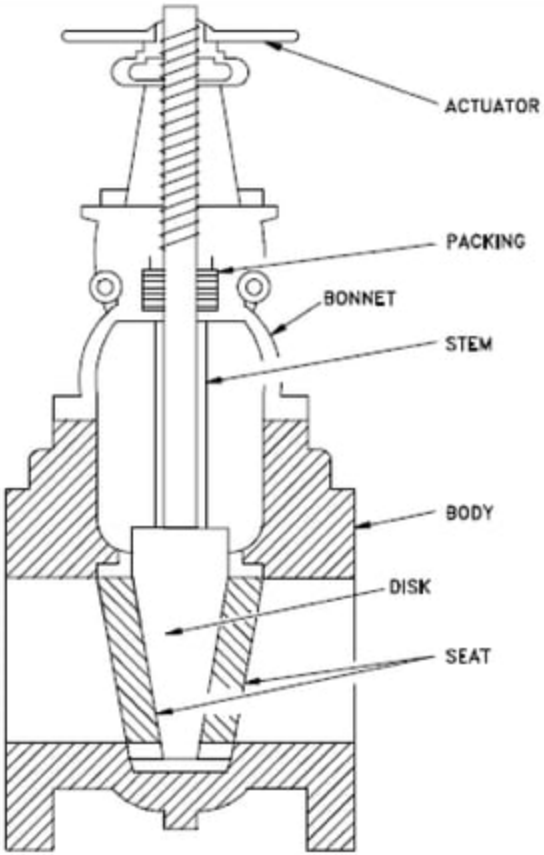
Piping - Valves

A valve is a mechanical device that controls the flow of fluid and pressure within a system or process.
A valve controls system or process fluid flow and pressure by performing any of the following functions:

- Stopping and starting fluid flow.
- Varying (throttling) the amount of fluid flow.
- Controlling the direction of fluid flow.
- Regulating downstream system or process pressure.
- Relieving component or piping over pressure.
- There are many valve designs and types that satisfy one or more of the functions identified above.
- A multitude of valve types and designs safely accommodate a wide variety of process applications.

Complex control systems will use feedback from an instrument to control these types of valves to regulate pressure, temperature or flowrate depending on the control parameters required.

Piping - Valves



Types of Valves

- Globe
- Gate
- Plug
- Ball
- Needle
- Butterfly
- Diaphragm
- Pinch
- Check
- Safety/relief
- Reducing

Classification

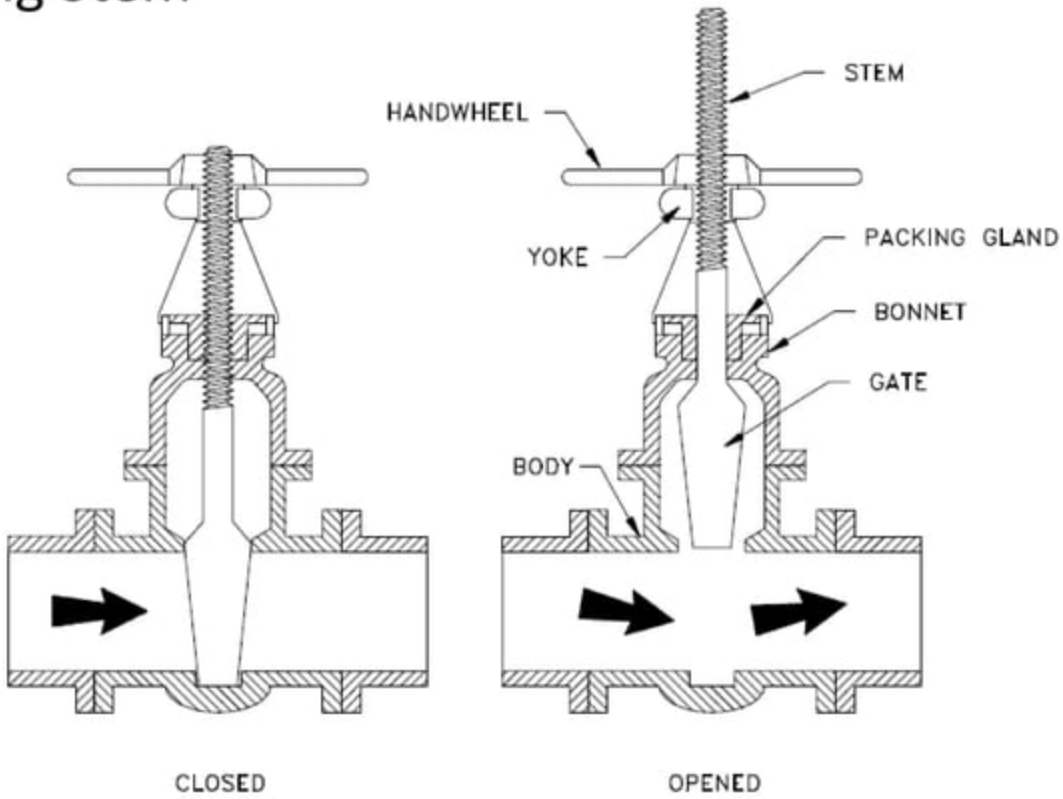
Isolation
- Gate Valves
- Ball Valves
- Plug Valves
- Piston Valves
- Diaphragm Valves
- Butterfly Valves
- Pinch Valves

Regulation
- Globe Valves
- Needle Valves
- Butterfly Valves
- Diaphragm Valves
- Piston Valves
- Pinch Valves

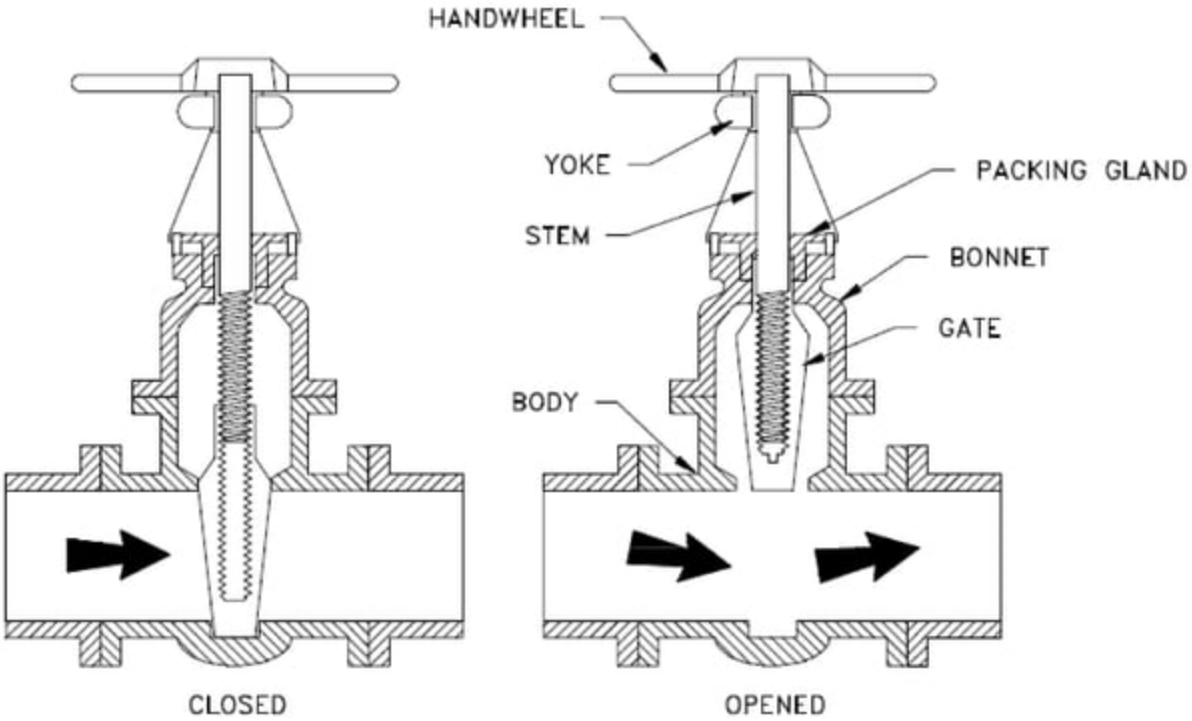
Non-Return
- Check Valves

Special Purpose
- Multi-port Valves
- Float Valves
- Blind Valves

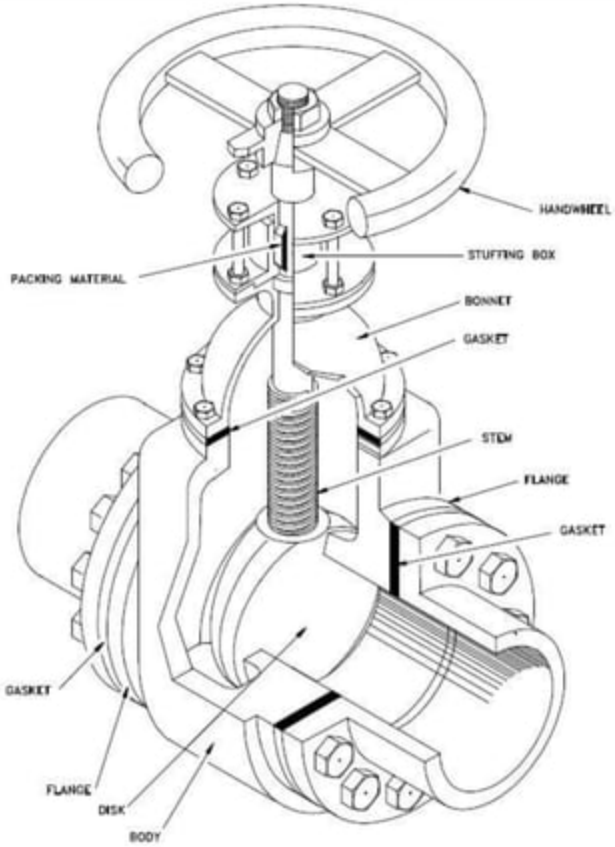
Rising Stem


STEM
HANDWHEEL
YOKE
PACKING GLAND
BONNET
GATE
BODY
CLOSED
OPENED

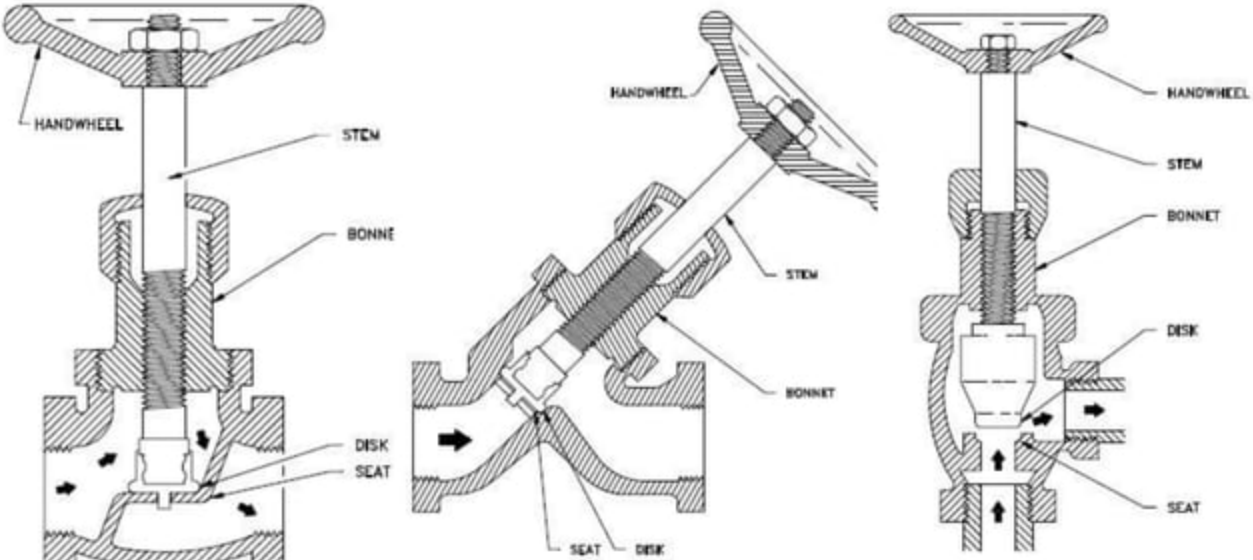
Non Rising Stem



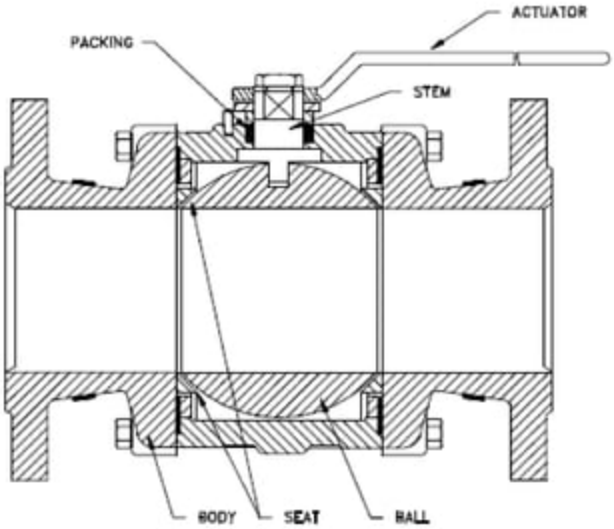
Gate Valve

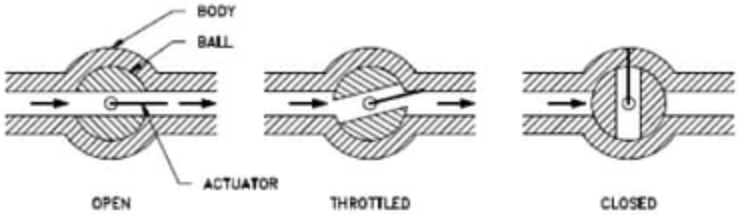

HANDWHEEL
STUFFING BOX
PACKING MATERIAL
BONNET
GASKET
STEM
FLANGE
GASKET
GASKET
FLANGE
DISK
BODY

Globe Valve

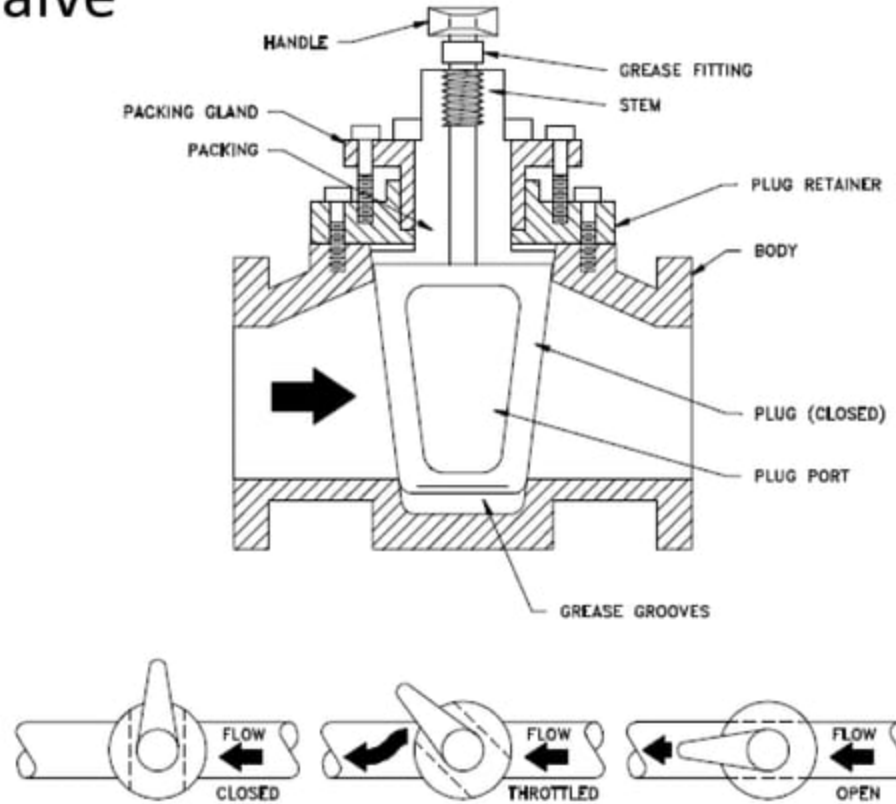

HANDWHEEL
STEM
BONNE
DISK
SEAT
HANDWHEEL
STEM
BONNET
SEAT
DISK
HANDWHEEL
STEM
BONNET
DISK
SEAT

Ball Valve

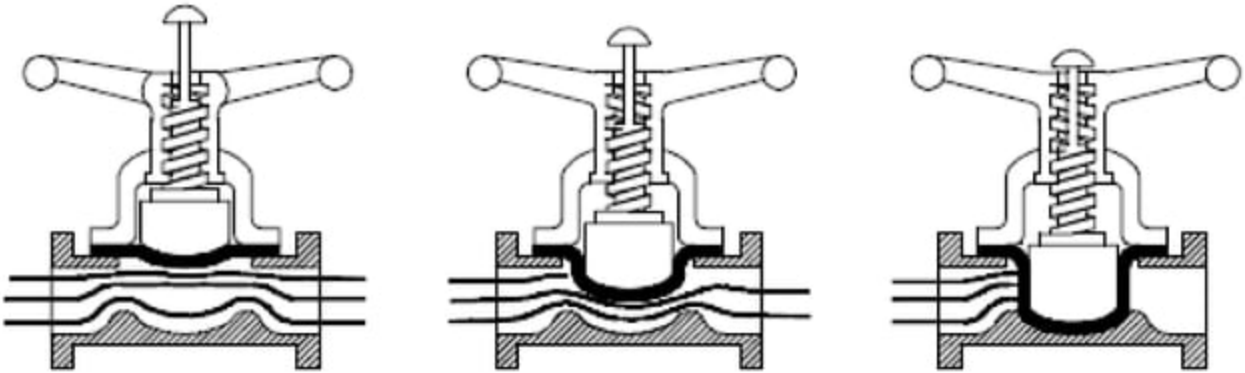

ACTUATOR
PACKING
STEM
BODY
SEAT
BALL


BODY
BALL
ACTUATOR
OPEN
THROTTLED
CLOSED

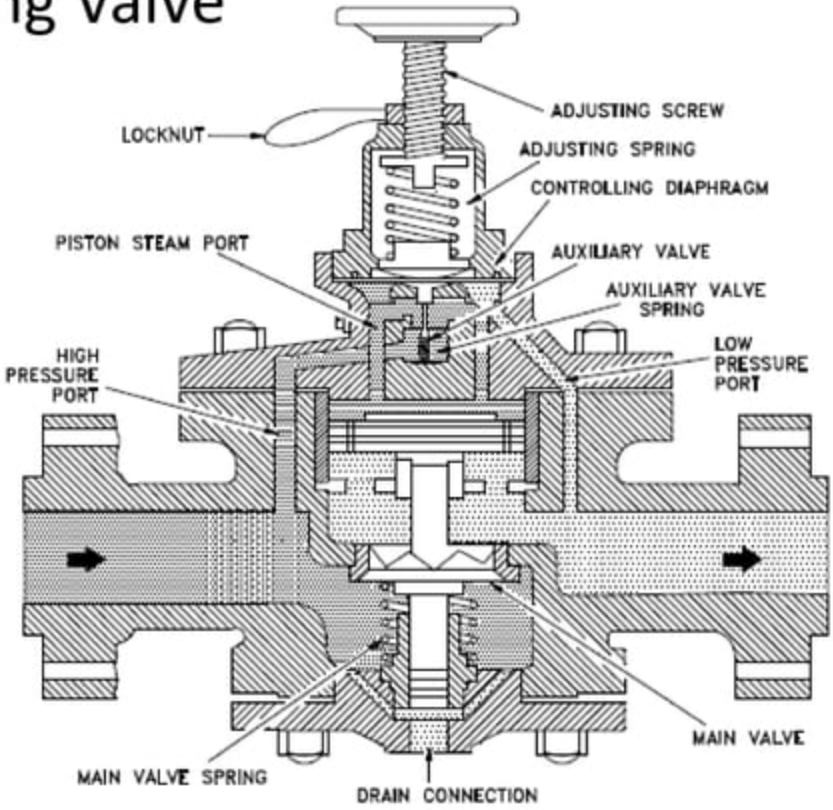
Plug Valve


HANDLE
GREASE FITTING
STEM
PACKING GLAND
PACKING
PLUG RETAINER
BODY
PLUG (CLOSED)
PLUG PORT
GREASE GROOVES
FLOW
CLOSED
FLOW
THROTTLED
FLOW
OPEN

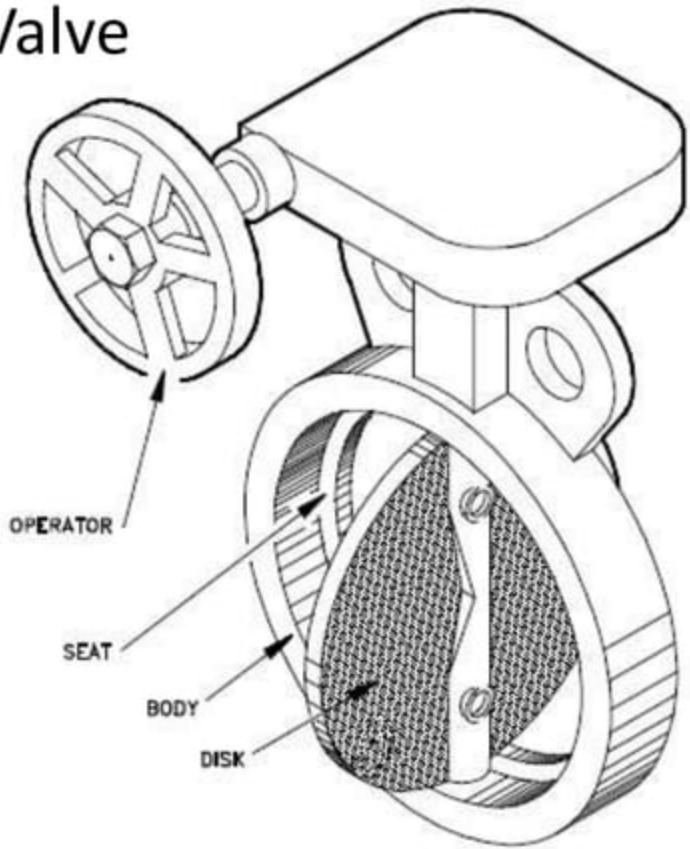
Diaphragm Valve



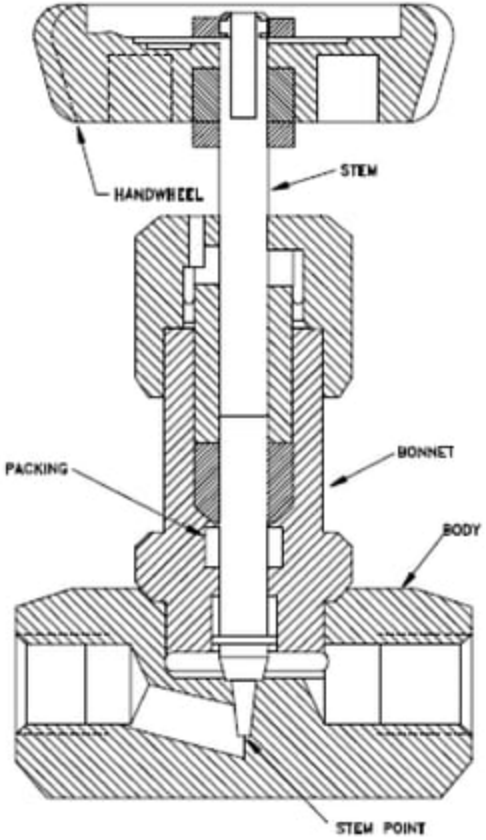
Reducing Valve



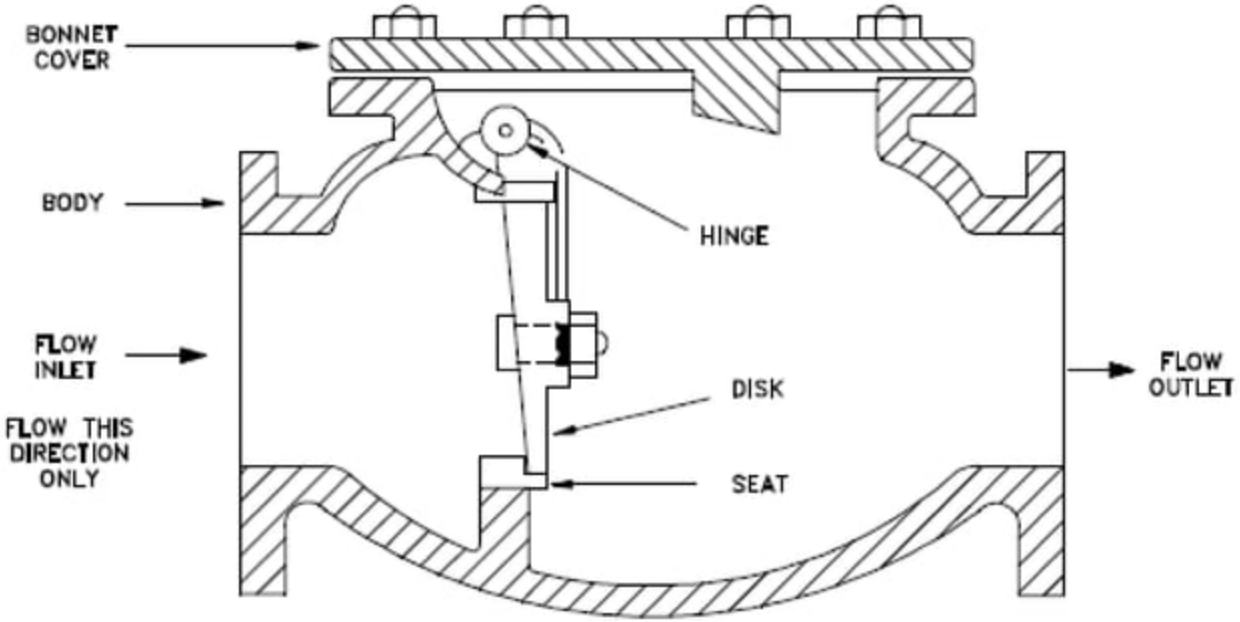
Butterfly Valve



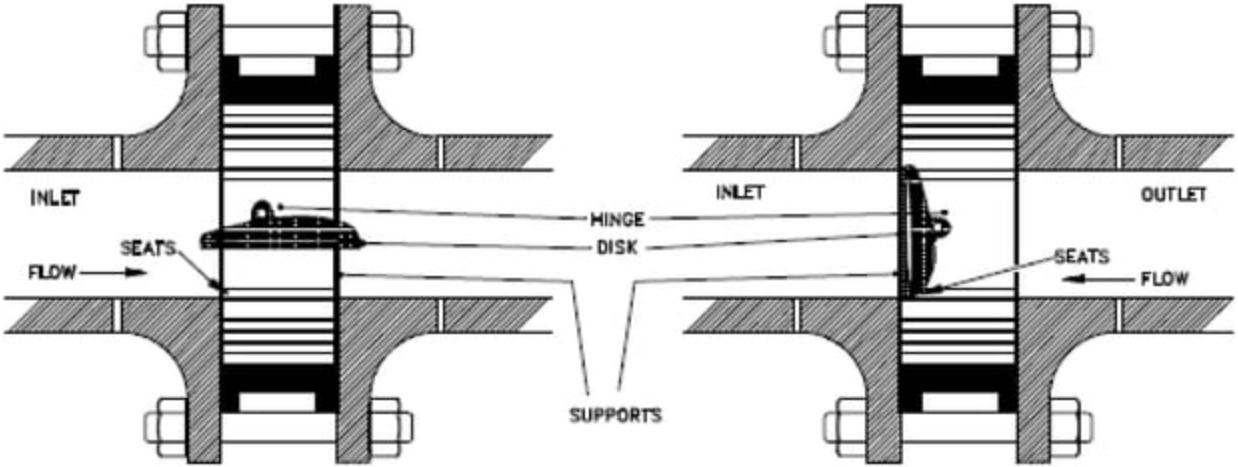
Needle Valve



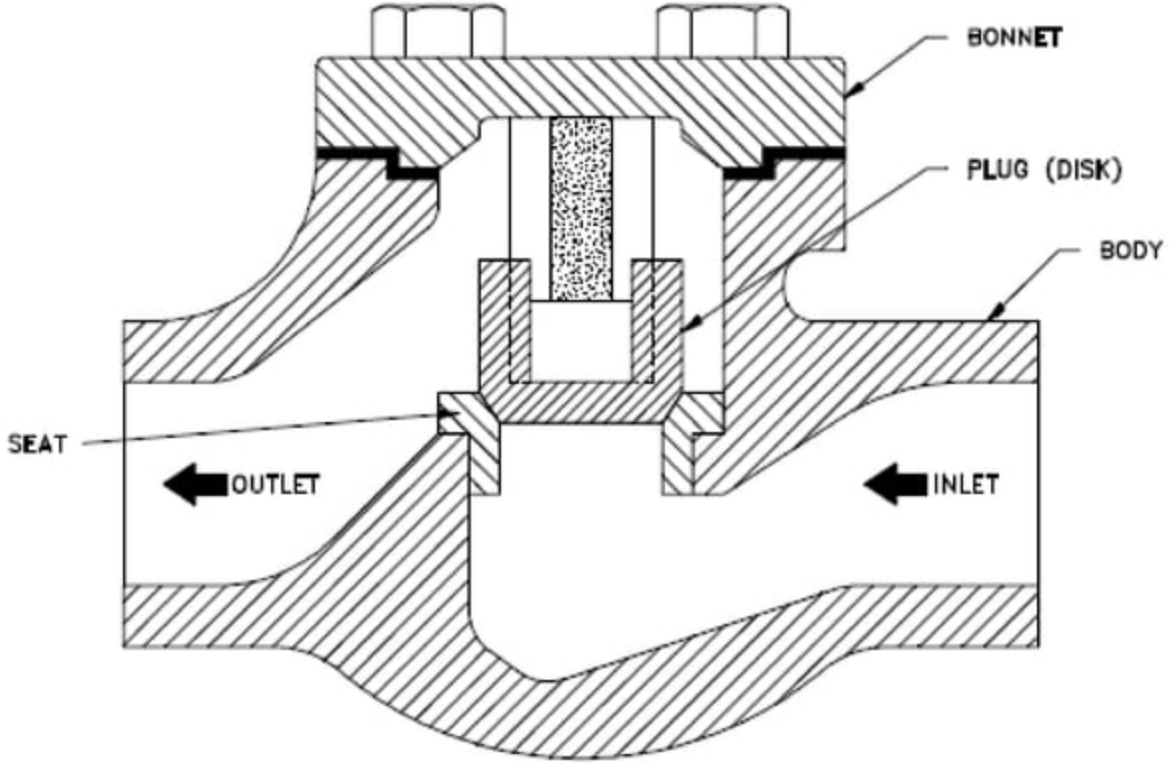
Check Valve - Swing



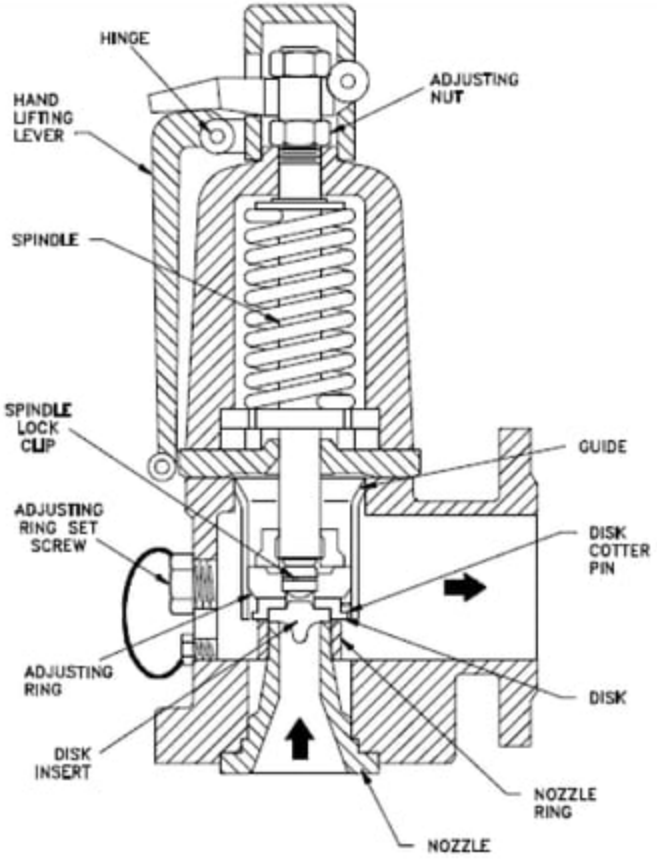
Check Valve - Tilting



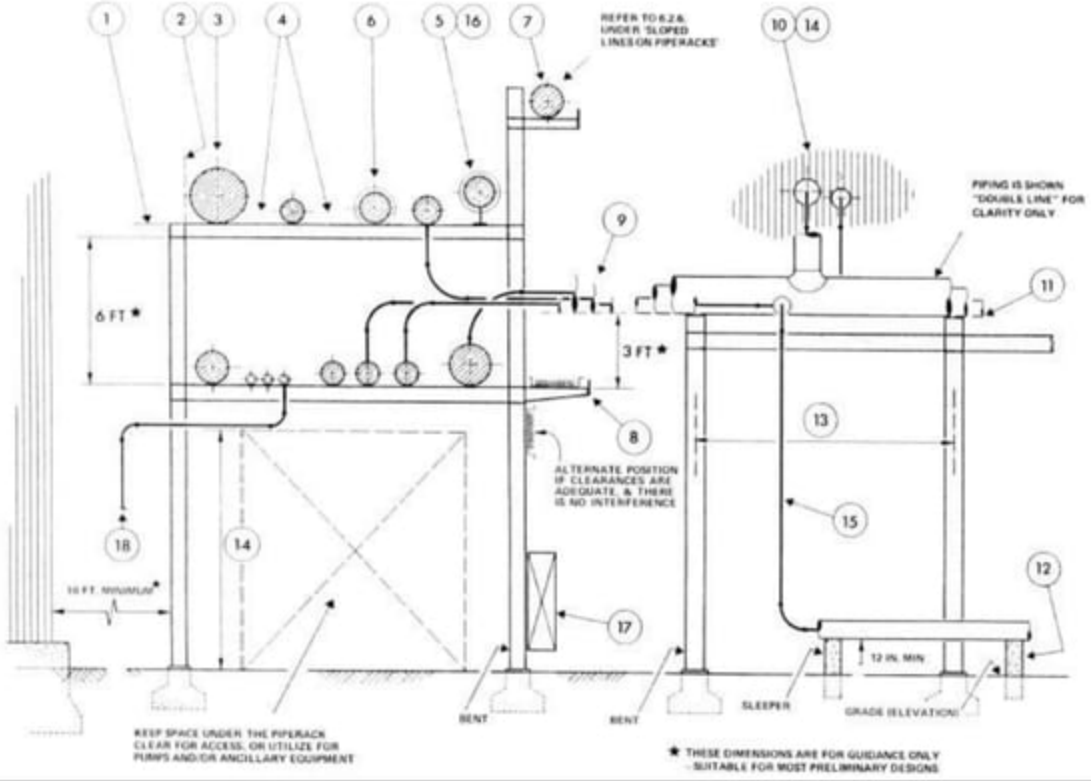
Check Valve - Lift



Relief Valve



Piperack configuration



Piperack configuration

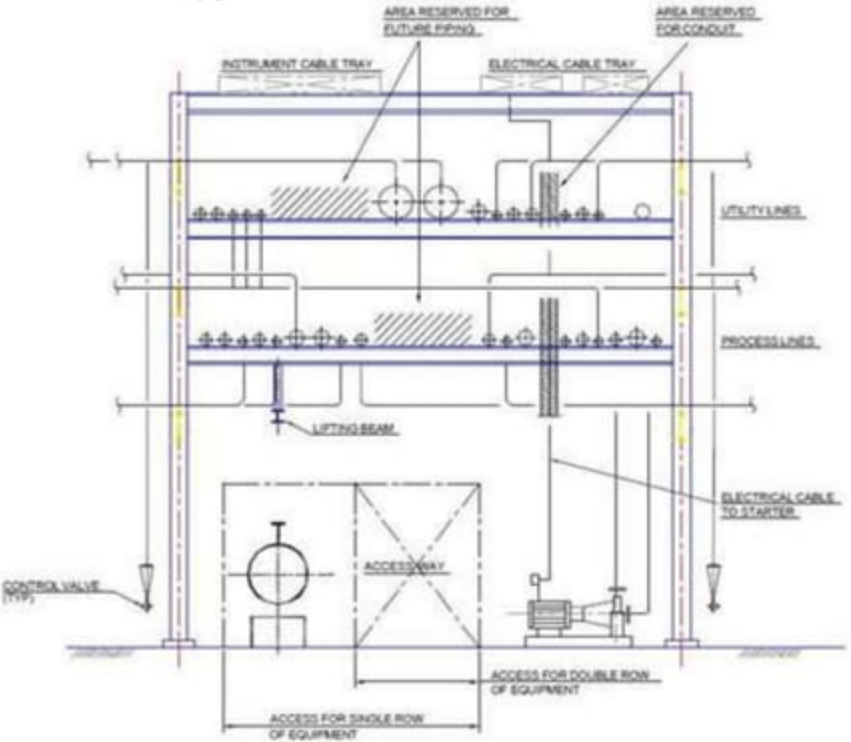
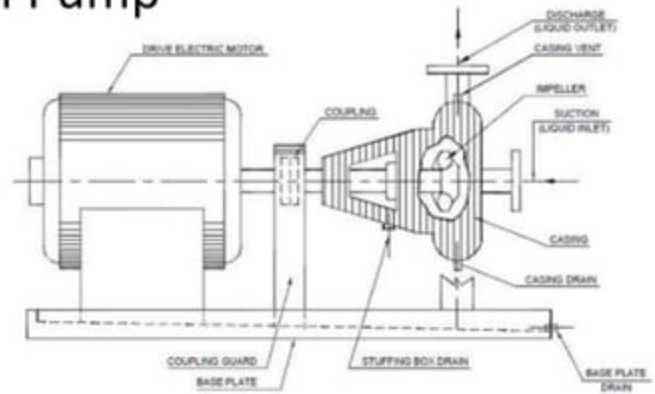
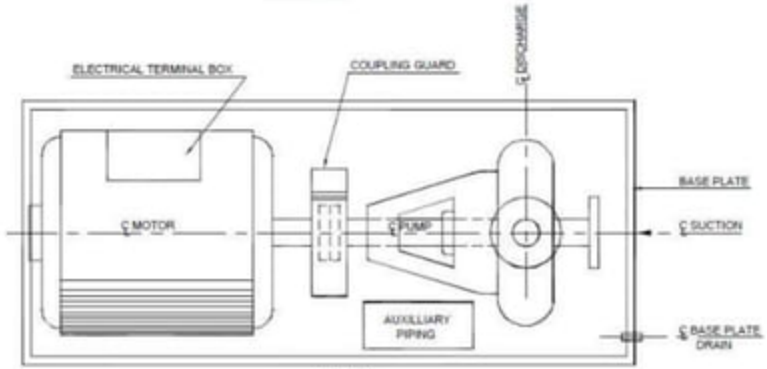


Fig 1- Typical cross-section for composite piperack

Centrifugal Pump

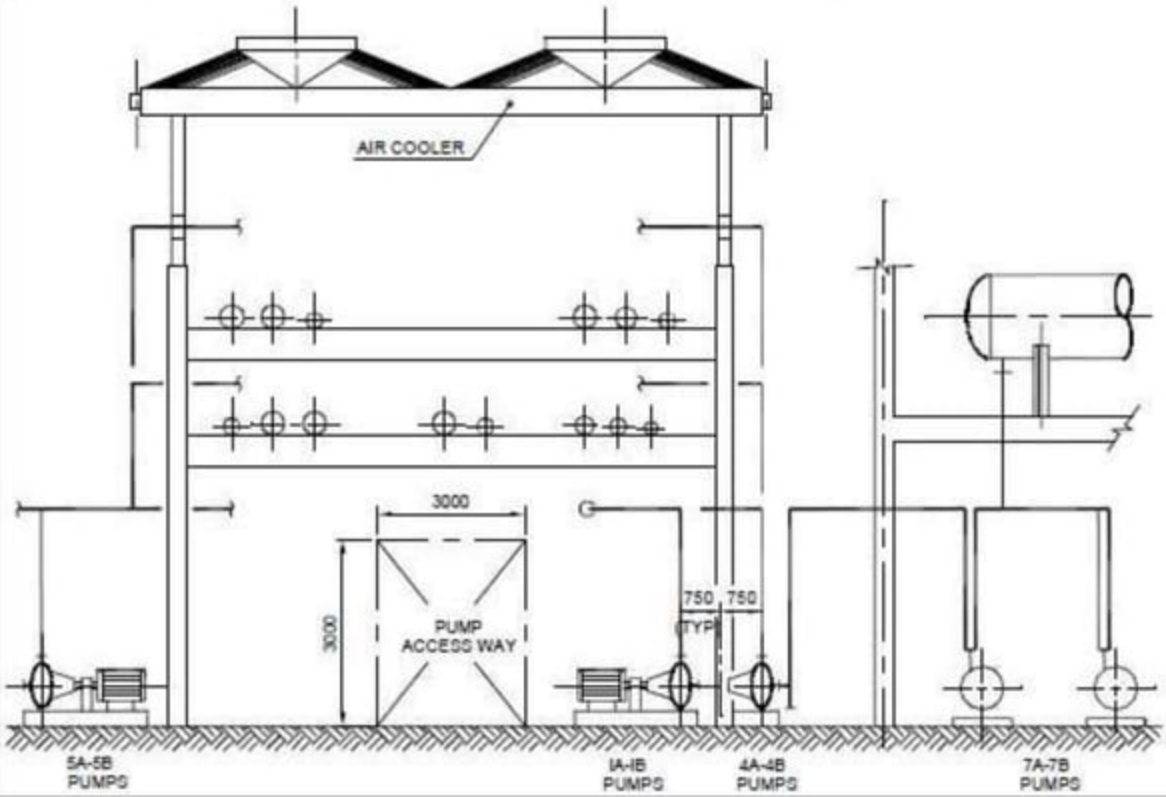


ELEVATION

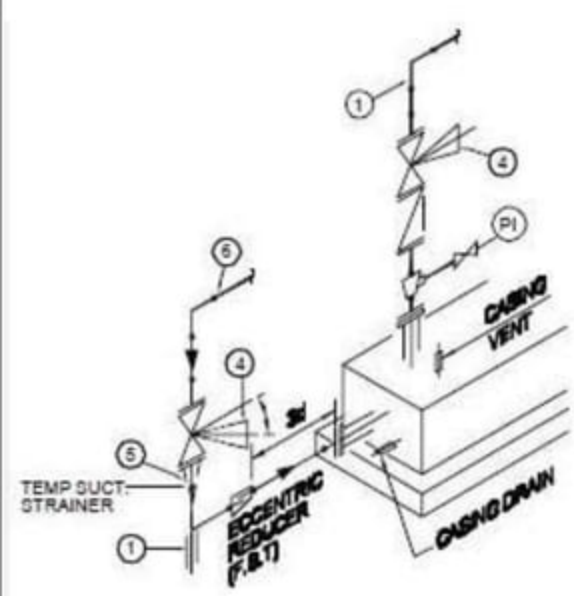


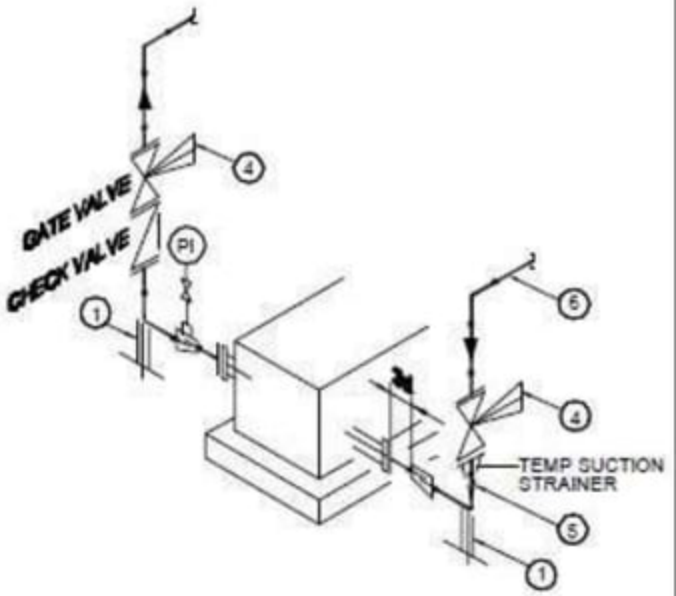
PLAN

Typical pump locations - elevation

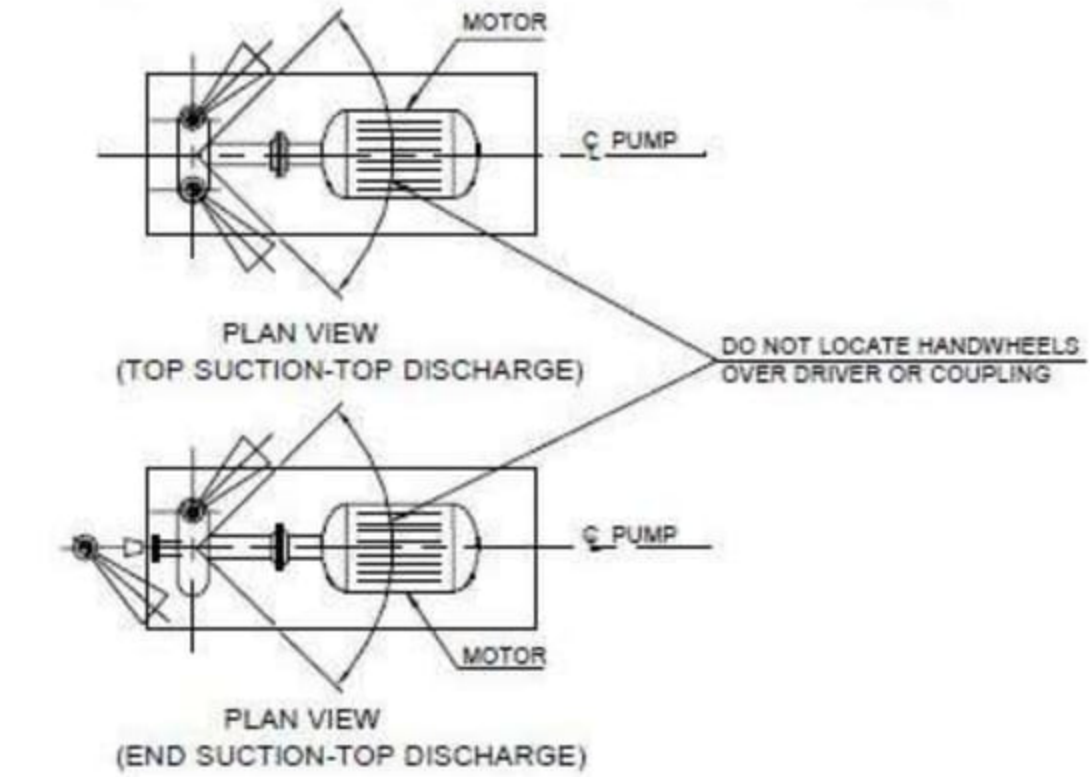


Typical pump suction and discharge piping

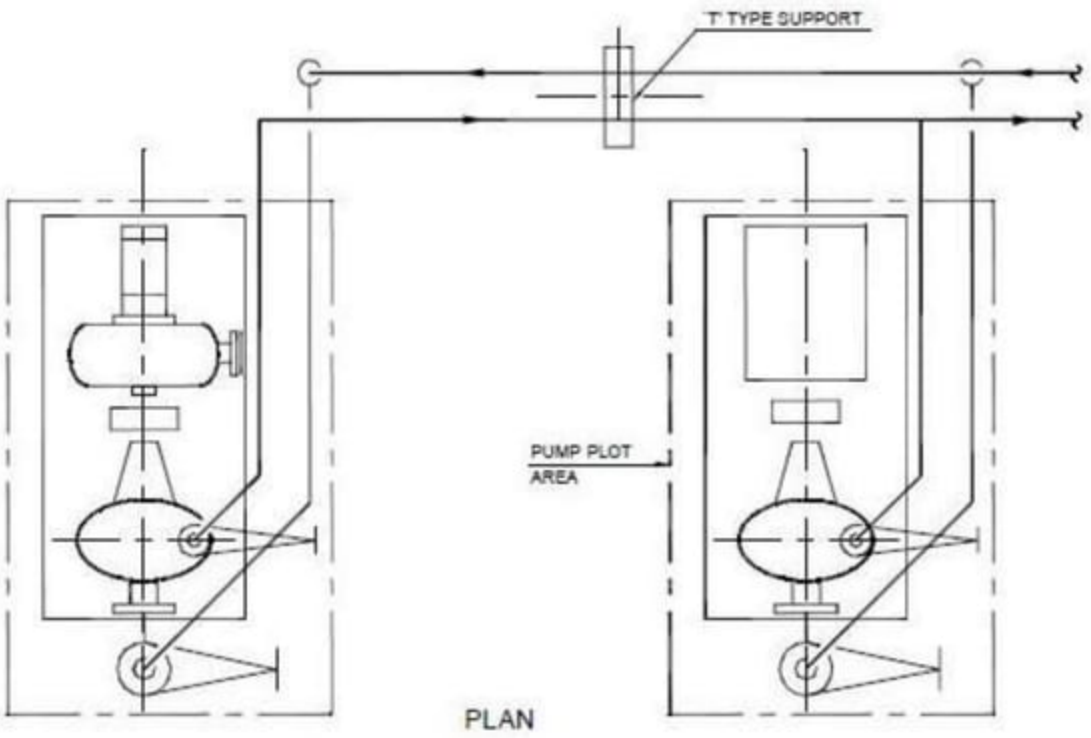




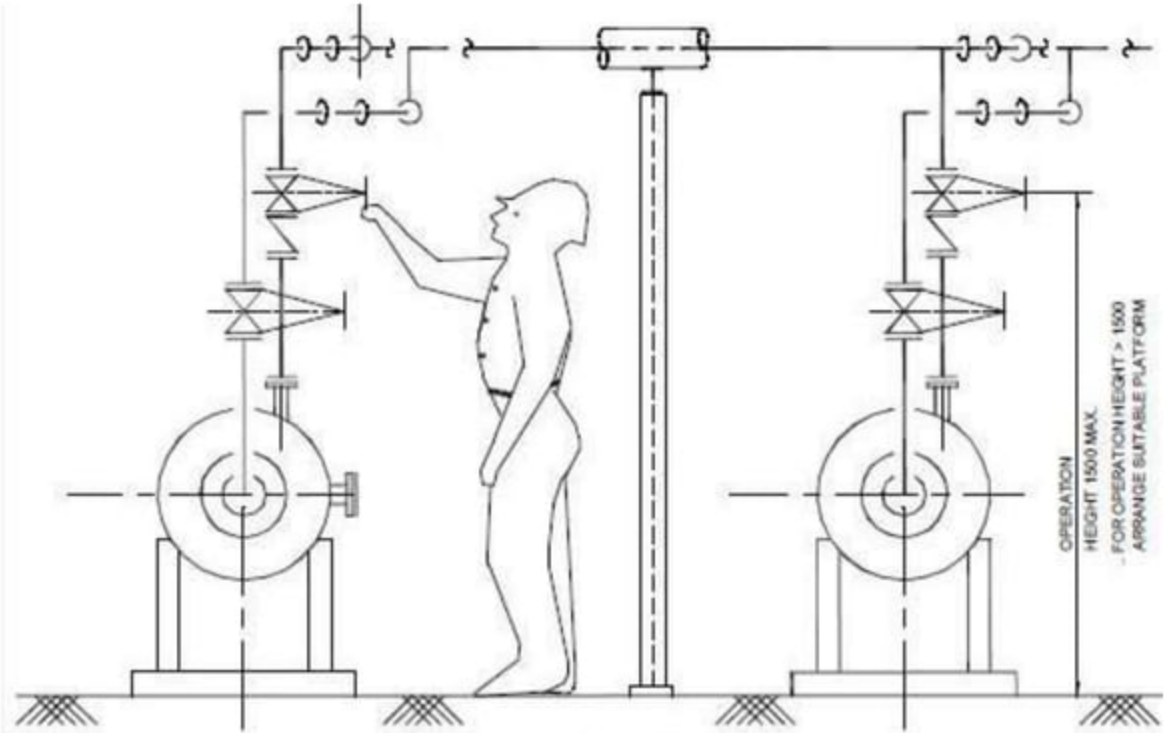
Orientation of handwheels



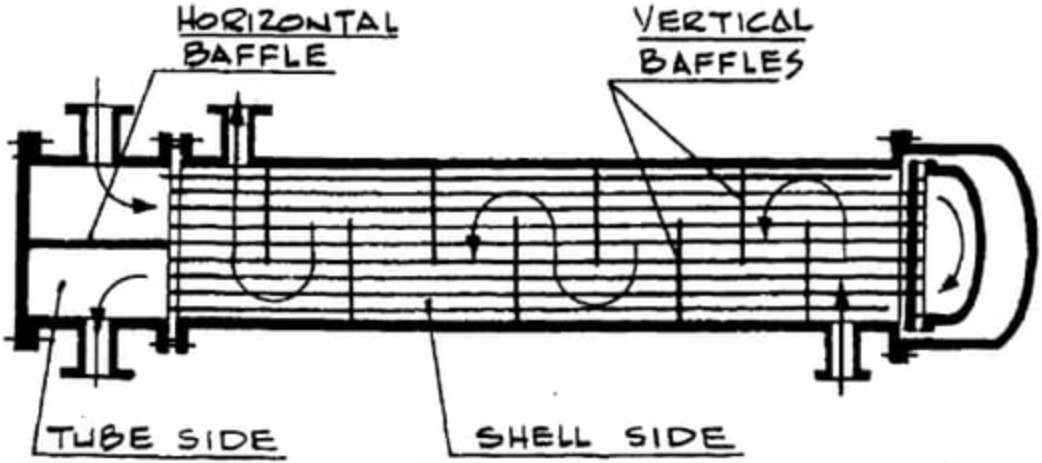
Typical auxilliary pump piping

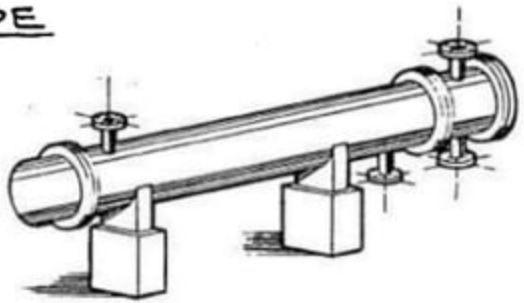


Maintenance and operation access requirements



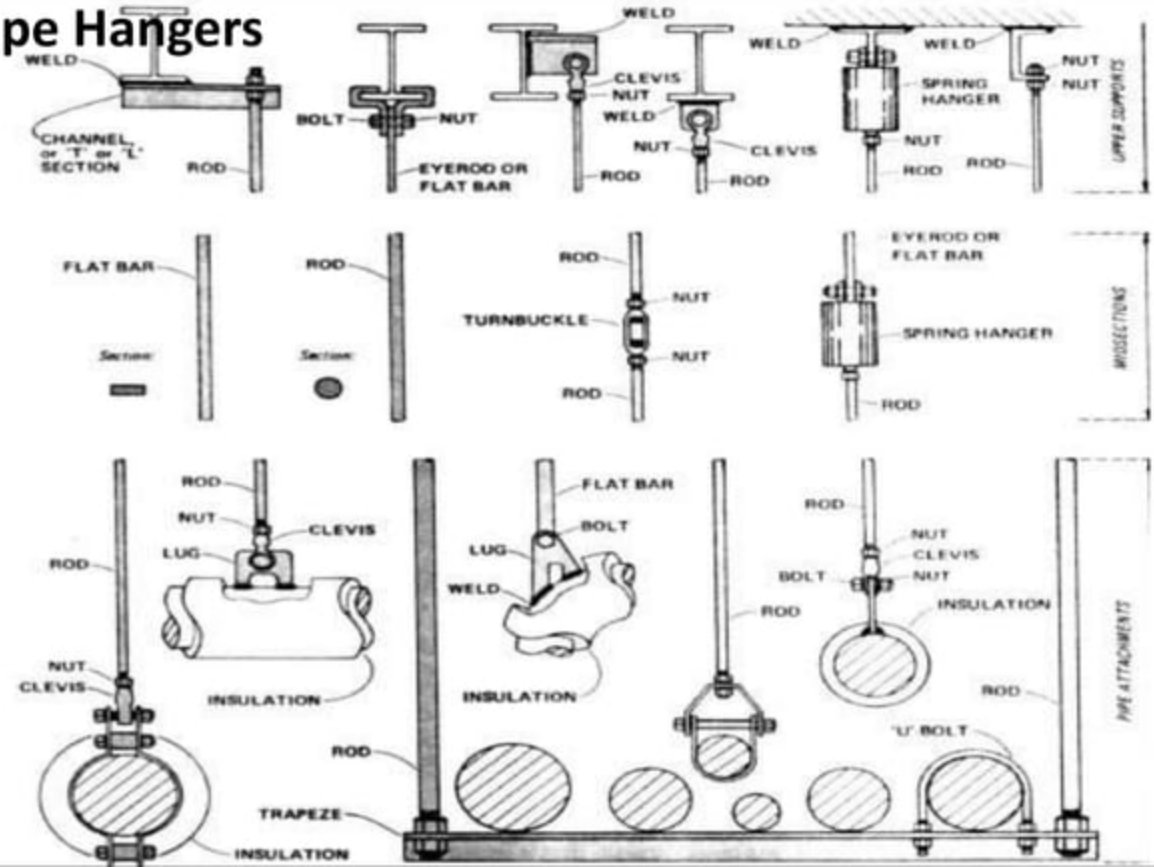
Various other equipment



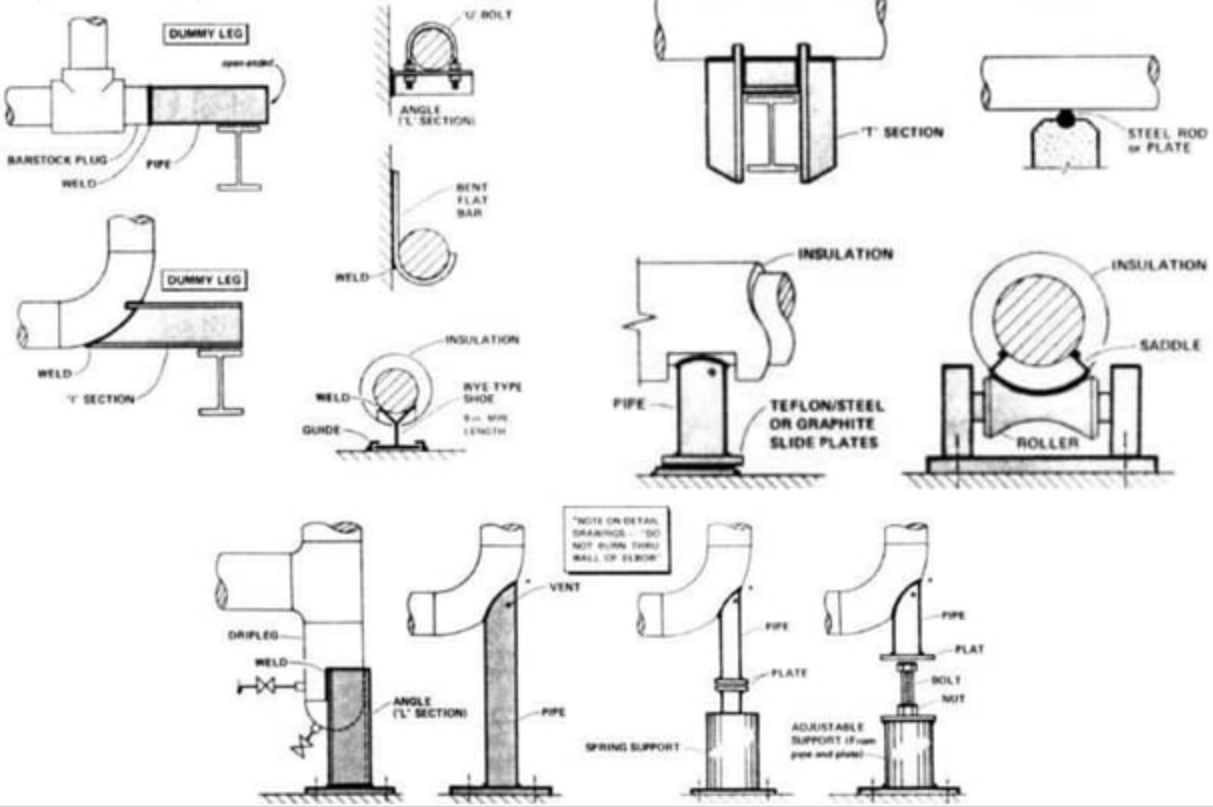


a. Shell and Tube Exchanger

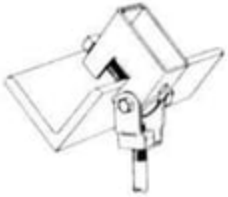
Pipe Hangers

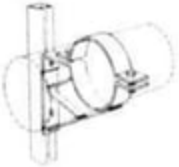


Pipe Supports

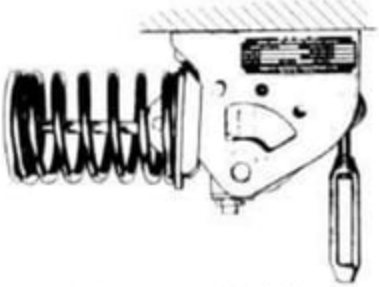


Anchor, Spring hangers and Guides

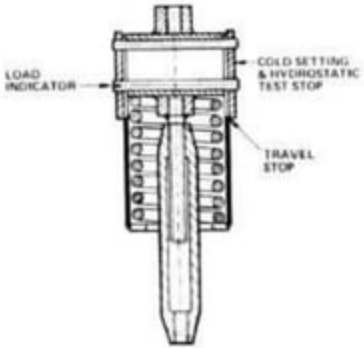


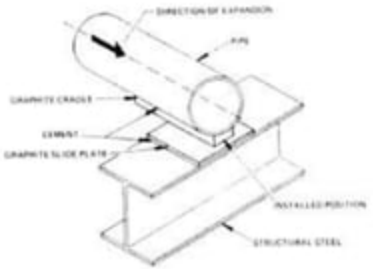


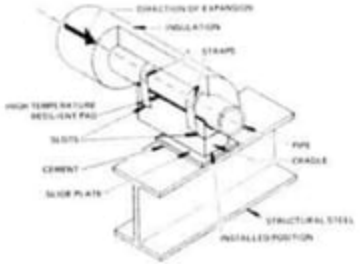
1. CONSTANT LOAD TYPE



2. VARIABLE LOAD TYPE







Outputs from the Piping Discipline

1. Overall plot plans showing location of various process units, offsite, package units, roads, piperacks, sleepers, etc.
2. PMS (Piping Material Specifications) & Valve Material Specifications.
3. Equipment general arrangement layouts/drawings indicating the location of all the equipment within a unit, platforms, ladders, overhead crane elevation.
4. Piperack general arrangements drawings & structures for equipment support.
5. Piping general arrangement layouts/drawings showing all the piping and equipment.
6. Piping BOM (Bill of Material).
7. Piping stress analysis reports for critical lines.
8. Drawing showing the vessel cleats location for pipe supports.
9. Layout for underground services.
10. Piping isometrics with bill of material.
11. Pipe support location plan, support schedules, pipe support drawings.
12. Purchase specification for insulation, painting, wrapping and coating.

Piping Material Control

The material controller is responsible for all piping material requirement planning. This includes quantity take-off activities, production of bill of material, piping material quantity summaries, piping requisitions, piping order bit tabulation/summaries and technical comparison and required at site date planning.

The list of deliverables may include the following.

- Bill of material for each piping documents
- Bill of material summary
- Special take-off summaries (large diameter or long delivery valves)
- Piping material procurement request for quote (RFQ) draft
- Piping material procurement purchase order (PO)

Electrical engineering

Responsible for all of the project power, lighting and communication needs.

- Normal and emergency systems
- hardware selection such as transformers and switchgear
- Aboveground and underground distribution systems
- electrical design considerations and electrical code requirements

Instrument engineering

Responsible for the 'nervous' system of the plant. Input is preliminary data sheet originated by process and complete the definition requirements, including final sizing and vendor selection. Other responsibilities are:

- layout of any control room
- control system hardware
- control system software
- local indicators
- sensing elements and circuits
- defining the physical hardware elements that constitute the in-line and on-line instruments for the project.