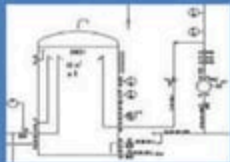


Fundamentals of Process Plant Design

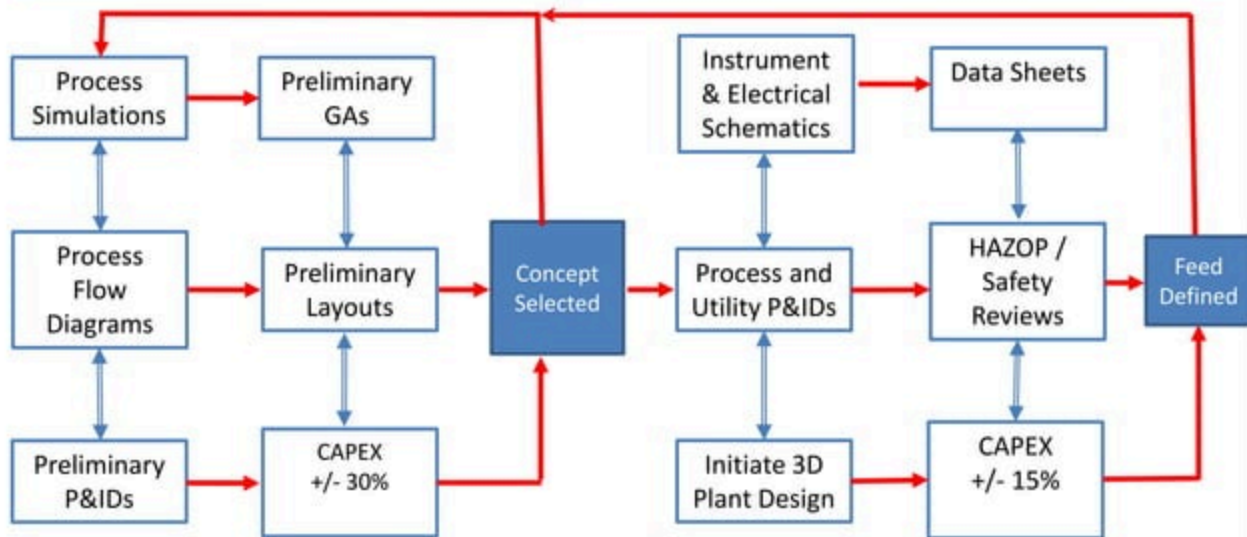
- Understand the basic fundamentals of an EPC role in Process Plant Engineering.
- Help / Guide you in your job to try and apply some thought, where can you add value to the industry we serve.
- Presentation where we can learn about Plant Design.
- Does not cover all aspects of Plant Design.
- Does not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

Plant Design Workflow

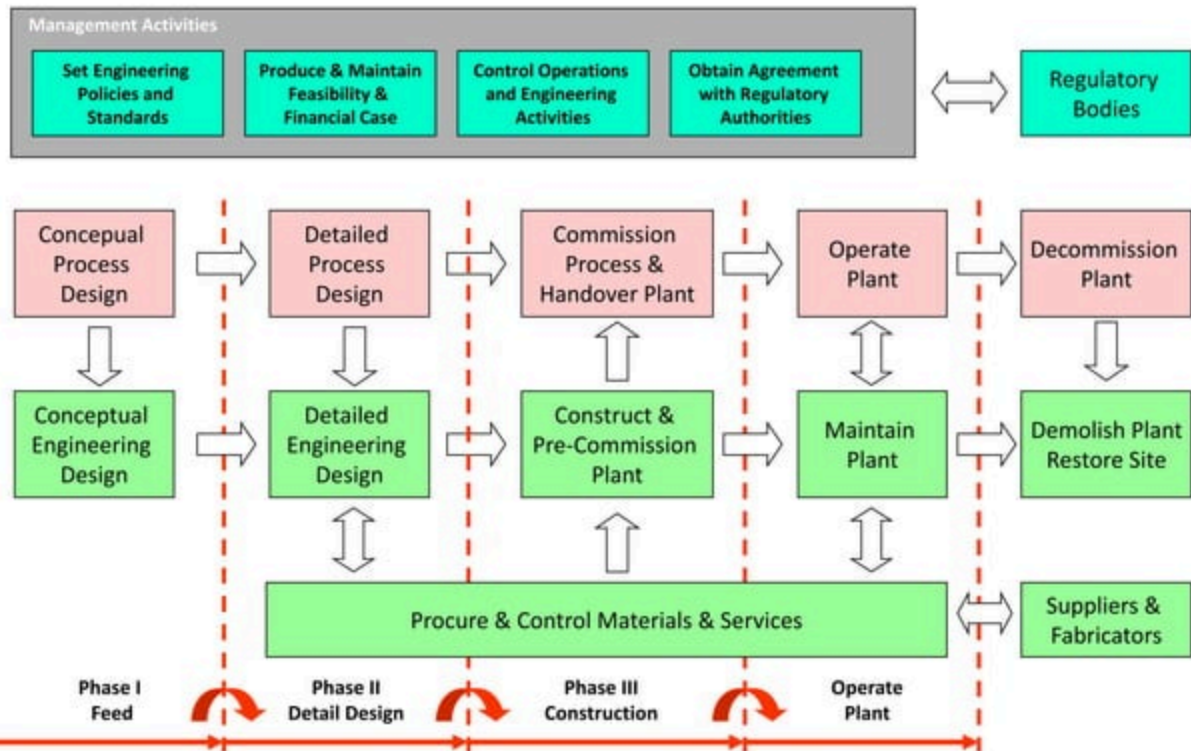


Concept Selection (Pre-FEED)

Front-End Engineering and Design (FEED)



Process Plant Activity Model



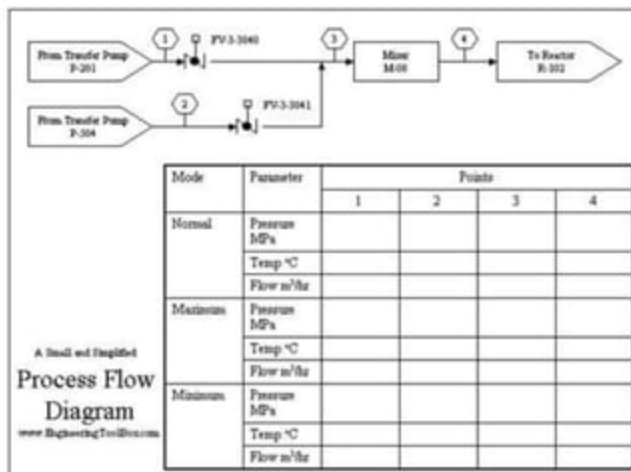
Process department and its role

- 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



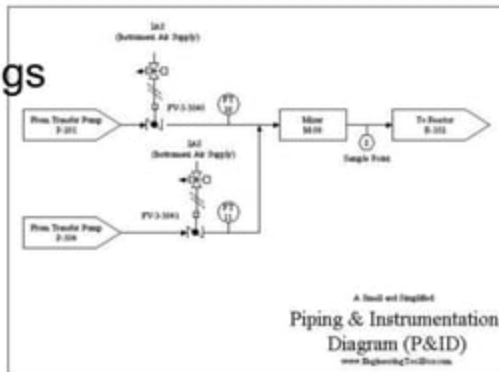
A PFD should include:

- 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

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

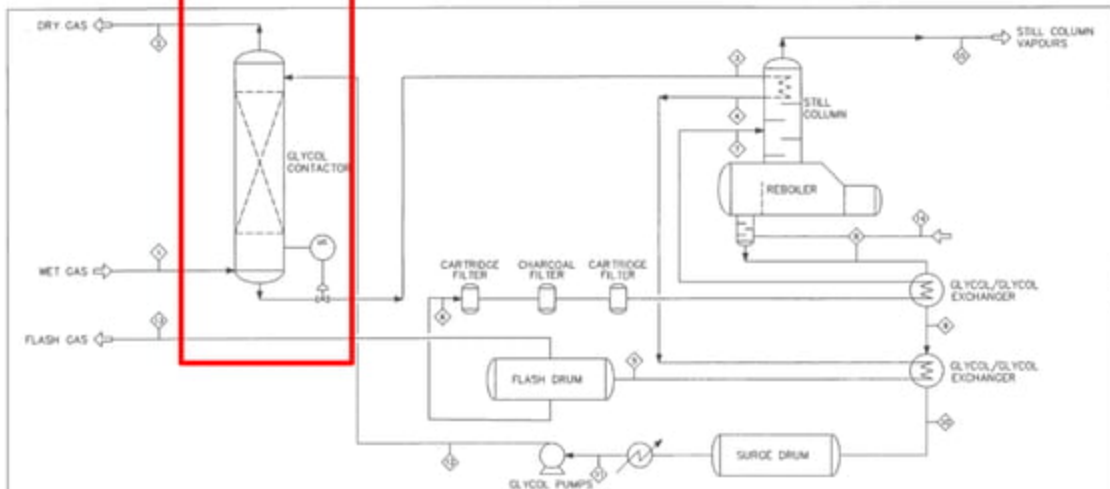


P&ID (Piping & Instrumentation Diagram)

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)

[illegible]

NATCO AG LTD

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 Intel Corporation and is not to
 be distributed outside the company.

be used to further any information
on matters of business or otherwise.

design: there is no need for it.

1-800-441-2345

DECEMBER

PROCESS FLOW DIAGRAM FOR LYCOL DEHYDRATION PACKAGE

NAME	SSN	ADDRESS	PHONE NO.
J. F. JONES	975		
ADDRESS			

1999

1000-0000-2006-0100-0000

0000-0001-9000-0000

[illegible]

2008.08.08

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403</
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WILEY-BLANKENHORN & A.

[illegible]

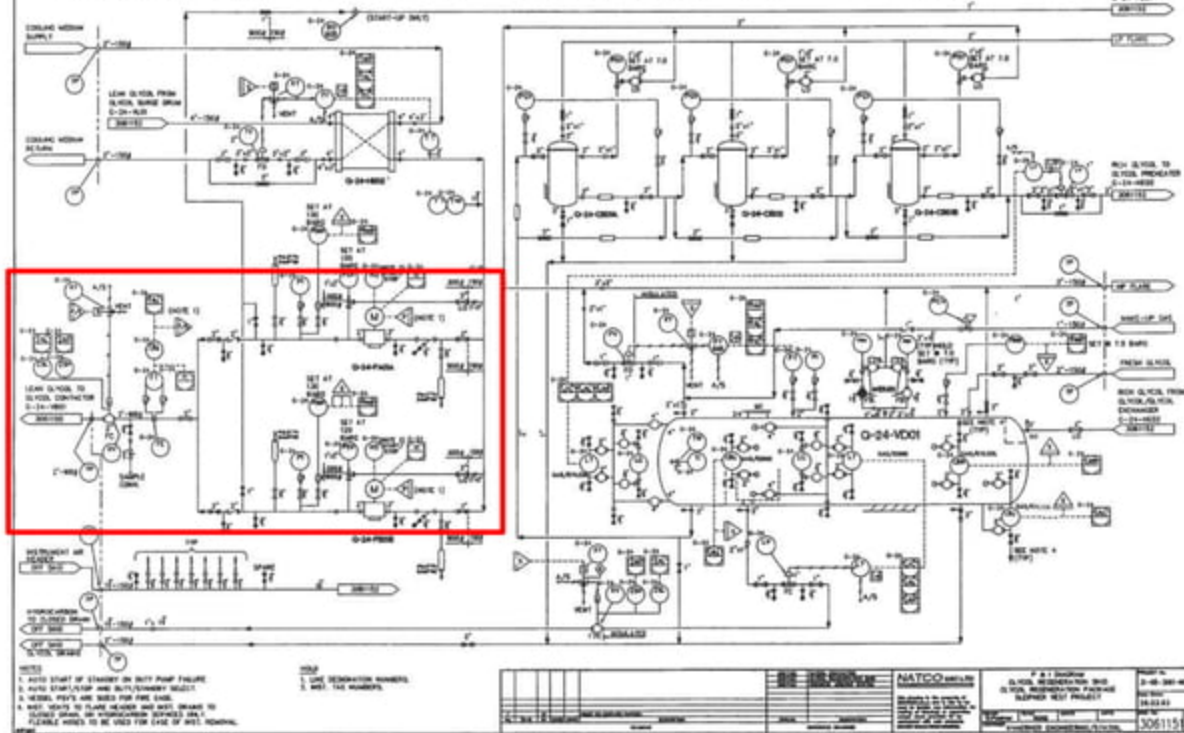
P&ID (Piping and Instrumentation Diagram)

1ST NUMBER	0-9	0001
2ND	0-9	0002
3RD	0-9	0003
4TH	0-9	0004
5TH	0-9	0005
6TH	0-9	0006
7TH	0-9	0007
8TH	0-9	0008
9TH	0-9	0009
10TH	0-9	0010
11TH	0-9	0011
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91TH	0-9	0091
92TH	0-9	0092
93TH	0-9	0093
94TH	0-9	0094
95TH	0-9	0095
96TH	0-9	0096
97TH	0-9	0097
98TH	0-9	0098
99TH	0-9	0099

TAT NUMBER	1-10-00000000
STATUS	SYSTEM CIRCULAR
NEWTON CAPACITY (LBS)	100
DISCHARGE RATE (LBS)	100
SUPPLEMENTAL PAGES	100
ORDER NUMBER	100
FOR PRODUCTION	

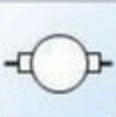
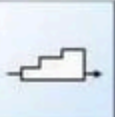
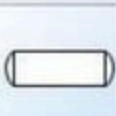
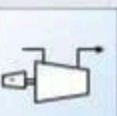
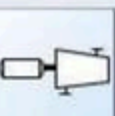
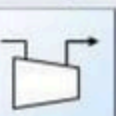
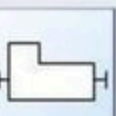
[illegible]

THE HOUSE	2 1/2 W
SEWER	8 INCH PLASTIC
W x D	10'0" x 10'0"
DOWN P/W	1/2" x 1/2"
BOARD OF WALK	6'0"
WALKWAY	10'0" (CONCRETE)
THE PROVISION	
INTERNAL LAMP	4'0"
INTERNAL P/W	1/2" x 1/2"

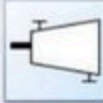
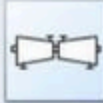
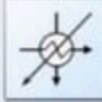
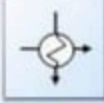
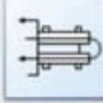
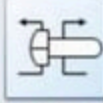
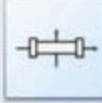


P&ID / Project deliverables Symbology

Process and Instrument Shapes

						
Centrifugal pump	Centrifugal pump 2	Centrifugal pump 3	Vertical pump	Horizontal pump	Vertical pump	Sump pump
						
Vacuum pump	Screw pump	Screw pump 2	Positive displacement	Gear pump	Progressive cavity pump	Bin
						
Tank	Drum	Dome roof tank	Open top tank	Cone roof tank	Internal floating roof	Double wall tank
						
Onion tank	Centrifugal compressor	Centrifugal compressor	Centrifugal compressor 2	Centrifugal blower	Axial compressor	Reciprocating compressor

P&ID / Project deliverables Symbology

						
Rotary compressor	Rotary compressor	Liquid ring vacuum	Positive displacement	Turbine driver	Doubleflow turbine	Motor
						
Agitator or mixer	Diesel motor	Plate and frame heat	Air cooled exchanger	Double-pipe heat	Spiral heat exchanger	Heater
						
Condenser	Shell and tube heat	Shell and tube heat 2	Shell and tube heat 3	Hairpin exchanger	U-tube heat exchanger	Single pass heat
						
Reboiler	Crossflow induced	Counterflow forced draft	Chimney tower	Counterflow natural draft	Furnace	Boiler

P&ID / Project deliverables Symbology



Oil burner



Automatic
stoker



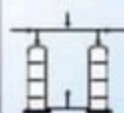
Evaporative
condenser



Plate tower



Packed tower Hydrocracki... Hydrodesu...



Reformer



Fluid catalytic



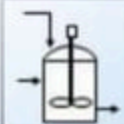
Fluid coking



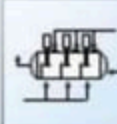
Tubular



Fluidized
reactor



Mixing
reactor



Alkylation



Boom loader



Screw
conveyor



Scraper
conveyor



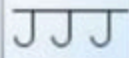
Elevator 1



Elevator 2



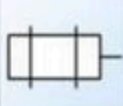
Skip hoist



Overhead
conveyor



Hoists



Electric
motor



Conveyor

P&ID / Project deliverables Symbology

Valves



Gate valve,
Hand-oper...



Gate valve



Globe valve,
Hand-oper...



Globe valve



Needle valve



Control valve



Back
Pressure



Plug or cock
valve



Check valve



Check valve
2



Butterfly
valve



Flanged
valve,



Flanged
valve 2



Angle valve,
Hand-oper...



Relief valve



Angle valve,
Hand-oper...



Ball



Diaphragm



Solenoid
valve



Hydraulic
valve



Motor-oper...
valve



Powered
valve



Float-operat...
valve



Needle valve



3-way plug
valve



Four-way
valve



Gauge



Bleeder valve

P&ID / Project deliverables Symbology

Instruments



Indicator



Indicator 2



Indicator 3



Indicator 4



Indicator 5



Shared
Indicator



Shared
Indicator 2



Computer
Indicator



Programma...
Indicator



Temp
Indicator



Temp
Transmitter



Temp
Recorder



Temp
Controller



Flow
Indicator



Flow
Transmitter



Flow
Recorder



Flow
Controller



Level
Indicator



Pressure
Indicator



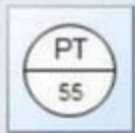
Level
Transmitter



Level
Recorder



Level
Controller



Pressure
Transmitter



Pressure
Recorder



Pressure
Controller



Pressure
Indicating



Pressure
Recording



Level Alarm

P&ID / Project deliverables Symbology

 LOCALLY MOUNTED INSTRUMENT  BOARD MOUNTED INSTRUMENT	 FA FLOW ALARM  FE FLOW ELEMENT  FI FLOW INDICATOR  FR FLOW RECORDER  FRC FLOW RECORDING CONTROLLER	 USD UNIT SHUT DOWN  ZSC V-230 POSITION/ UNIT SWITCH CLOSED  SDY V-230 SHUT DOWN VALVE RELAY  SDV V-230 SHUT DOWN VALVE  ZLO V-250 POSITION/ LIMIT INDICATOR OPEN  TY F-250 TEMPERATURE RELAY
 PC PRESSURE CONTROLLER  PI PRESSURE INDICATOR  PR PRESSURE RECORDER  PIC PRESSURE INDICATING CONTROLLER  PRC PRESSURE RECORDING CONTROLLER  PSV PRESSURE SAFETY VALVE  RV RELIEF VALVE	 TA TEMPERATURE ALARM  TI TEMPERATURE INDICATOR  TR TEMPERATURE RECORDER  TRC TEMPERATURE RECORDING CONTROLLER  TW TEMPERATURE WELL	 SPECTACLE BLIND OPEN  SPECTACLE BLIND CLOSED  ORIFICE FLANGES  PIPING SPECIALITY ITEM
 LA LEVEL ALARM  LAH LEVEL ALARM HIGH  LAL LEVEL ALARM LOW  LC LEVEL CONTROLLER  LG LEVEL GLASS  LI LEVEL INDICATOR  LIC LEVEL INDICATING CONTROLLER  LRC LEVEL RECORDING CONTROLLER	 GATE VALVE  GLOBE VALVE  CHECK VALVE  CONTROL VALVE  PLUG VALVE  BALL VALVE  BUTTERFLY VALVE	 INSTRUMENT AIR LINE  INSTRUMENT ELECTRICAL  INSTRUMENT CAPILLARY TUBING  PIPE
		 T TRANSMITTER (OR)  HCV HAND CONTROL VALVE

P&ID / Project deliverables Symbology

Piping and Connection Shapes

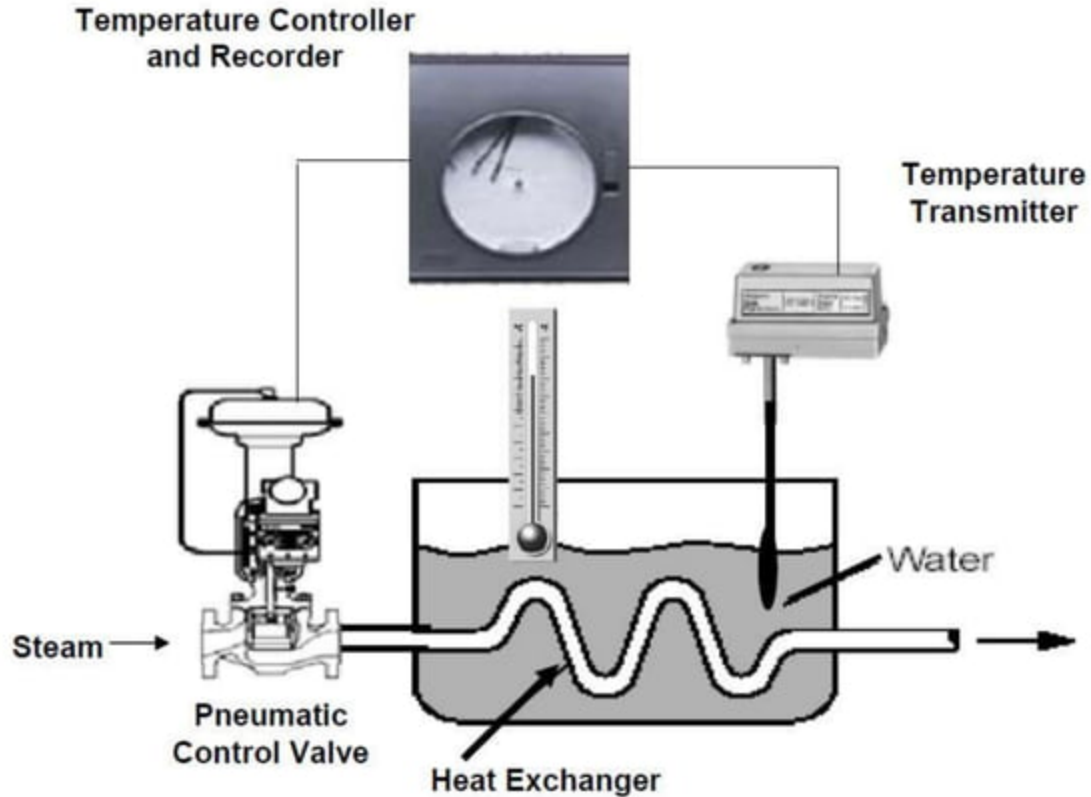
Major pipeline	Connect pipeline	Major Straight line	Straight line pipe	Process connection	Side by side	Top-bottom
One-to-many	Multi-lines	Mid arrow	Multi-lines elbow	Top to top	Electrical signal	Sonic signal
Nuclear	Pneumatic	Hydraulic signal line	General joint	Butt weld	Mechanical Link	Soldered/Solvent
Double Containment	Flange	End caps	End caps 2	Breather	Flange	Electrical Bounded

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

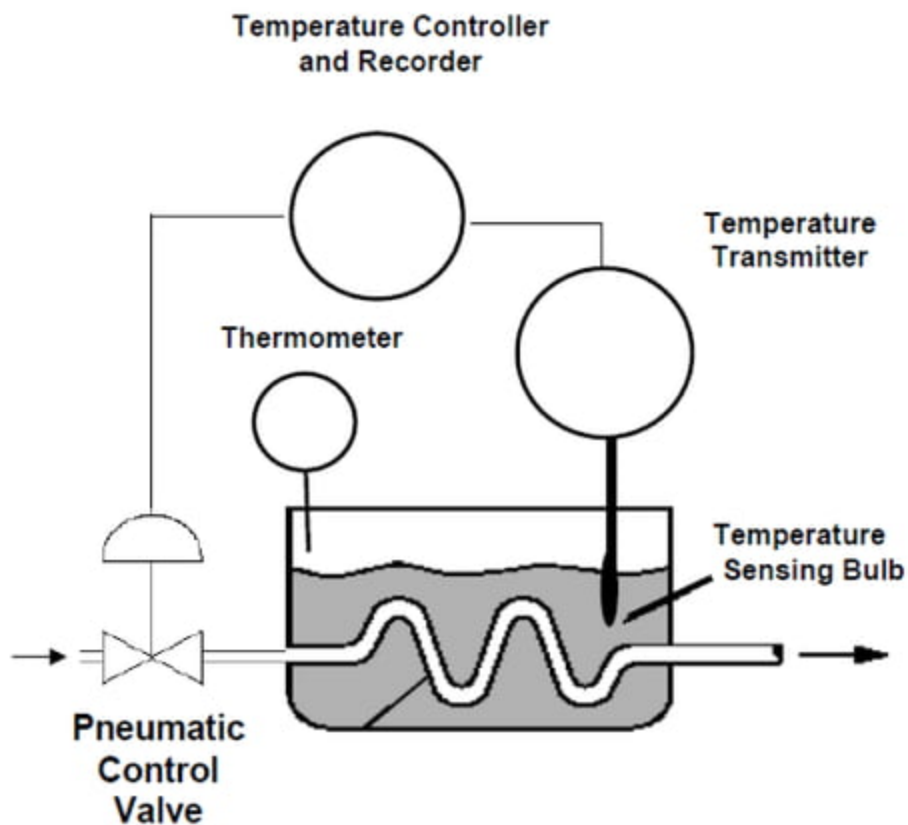
The P&ID is used by the field technicians, engineers and operators to better understand the process and how the instrumentation is interconnected, ensuring the plant is operating efficiently.

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

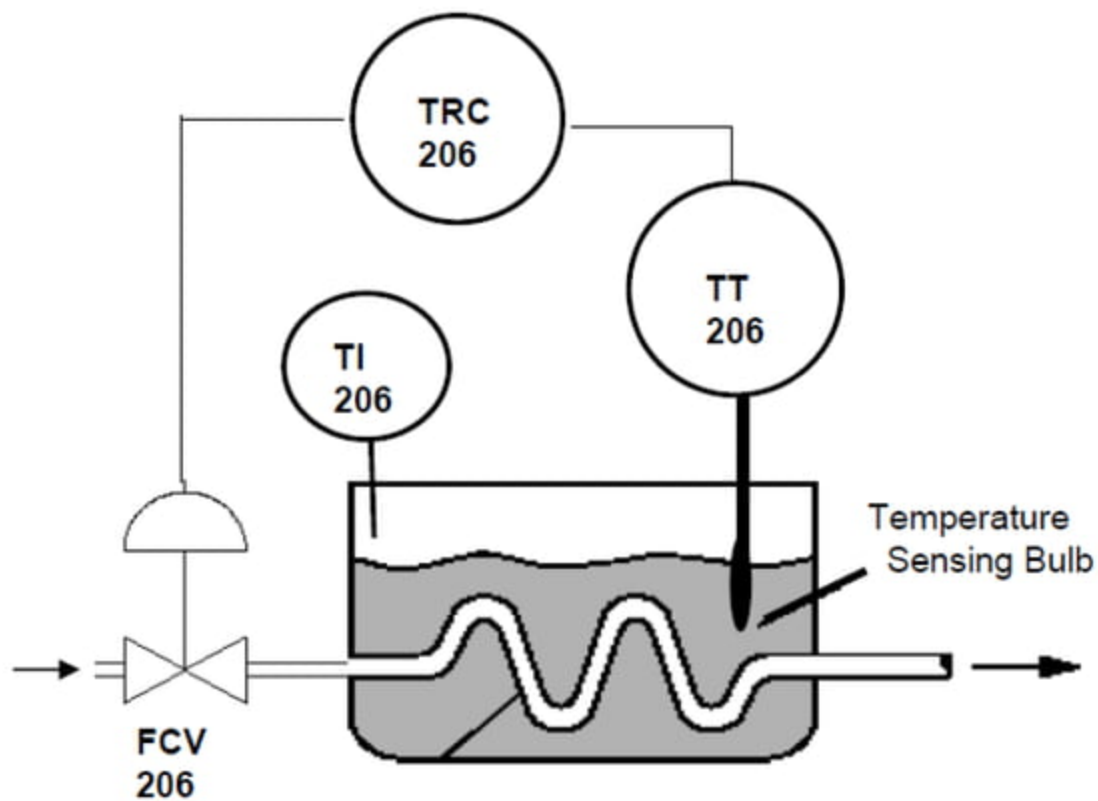
Temperature Process / Loop Diagram



Tag Numbers in a Loop

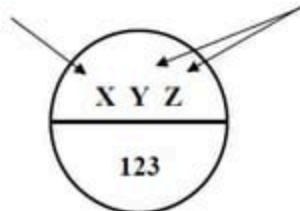


Tag Numbers



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

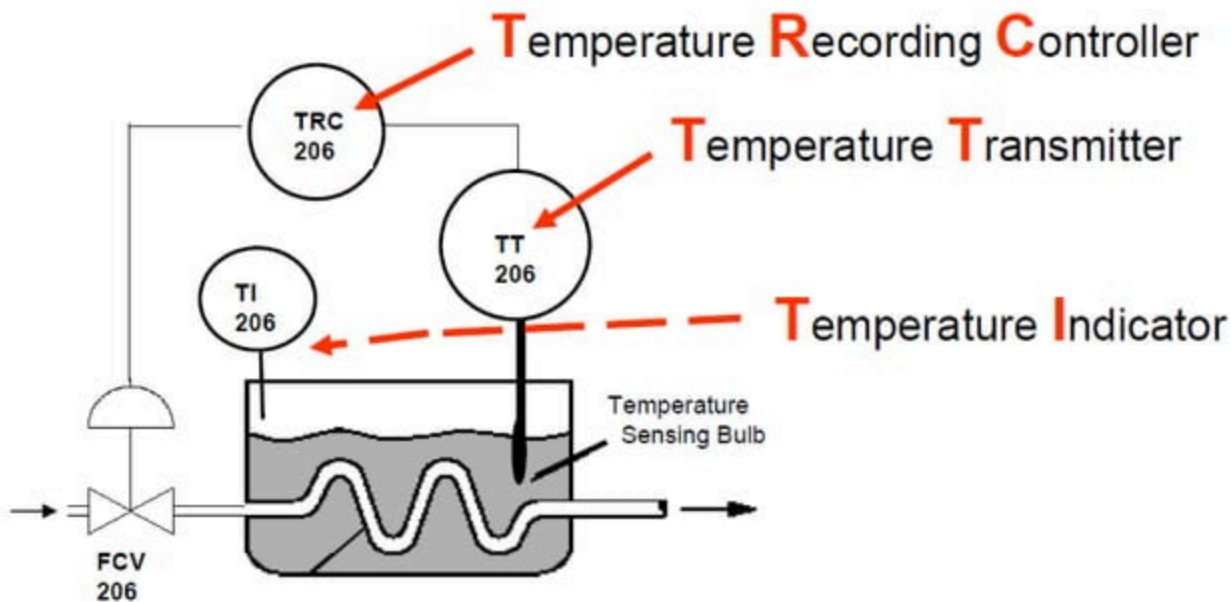
Temperature

Indicator

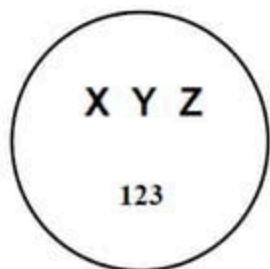
Recorder

Controller

Transmitter

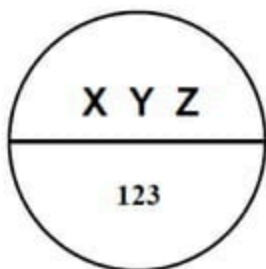


Instrumentation Location



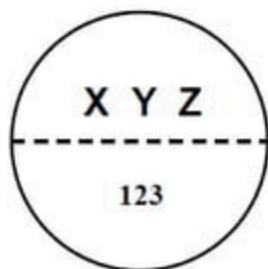
No Line

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



Solid Line

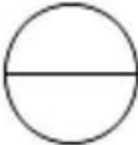
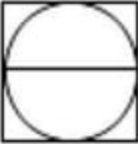
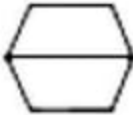
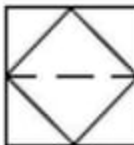
The instrument is mounted in the control room (accessible to the operator)



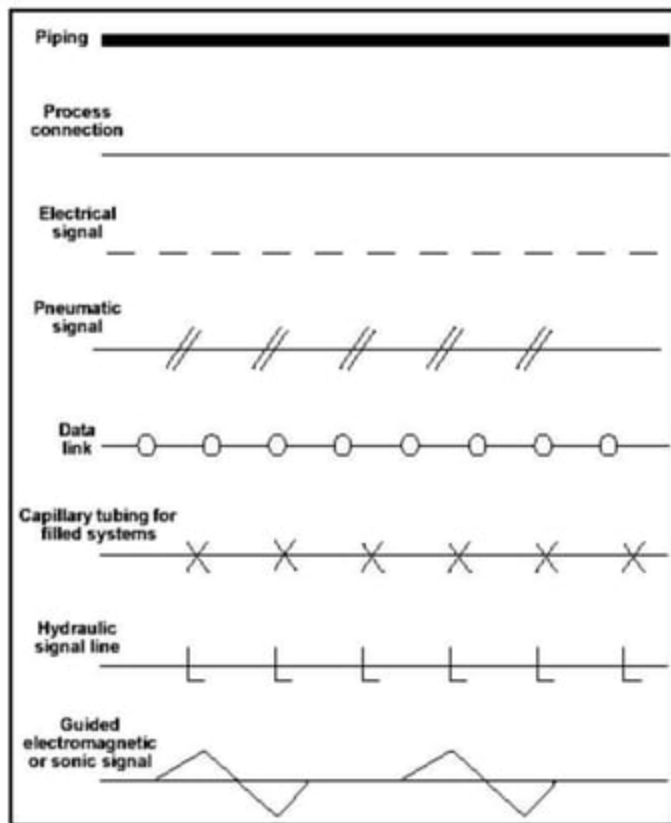
No Line

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

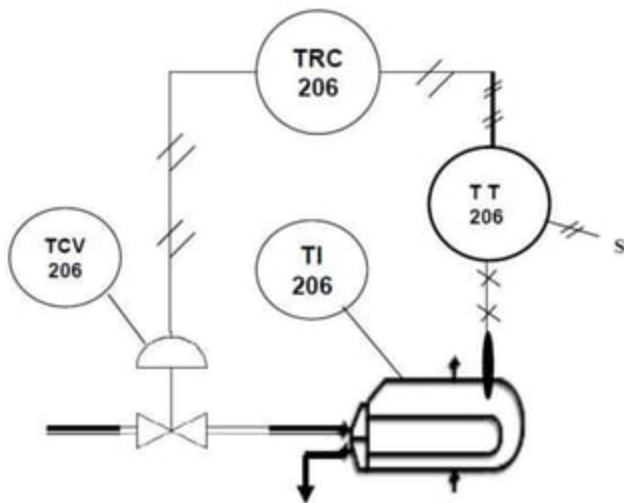
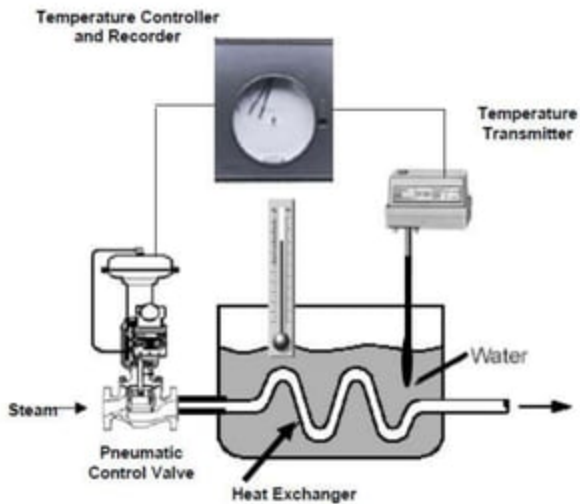


Piston-operated

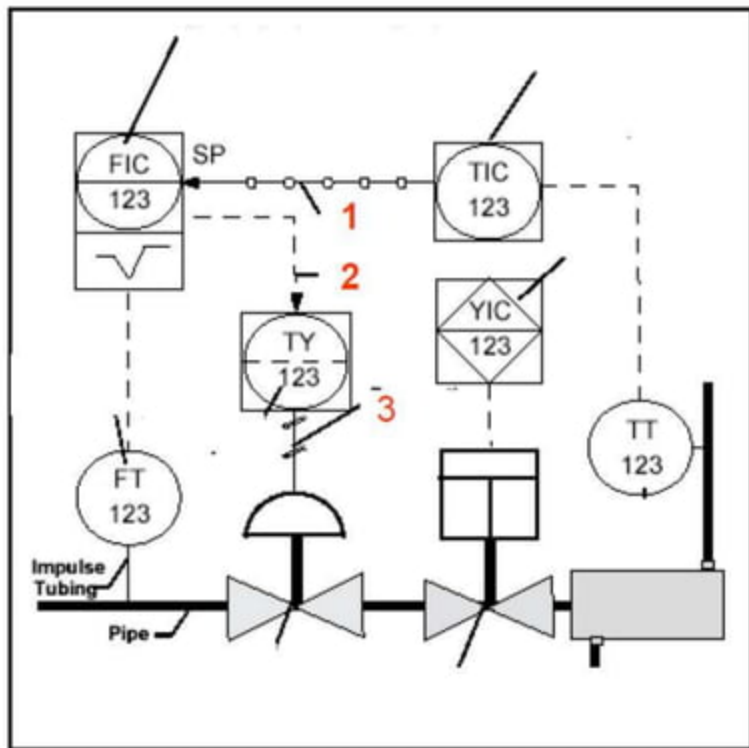


Safety Valve or Relief Valve

P&ID Example of an Instrument Loop



P&ID Exercise



FIC

TIC

YIC

TY

FT

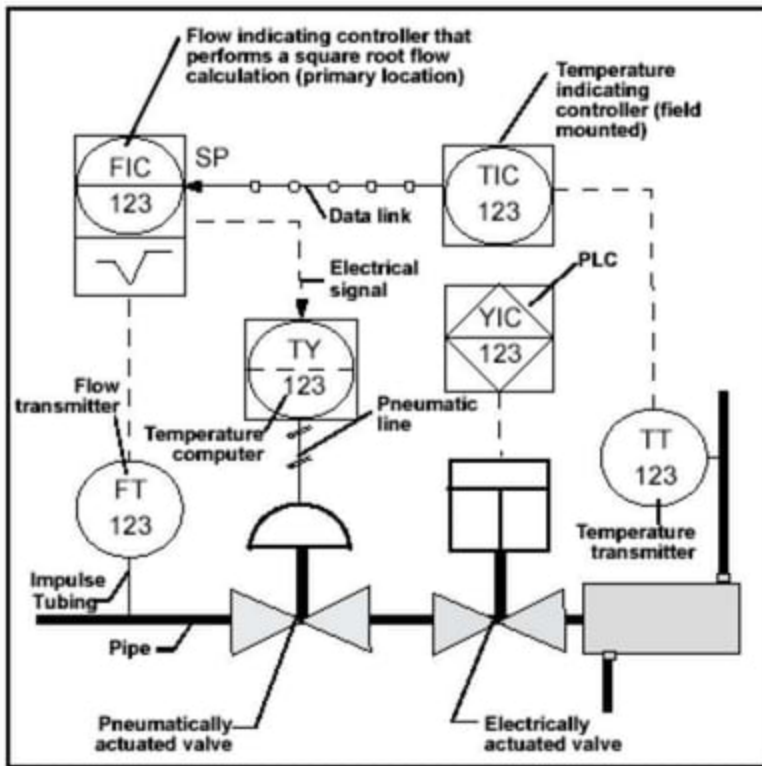
TT

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

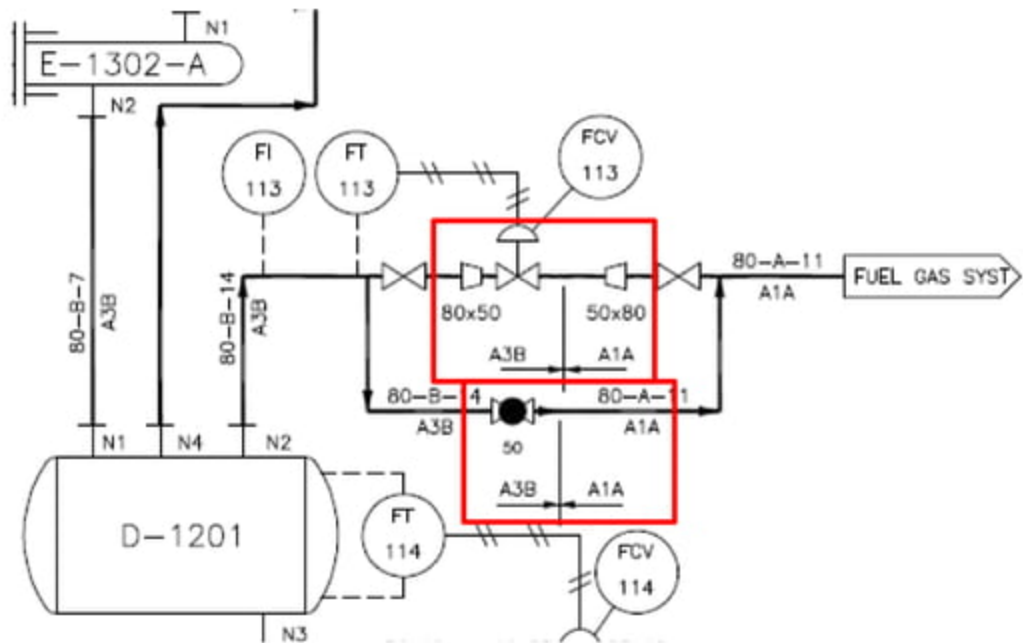
AD20XS – Pipe Class

03 – Insulation Class

050 – Insulation Thickness

N – Heat Tracing

Pipe Spec Breaks



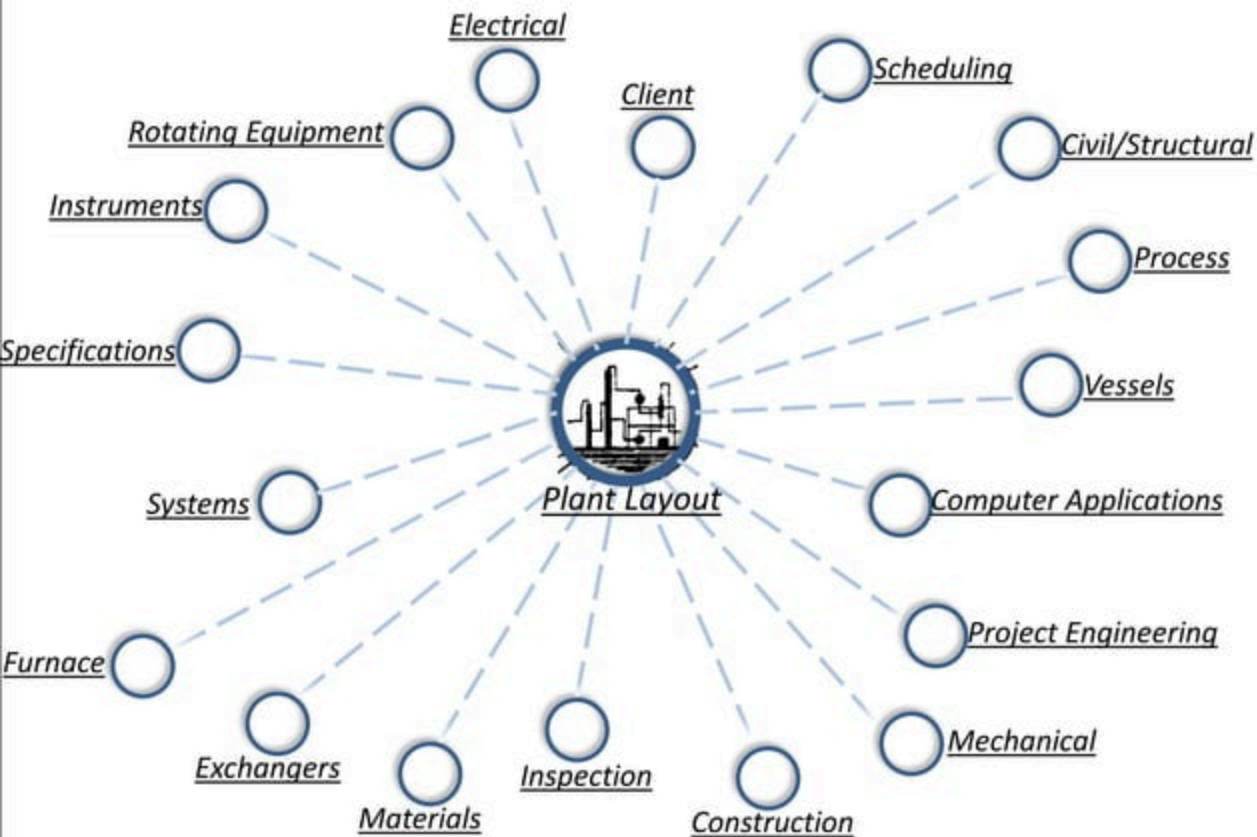
Bulk MTO / Estimates

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			

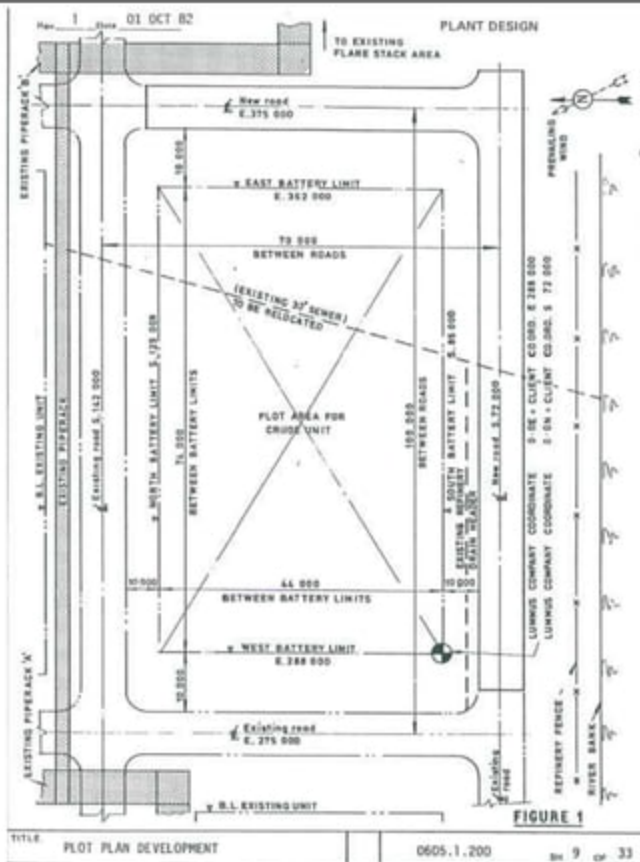
Piping Engineering

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)

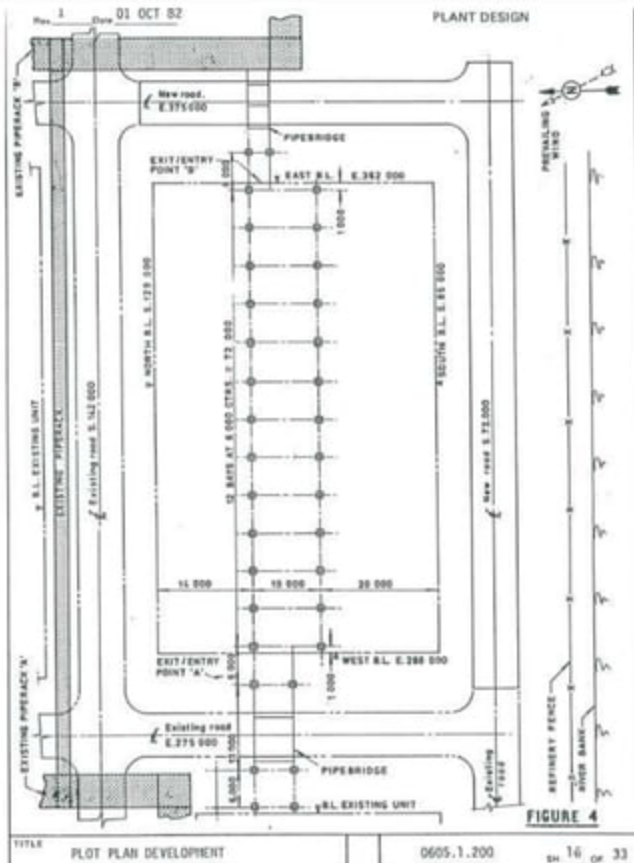
Plot Plan Development – General Information Required

- 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 safety 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

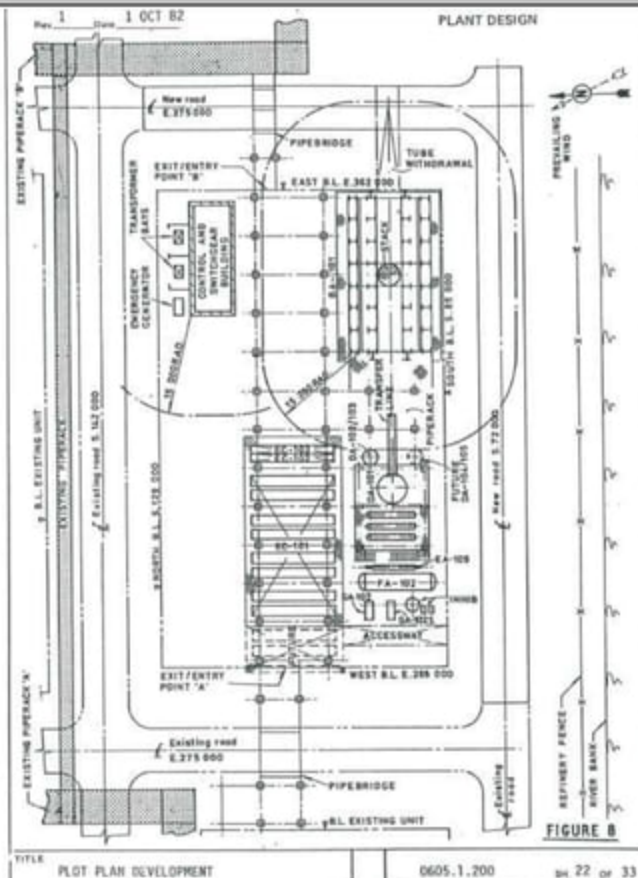
Plot Plan Development – General Information Required

- 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

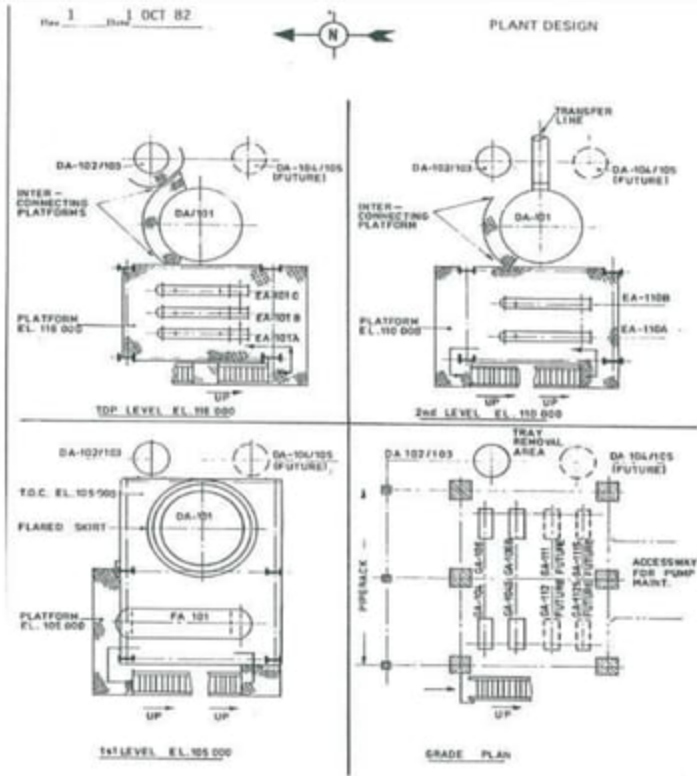
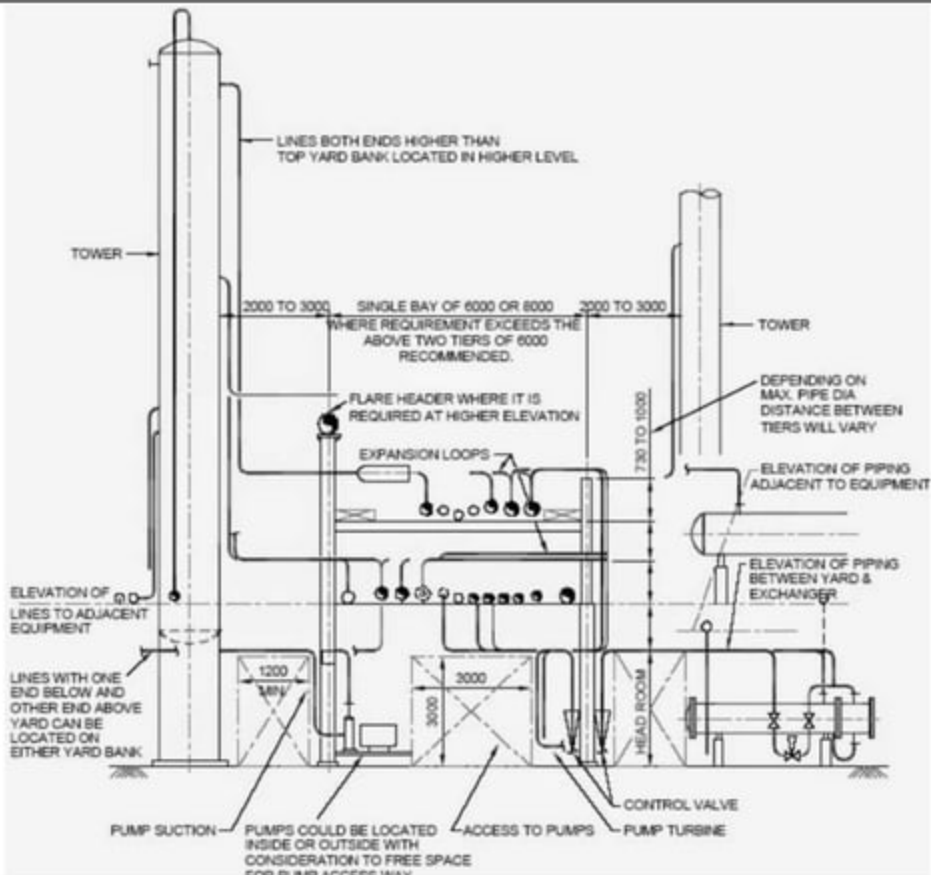


FIG. 12
PROPOSED PLOT PLAN

Piping Study



Plot Plan Development

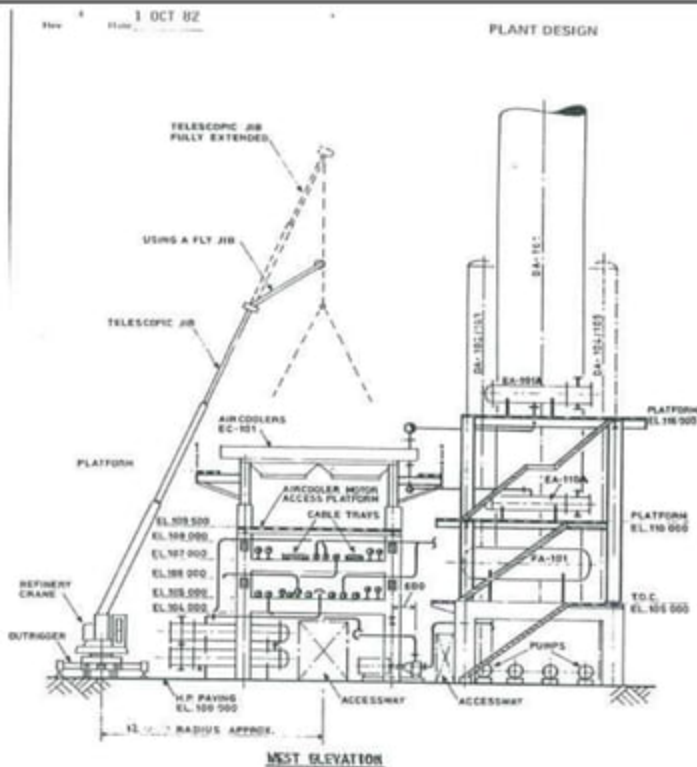
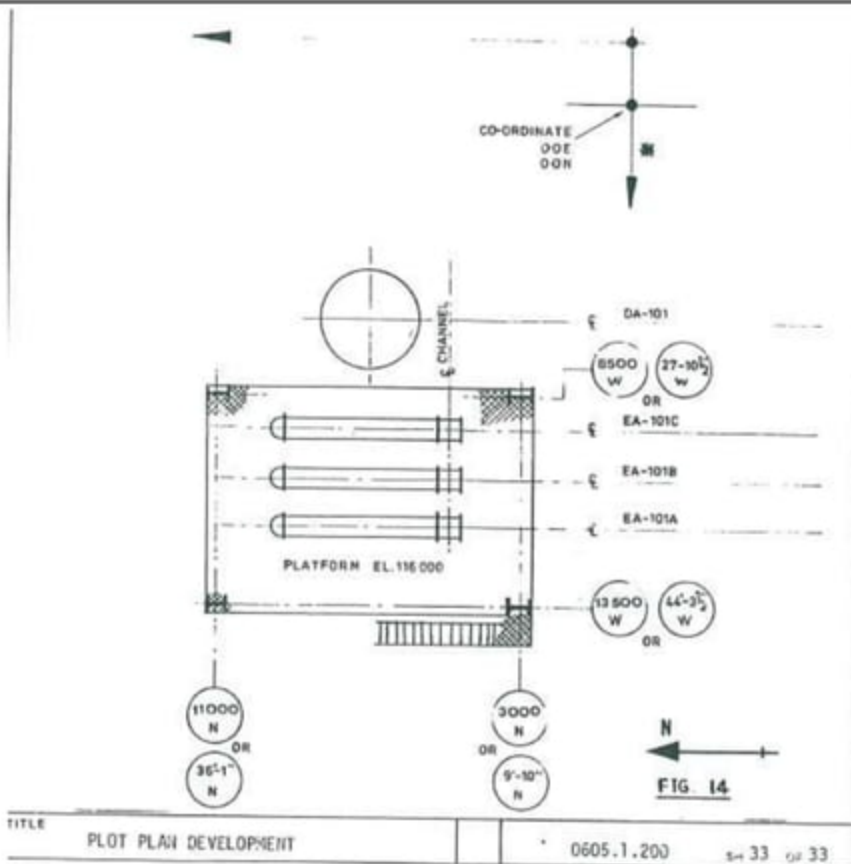
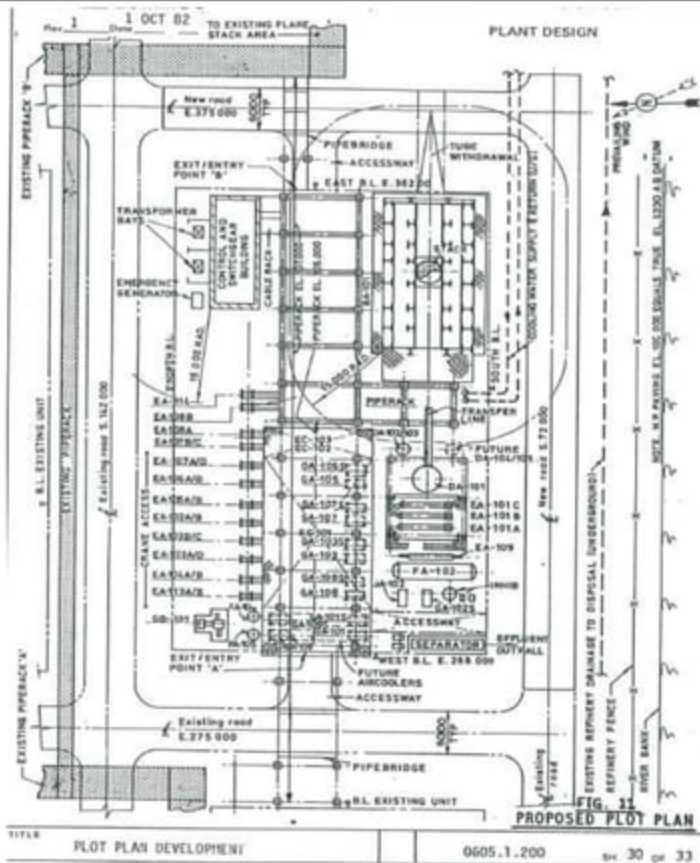


FIG. 13
PROPOSED PLOT PLAN

Plot Plan Development



Plot Plan Development



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	Country	Organization	
1.	USA	American National Standard Institute	ANSI
2.	Canada	Canadian Standard Association	CSA
3.	France	<u>Francaise</u>	AFNOR
4.	United Kingdom	British Standards Institute	BSI
5.	Europe	European Community for standardization	CEN
6.	Germany	<u>Deutsches</u> Institute for <u>Normung</u>	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 - Specifications

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
Butt-weld Fittings	½ - 24	Schedule Tables	ASME B16.9	ASTM A234	WPB	
Butt-weld 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	

Piping - Specifications

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.

Piping - Specifications

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).

Piping - Specifications

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

Piping - Specifications

Table D-3 Valve Selection

Valve	Type	Mode of Flow Regulation			Fluid				
		On-Off	Throttling	Diverting	Free of Solid	Solids in Suspension		Sticky	Sanitary
						Non-Abrasive	Abrasive		
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

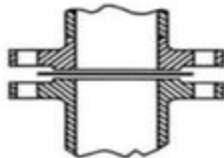
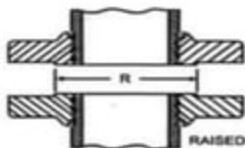
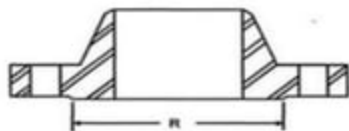
Piping – Fittings and Components

- Fittings are used in pipe systems to connect straight pipe or where change in 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.

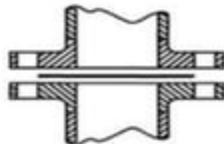
Piping - Flanges



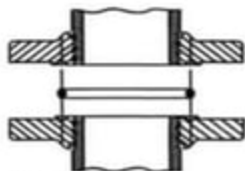
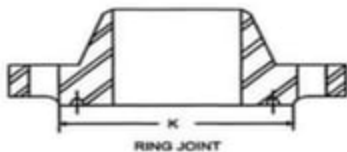
Piping - Flanges



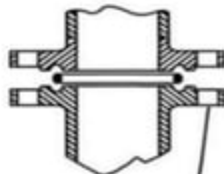
(A) RAISED-FACE FLANGE FACINGS



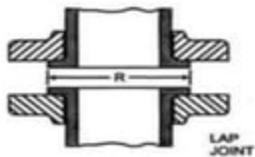
(B) FLAT-FACE FLANGE FACINGS



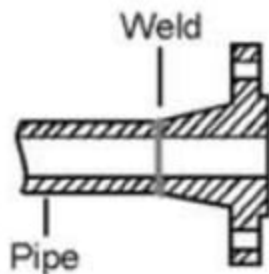
(C) RING-JOINT FLANGE FACINGS



BOLT HOLES

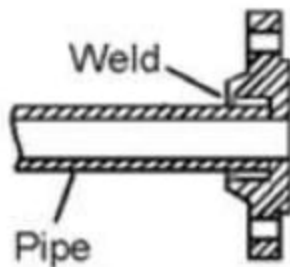


(D) LAP-JOINT FLANGE FACINGS



Weld Neck

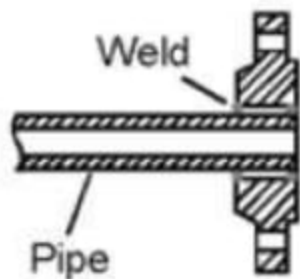
Weld Neck flanges are used in critical applications. These are circumferentially welded onto the system at their necks which means that the integrity of the butt-welded area can easily be examined by X-ray radiography. The bores of both pipe and flange match thus reducing turbulence and erosion.



Socket Weld

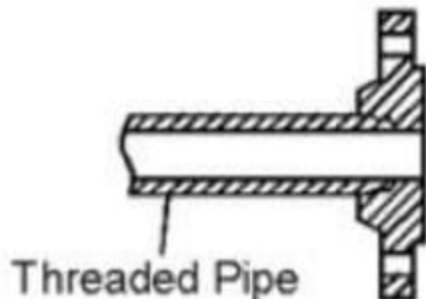
Socket Weld Flange is counter-bored to accept the pipe, which is then fillet welded.

The bore of both the pipe and the flange are the same to ensure good flows.



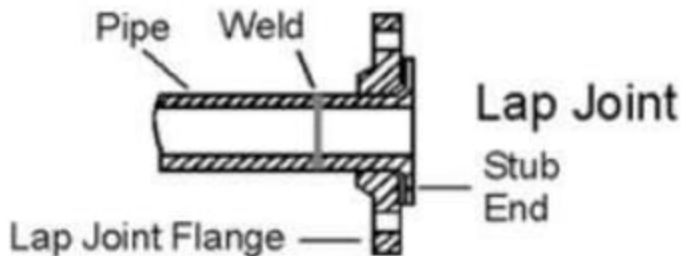
Slip On

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

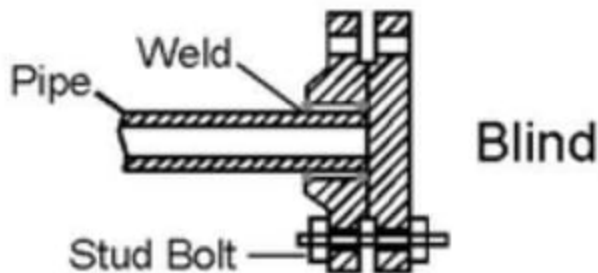


Threaded

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

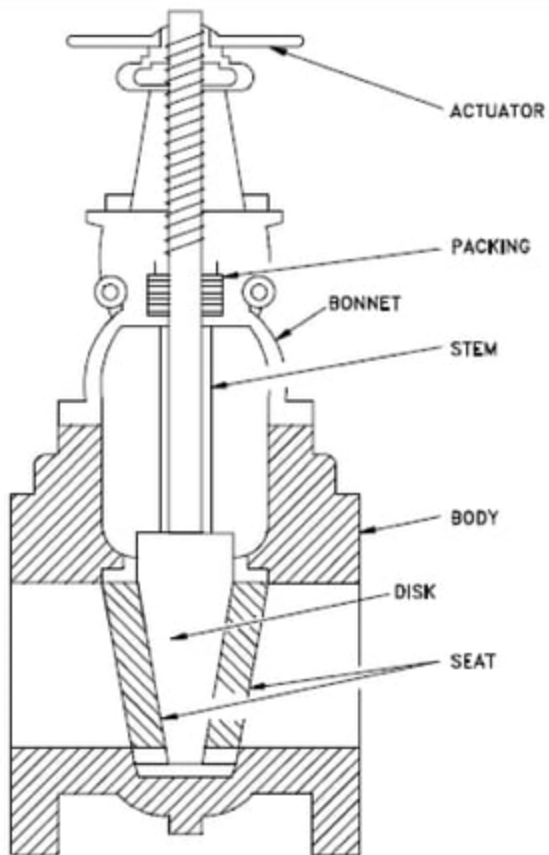
A valve is a mechanical device that controls the flow of fluid and pressure within a system or process.

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

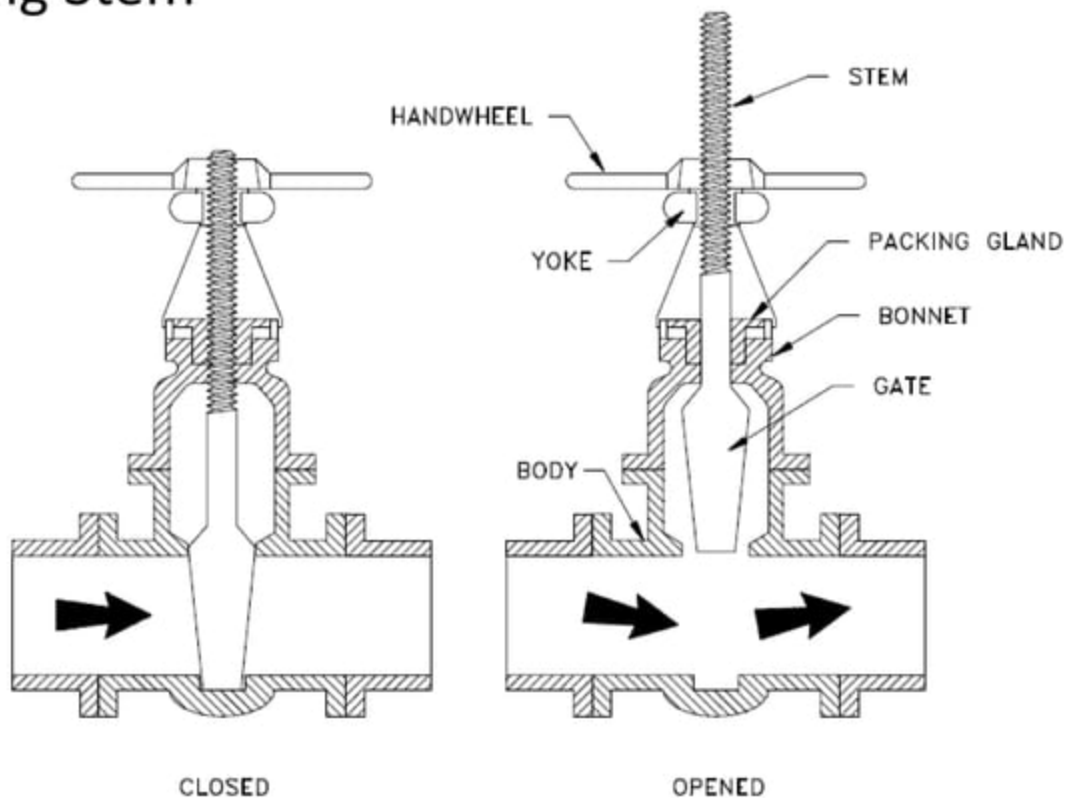
Non-Return

Check Valves

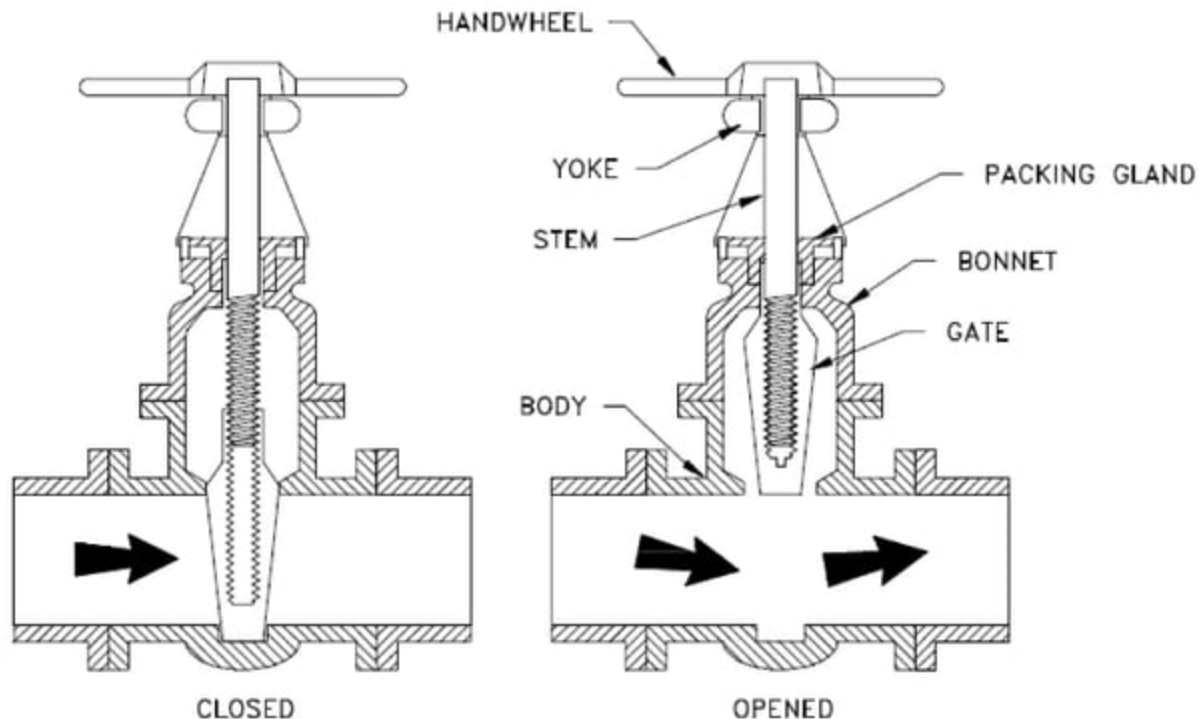
Special Purpose

Multi-port
Valves
Float Valves
Blind Valves

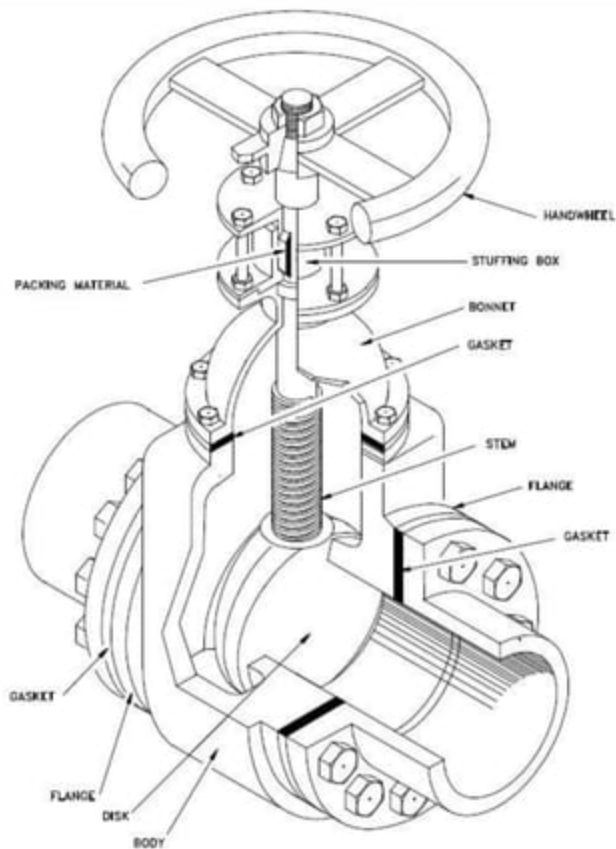
Rising Stem



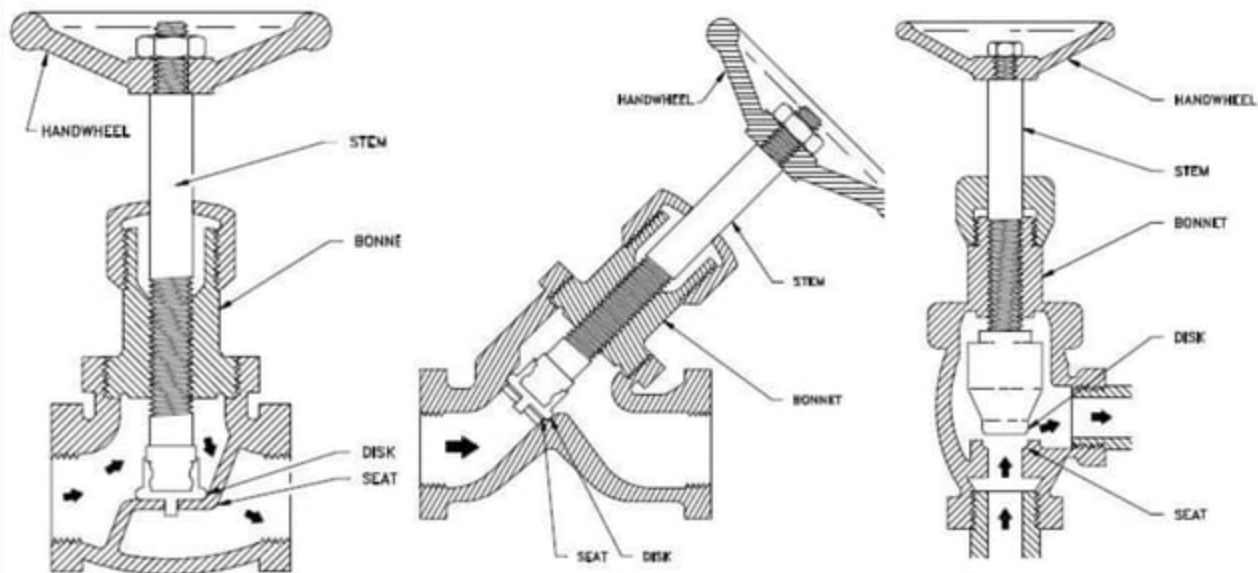
Non Rising Stem



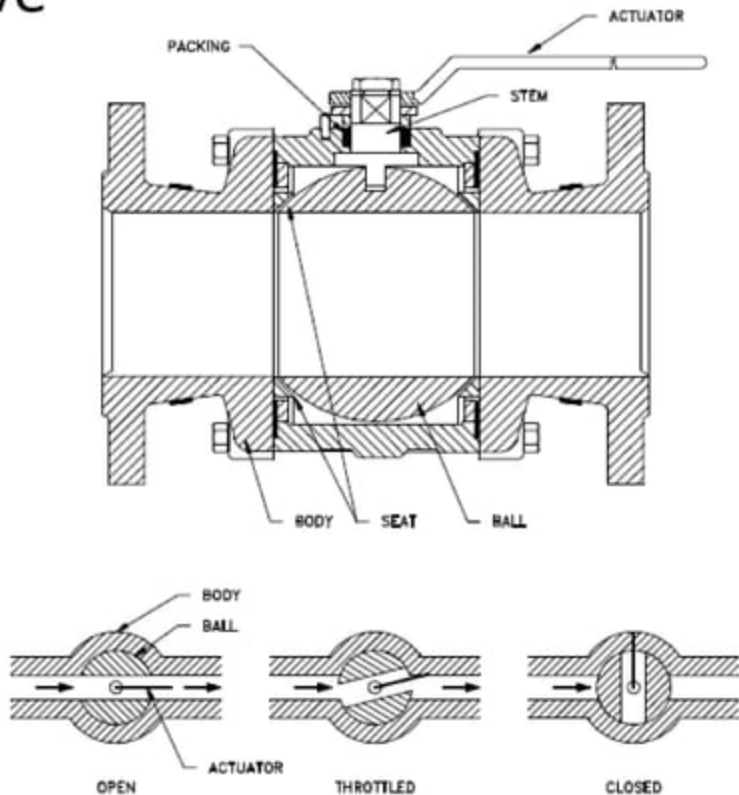
Gate Valve



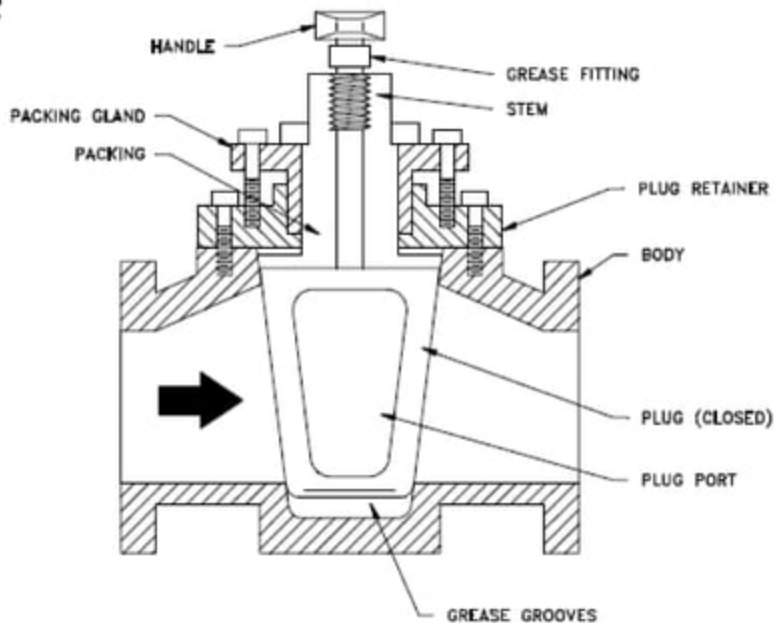
Globe Valve



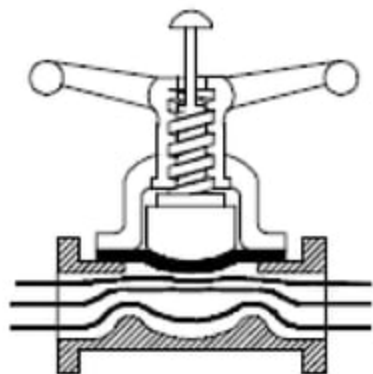
Ball Valve



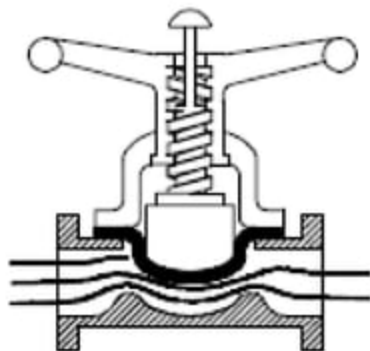
Plug Valve



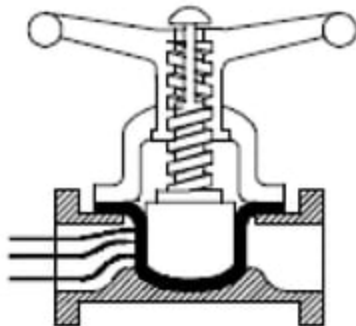
Diaphragm Valve



OPEN

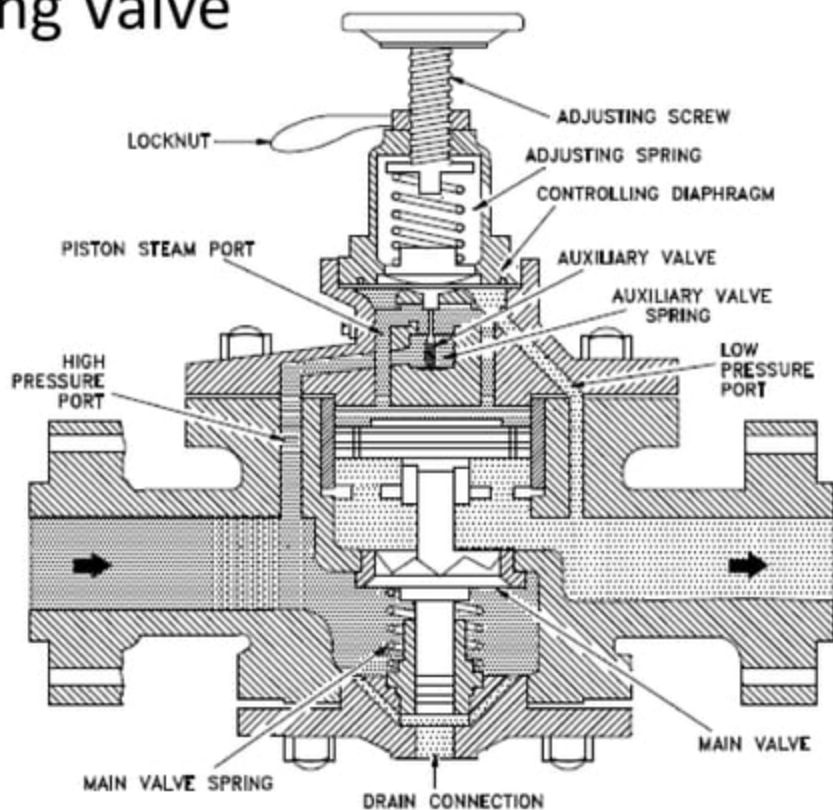


THROTTLING

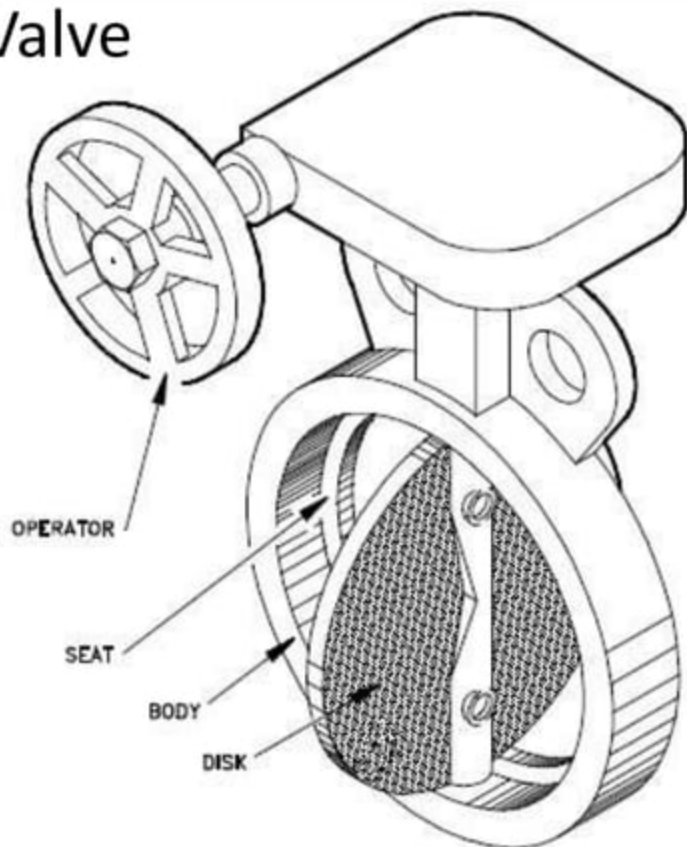


CLOSED

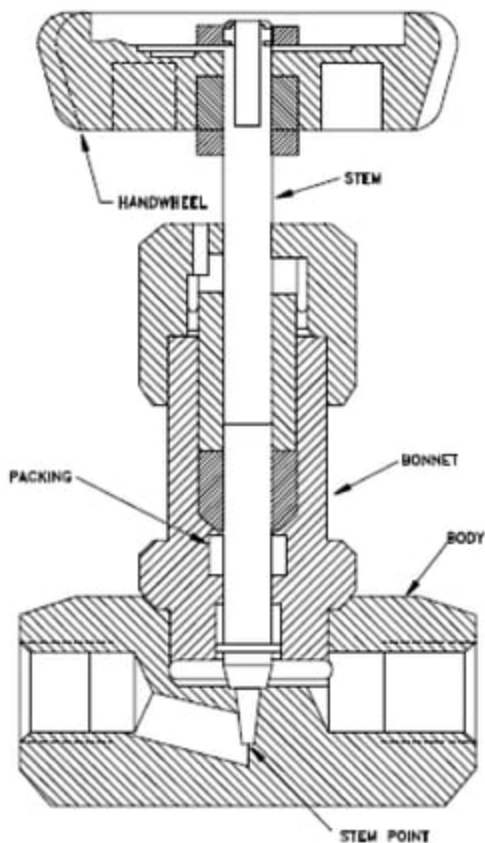
Reducing Valve



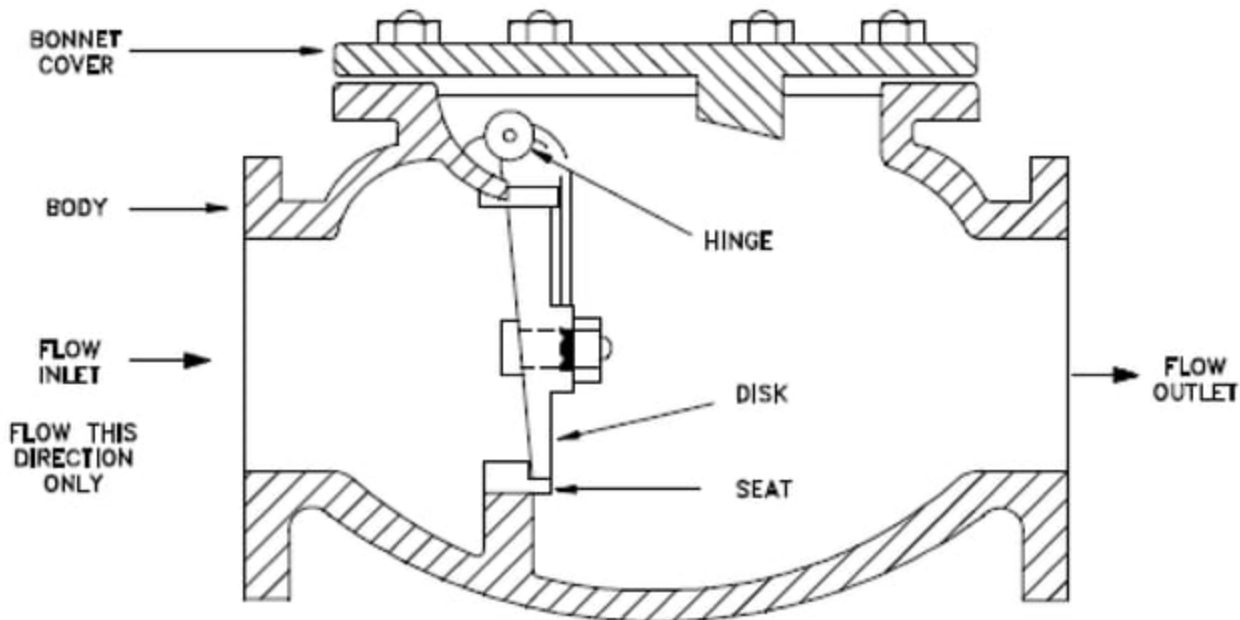
Butterfly Valve



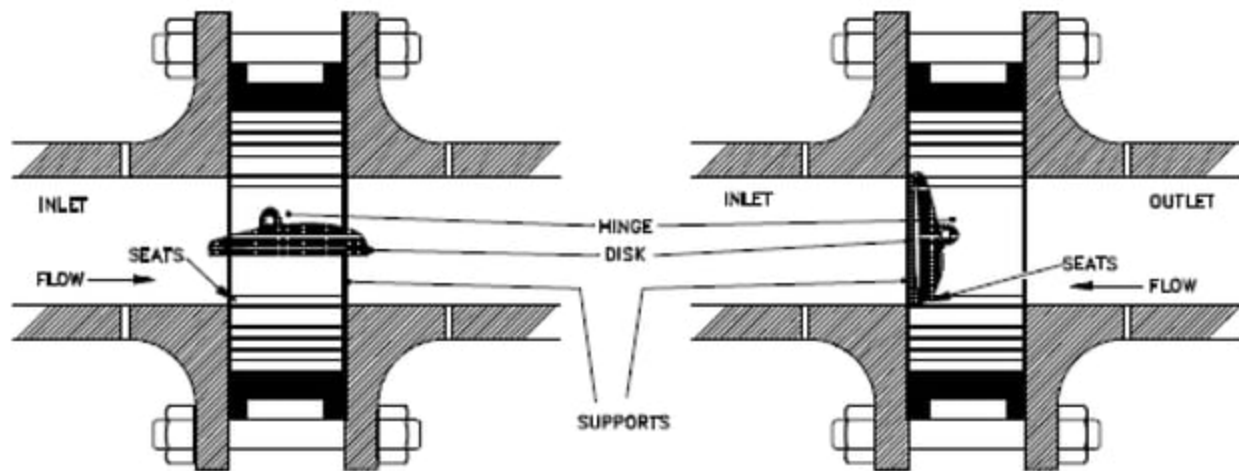
Needle Valve



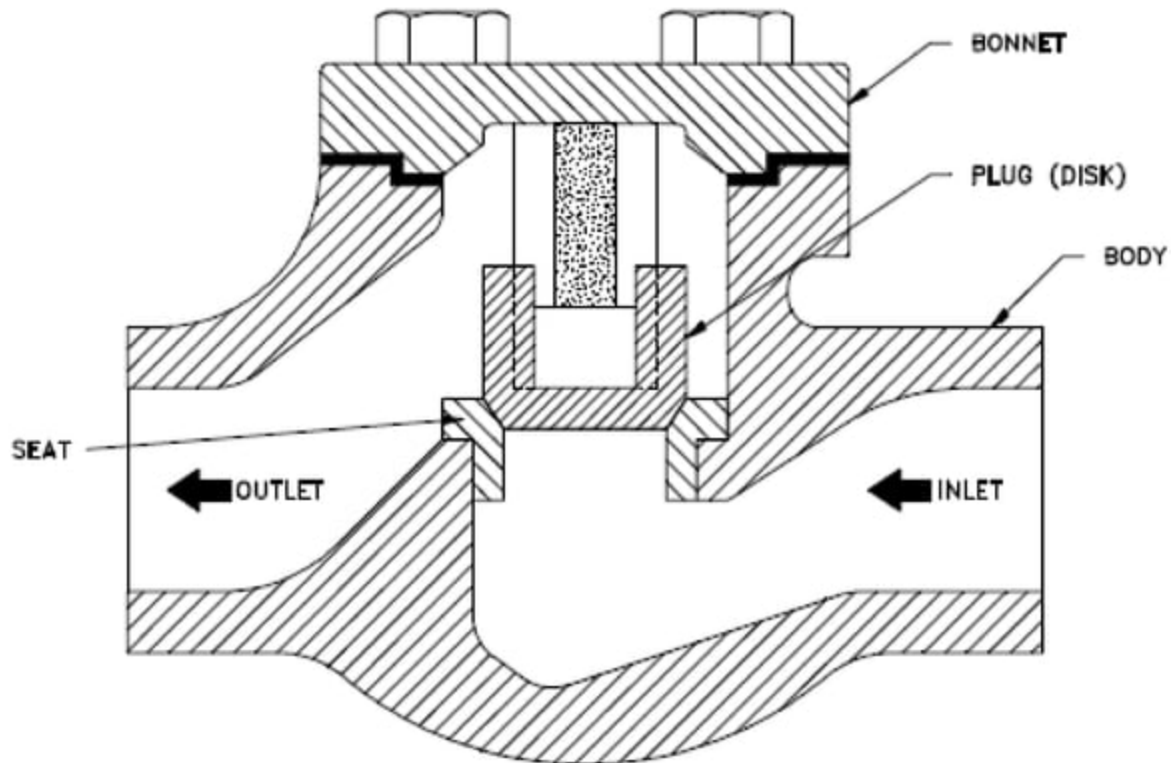
Check Valve - Swing



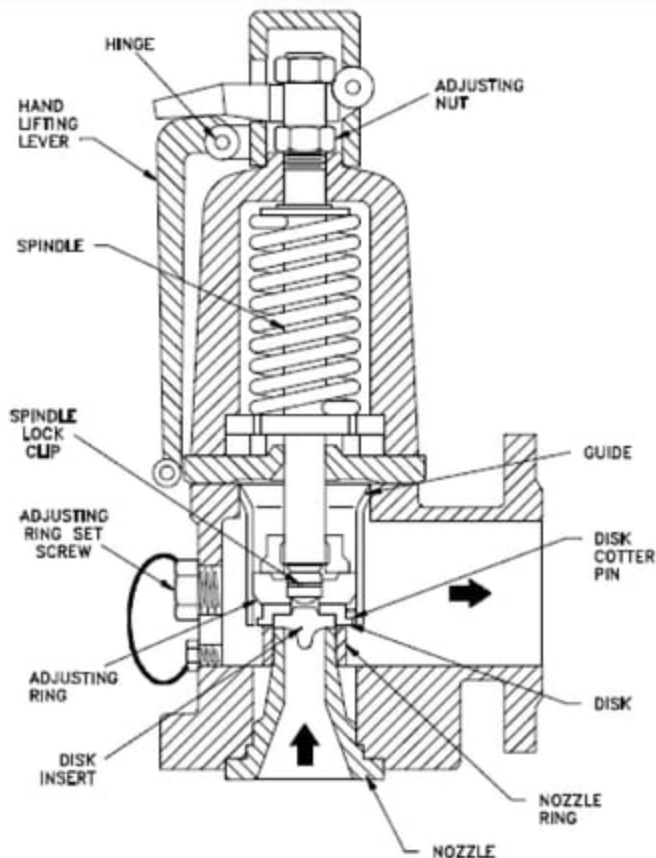
Check Valve - Tilting



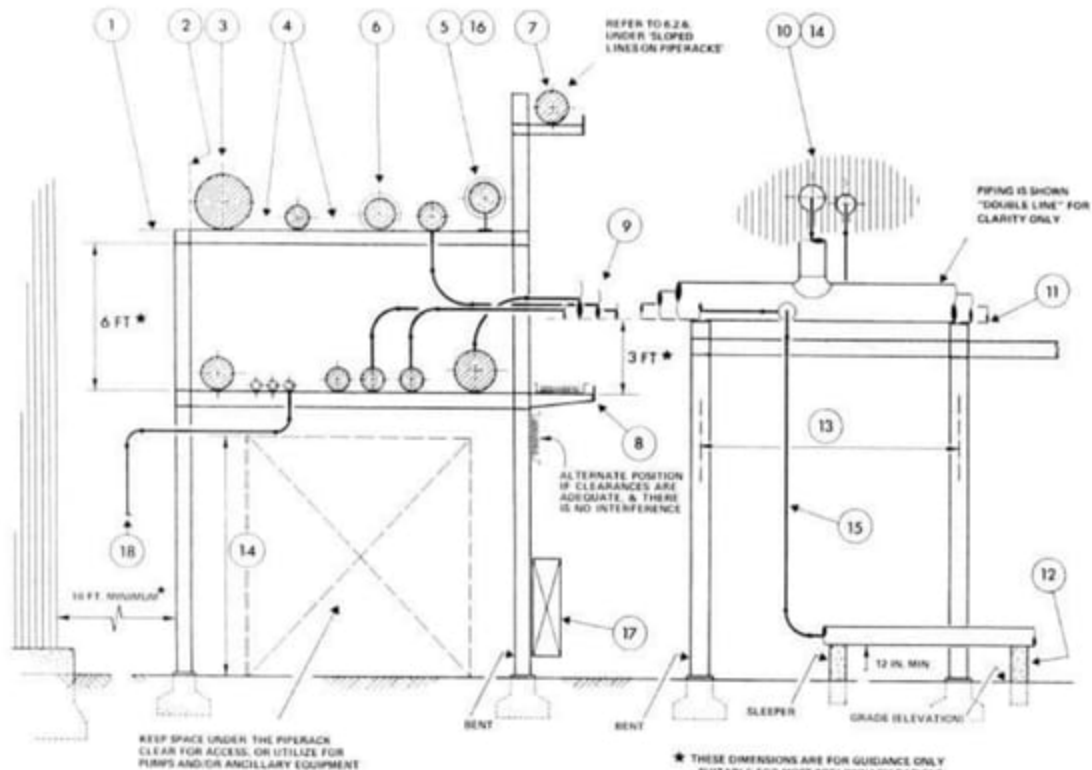
Check Valve - Lift



Relief Valve



Piperack configuration



Piperack configuration

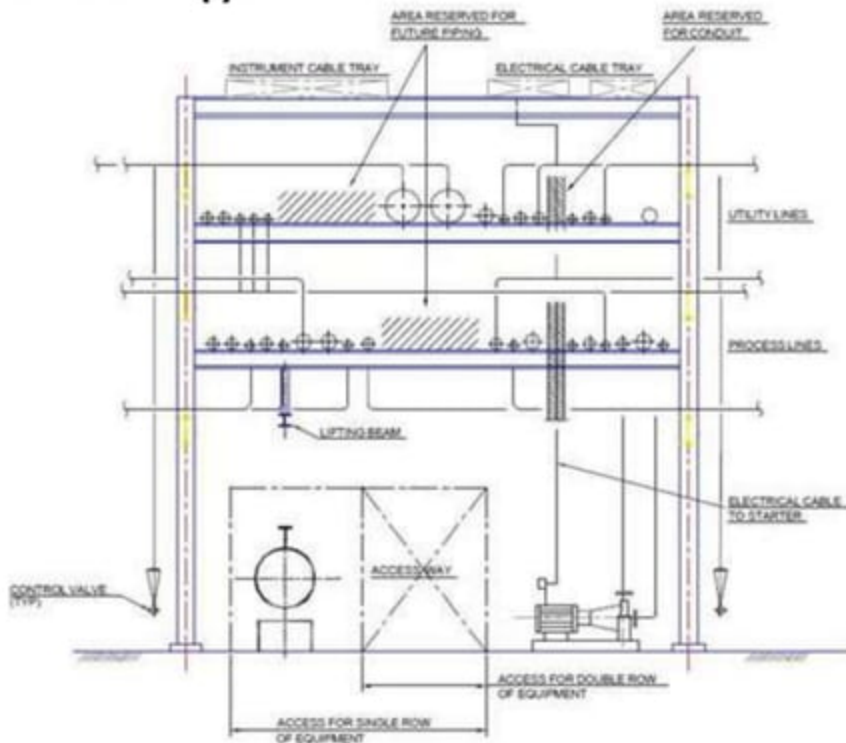
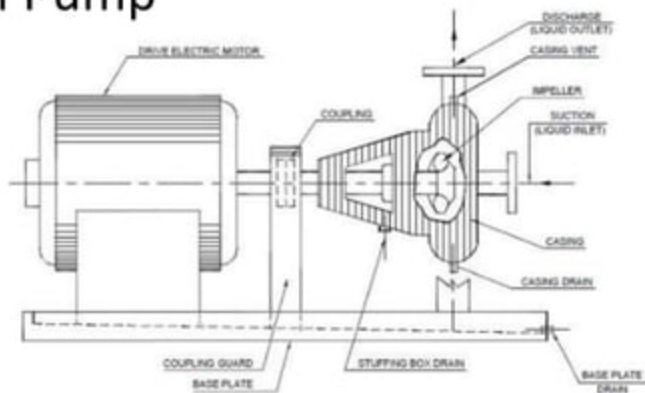
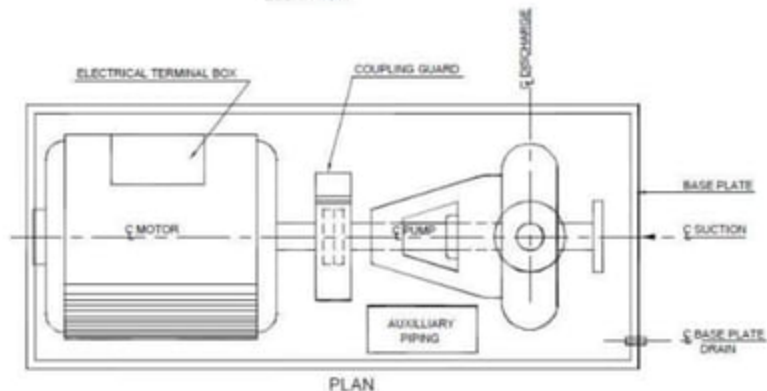


Fig 1- Typical cross-section for composite piperack

Centrifugal Pump

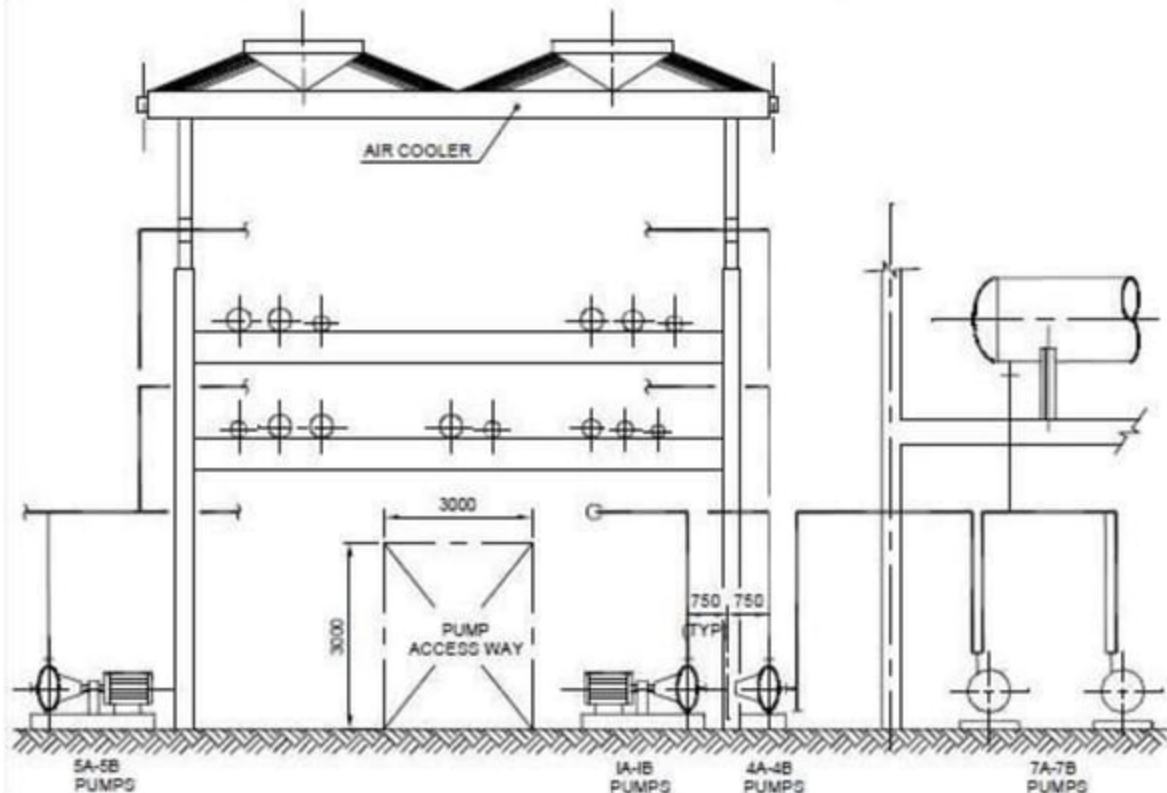


ELEVATION

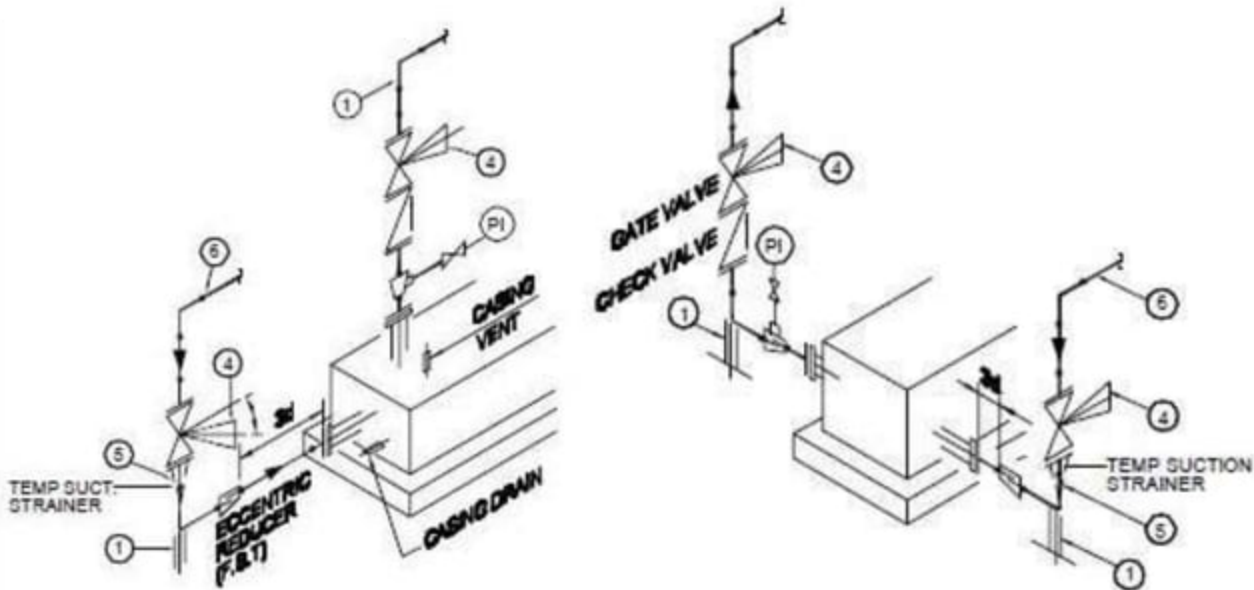


PLAN

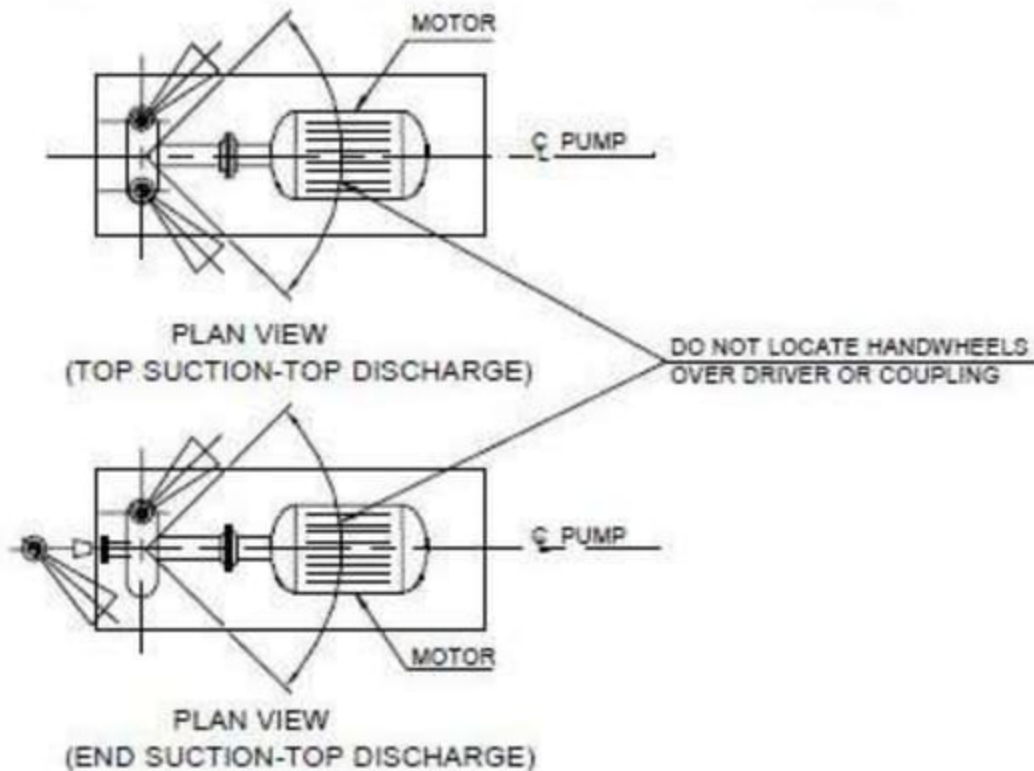
Typical pump locations - elevation



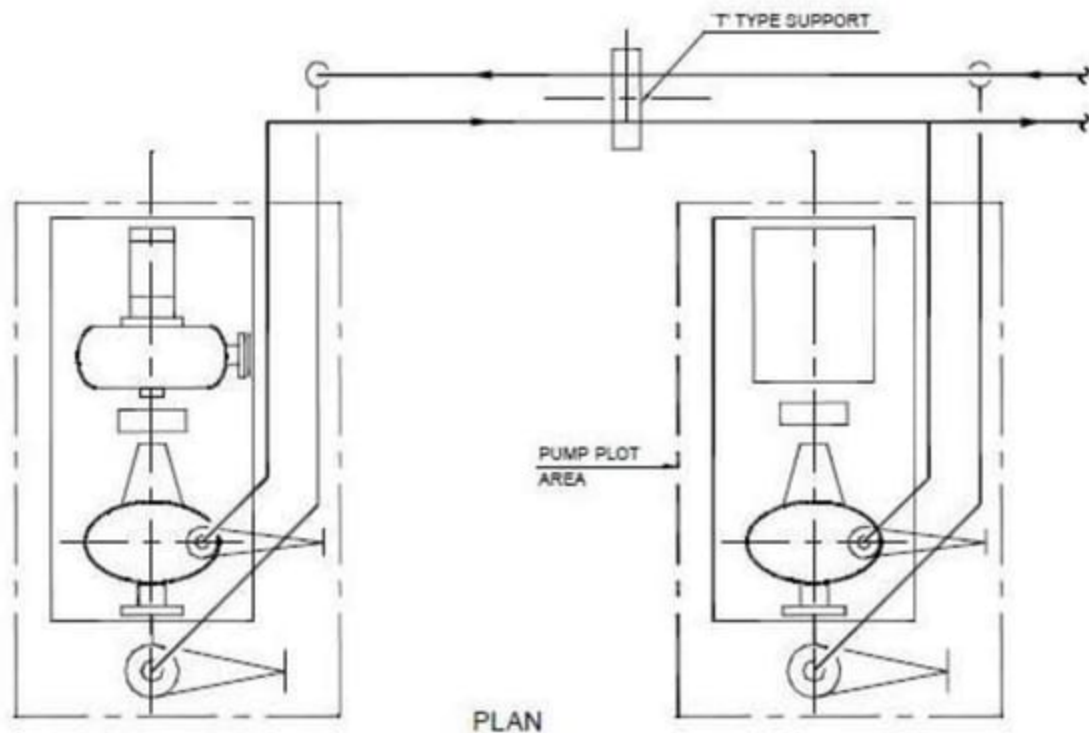
Typical pump suction and discharge piping



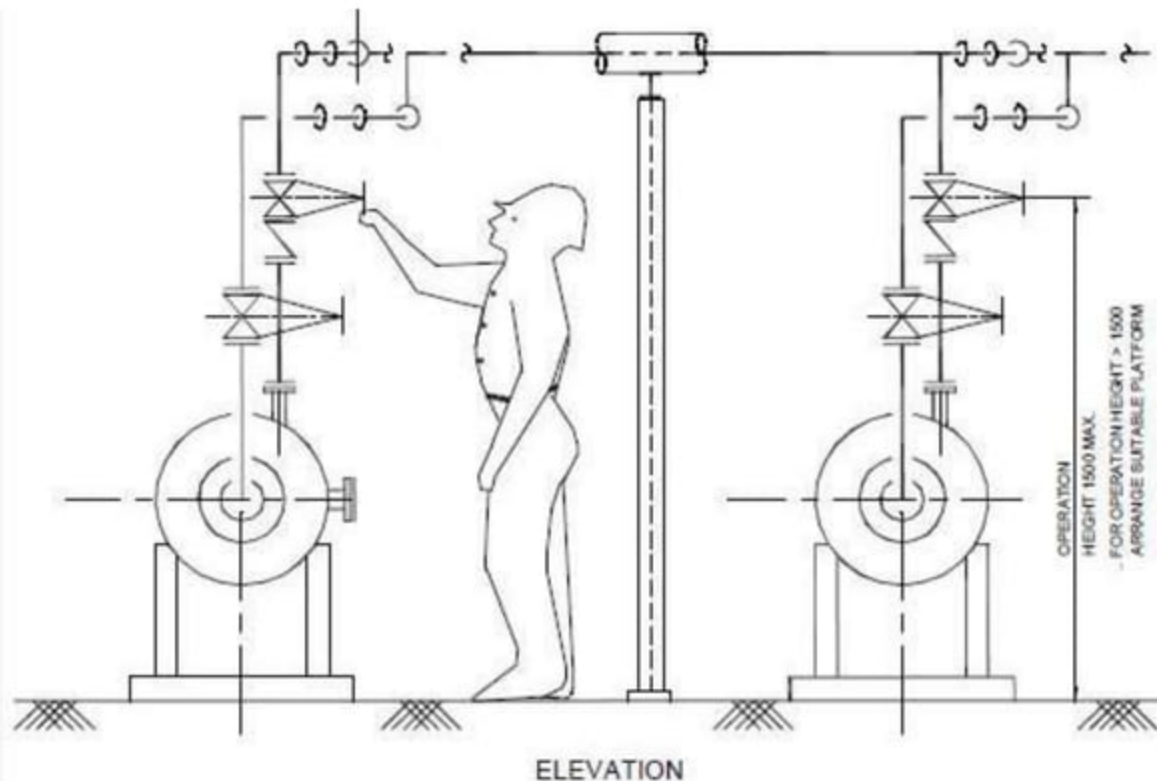
Orientation of handwheels



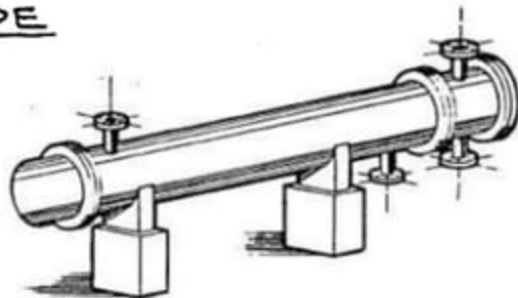
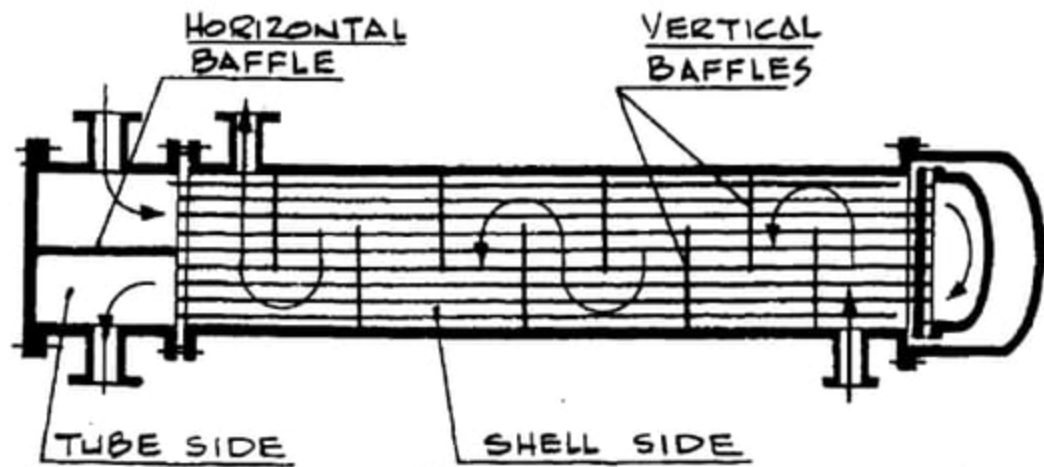
Typical auxilliary pump piping



Maintenance and operation access requirements

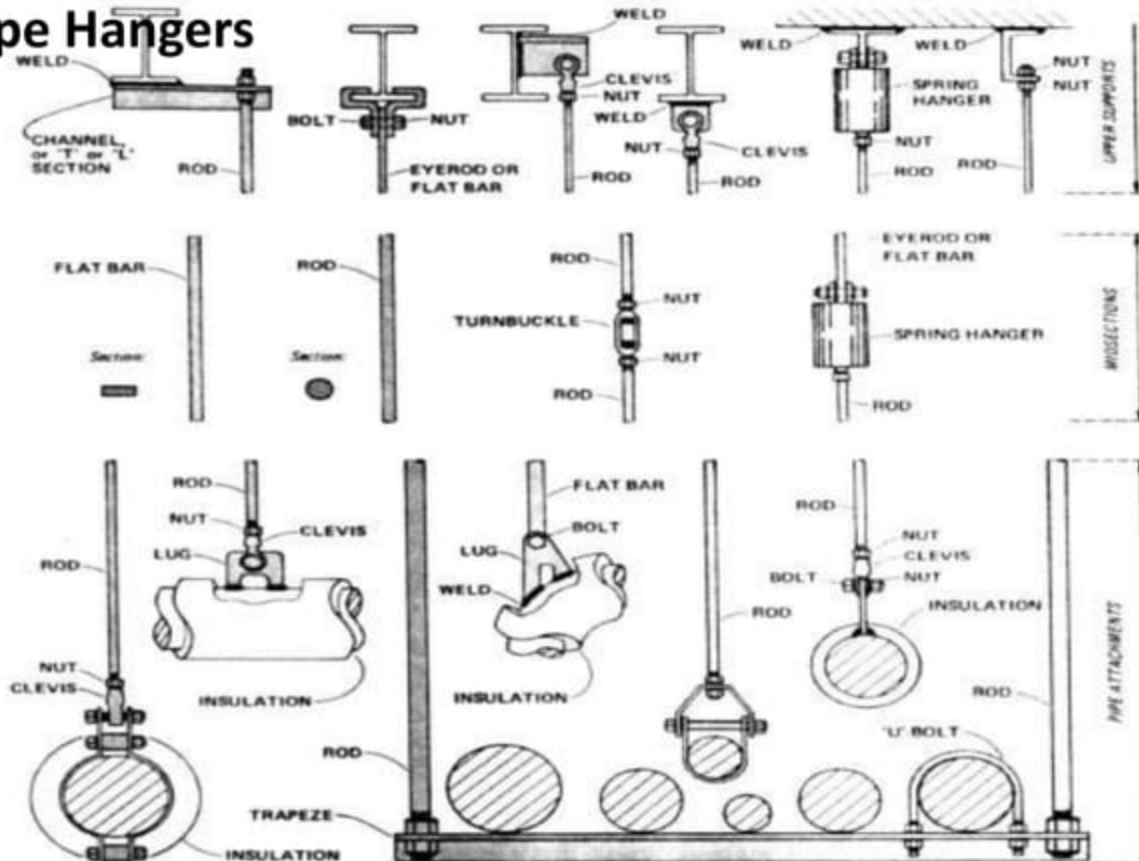


Various other equipment

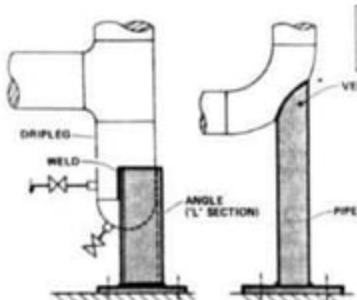
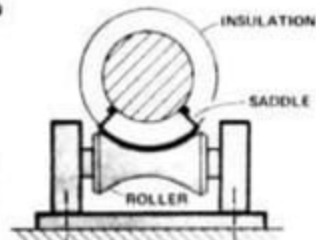
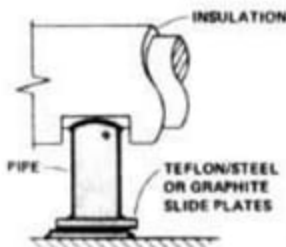
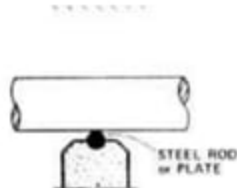
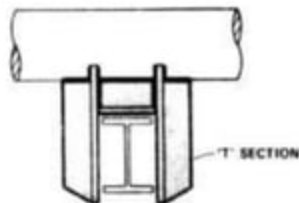
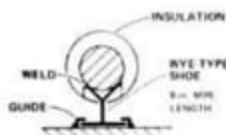
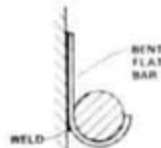
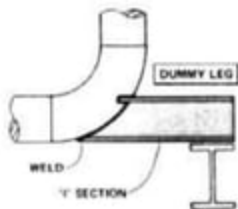
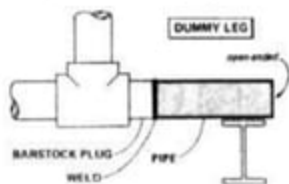


a. Shell and Tube Exchanger

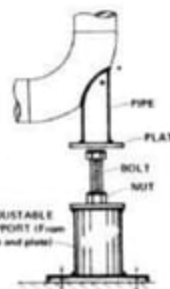
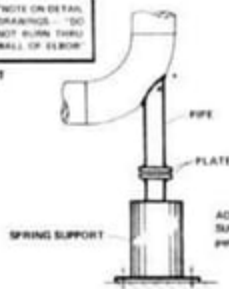
Pipe Hangers



Pipe Supports

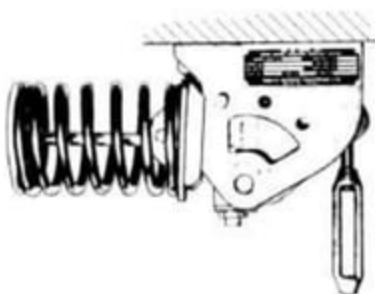
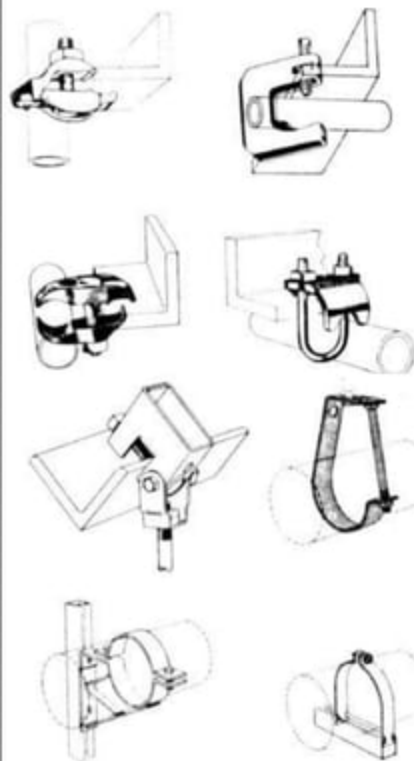


NOTE ON DETAIL DRAWINGS - "DO NOT TURN THIRD WALL OF ELBOW"

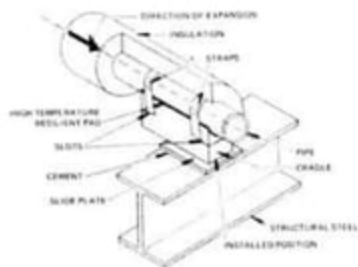
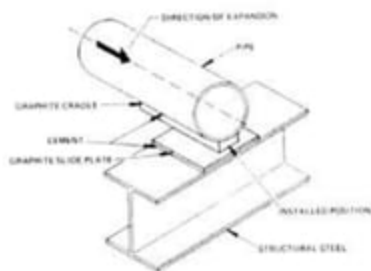
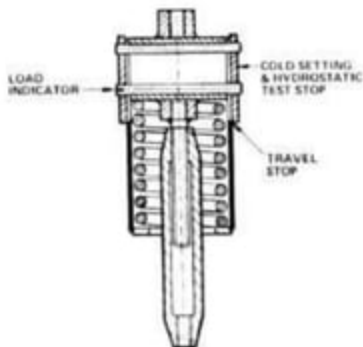


Anchor, Spring hangers and Guides

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.