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Piping Engineering

PIPING DESIGN

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BASIC DESIGN CONCEPTS

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PIPING DRAWINGS

PIPING DRAWINGS

The primary drawings that a Piping/Mechanical Field Engineer will use in the course of completing a field assignment are:

- PFD (Process Flow Diagram)
- Piping and Instrument Diagram (P&ID)
- Piping Isometric
- Plot Plans
- Piping Class Sheets
- Piping Support & Hanger Drawings (*Ref Topic #3)*
- Vendor Drawings and Manuals

PIPING DRAWINGS

- Instrument and Tubing Drawings
- Standard Instrument Details

These drawings along with project installation specifications provide quality guidelines for properly completing the assigned system.

PIPING DRAWINGS – Process Flow Diagram

Process Flow Diagram

A Process Flow Diagram - PFD shows the **relationships** between the major components in the system. PFD also tabulate process design values for the components in different operating modes, typical minimum, normal and maximum. A PFD does not show minor components, piping systems, piping ratings and designations.

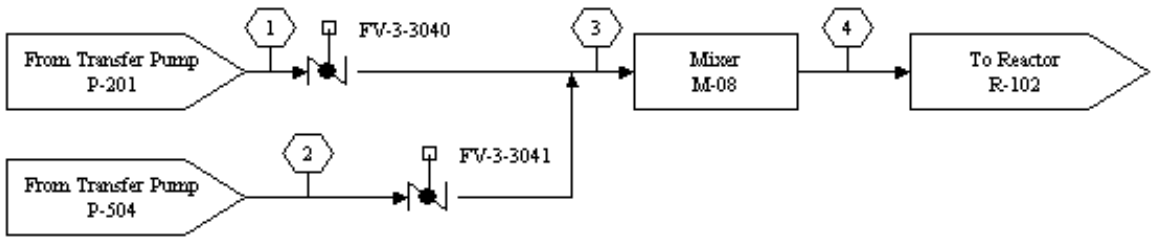
PIPING DRAWINGS – Process Flow Diagram

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

PIPING DRAWINGS – Process Flow Diagram

This figure depict a small and simplified PFD:



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

A Small and Simplified

Process Flow Diagram

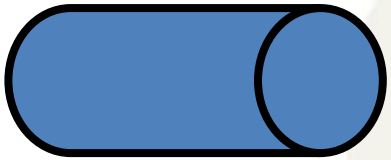
www.EngineeringToolBox.com

PIPING DRAWINGS – Process Flow Diagram

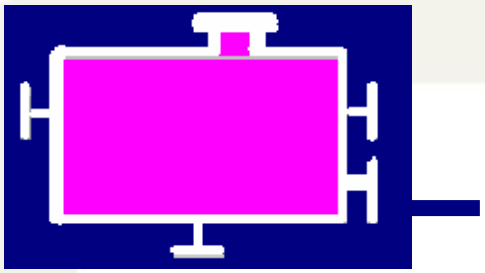
Conveys the major processing steps represented by the equipment

- Useful for conveying the heat and material balances
- Useful for conveying major pieces of equipment
- Useful for conveying processing conditions
- Useful for conveying utilities

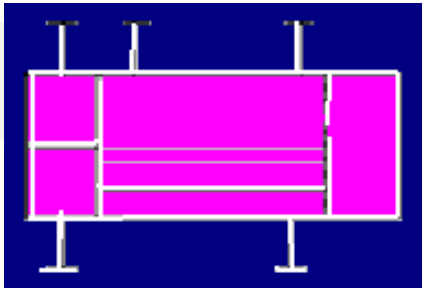
PIPING DRAWINGS – PFD Symbols



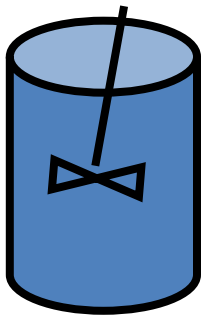
Reactor



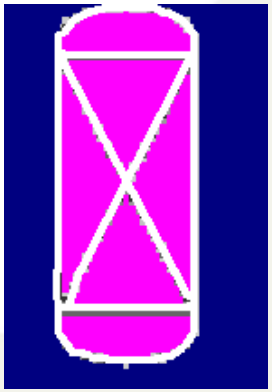
Sealed tank



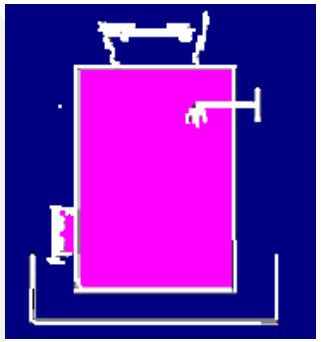
Heat exchange



Tray column



Fluid contacting column



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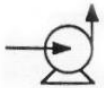
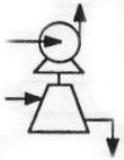
FLUID HANDLING

Centrifugal pump or blower, motor driven

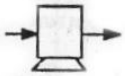


Centrifugal pump or blower, turbine driven



Rotary pump or blower

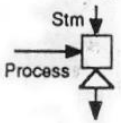
Reciprocating pump or compressor



Centrifugal compresso

Centrifugal compressor alternate symbol

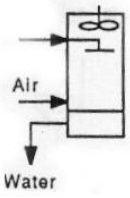
Steam ejector



Coil in tank

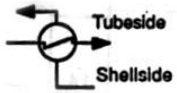
Evaporator

Cooling tower forced draft



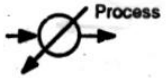
HEAT TRANSFER

Shell-and-tube heat exchanger

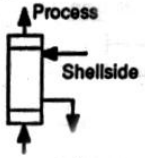


Condenser

Reboiler



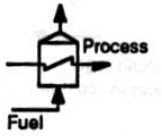
Vertical thermosiphon reboiler



Kettle reboiler

Air cooler with finned tubes

Fired heater

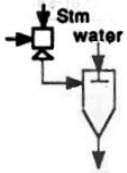


Fired heater with radiant and convective coils

Rotary dryer or kiln

Tray dryer

Spray condenser with steam ejector



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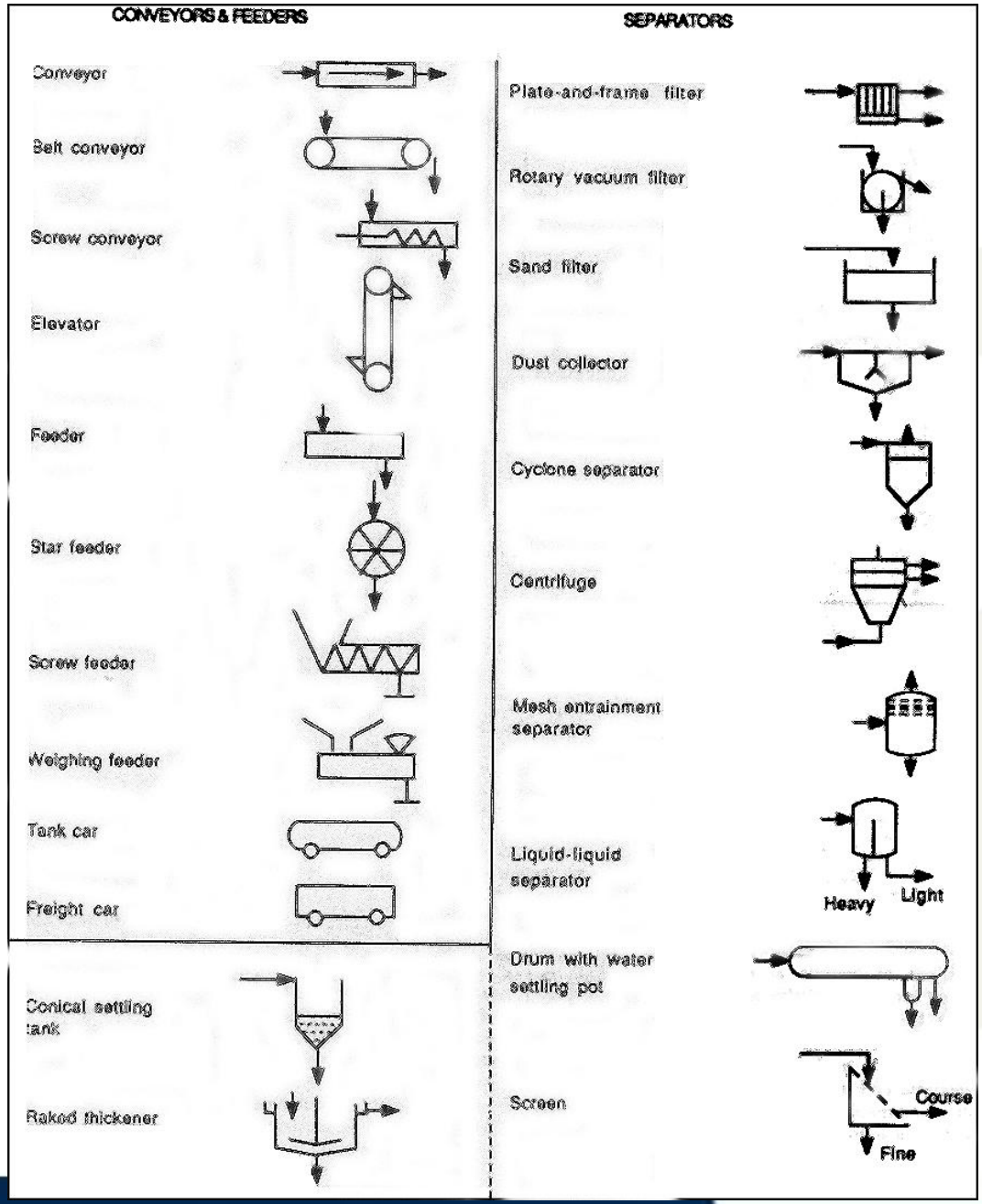
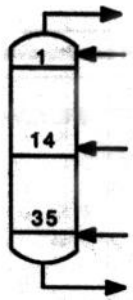
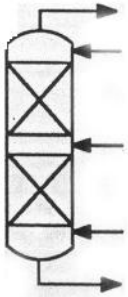

CONVEYORS & FEEDERS
Conveyor
Belt conveyor
Screw conveyor
Elevator
Feeder
Star feeder
Screw feeder
Weighing feeder
Tank car
Freight car
Conical settling tank
Raked thickener
SEPARATORS
Plate-and-frame filter
Rotary vacuum filter
Sand filter
Dust collector
Cyclone separator
Centrifuge
Mesh entrainment separator
Liquid-liquid separator
Heavy
Light
Drum with water settling pot
Screen
Course
Fine

Continued

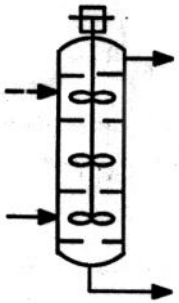
MASS TRANSFER



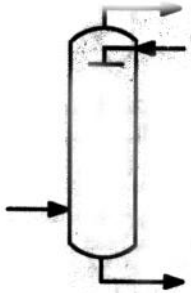
Tray column



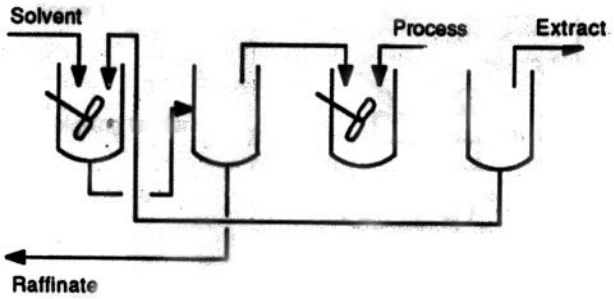
Packed column



Multistage stirred column



spray column



Mixer-settler extraction battery

VESSELS

Drum or tank

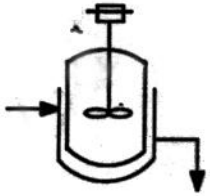
Drum or tank

Storage tank

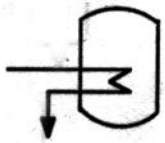
Open tank

Gas holder

Jacketed vessel with agitator



Vessel with heat transfer coil



Bin for solids

Continued

PIPING DRAWINGS – Process Flow Diagram

The following diagrams are examples of class and commercial process flow diagrams (PFD's). The content depends on the goals for the communication.

Unless there are reasons to the contrary, the standard is:

- All major equipment
- All major process lines
- All major utility lines involving material flow
- All stream numbers, temperatures, pressures, flows
- All major process controls and valves
- All equipment sizes with relevant MEB information as required
- All equipment names and numbers

PIPING DRAWINGS – Process Flow Diagram

The goal is to present the most amount of information with the least amount of effort on the part of the reader.

- The flowsheet should generally flow from left to right.
- The flowsheet should not be cluttered - use multiple sheets.
- The flowsheet should be in landscape with the bound edge at top.
- The equipment should be drawn in approximately relative size, e.g. towers larger than drums, exchangers larger than pumps etc.
- The major towers and reactors are generally on one, or nearly one, level.

PIPING DRAWINGS – Process Flow Diagram

- The reader should be able to follow it with his or her eye.
- The streams should have the minimum of direction changes.
- The streams that enter across the battery limits should be on the left.
- The streams that leave across the battery limits should be on the right.
- The streams that move to the next sheet should leave on the right.
- The streams that recycle to earlier sheets should leave on the left.

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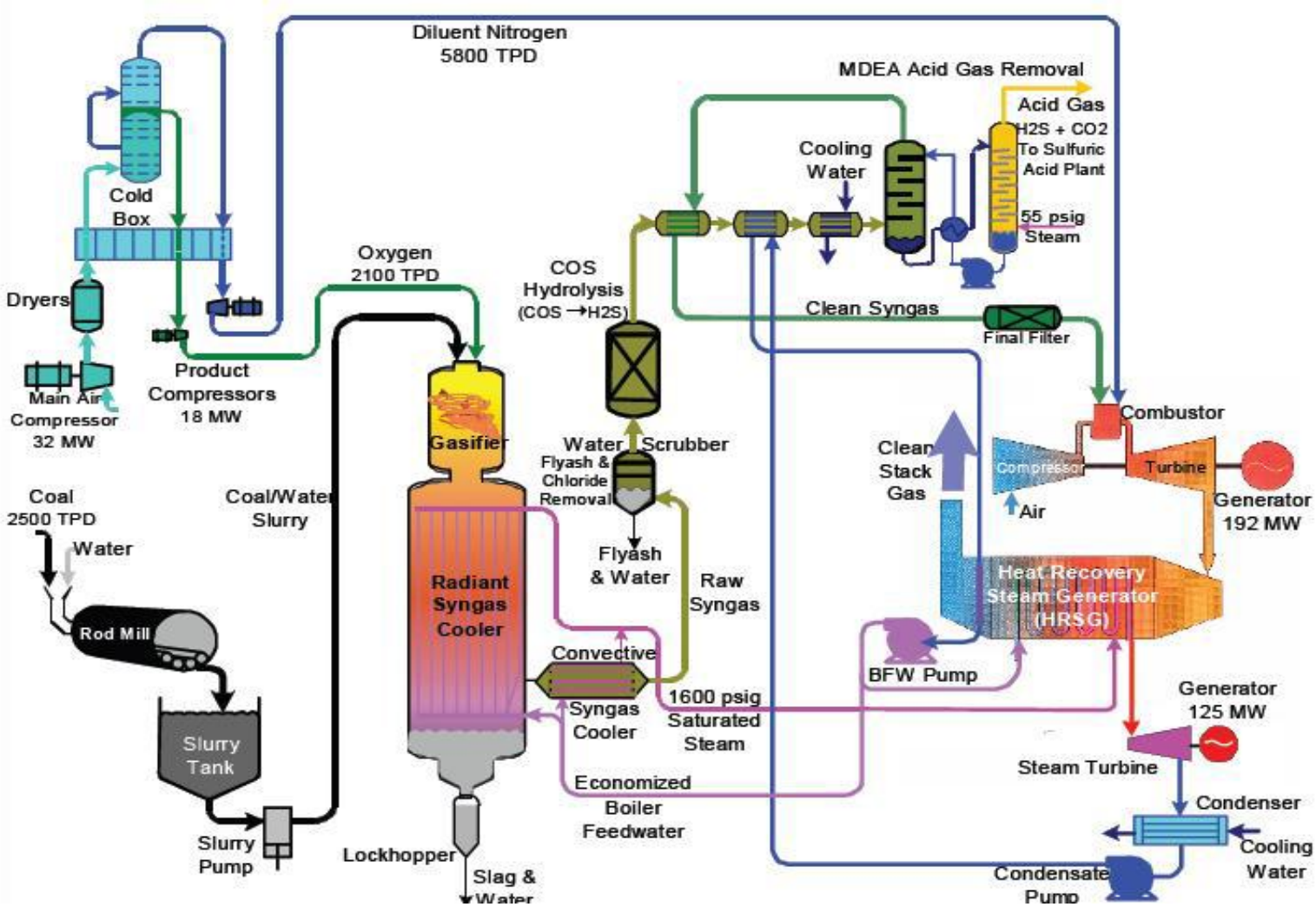
PIPING DRAWINGS – Process Flow Diagram



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PIPING DRAWINGS – Process Flow Diagram

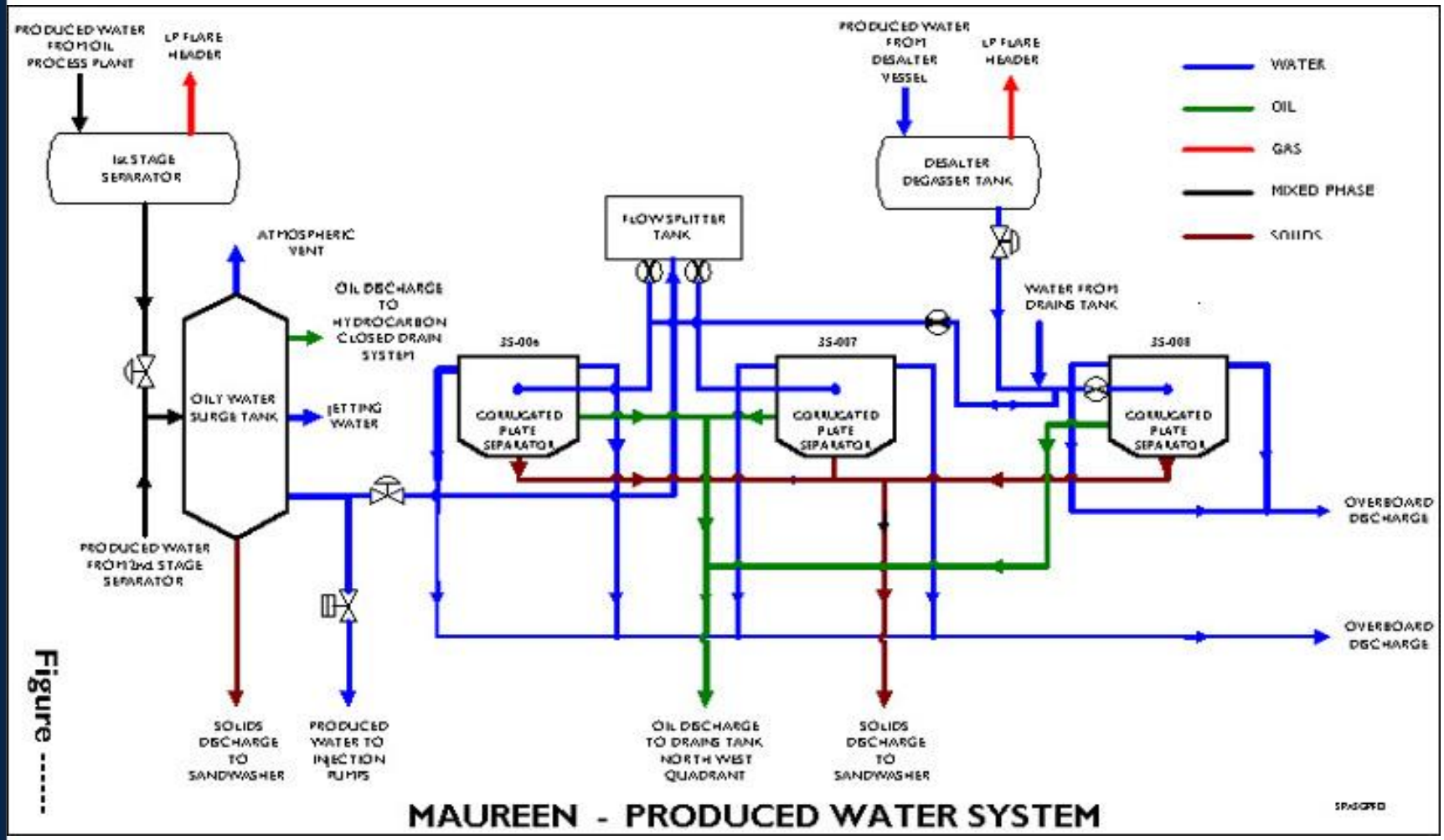

Figure ------

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Piping & Instrumentation Diagram/Drawing

(P& ID)

PIPING DRAWINGS – P&ID

A diagram in the process industry which shows the piping of the process flow together with the installed equipment and instrumentation

A diagram which shows the interconnection of process equipment and the instrumentation used to control the process.
In the process industry, a standard set of symbols is used to prepare drawings of processes.

The instrument symbols used in these drawings are generally based on International Society of Automation(ISA)Standard S5.1.
The primary schematic drawing used for laying out a process control installation.

PIPING DRAWINGS – P&ID

- P&ID s play a significant role in the maintenance and modification of the process that it describes.
- It is critical to demonstrate the physical sequence of equipment and systems, as well as how these systems connect.
- During the design stage, the diagram also provides the basis for the development of system control schemes, allowing for further safety and operational investigations, such as the hazard and operability study(HAZOP)

PIPING DRAWINGS – P&ID

For processing facilities, it is a pictorial representation of

- Key piping and instrument details
- Control and shutdown schemes
- Safety and regulatory requirements
- Basic start up and operational information
- Instrumentation and designations
- Mechanical equipment with names and numbers
- All valves and their identifications
- Process piping, sizes and identification

PIPING DRAWINGS – P&ID

- Miscellanea -vents, drains, special fittings, sampling lines, reducers, increasers and swages
- Permanent start-up and flush lines
- Flow directions
- Interconnections references
- Control inputs and outputs, interlocks
- Interfaces for class changes
- Computer control system input
- Identification of components and subsystems delivered by others

PIPING DRAWINGS – P&ID

What information can you get?

For Equipment

- Outline/Internals

For Piping

- Line No./Size/Material/Insulation/Line Configuration/Piping Component Type

For Instrument

- Tag No./Function/Control Method

PIPING DRAWINGS – P&ID

P&ID is used for

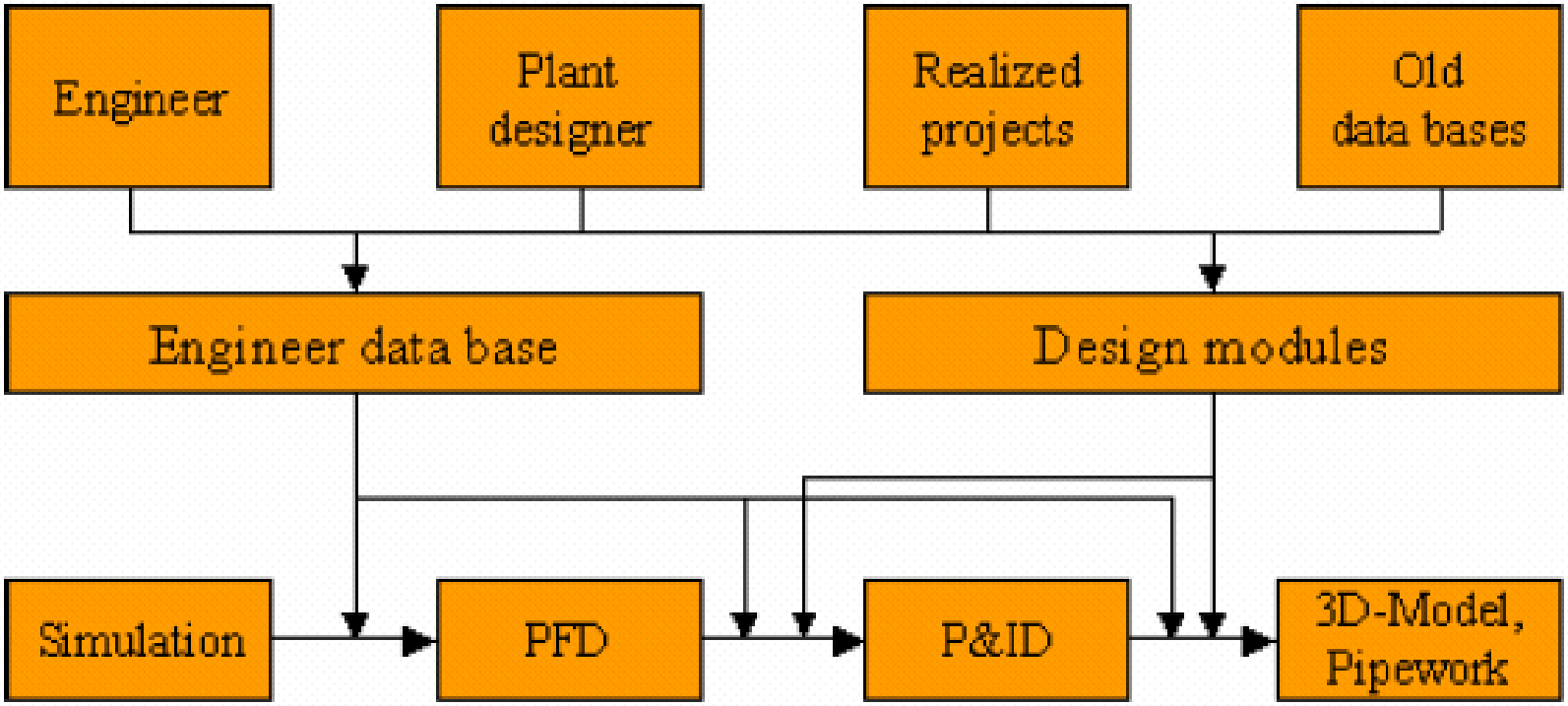
- Detail Engineering of each disciplines

Piping layout/Material Purchase Instrument Logic/DCS Plan, etc

- Planning of

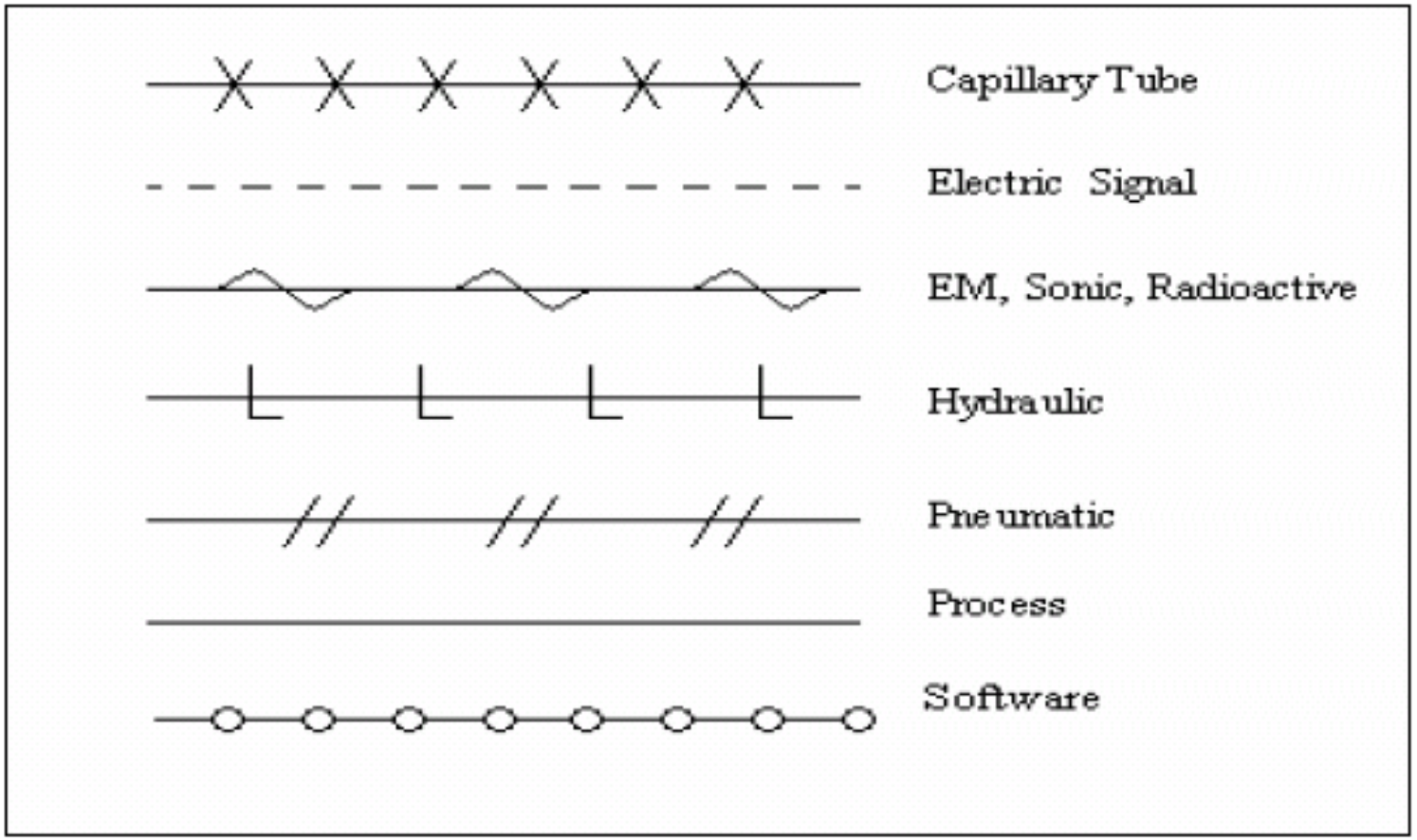
Construction/Commissioning/Plant Operation/Maintenance

PIPING DRAWINGS – P&ID



PIPING DRAWINGS – P&ID

P&ID Symbols



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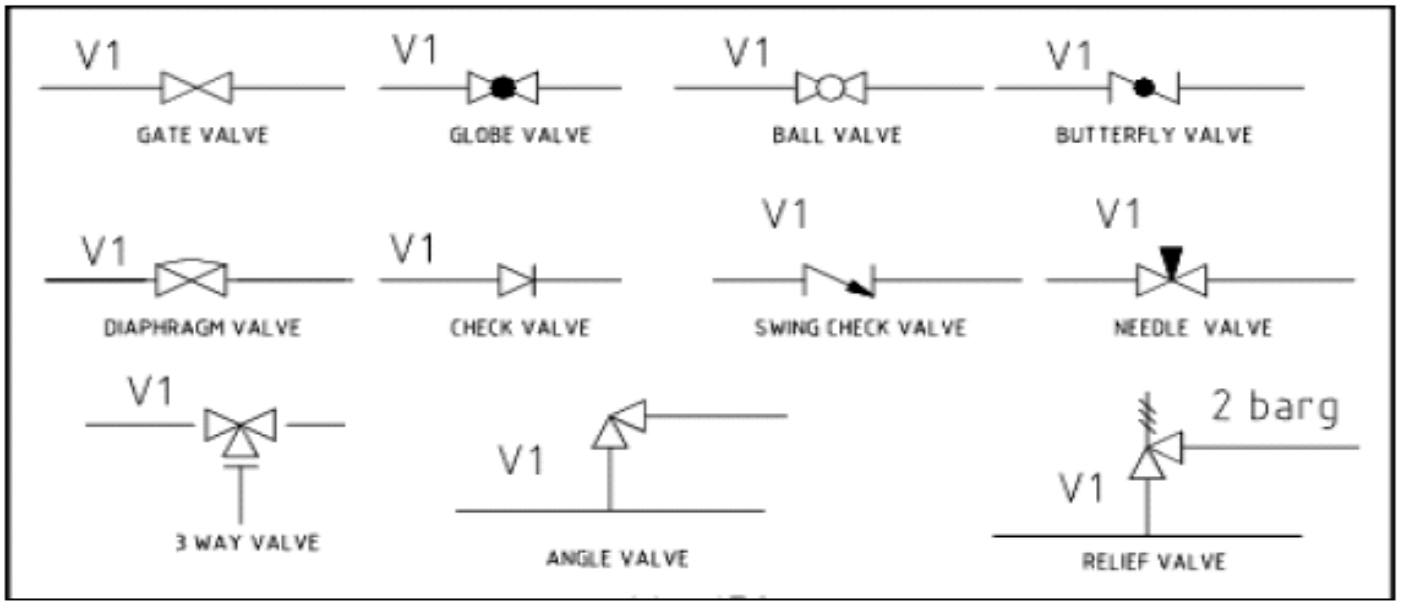
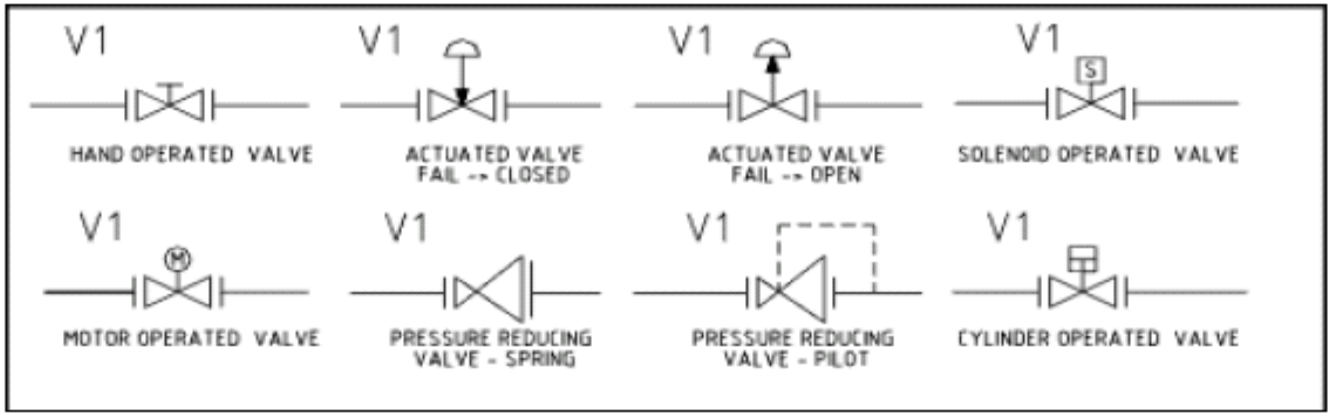
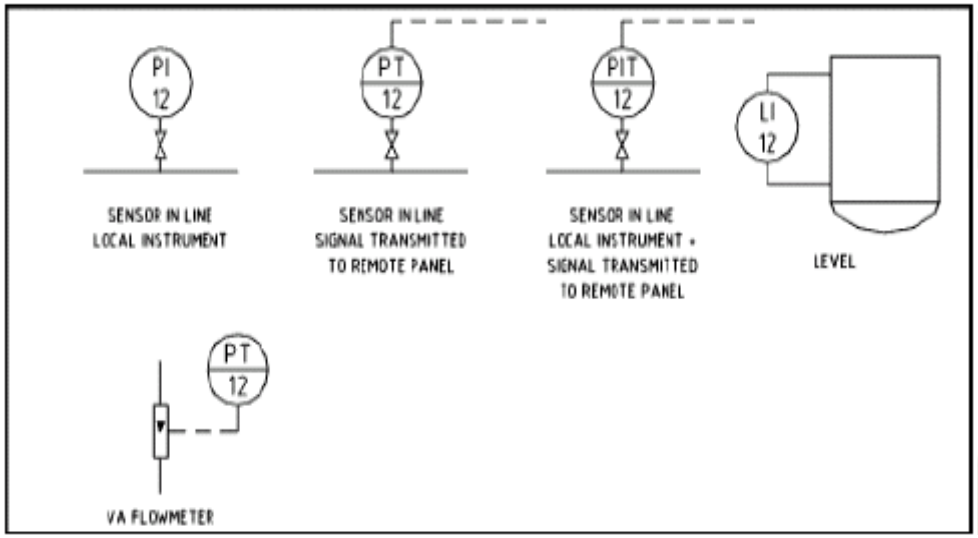
PIPING DRAWINGS – P&ID





PIPING DRAWINGS – P&ID



Measured Variable	Type of Conditioner	Type of Component
F = Flow	R = Recorder	T = Transmitter
L = Level	I = Indicator	M = Modifier
P = Pressure	C = Controller	E = Element
Q = Quantity	A = Alarm	
T = Temperature		

PIPING DRAWINGS – P&ID

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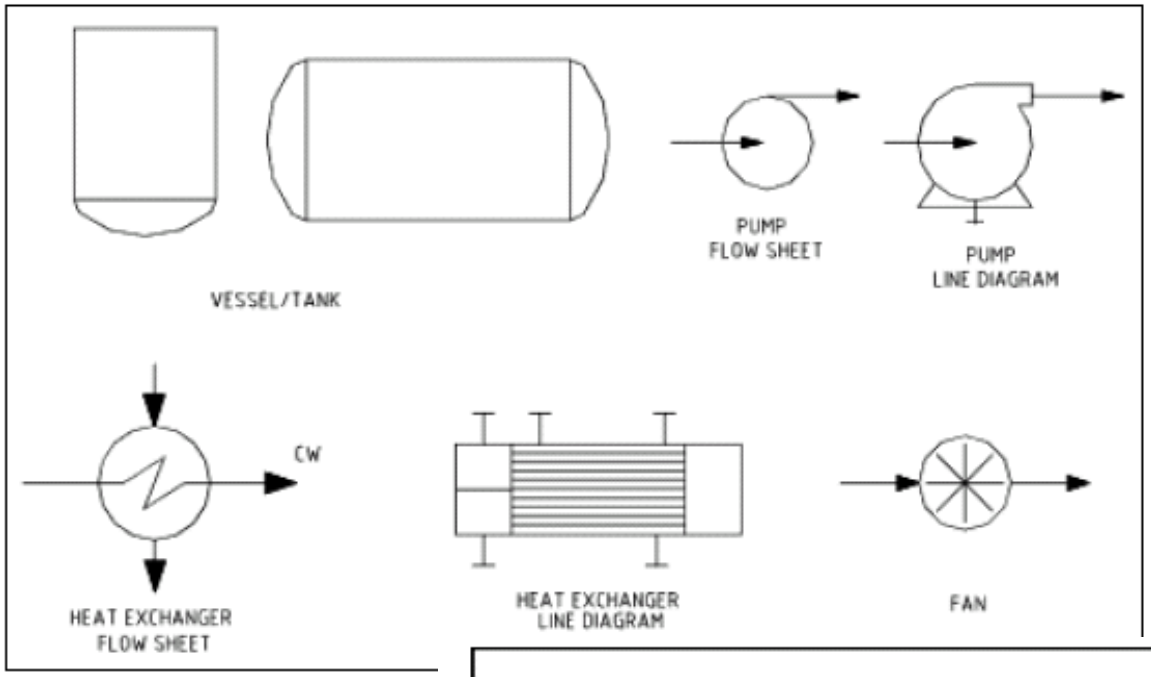
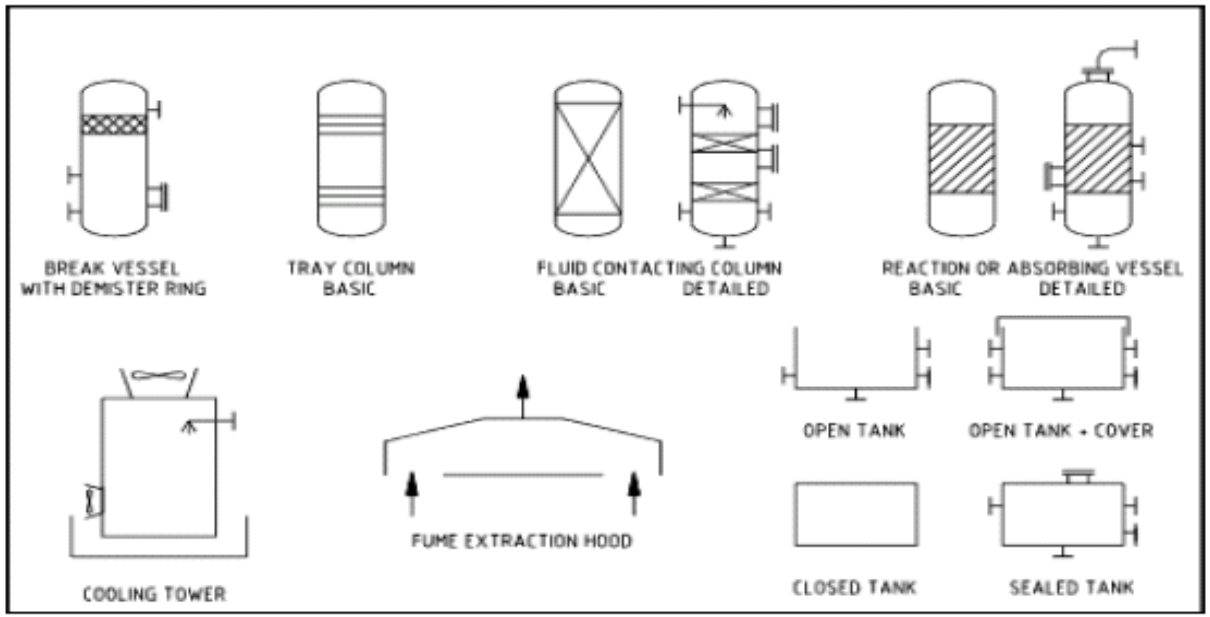
Piping Engineering





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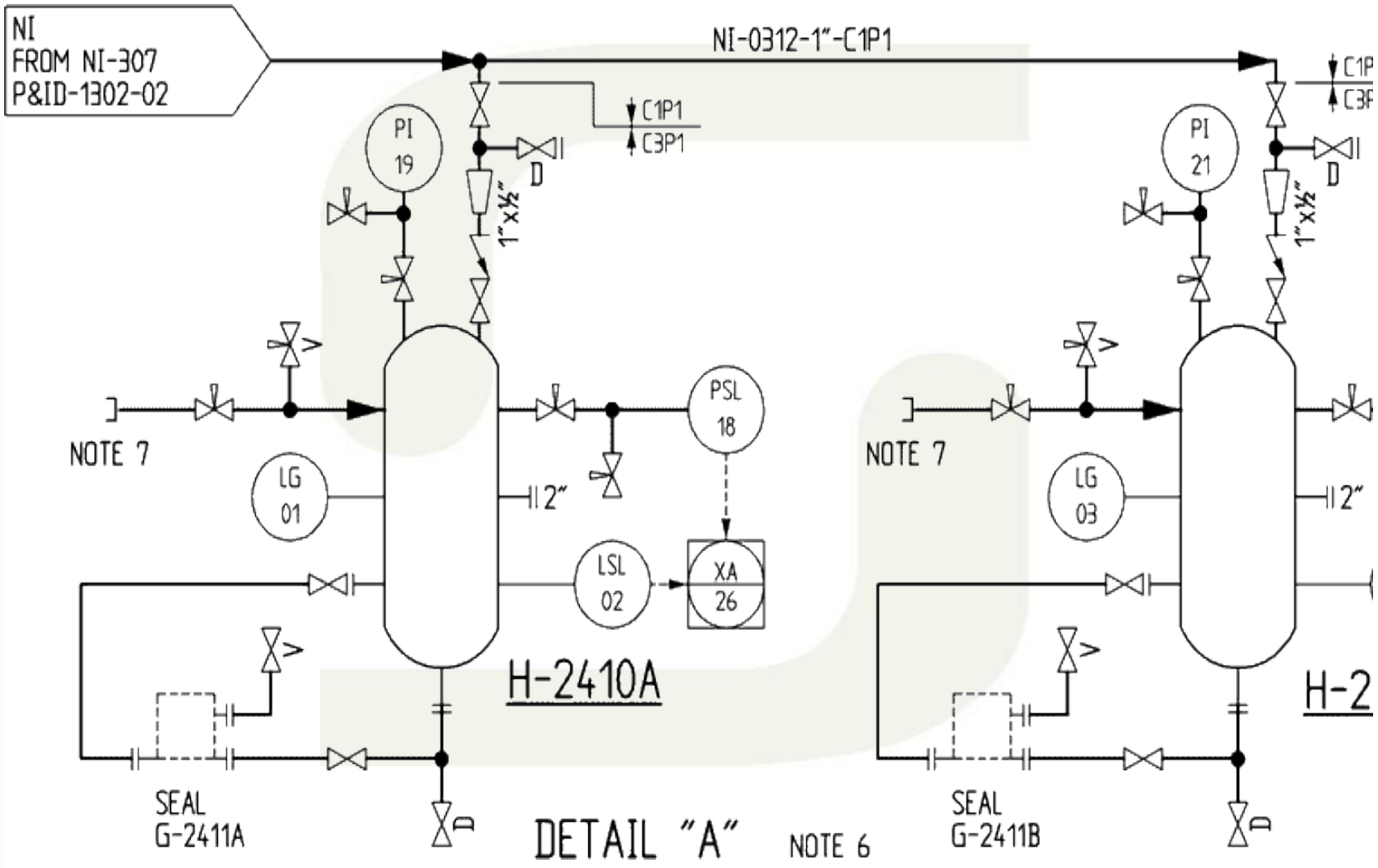
PIPING DRAWINGS – P&ID



PIPING DRAWINGS – P&ID

- Place equipment and its components
- Connect main piping
- Complete control valve loop
- Place other instrument and connect signals
- Indicate safety devices incl. alarm
- Place piping components (Valve/Fitting) as required
- Check detail and add items required incl. vent/drain connection

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Piping Engineering

General Arrangement Drawings

PIPING DRAWINGS – GAD

General Arrangement drawings

General Arrangement drawings for piping systems and equipments are developed by piping designers. These drawings indicate the locations of main equipments in the plant. The main piping items, valves, and fittings are also indicated in the General Arrangement or GA drawings. Most often the piping is indicated using a top-view. Sometimes a side view of the pipe rack is also presented on the GA drawing.

PIPING DRAWINGS – GAD

General arrangement drawings are also developed for individual equipments. These drawings present the main dimensions of that equipment using 2D views, top-view, side-view and sometimes front-view. All the nozzles for concerned equipment are indicated on the equipment General Arrangement or GA drawing.

For a green field engineering project, equipment location drawings are prepared at the proposal stage by piping designers. On commencing the project work, these drawings are used as first basis for development of piping layout

PIPING DRAWINGS – GAD

Depending on the feasibility of the piping layout arrangement, often the equipment locations are revised and updated. The changes to equipment location can sometimes be substantial in order to have the desired piping arrangement.

Thus piping layout arrangement and development of piping general arrangement or GA drawings is dependent on reference sources developed prior to the piping arrangement work and modifications required to those references to allow for the desired piping layout arrangement.

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PIPING GENERAL ARRANGEMENT DRAWING CHECK LIST

PIPING DRAWINGS – GAD CHECKLIST

- Title Block
- North Arrow Orientation.
- Match line Continuation.
- Line Continuation.
- Equipment Location To Grid.
- Equipment Nozzle Details (No., Size & Rating).
- Pipeline Location To Grid/Equipment. By Piping Or Valves).
- Structural Penetrations.
- Locations Of Item.
- Pipeline Elevations Shown.

PIPING DRAWINGS – GAD CHECKLIST

- Dimensional Completion.
- Valve Orientation. (is enough space provided for:)
- Electrical And Instrument Cable Trays And Junction Boxes.
- Erection Of Equipment.
- Tube Bundles.
- Maintenance Space (Including Choke And Safety Valves).
- Equipment Removal.
- Operating Space.
- Manway Clearance.
- Davit Dropping.

PIPING DRAWINGS – GAD CHECKLIST

- Overhead Clearance.
- Future Installation Area.
- Ducting And H.V.A.C. Equipment.
- Platforms And Walkways (I.E. Not Blocked By Piping Or Valves)
- Do Drawing Comply With Piping & Instrument Diagrams And Line List
- Direction Of Flow And Flow Arrows.
- Valve And Specialties In Each Line.
- Instrument Conn's In Lines And Equipment.
- Steam/Electric Tracing.

PIPING DRAWINGS – GAD CHECKLIST

- Insulation.
- Equipment Numbers And Titles.
- Completeness Of Lines.
- Pipeline Numbers.
- Instrument Tag Numbers.
- Valve Tag Numbers.

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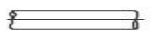
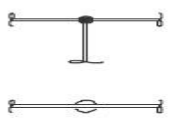
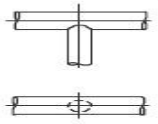
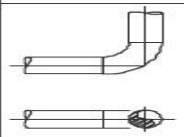
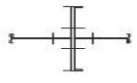
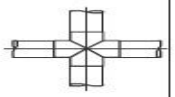
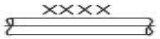
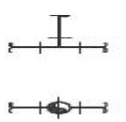
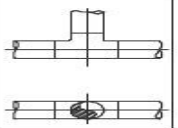
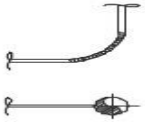
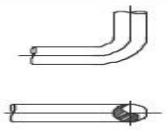
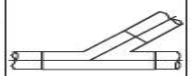
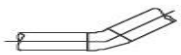
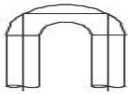
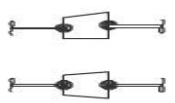
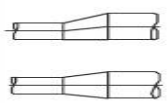
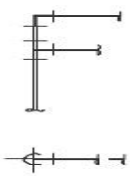
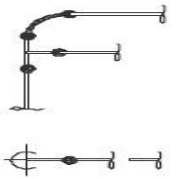
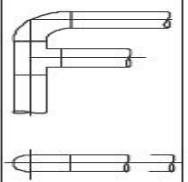
PIPING DRAWING GA SYMBOLS

PIPING DRAWINGS – GA SYMBOLS

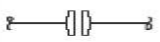
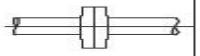
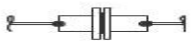
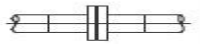
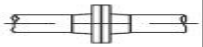
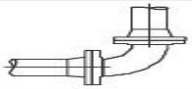
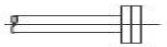
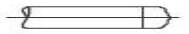
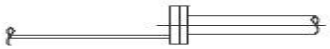
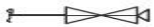
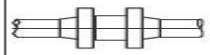
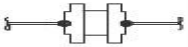
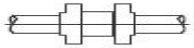
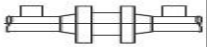
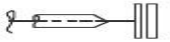
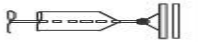
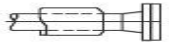
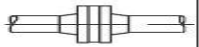
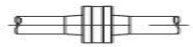
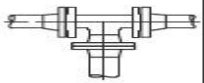
Piping Engineering

SCREWED SINGLE LINE	WELDED SINGLE LINE	WELDED DOUBLE LINE	DESIGNATION	SCREWED SINGLE LINE	WELDED SINGLE LINE	WELDED DOUBLE LINE	DESIGNATION
			PIPING				FLOW DIRECTION
			CONNECTION OF PIPE BRANCH TOP VIEW				ELBOW 90° TOP VIEW
			CROSS				LINE Nos.
			STRAIGHT TEE TOP VIEW				BENDING TOP VIEW
			45° Y BEND				ELBOW 45°
			CONCENTRIC REDUCER				180° RETURN
			ECCENTRIC REDUCER TOP VIEW				
			PIPING SUPER–POSITION TOP VIEW				

Continued

Seabird

Piping Engineering

SCREWED SINGLE LINE	WELDED SINGLE LINE	WELDED DOUBLE LINE	DESIGNATION	SCREWED SINGLE LINE	WELDED SINGLE LINE	WELDED DOUBLE LINE	DESIGNATION
			SLIP—ON RANGE				LAP—JOINT FLANGES
			FLANGE				UNION
			90° FLANGED ELBOW				COUPLING WELDED ON PIPE
			BLIND FLANGE				CAP
			REDUCING FLANGE				PLUG ON VALVE
			WELD—NECK ORIFICE FLANGE				CAP ON VALVE
			SLIP—ON ORIFICE FLANGE				HOSE COUPLING
			ORIFICE FLANGE FOR FLOW—METER PIPE TAPE				JACKETED LINE
			INTERMEDIATE FLANGE				SPADE
			FLANGED—TEE				END VIEW
			FLANGED 45° TEE				
			HEAVY—TEE				

Continued

Piping Engineering

GENERAL TERM	DESIGNATION	PIPE SUPPORT TYPE	DESIGNATION	
	BATTERY LIMIT		PLACED	PIPING ON SKID
	DRAWING LIMIT		GUIDED	
	DEVICE AXIS		ANCHORED	
	REFERENCE LINE		PLACED	PIPING WITHOUT SKID
A B	NUMBERS FOR REFERENCE LINES		GUIDED	
5	SPOOL NUMBER		ANCHORED	
ENGINEER OTHERS	SUPPLYING LIMIT			PIPING ON HOIST
C E	SPECIFICATION CHANGE			

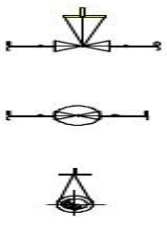
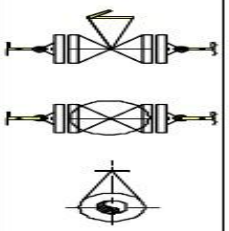
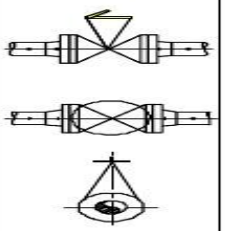
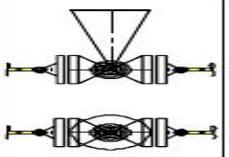
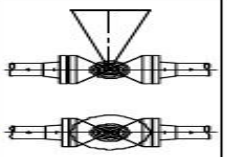
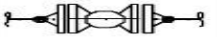
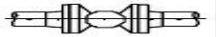
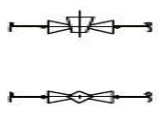
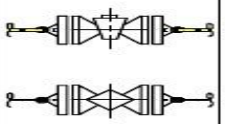
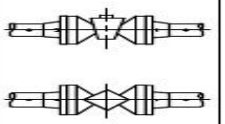
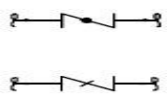
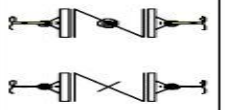
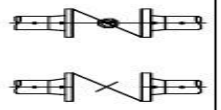
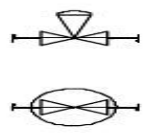
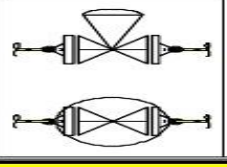
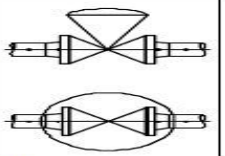
Continued

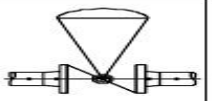
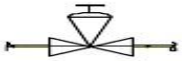
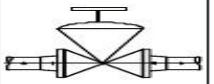
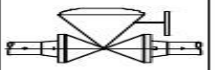
Piping Engineering

SCREWED	FLANGED ø < 10"	FLANGED ø < 10"	DESCRIPTION	SCREWED	FLANGED ø < 10"	FLANGED ø < 10"	DESCRIPTION
			SPECTACLE BLIND				SAFETY VALVE
			END VIEW OPENED				
	LOCATION FOLLOWING ROTATIONAL AXIS		CLOSED				END VIEW
			STRAINER				CHECK VALVE
			TRAP				CHAIN WHEEL VALVE
			SEPARATOR				EXTENSION STEM VALVE
			CHOKE				VALVE WITH BY PASS
			EJECTOR				BLOW-OFF VALVE
			EJECTOR WITH DIAPHRAGM				ANGLE VALVE
	M	M	MOTORIZE VALVE				END VIEW

Continued

Piping Engineering

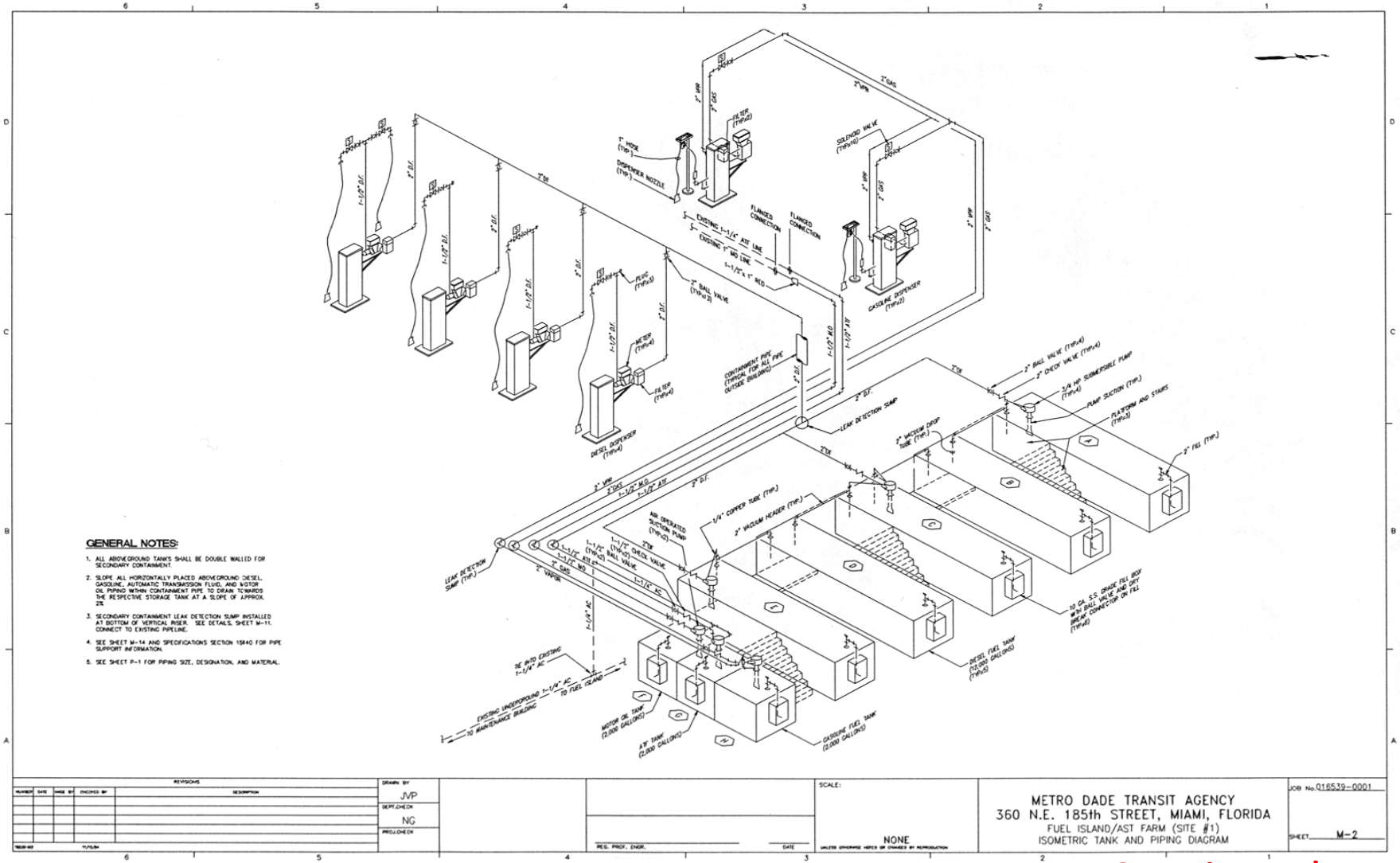
SCREWED	FLANGED ø < 10"	FLANGED ø < 10"	DESCRIPTION
			GATE VALVE TOP VIEW END VIEW
			GLOBE VALVE TOP VIEW
			BALL VALVE
			PLUG VALVE TOP VIEW
			BUTTERFLY VALVE TOP VIEW
			CONTROL VALVE WITH DIAPHRAGM TOP VIEW

SCREWED	FLANGED ø < 10"	FLANGED ø < 10"	DESCRIPTION
			BUTTERFLY CONTROL VALVE WITH DIAPHRAGM
			CONTROL VALVE WITH DIAPHRAGM & HAND CONTROL ON TOP
			ON SIDE
			CONTROL VALVE WITH POSITIONER
			HAND CONTROL VALVE
			PRESSURE REDUCING VALVE
			3 WAY CONTROL VALVE
	ø ≤ 6" 		NEEDLE VALVE

Continued

PIPING DRAWINGS – GAD

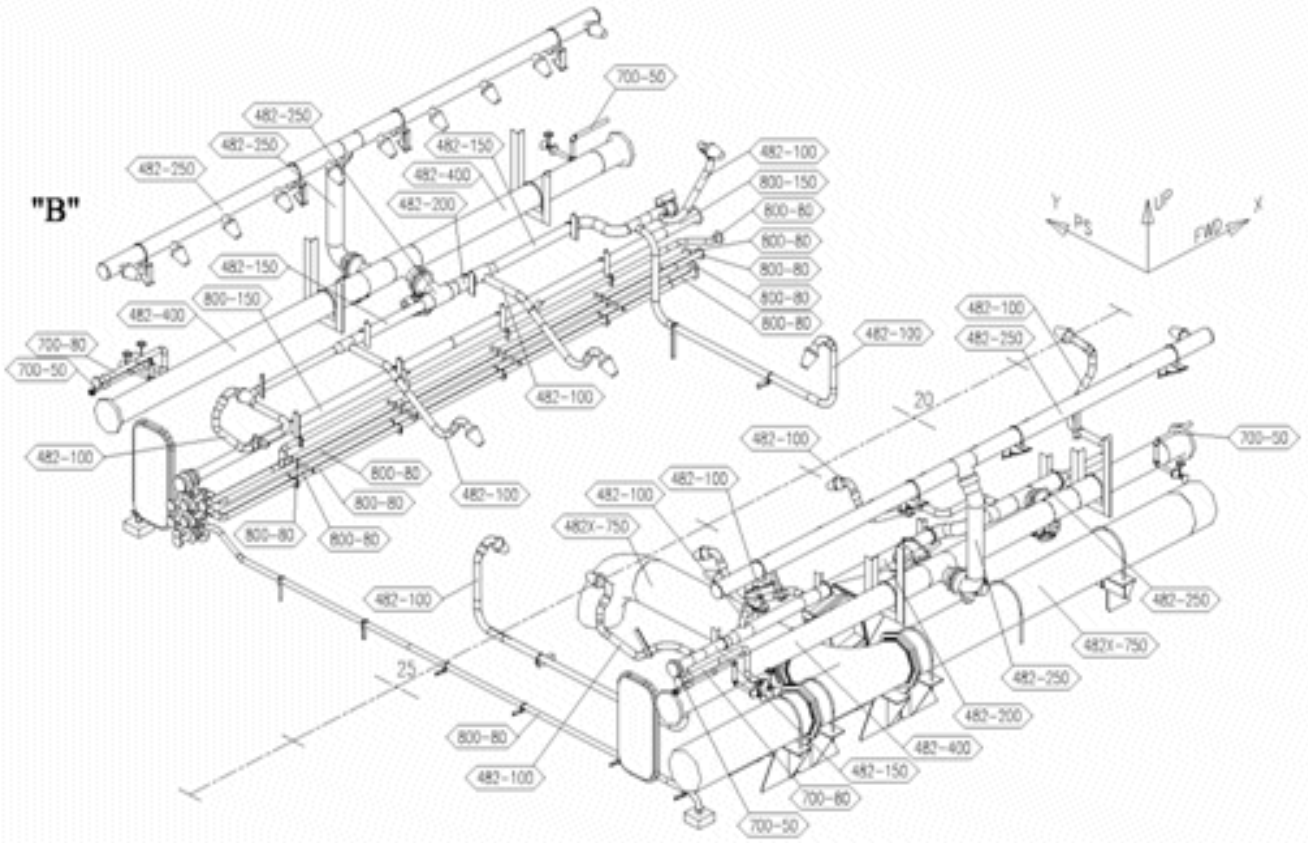
Piping Engineering



Continued

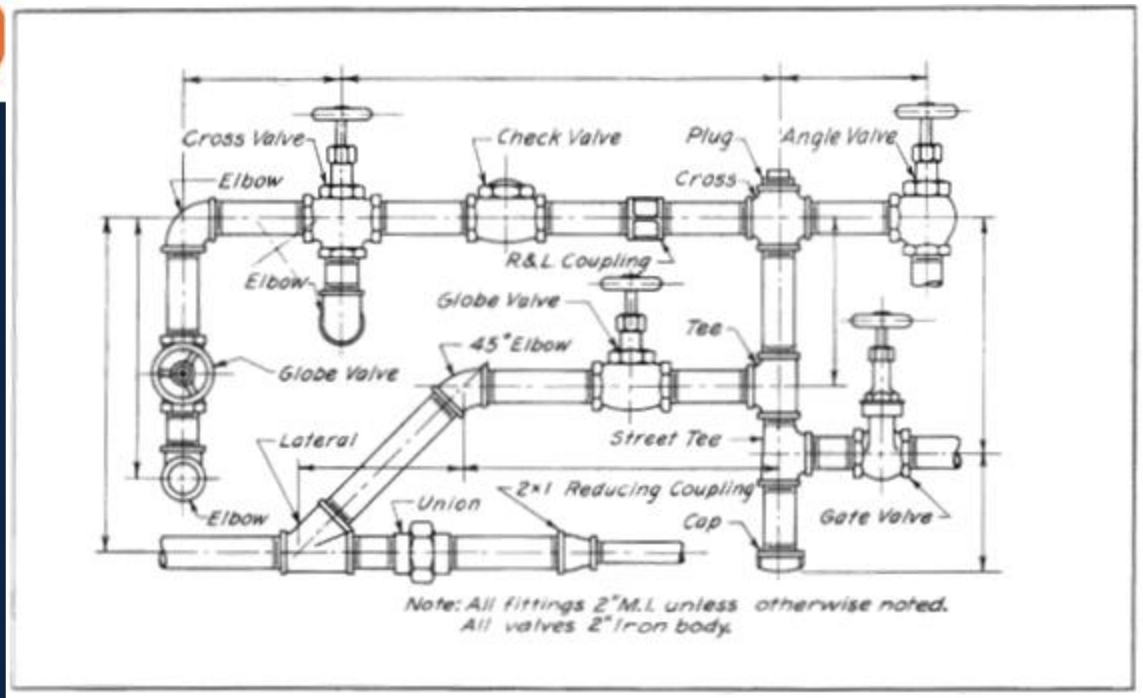
Piping Engineering

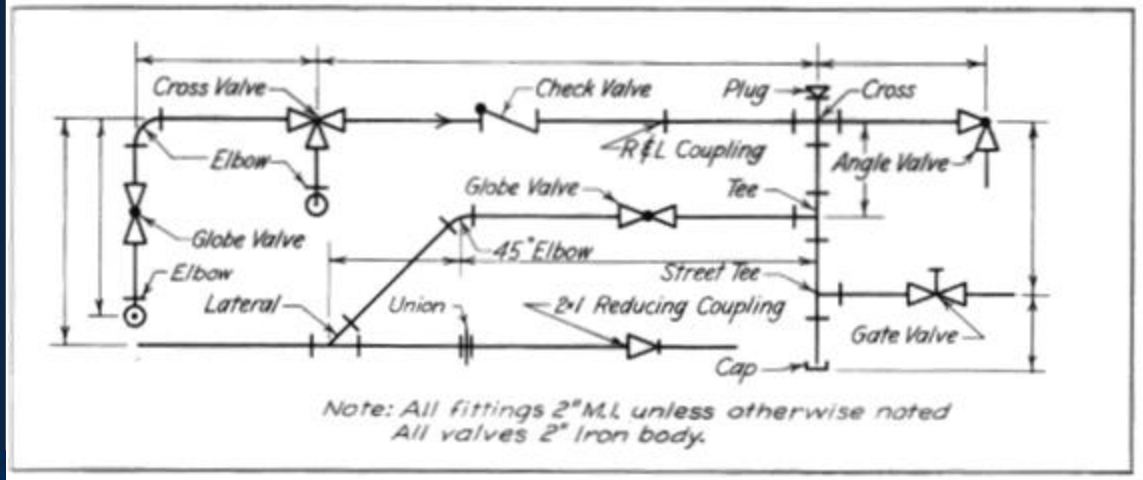
PERSPECTIVE VIEW
ALL SYSTEMS



StoGda

Continued


Cross Valve
Elbow
Check Valve
Plug
Cross
Angle Valve
R&L Coupling
Elbow
Globe Valve
45° Elbow
Tee
Globe Valve
Lateral
Street Tee
2×1 Reducing Coupling
Union
Elbow
Cap
Gate Valve
Note: All fittings 2" M.I. unless otherwise noted.
All valves 2" Iron body.


Cross Valve
Check Valve
Plug
Cross
Elbow
R&L Coupling
Angle Valve
Globe Valve
Tee
Globe Valve
45° Elbow
Elbow
Street Tee
Lateral
Union
2×1 Reducing Coupling
Gate Valve
Cap
Note: All fittings 2" M.I. unless otherwise noted
All valves 2" Iron body.

Piping Isometrics

PIPING DRAWINGS – ISOMETRIC

- An isometric drawing is a type of pictorial drawing in which three sides of an object can be seen in one view.
- It's popular within the process piping industry because it can be laid out and drawn with ease and portrays the object in a realistic view.
- Sometimes it is used in lieu of plans and elevations but typically it is used to supplement the plan drawings

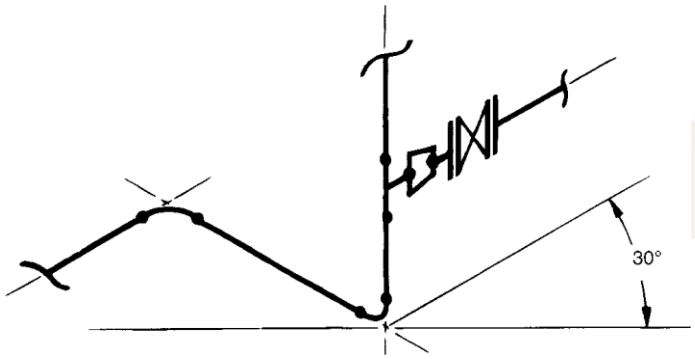
PIPING DRAWINGS – ISOMETRIC

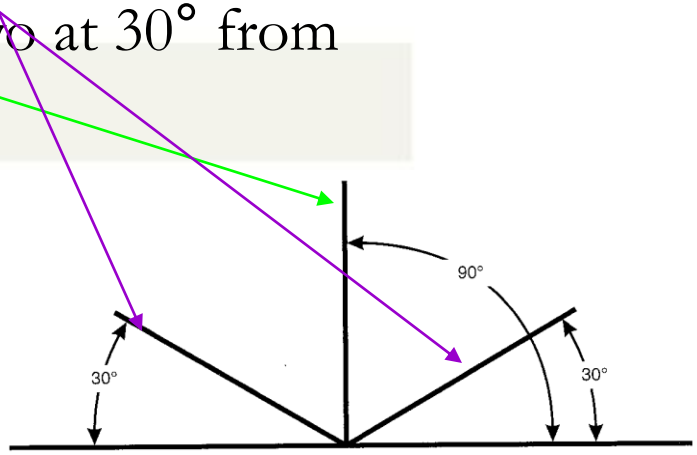
- Isometrics are used as fabrication & shop drawings for pipe run fabrication
- Isometrics also provide a drafter with the ability to calculate angular offsets in the pipe run.

PIPING DRAWINGS – ISOMETRIC LAYOUT

Isometric lines: one vertical & two at 30° from horizontal

- Isometric lines *can* be measured
- Non-isometric lines: lines NOT parallel to the isometric lines – these lines cannot be measured





Example of isometric axis

You will use the isometric axis on ALL of your isometric drawings!

In the example at left, note that all directions of the pipe match the three isometric axis lines

PIPING DRAWINGS – ISOMETRIC SCALE

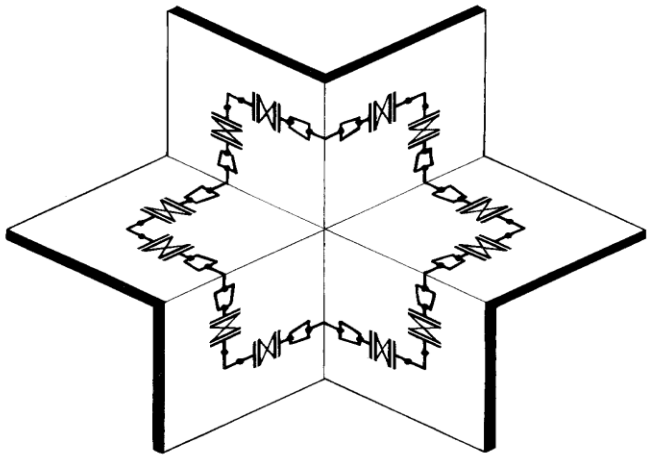
- isometrics are seldom drawn to scale
- however, pipe lengths should be shown proportionately
- many companies draw isometrics on B-size paper (11" x 17") which is a limited space so sometimes proportion may be sacrificed
- because of the lack of scale in an isometric, it's IMPORTANT that the written dimensions are accurate

PIPING DRAWINGS – ISOMETRIC DIRECTIONS

- location and direction help to properly orient the isometric drawing
- a north arrow give direction and should ALWAYS point to the upper-right corner of the paper
- structural reference points that provide location can be shown on isometric
  - dimensions MUST always be given to points of reference; such as structures, existing equipment…etc
- coordinates should also be shown on the isometric drawing

PIPING DRAWINGS – ISOMETRIC PLANES

- ✓ there are three planes that exist in isometric drawings
- ✓ with three planes, there are a number of ways for valves and fitting to be shown

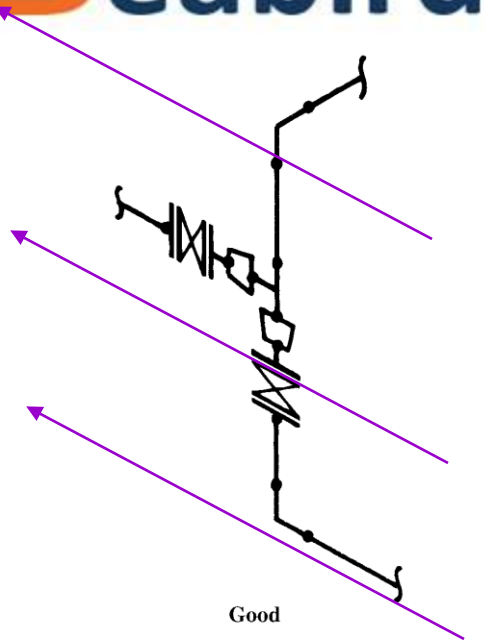


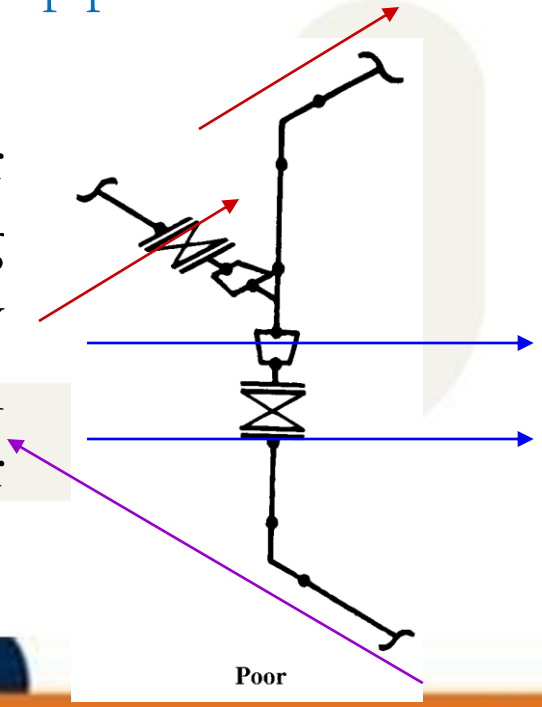
- ✓ the illustration shown above shows the planes and possible positions of fittings & valves
- ✓ remember that if pipes or features are parallel in the piping layout, they'll be parallel in the isometric view

Fitting symbols and orientation:

- when orienting fittings and valves it's important to know that there are **good** methods and poor methods in this orientation process
- the general rule for producing an isometric using GOOD techniques, is to draw the fittings so they are parallel to the last direction change or branch in the pipe

Notice how the flow of the isometric is continuous and provides a clear picture of the pipe run





Not following the "general rule" leads to a chaotic looking isometric … it doesn't look professional

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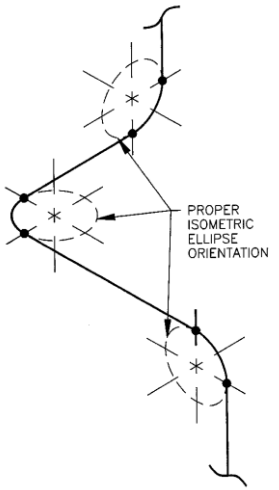
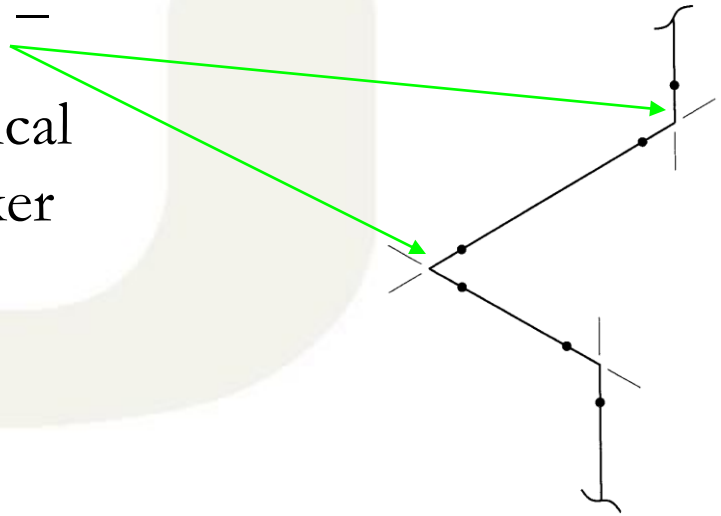
- fittings are drawn the same shape as they appear on the plan & elevation drawings EXCEPT they're at an isometric angle

- elbows can be drawn a couple of ways… check with company standards

- we will use square corner elbows –
  - ✓ not only is this the most typical method used, but it's also quicker to draw.



Curved Elbow Representation



Squared Elbow Representation

Connected piping:

- one run of pipe per isometric drawing
- branches of the pipe run or continuations are placed on other drawings … typically shown as short portion of dashed line on main pipe run
  - usually a note indicates he name or specification of the branch line
- existing piping is sometimes shown using double line method or dashed lines – in this class we will use dashed lines
  - either method is useful in that it distinguishes new pipe from existing piping

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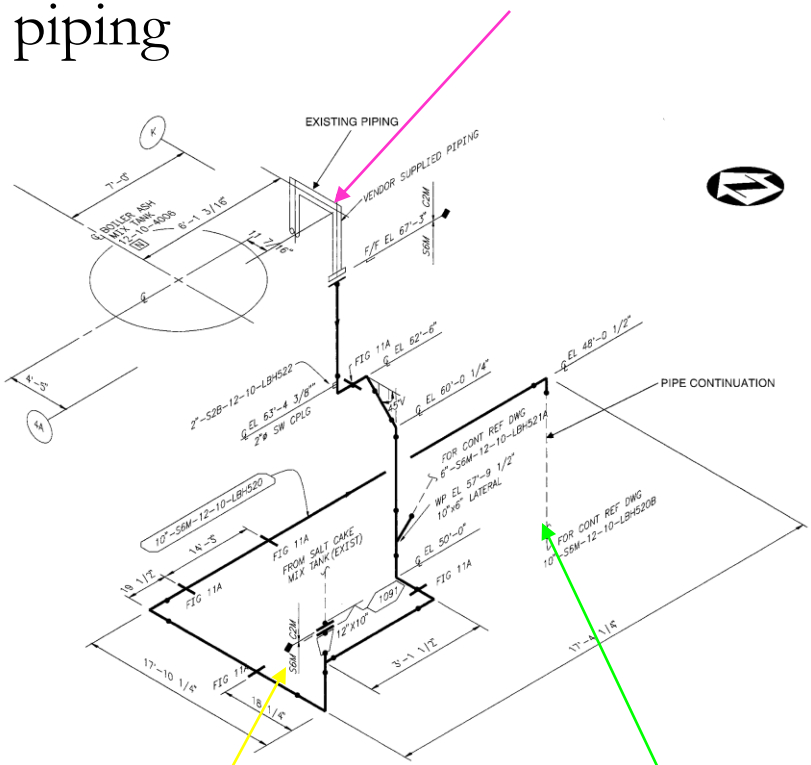
Example of double-line method showing existing piping



Notice spec change between "new" and existing pipe & note for reference drawing

Dashed line showing pipe continuation and note providing reference drawing information.

Isometric Drawing Techniques:

To increase drawing efficiency:

- Create a prototype for isometric drawings
  - set up grid, snap, isometric plane orientation, border and title block, BOM, text styles & dimension settings
- Develop library of isometric symbols
  - valves, fittings, instruments, equipment… common drawing components
- Create dimension styles in all three isometric planes
- Construct menus that you can pick symbols from

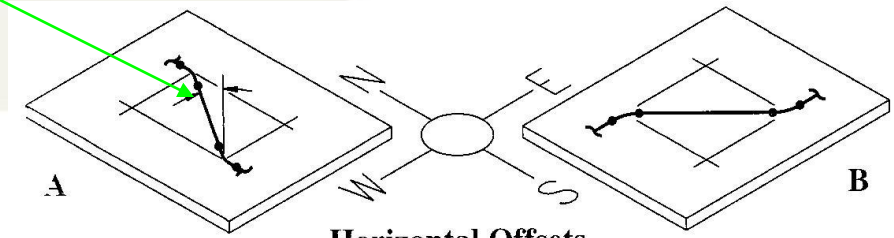
Drawing Isometric Offsets:

Offset:

- ✓ indicates that a piece of pipe is shifted from one line of direction to another
- ✓ is done with a fitting (typically a 45° elbow)
- ✓ one of the few times you might have "artistic license" in making a piping drawing

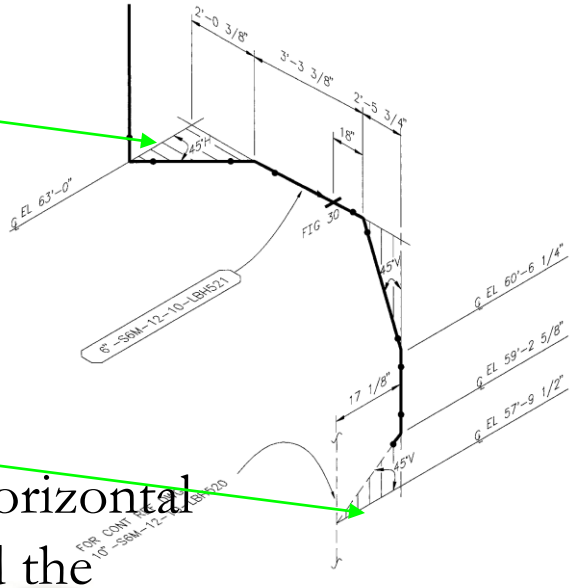
Horizontal offsets:

If you draw a horizontal pipe with a 45° elbow running form southeast to northwest technically correct, it would look like a vertical line… to prevent confusion, the offset is drawn 22 ½ ° from vertical to give the illusion of the angle.



Horizontal Offsets

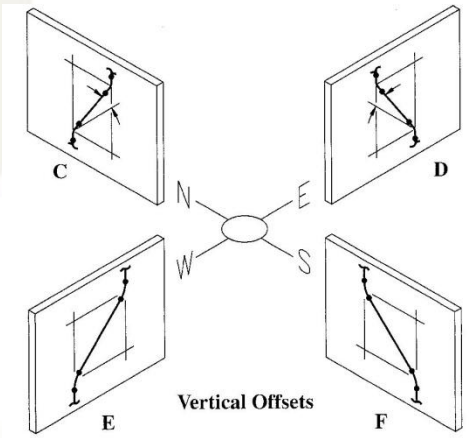
That's why many companies use a "squaring-in" plane within the plane of the offset



Vertical Offsets:

These offsets can get just as confusing as the horizontal offsets. Using the same techniques; 22 ½ ° and the "squaring – in" planes help remedy the visualization of these offsets as well.

FYI: As a drafter, you should always be aware of some of the confusing qualities inherent to isometric piping drawings and take measures to ensure the drawings are easily understood.



Calculating Isometric Offsets

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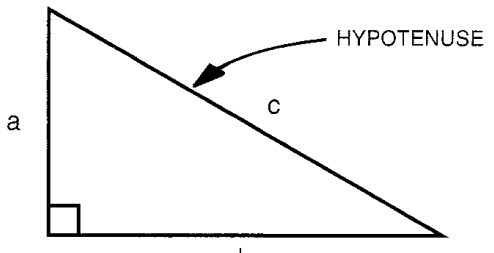
Although you can "get away" with an educated guess as to making an angular offset easy to see when laying out an isometric, you **can't** make a "guess-ti-mate" when it comes to determining pipe lengths and angles.

So, pull out the old calculator, paper, pencil & a BIG eraser and let's get started.

The "basic" calculations any pipe drafter uses are those involving trigonometry and right angles.



$$a = \sqrt{c^2 - b^2}$$
$$b = \sqrt{c^2 - a^2}$$
$$c = \sqrt{a^2 + b^2}$$

Pythagoras, a 6th century B.C. Greek philosopher, came up with a way to deal with calculations involving right angles… and it's called the… anyone? …. Anyone??? **Pythagorean Theorem**

Simply, what Pythagoras concluded was that when working with right angle triangles the square of the hypotenuse is equal to the sum of the squares of the two sides. $c^2 = a^2 + b^2$

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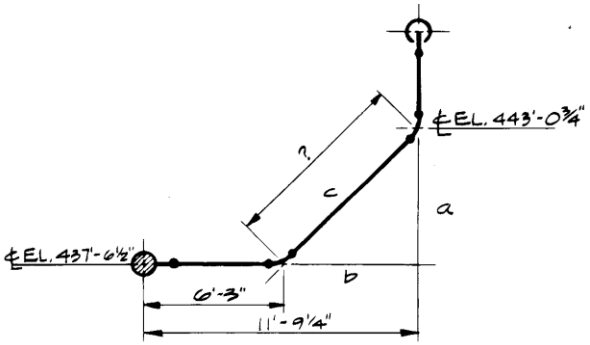
Example: Pythagorean Theorem

1. Start off with what's given or what you can determine from the pipe drawing itself.

   a) We are given an 45° angle rise, that clues us in on the fact that the two sides of our triangle are going to be the same length

   b) By doing simple subtraction, we can come up with the length for side B: 11'-9 ¼" – 6'-3" = 5'-6 ¼" OR you can subtract the elevations given and get the same dimension for side A.

   c) Since B = A: side A = 5' -6 ¼" as well.



BREAKING DOWN THE NUMBERS:

FYI: 5’ -6 ¼” = 5.0 ft.

6” = 6/12 = .5 in.

¼” = .25/12 = .0208 in.

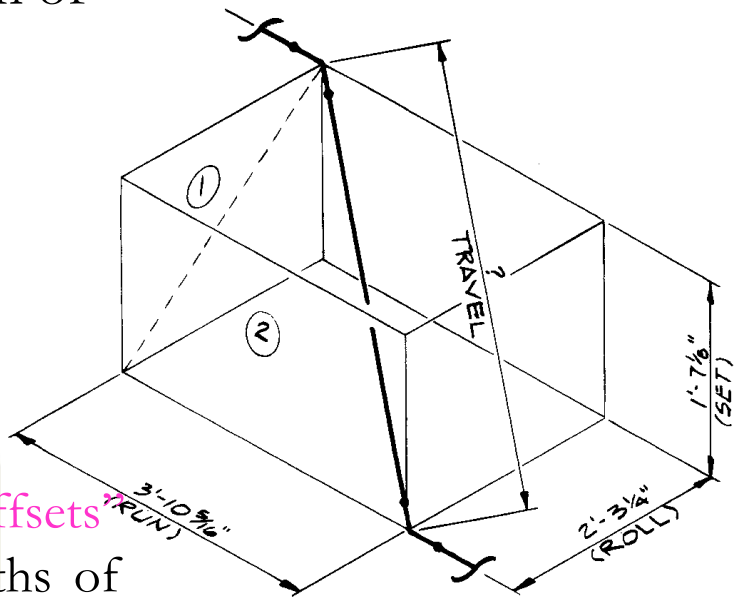
= 5.5208 ft.

Solving Compound Angles:

When piping has to be "snaked" through equipment, steel, conduit and other pipe, the pipe may be *rolled* along with the offset. This type of piping design is called a rolling offset and forms a compound angle.

Four terms associated with a rolling offset configuration:

- ✓ RUN: Length of total offset in direction of pipe run
- ✓ SET: Depth of offset
- ✓ ROLL: Breadth of offset
- ✓ TRAVEL: True length of pipe through offset



FYI: Separate tutorial "Working with Offsets" provides in depth detail of solving for lengths of pipe and angles… it'll come in handy with some assignments!

Isometric Dimensioning & Labeling

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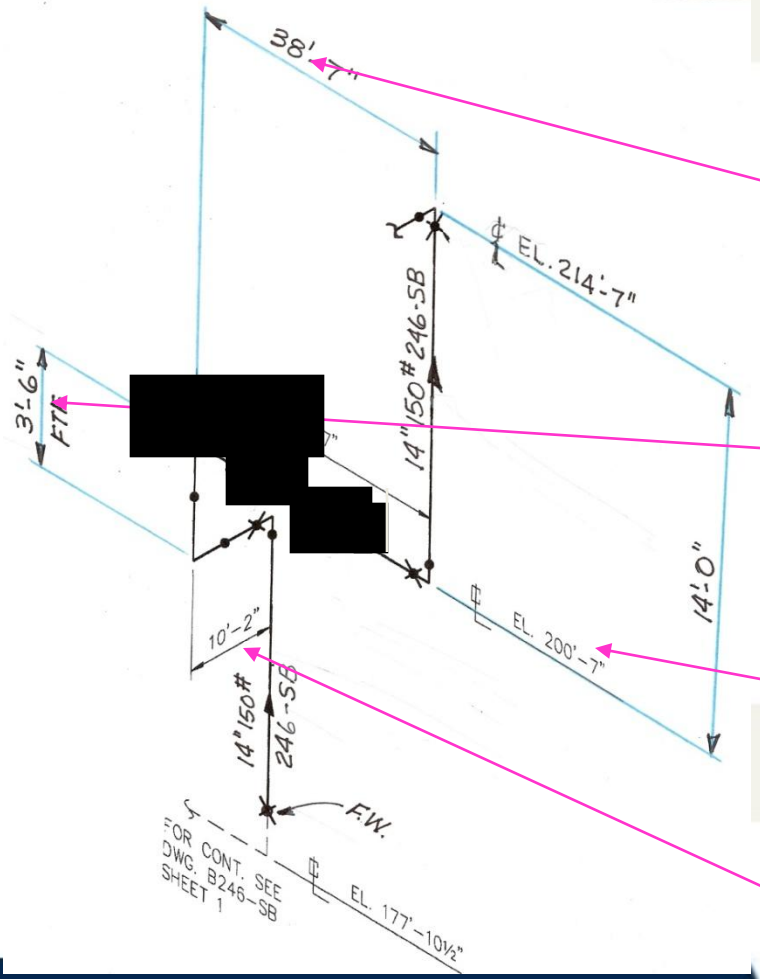
Piping Engineering

Two planes are used in dimensioning and labeling-horizontal and vertical.

DIMENSIONING PRACTICES:



1. Best way to dimension a pipe is to its centerline at the intersection point
2. Try to keep all dimensions outside the piping view when possible
3. Dimensions should ALWAYS be shown between points in the same plane
4. One of the extension lines of the dimension should be a centerline of the run of pipe
5. Vertical lines of text should always be parallel with extension lines

PIPING CLASS SHEETS

Piping class is an assembly of piping components, suitable for a defined service and design limits, in a piping system. Piping class sheets specify the material and code requirements for designated piping system pressure and temperature ratings.

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Sample Sheet

PIPE CLASS SHEET			
SIZE OF PIPE	2 1/2 INCHES TO 3 INCHES 65mm TO 80mm	3/4 INCHES TO 2 INCHES 20mm TO 50mm	1/4 INCHES TO 1/2 INCHES 8mm AND 15mm
SCHEDULE AND MATERIAL OF PIPE	SCHEDULE 40S SEAMLESS STAINLESS STEEL ASTM A312/A312M GRADE TP304		STAINLESS STEEL SEAMLESS TUBING ASTM A213/A213M GRADE TP304L, FULLY ANNEALED AND SUITABLE FOR BENDING, HARDNESS NOT GREATER THAN ROCKWELL B90 (B80 OR LESS PREFERRED), WALL THICKNESS 0.049 INCH
STOP VALVES	CLASS 150 STAINLESS STEEL ASTM A351/A351M GRADE CF8M BALL OR GLOBE VALVES		CLASS 800 STAINLESS STEEL ASTM A182 GRADE F316/F316L GLOBE VALVES, SOCKET WELDED
		CLASS 800 STAINLESS STEEL ASTM A182/182M GRADE F316/316L GLOBE VALVES AND CLASS 150 BALL VALVES, SOCKET WELDED	
CHECK VALVES	CLASS 150 STAINLESS STEEL ASTM A351/A351M GRADE CF8M SWING CHECK AND SPRING CHECK VALVE.		NOT REQUIRED
		CLASS 800 SOCKET WELDED STAINLESS STEEL ASTM A182/182M GRADE F316/316L SWING CHECK VALVE.	
FITTING	DIRECTIONAL CHANGES SHALL BE SCHEDULE 40S ASTM A312/312M GRADE TP304 5 DIAMETER PIPE BENDS BUTT WELDING. NON-PIPE BEND FITTINGS SHALL BE SCHEDULE 40S ASTM A403/403M GRADE WP304 BUTT WELDING		DIRECTIONAL CHANGES SHALL BE 5 DIAMETER BENDS. OTHER FITTINGS SHALL BE STAINLESS STEEL FLARELESS MECHANICAL GRIP-TYPE. FOR TAPERED THREADS INTO STAINLESS STEEL VALVES OR FITTINGS USE APPROVED THREAD LUBRICANT.
		CLASS 3000 ASTM A182/A182M GRADE F304 SOCKET WELDING	
TYPE OF PIPING JOINT	BUTT WELDING EXCEPT WHERE FLANGED JOINTS ARE SHOWN.		FLARELESS, MECHANICAL GRIP FITTING
		SOCKET WELDING	

PIPING DRAWINGS – VENDOR DRGS.

Drawings supplied by vendors will vary by manufacturer but generally provide:

- Outline drawings
- Material types
- Parts listing
- Weights and Centres of Gravity
- Field test requirements
- Operating pressures and temperatures and data (e.g. pump curves)
- Start-up, operating, and maintenance procedures

Technical Review of Vendor Documents

Project Engineering, in addition to its responsibility to review certain documents, shall be responsible for ensuring that the documents are sent to any and all disciplines which need to review vendor documents or need input from vendor documents.

Project Engineering shall ensure that all disciplines which are required to review the documents, have initialled the documents after review.

Each responsible project engineer shall familiarize himself with the requirements of all appendices to this procedure to ensure that all documents are routed to the correct departments.

Technical review of vendor documents shall ensure that:

- The vendor design is adequate for its purpose and complies with the latest issue of the Company requisition and the latest issue of the applicable Company documents and authority requirements mentioned therein;

- All information which Company requires to complete the work is given (including information required by disciplines not included in the routing);

- Instructions for erection, installation, commissioning, operation and maintenance cover the requirements as set out for these documents and are reviewed by the Specialist Engineer.

INSTRUMENT AND TUBING DRAWINGS

Design Engineering provides a standard set of drawings for the Mechanical Field Engineer to use in the installation process. The Piping/Mechanical Field Engineer will match the instrument category and service fluid and instruct the craft in which detail should be used. The standard usually will show routing, vents and drains, manifolds, bill of material and stock codes.

DATA SHEET

Data Sheet

Data sheet describes technical requirements for the design, manufacturing, assembling, product inspection, installation and testing of mechanical equipment.

DATA SHEET

VERTICAL CENTRIFUGAL PUMPS FOR WATER SERVICE (U.S. CUSTOMARY UNITS)

ISSUED FOR: PROPOSAL PURCHASE AS BUILT

FACILITY NAME/LOCATION:

ITEM NAME:
ITEM TAG NO.:
SERVICE:
UNIT:
P&ID NO.:

PURCHASER/LOCATION:
JOB NO:
PURCHASER ORDER NO.:
SUPPLIER/LOCATION:
SUPPLIER ORDER/SERIAL NOS.: /

DATA PROVIDED BY: ● PURCHASER ■ SUPPLIER ◆ SUPPLIER IF NOT BY PURCHASER

PURCHASERS REFERENCES

■ PUMP MFR:
■ SIZE & TYPE:
■ SERIAL NO.:
● DRIVER TYPE:
● THIS DATA SHEET COVERS: PUMP(S)
● PUMP MARK NO(S).: *change mark to asset*
● PUMPS OF IDENTICAL TYPE AND SIZE IN OPERATION:
● DRIVER DATA SHEET:
● GEAR UNIT DATA SHEET:
● LUBE OIL SYSTEM DATA SHEET:

DESIGN OPERATING DATA

● **SERVICE**
CONTINUOUS INTERMITTENT STANDBY
ATTENDED UNATTENDED
PUMP FUNCTION:
INDIVIDUALLY IN SERIES IN PARALLEL
UPSTREAM OF PUMP NO(S).
DOWNSTREAM OF PUMP NO(S).

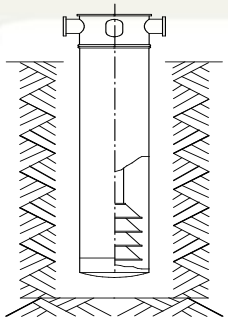
● **LIQUID CHARACTERISTICS**
LIQUID PUMPED: TDS: PPM
NORMAL FLOW TEMPERATURE: °F
MAX. FLOW TEMPERATURE: °F
RELATIVE DENSITY AT NORMAL FLOW TEMP.: *change to Specfic Gravity*
VISCOSITY AT FLOW TEMPERATURE: CS/CP/SSU
VAPOR PRESSURE AT NORMAL FLOW TEMP.: PSIA
VAPOR PRESSURE AT MAXIMUM FLOW TEMP.: PSIA
TSS: NONE PPM UNKNOWN
CHARACTER OF SOLIDS: PULPY GRITTY HARD SOFT
GAS IN FLUID: NONE VOL. % UNKNOWN
PRINCIPAL CORROSIVES:
PH: CL: PPM

● **RATED OPERATING CONDITIONS**
RATED CAPACITY: USGPM
TOTAL DIFFERENTIAL HEAD: FT
VISCOSITY CORRECTION FACTORS C_Q; C_H; C_E:
SUCTION SYSTEM: CLOSED OPEN
FOR CLOSED SUCTION SYSTEMS: ENTER DATA ON FIG. 1
NPSH AVAILABLE AT SUCTION FLG.:
AT RATED CAPACITY: FT
AT 120% OF RATED CAPACITY: FT
RATED SUCTION PRESSURE: PSIA
MAX. SUCT. PR. AT RATED CAP: PSIA
MAX. SUCT. PR. AT SHUT OFF: PSIA
RATED DISCHARGE PRESSURE: PSIA
MAX. DISCH. PR. AT RATED CAP.: PSIA
FOR OPEN SUCTION SYSTEMS: ENTER DATA ON FIG. 2
RATED DISCHARGE PRESSURE: PSIA

● **SITE CONDITIONS**
INDOOR OUTDOOR UNDER ROOF
ONSHORE COASTAL OFFSHORE
ELECTRICAL AREA CLASS: DIV GROUP

DESIGN OPERATING/INSTALLATION DATA

FIGURE 1 CLOSED SUCTION SYSTEM



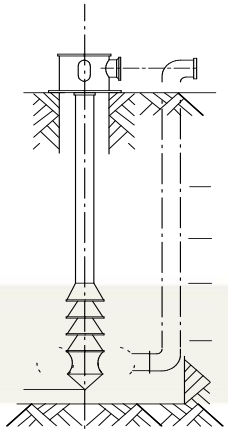
AT NOZZLES CL:
■ TOTAL SUCTION HEAD: FT
■ TOTAL DIFF. HEAD: FT
■ TOTAL DISCH. HEAD: FT

■ NOZZLE CL ABOVE DATUM: FT
● DATUM ELEVATION: FT
● NPSHA AT DATUM: FT

■ BARREL WALL THICKN: IN
■ BARREL OD: IN
■ BARREL LENGTH: IN
■ CL 1ST STAGE IMPELLER TO CL SUCTION NOZZLE: FT

● MOUNTED ON:
CONCRETE
STRUCTURAL STEEL

FIGURE 2 OPEN SUCTION SYSTEM



● TYPE:
CONCENTRIC RISER COLUMN
SIDE DISCHARGE PIPE

■ NOZZLE CL ABOVE DATUM: FT
■ DATUM ELEVATION: FT

● STATIC LEVEL: FT
● PUMPING LEVEL: FT
■ MIN. LIQUID LEVEL: FT
■ CL FIRST STAGE: FT
● BOTTOM OF SUMP/TANK: FT

● MOUNTED ON:
CONCRETE
STRUCTURAL STEEL

NO.	DATE	REVISION DESCRIPTION	BY	APVD.

Piping Computer Aided Design

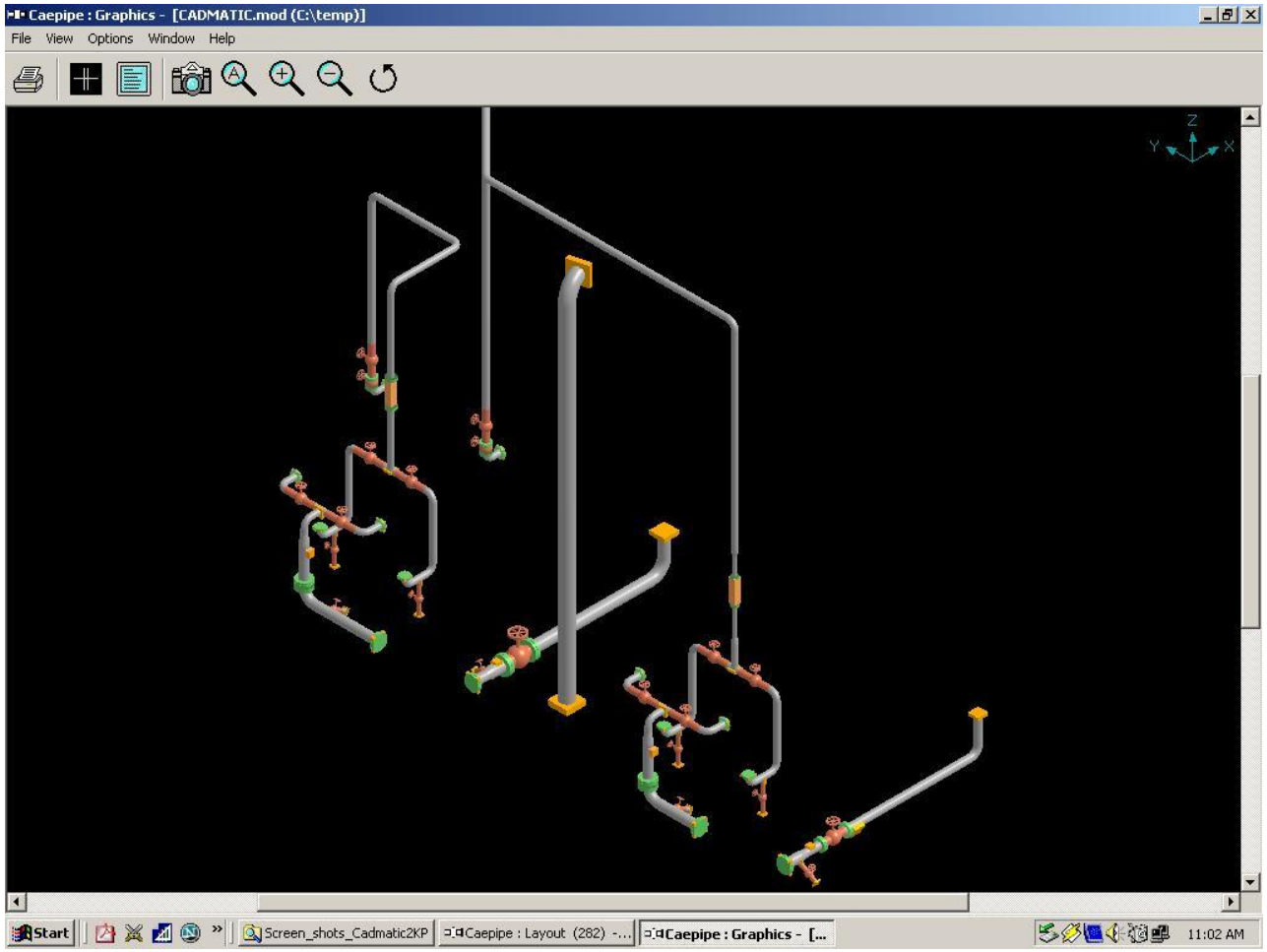
"Piping" sometimes refers to Piping Design, the detailed specification of the physical piping layout within a process plant or commercial building. In earlier days, this was sometimes called Drafting, Technical drawing, Engineering Drawing, and Design but is today commonly performed by Designers who have learned to use automated Computer Aided Drawing / Computer Aided Design (CAD) software as given below.

Piping Computer Aided Design – CAE PIPE

CAEPIPE is the preferred piping stress analysis program to model and analyze statically and dynamically the effects of weight, temperature, pressure, earthquake, time varying and harmonic loads, among others, on piping systems of any complexity in energy, petrochemical, aerospace, and related industries. Program also checks for piping code and guideline compliance (ASME, B31, International, API, NEMA). CAEPIPE can import and export data from major plant design systems

Piping Engineering

Piping Computer Aided Design – CAE PIPE



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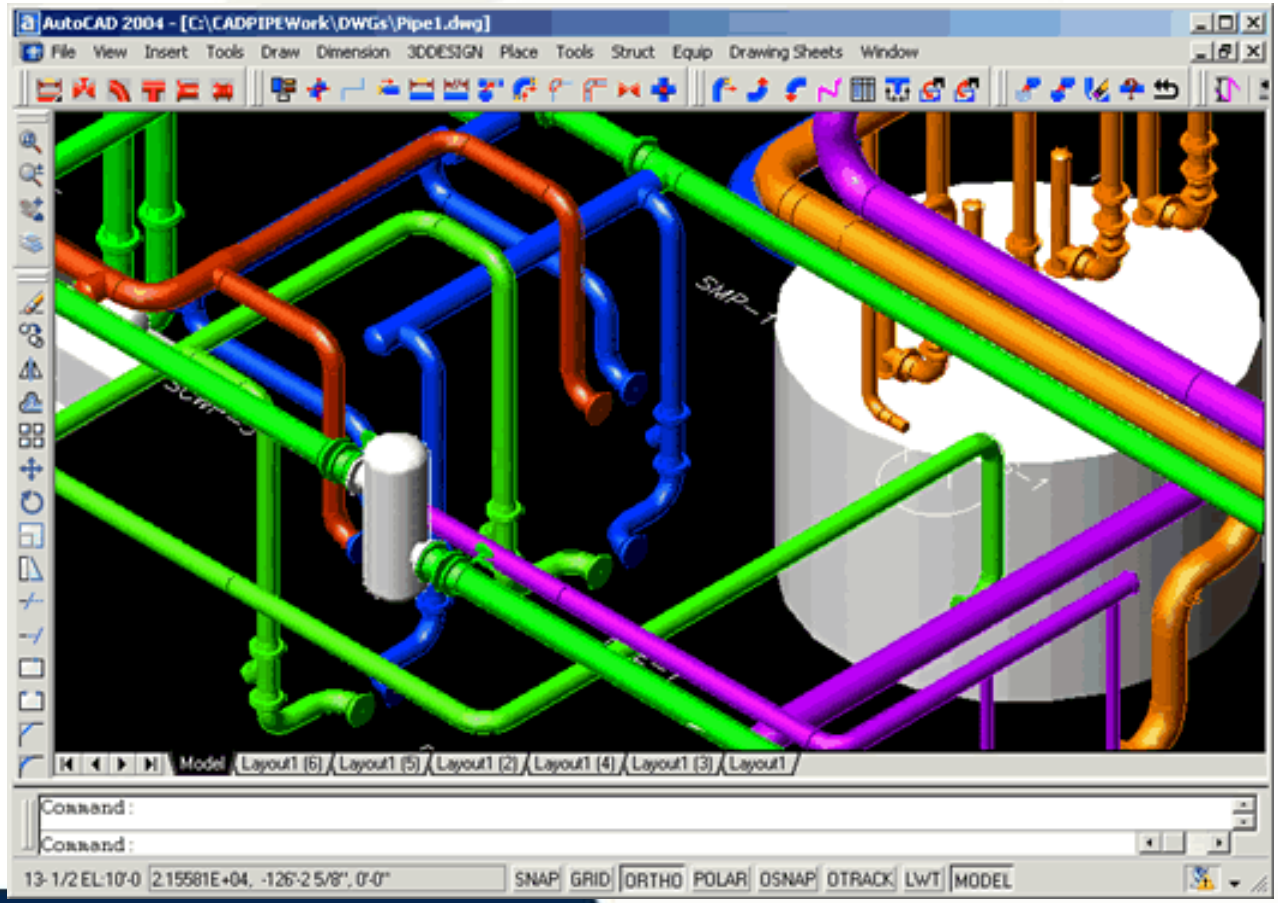
Piping Computer Aided Design – CADPIPE

Design Group develops and distributes AutoCAD-based software called CADPIPE for the Process Piping, Commercial Piping, HVAC, and steel construction industries



Piping Computer Aided Design – AUTOPIPE Stress Analysis

AutoPIPE is a native Windows based program working in a 'CAD-Like' environment in which users can click on the actual pipe model graphics to perform modeling tasks. AutoPIPE combines object-oriented graphics technology with advanced analytical capabilities not found in other programs to provide a truly unique tool for piping analysis and design. Integration is seamless with all major CAD programs AutoPLANT, PlantSpace, PDS and PDM.

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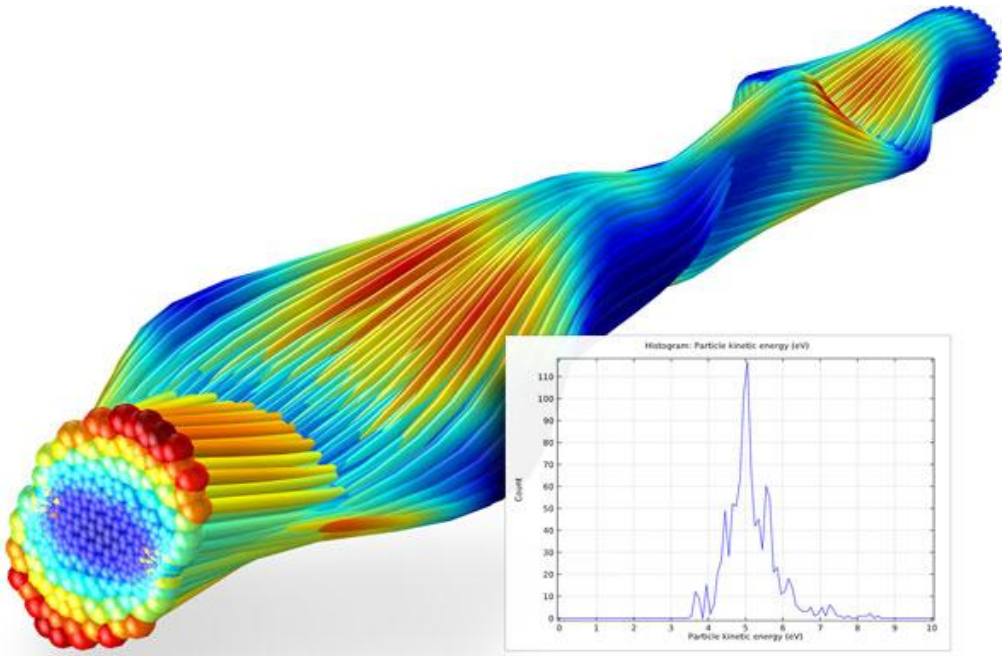
Visualisation of Fluid Flow

ViziFlow Innovative, low cost software dedicated to fluid flow modeling, streamline and pressure visualization and measurement. Streamlines and pressure distribution can be simulated and measured for pipes and aerofoils.

Design Flow Solutions

Design Flow Solutions is a must for the engineering professional who needs fast reliable reference information or solutions to fluid flow problem.



Piping Computer Aided Design – CAESAR II

CAESAR II is the Pipe Stress Analysis standard against which all others are measured and compared. The CAESAR II spreadsheet input technique revolutionized the way piping models are built, modified, and verified.

CAESAR II was the first pipe stress program specifically designed for the PC environment. The interactive capabilities permit rapid evaluation of both input and output, thereby melding seamlessly into the "design - analyze" iteration cycle.

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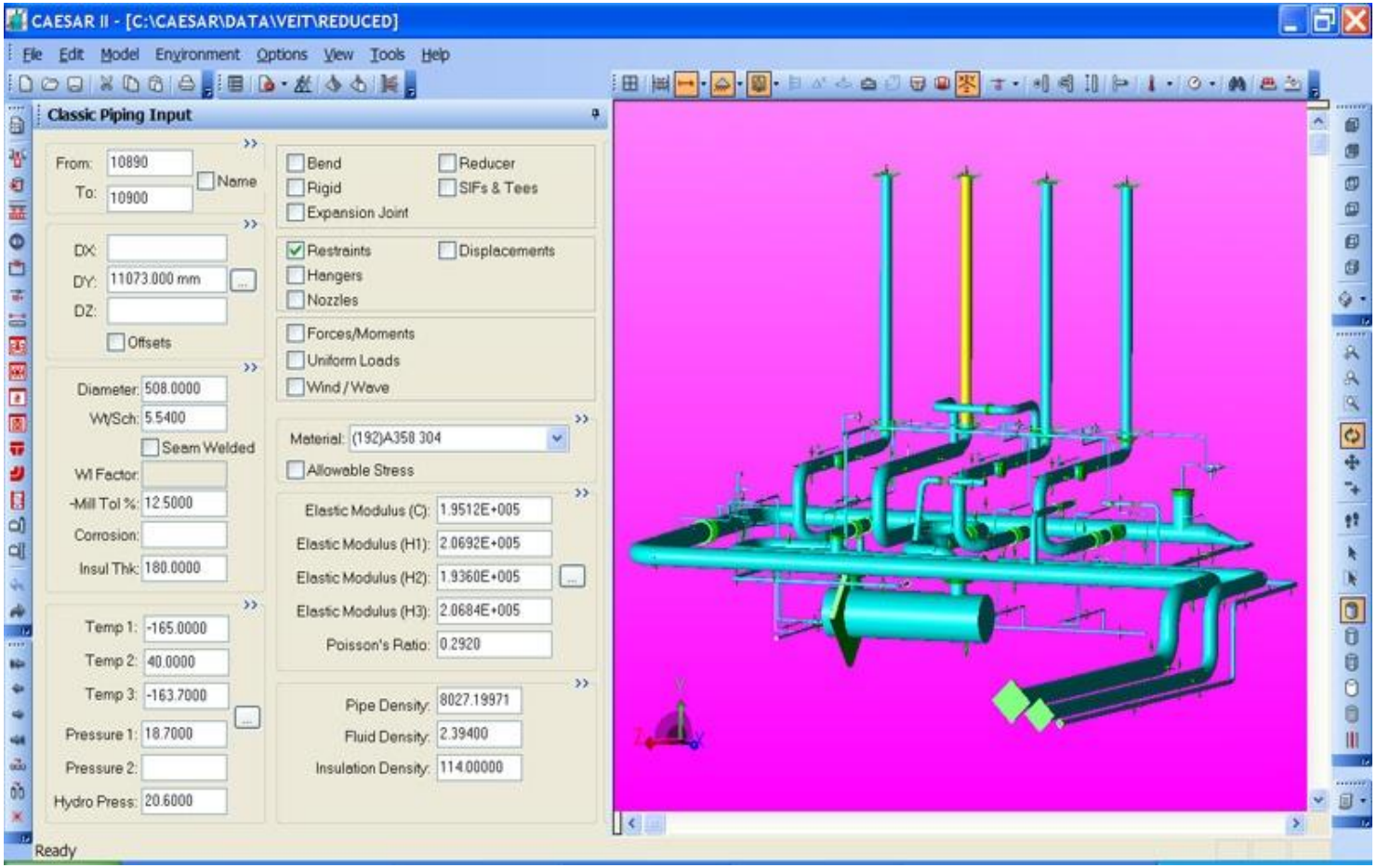
Piping Computer Aided Design – CAE PIPE



Piping Computer Aided Design – PDMS

PDMS (Plant Design management System)

PDMS as it is known in the 3D CAD industry, is a customizable, multi-user and multi-discipline, engineer controlled design software package for engineering, design and construction projects in, but not limited to, offshore and onshore oil & gas industry, chemical & process plants, mining, pharmaceutical & food industry, power generation and paper industries.

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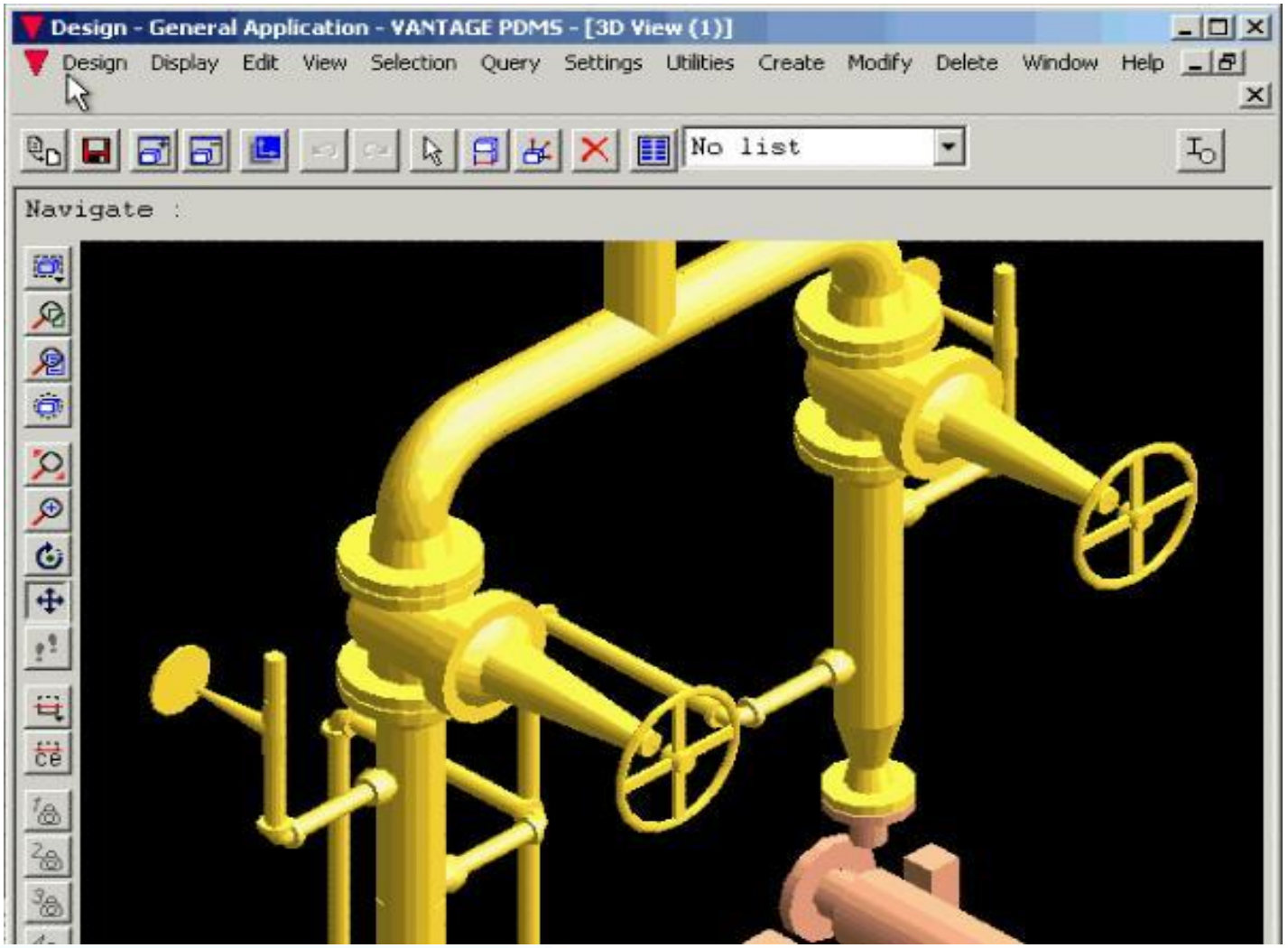
Piping Computer Aided Design – PDMS



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END OF SLIDE

THANK YOU