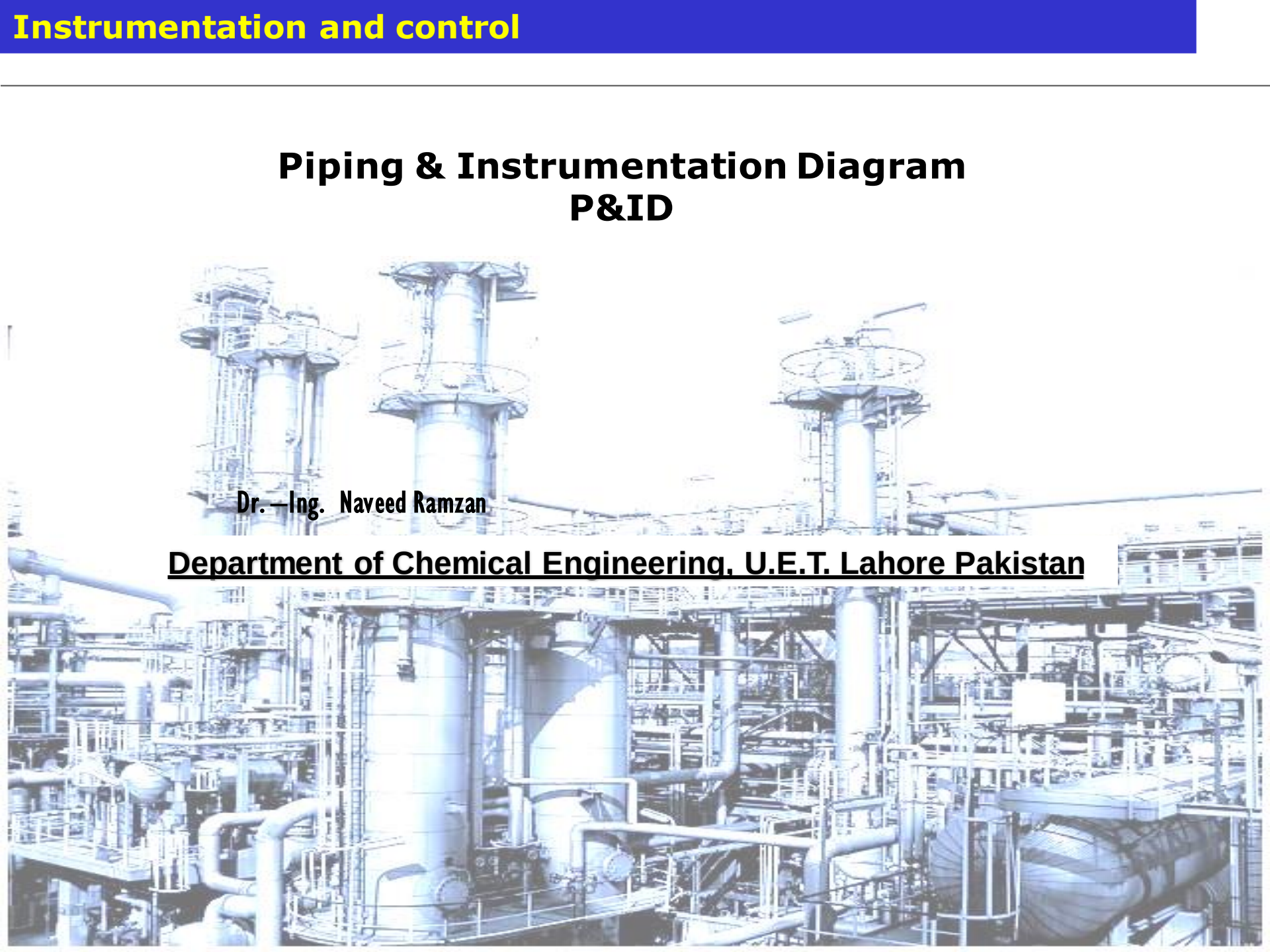


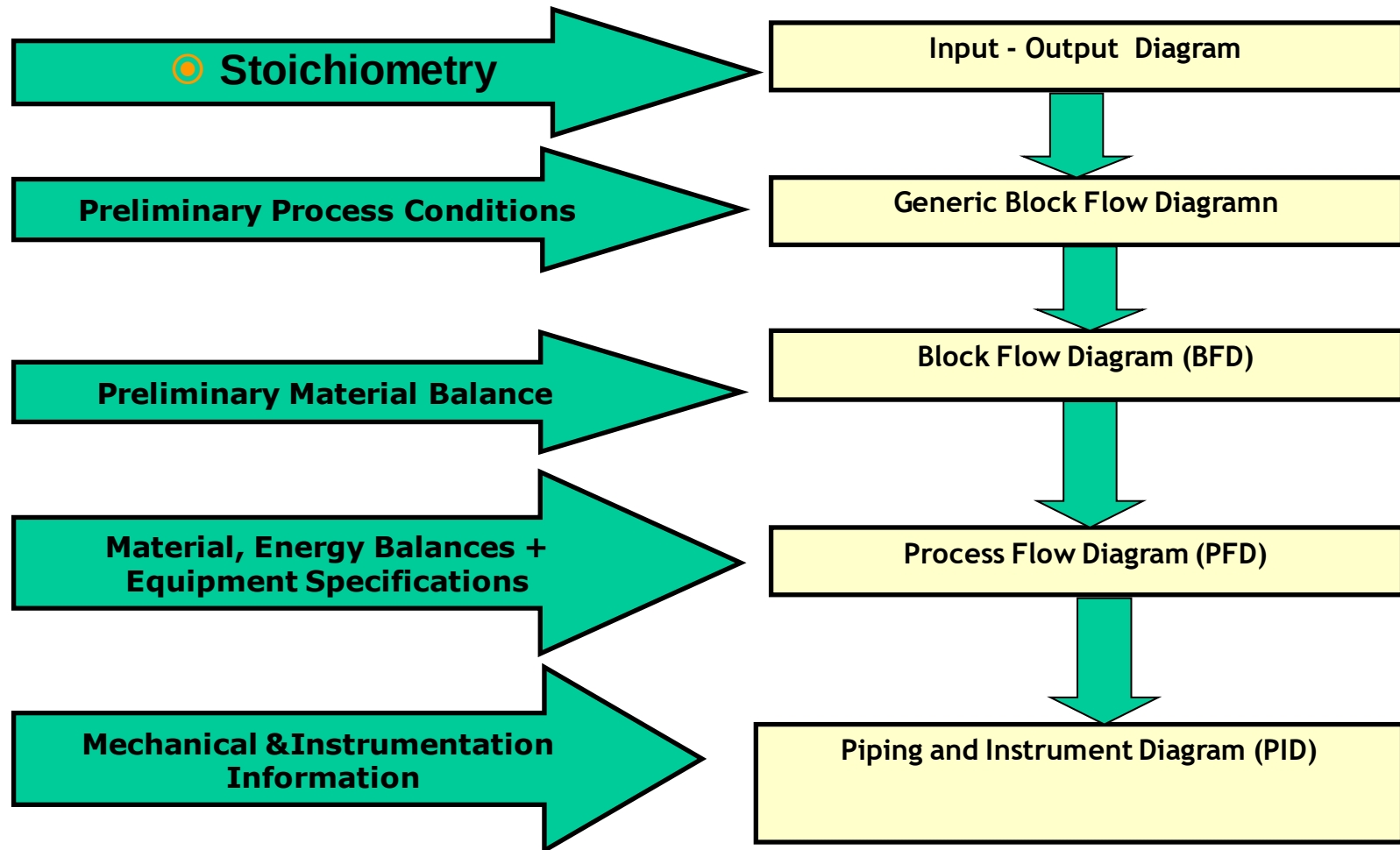
Piping & Instrumentation Diagram P&ID



Dr.—Ing. Naveed Ramzan

Department of Chemical Engineering, U.E.T. Lahore Pakistan

Sequence of process design



P&ID ----- Piping and Instrumentation Diagram



is the bird's eye view of the plant that compiles the results of its basic design

- ✓ **Communication tool**
- ✓ **A record to assist memory**
- ✓ **Extension of the flow diagram**

Block flow diagram



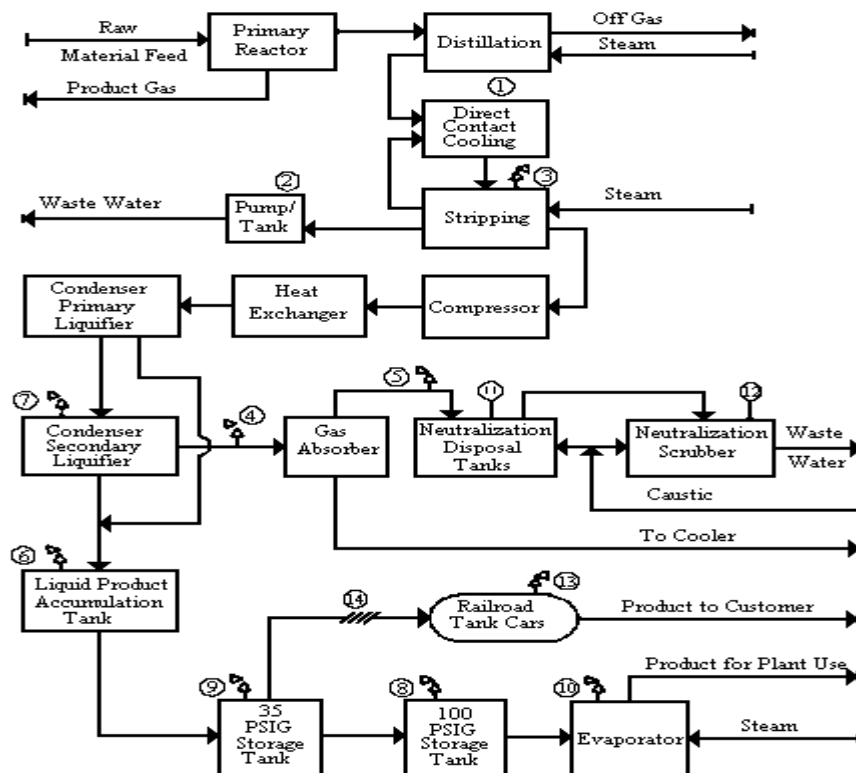
Process flow diagram



P&ID

Block Flow Diagram

The block or rectangles represents unit operations and the blocks are connected by lines representing the process flow streams

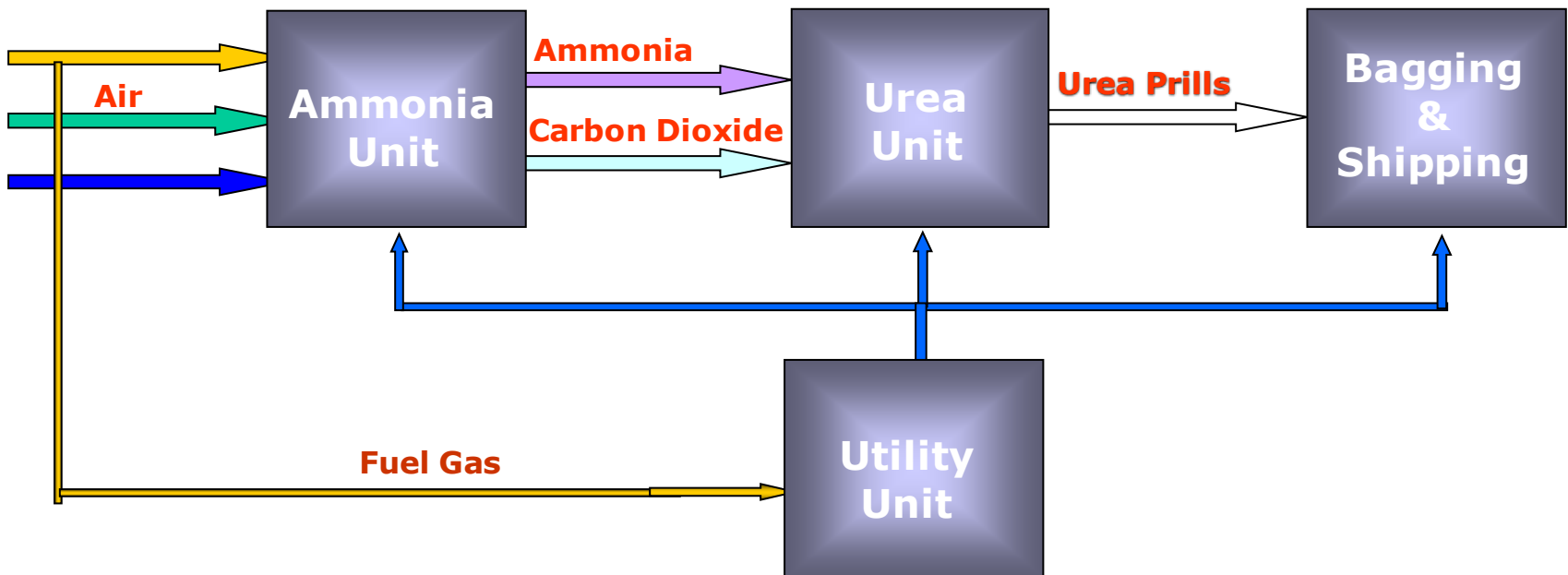


- ✓ Focus on process sequence
- ✓ Mass balance requirements

Block flow diagram

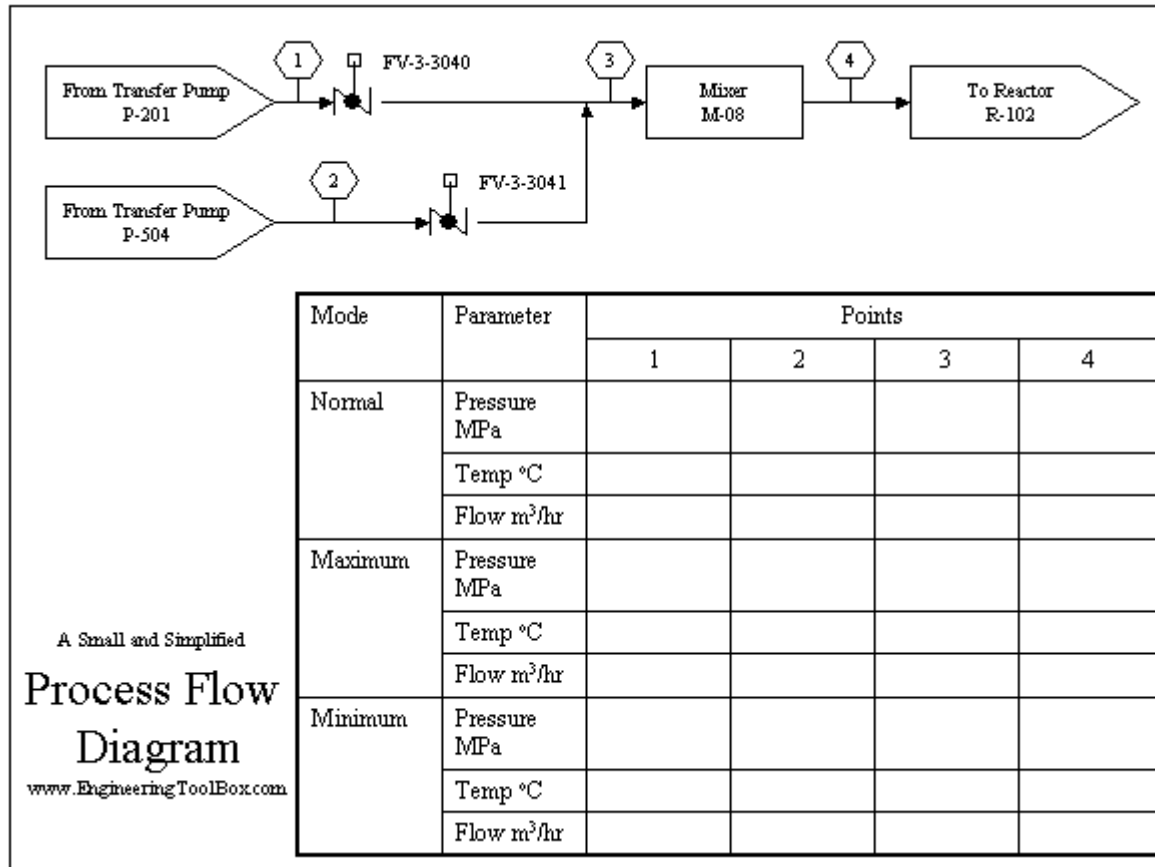
It consists of simple block elements that are connected with an arrow. It describes following information's,

- Each block represents a process function which in reality may consist of several pieces of equipment.
 - Gives a clear overview uncluttered by details.
 - Effective for conceptualizing a new process or a PFD.
 - Major flow lines shown with arrows giving direction of flow.
 - Flow goes from left to right whenever possible.
 - Light streams (gases, vapors) move towards top and heavy streams (solid, liquid) go towards bottom.
 - If lines cross each other then, horizontal line is continuous and vertical line is broken.
 - Provides preliminary material balance.
-



Process Flow Diagram or Flow Sheet

- ✓ Relationships between the major components in the system
- ✓ Tabulate process design values for the components



Process flow diagram

It is a diagram of fluid flow system showing the equipment items connected by major process pipes and containing data on essential process control circuits or major process requirements. It would include following details.

- ⦿ Process piping
- ⦿ Major equipment names
- ⦿ Major equipment numbers
- ⦿ Major equipment identification numbers
- ⦿ Control valves
- ⦿ Interconnection with other system
- ⦿ Major bypass and circulation lines
- ⦿ System rating and operational values as maximum, minimum and normal flow

Continued.....

- Process parameters i.e. temperature and pressure

- Composition of fluids

A process flow diagram does not following details,

- Pipe class

- Pipe line number

- Maintenance vents and drains

- Relief and safety valves

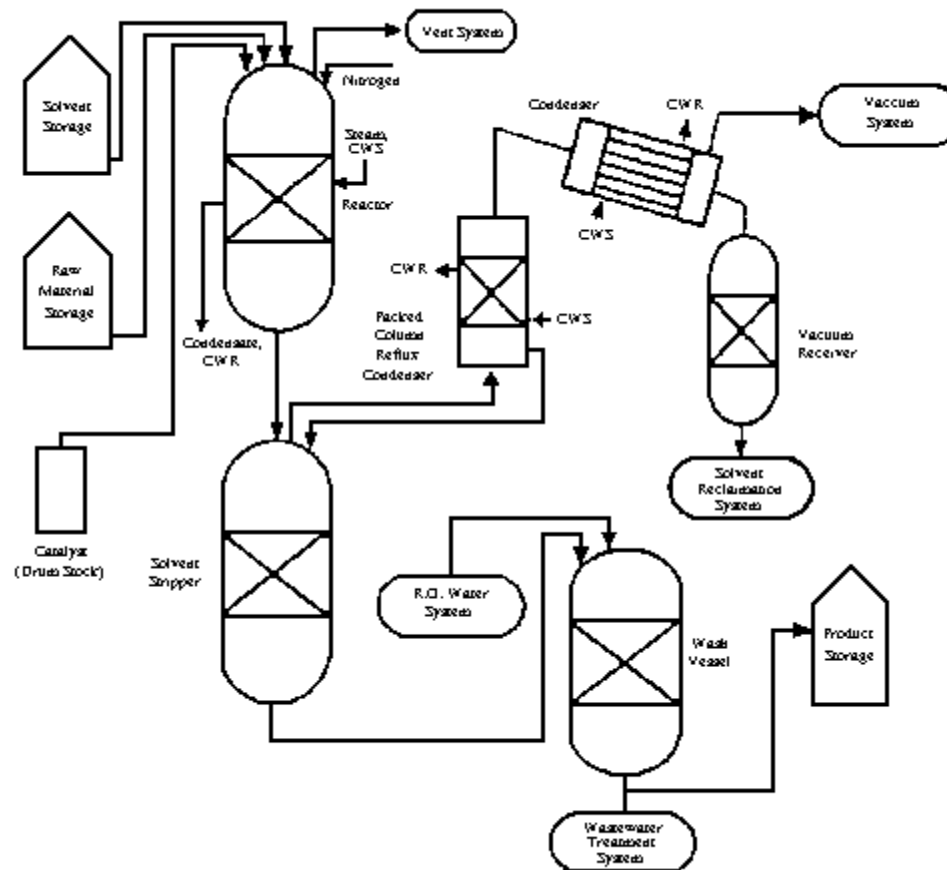
- Code class information

- Seismic class information

- Instruments

Process Flow Diagram or Flow Sheet (Cont'd)

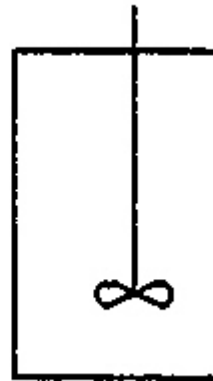
Example of a Process Flow Diagram



Classic Symbols



Pump

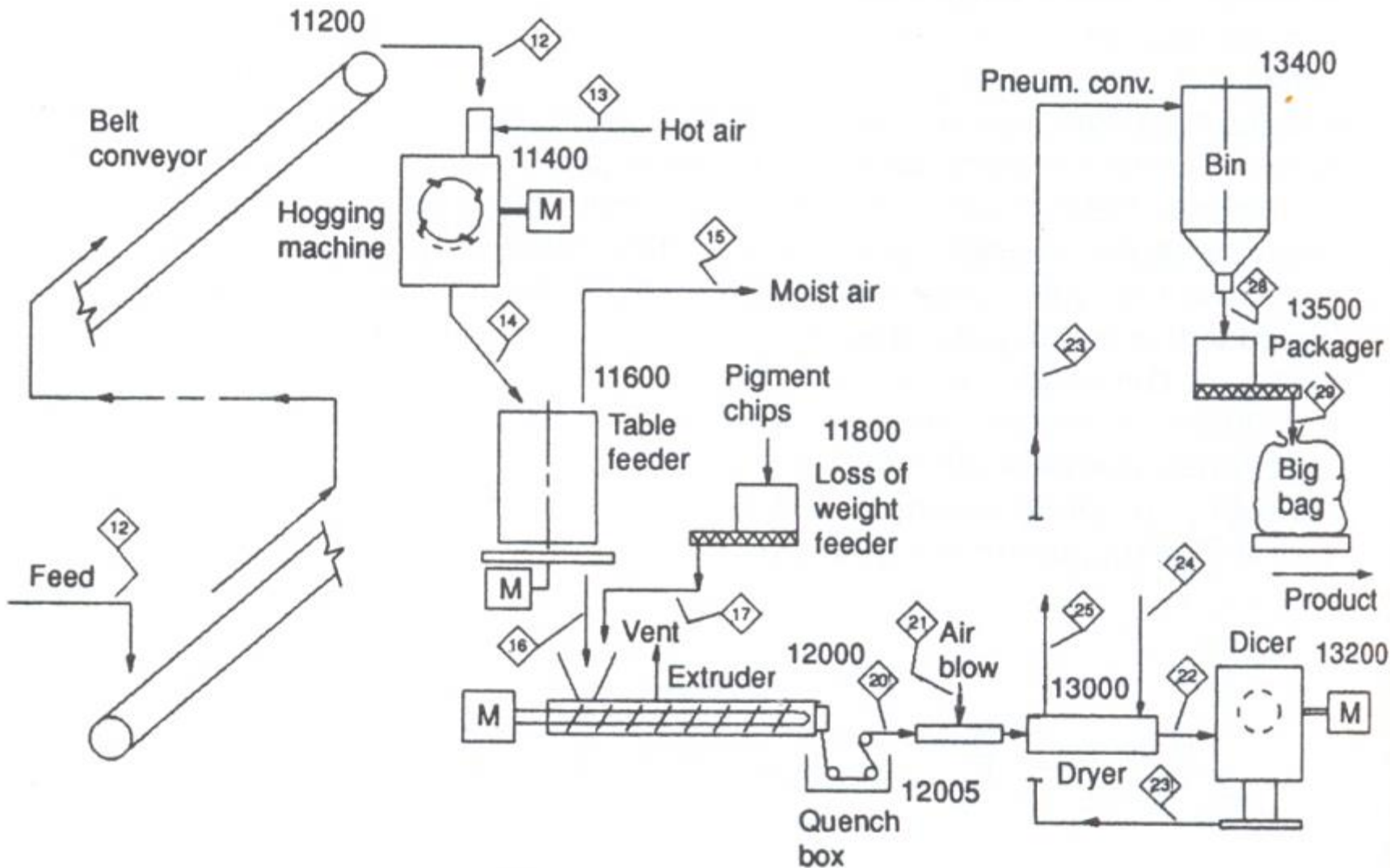


Stirred
tank

Assignment:

A- Each team come up with symbols of other equipments

Another Example of PFD



Another Example of PFD (Cont'd)

	12		13		14		15		16		17	
	hogger feed		drying air		hogger discharge		moist air		extruder feed		pigment chips	
	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate
polymer	1050	1260			1050	1260			1050	1260	26	34
pigment											4.1	6.3
dirt	2.6	5.2			2.6	5.2			2.6	5.2		
other #1	2.1	2.5			nil	.1			nil	.1		
name #1	water	water			water	water			water	water		
other #2												
name #2												
water			5	18	7.1	20.5	7.1	20.5				
air			450	900	450	900	450	900				
temperature			130	150	130	150	130	150				
pressure			~atm.	~atm.								

Another Example of PFD (Cont'd)

	18 [unused]		19 [unused]		20 extrudate		21 blow air		22 dicer feed		23 dicer output	
	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate	average rate	design rate
polymer					1076	1294			1076	1294	1076	1294
pigment					4.1	6.3			4.1	6.3	4.1	6.3
dirt					2.6	5.2			2.6	5.2	2.6	5.2
other #1					11	13	n/a	n/a	nil	.5	nil	.5
name #1					water	water						
other #2												
name #2												
water												
air							22.4	25.8				
temperature												
pressure												

Piping and instrument diagram

It is a schematic representation of functional relationship of piping, instrumentation and system equipment components. It is termed as final step of process design. It includes following information's,

- ⦿ Instrumentation and their designation along with indicators, recorders and controllers
 - ⦿ All equipments with their names and particular numbers
 - ⦿ All valves and their corresponding numbers
 - ⦿ Piping related to its size, schedule, material of construction and insulation
 - ⦿ Miscellaneous - vents, drains, special fittings, sampling lines, reducers
 - ⦿ Permanent start-up and flush lines
 - ⦿ Directions of flow
 - ⦿ Interlinked references
 - ⦿ Control inputs and outputs, interlocks
 - ⦿ Quality standard
-

Continued.

- Computer control system input
- Identification of components and subsystems delivered by others
- Intended physical sequence of the equipment
- All utilities with identification related to inputs and outputs

It doesn't include following parameters,

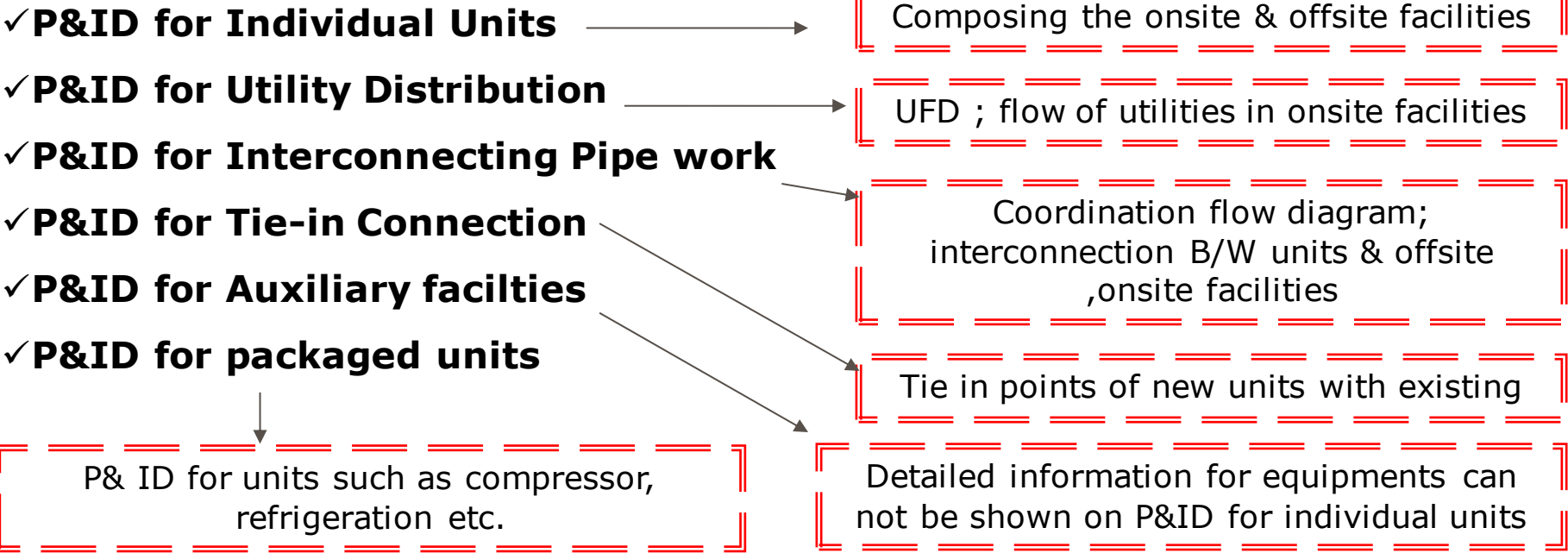
- Route valves for instruments
 - Control relays
 - Manual switches
 - Equipment rating or capacity
 - Pressure, temperature and flow data
 - Elbows, tees and its related standard fitting
 - Extensive explanatory notes
-

Distinction Between PFD & PID

	PFD	P&ID
1. Used During Construction	No	Yes*
2. Shows all process and service piping	No	Yes
3. Indicates presence of all controls	No	Yes
4. Shows all motors	No	Yes
5. Shows thermal insulations	No	Yes
6. Shows major equipment	Yes	Yes
7. Shows flow quantities	Yes	No
8. Shows stream compositions	Yes	NO

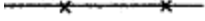
P&ID quality determines whether the projects succeeds or fails

Types of P&ID

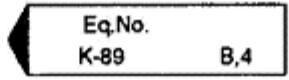
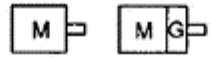


Not all of the above P&IDs are always prepared in a project

Good symbols are essential to helping the reader of P&ID

Lines and Connections	
	Common line for depicting a piping connection, or for tracing the outline of an equipment symbol. Arrow shows direction of flow. Often a heavy line is used to represent piping, while equipment is outlined with a normal line thickness. Major engineering companies do this. Equal line weights for the two are not uncommon, however.
	Tilde (~) means line is continued farther along the same trajectory. Occasionally it is used to show the end of a line. The symbol is meant to show a slight tear in the drawing whereby the line continues unimpeded under the paper.
	Mostly means electrical connection, but can be hidden line.
	Multipurpose. Perhaps most commonly a hidden line.
	Instrument capillary.
	Instrument air.
	Hydraulic, power and/or control.
	Multisignal.
	Class break.
	Duct.
	Elephant trunk or flexible duct.
	Hose.
	Insulated line.

A symbol expresses or suggests an idea by standing for it

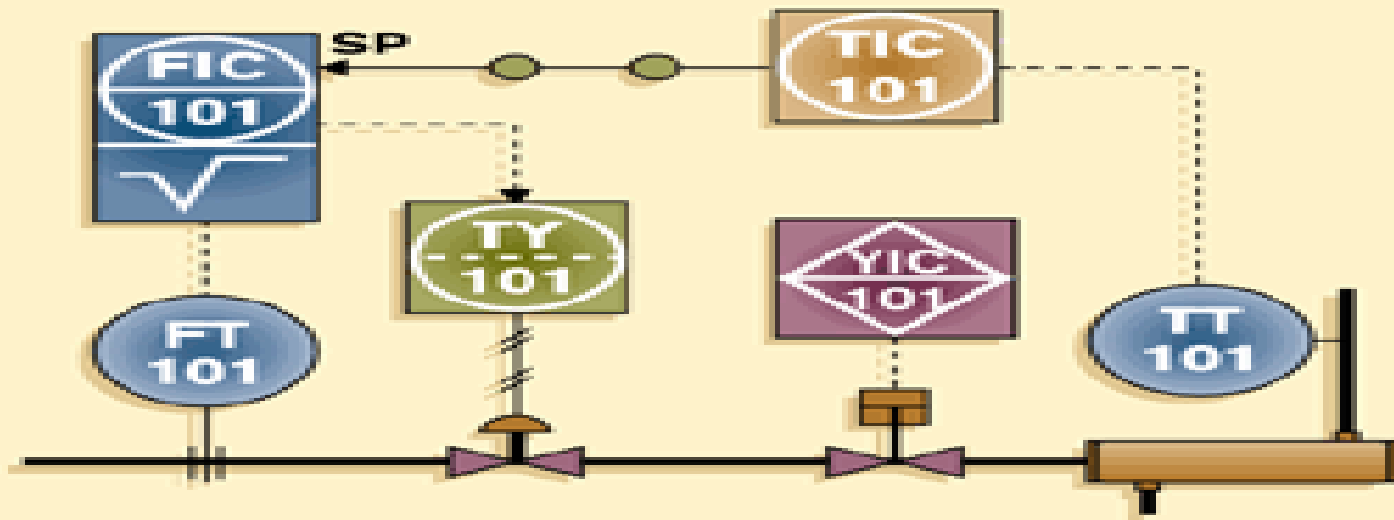
		Piping reducers (eccentric on the left, concentric on the right).		Check valve.
		This symbol flags items included with other components.		Air set, instrument air—type 8.
		Steam trap assembly—type 4.		Line delimiter. Equipment at destination is given. The continuing P&ID and pertinent coordinates are given.
		Specialty item—sketch 23 shows the details.		Electric motor and electric motor with integral speed reducer (gear motor).
		Instrument function performed via software in a programmable logic controller or a micro/mini computer (also referred to as MBE; see p. 191). Control room mounted.		Gearbox.
		Same function in a stand-alone unit.		Common field-mounted instrument.† This instance shows a manually operated switch.
		Air-operated control valve. Internals are the globe valve type—even though symbol is for a gate valve—by convention.		Rotameter.†
		Solenoid valve.		Interlock—interlock 9.
		Three-way solenoid valve.		Purge connection—type 6.
				Connection at battery limit.
				Shutdown.

Assignment:

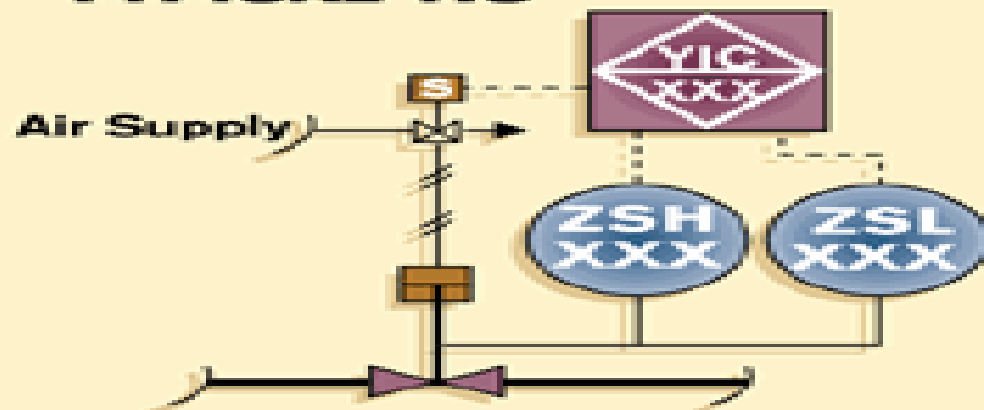
A– Come with as much symbols as you can

Winner who come with more symbols

Example P&ID



TYPICAL YIC



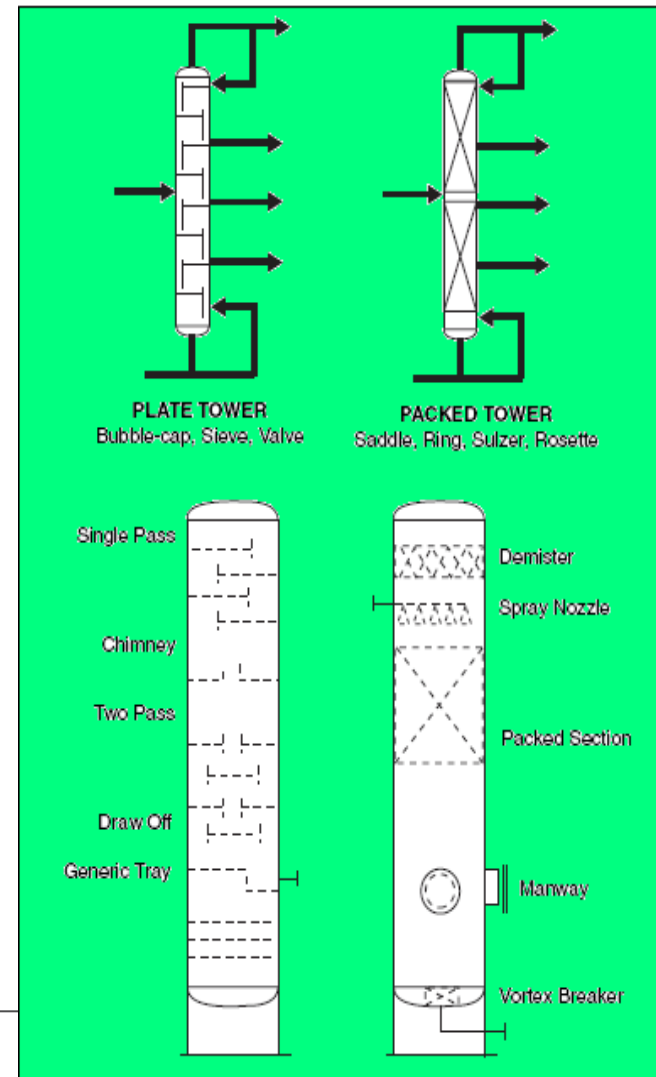
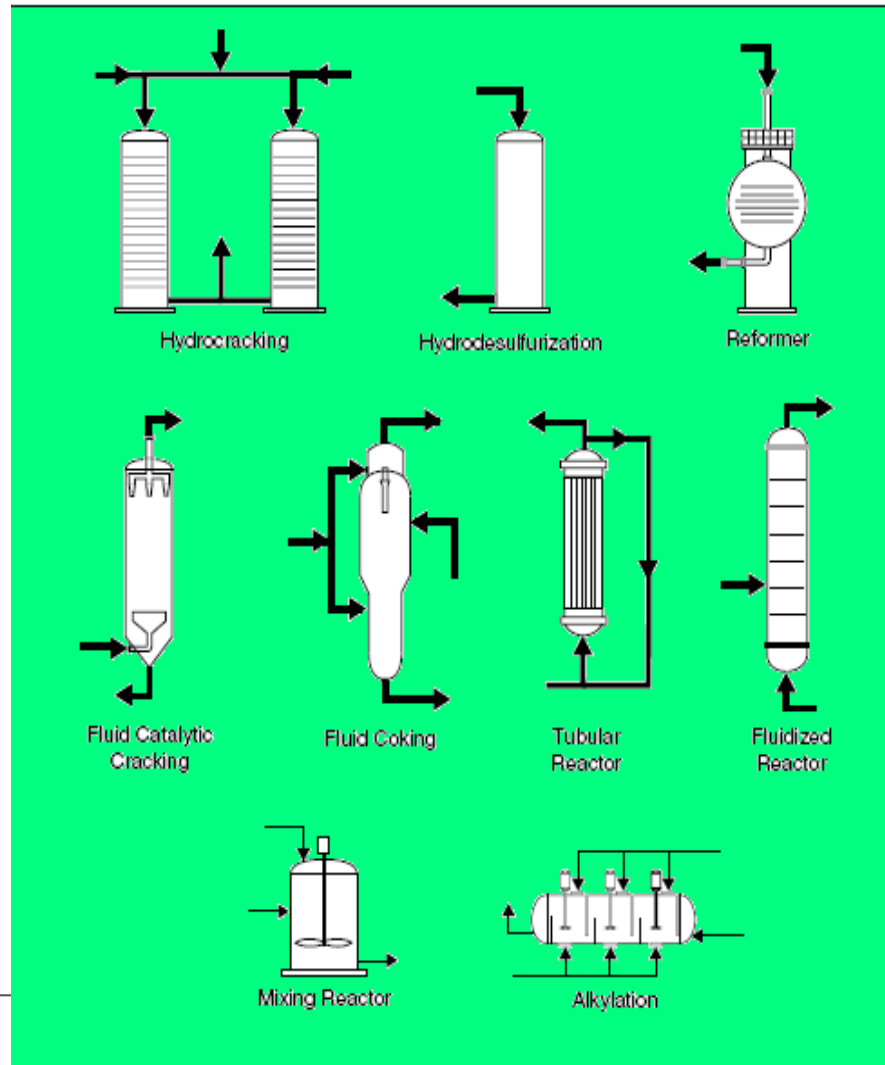
Source: Control Engineering

Standard symbols for instruments

Indicator	CRT	PLC
Computer	Light	Indicator 2
CRT 2	PLC 2	Computer 2
Dashed mid-line	Steam traced	Double
Level Meter	Pressure gauges	Thermom...
Flowmeters	Level meters	Indicator/recorder
Converter	Venturi	Flowmeter
Rotameter	Vortex sensor	Propeller meter
Generic Utility	Operator Box	AND gate

OR gate	NOT gate	Correcting element
Diamond	Signal	Data
Pneumatic	Pneumatic 2	Pneumatic Binary
Electric	Electric 2	Electric 3
Electric Binary	Electric Binary 2	Capillary Tube
Hydraulic	Hydraulic 2	Electro-magnetic
Electro-magnetic 2	Heated / Cooled	Heat Trace
Mechanical	Mechanical 2	

Standard symbols for equipments





Cooling tower



Condenser



Automatic stoker



Refrigerators



Evaporati...
Condenser



Condenser
(air cooled)



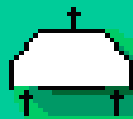
Oil separator



Chilling evaporator



Air cooling evaporator



Extractor hood



Autoclave



Fan blades



Triple fan blades



Heat exchanger1



Heat exchanger2



Shell and tube



Tube bundle 1



Tube bundle 2



Kettle reboiler



Air-blown cooler



Plate type



Finned tube



Double pipe type



Oil burner



Boiler



Fired heater



Cooling tower 1



Cooling tower 2



Breaker



Crusher



Roll crusher



Hammer
crusher



Various
crushers 1



Various
crushers 2



Ball mill



Various
mills



Mixer



Various
mixers



Kneader



Various
kneaders



Blender



Double
blender



Fluid
separators



Filter 1



Filter 2



Rotary
filter



Screen



Electrom...



Cyclone 1



Cyclone 2



Centrifuge
1



Centrifuge
2



Briquetting
machine



Pill tower



Dryer



Conveyor



Conveyor
wheel



Boom
loader



Scraper
conveyor



Screw
conveyor



Elevator 1



Elevator 2



Skip hoist



Overhead
conveyor



Hoists



Electric
motor

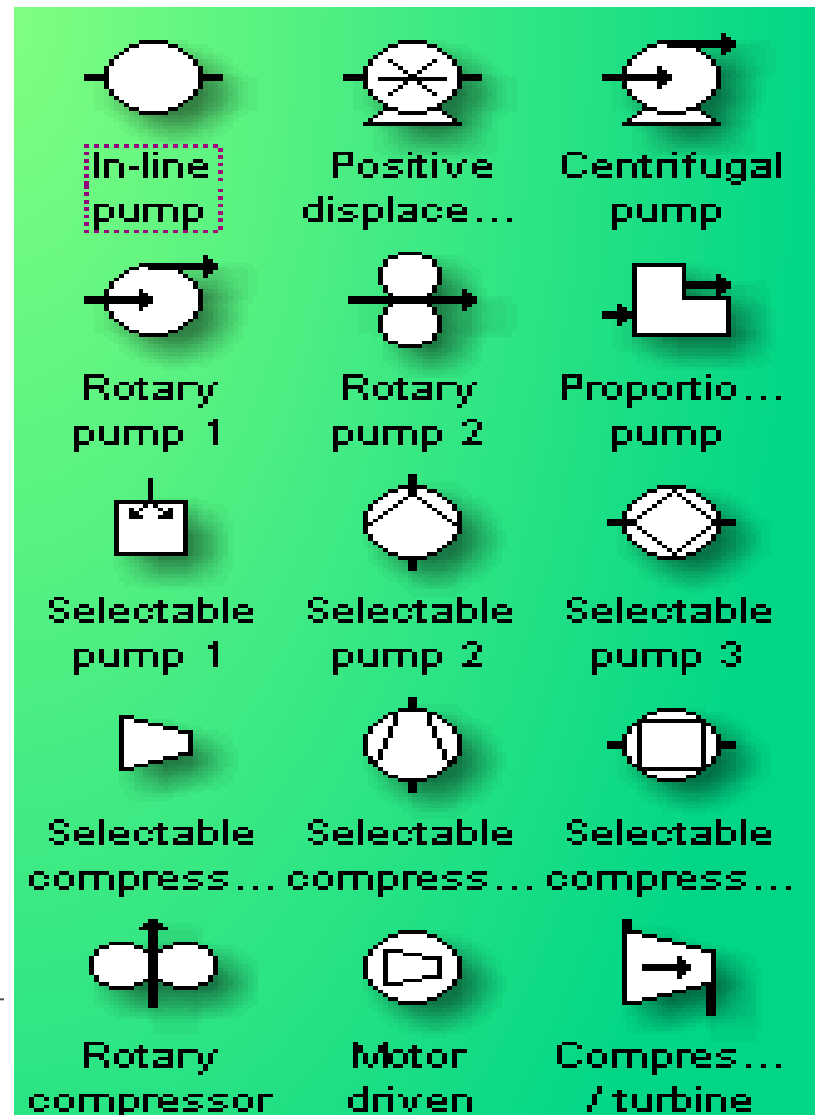
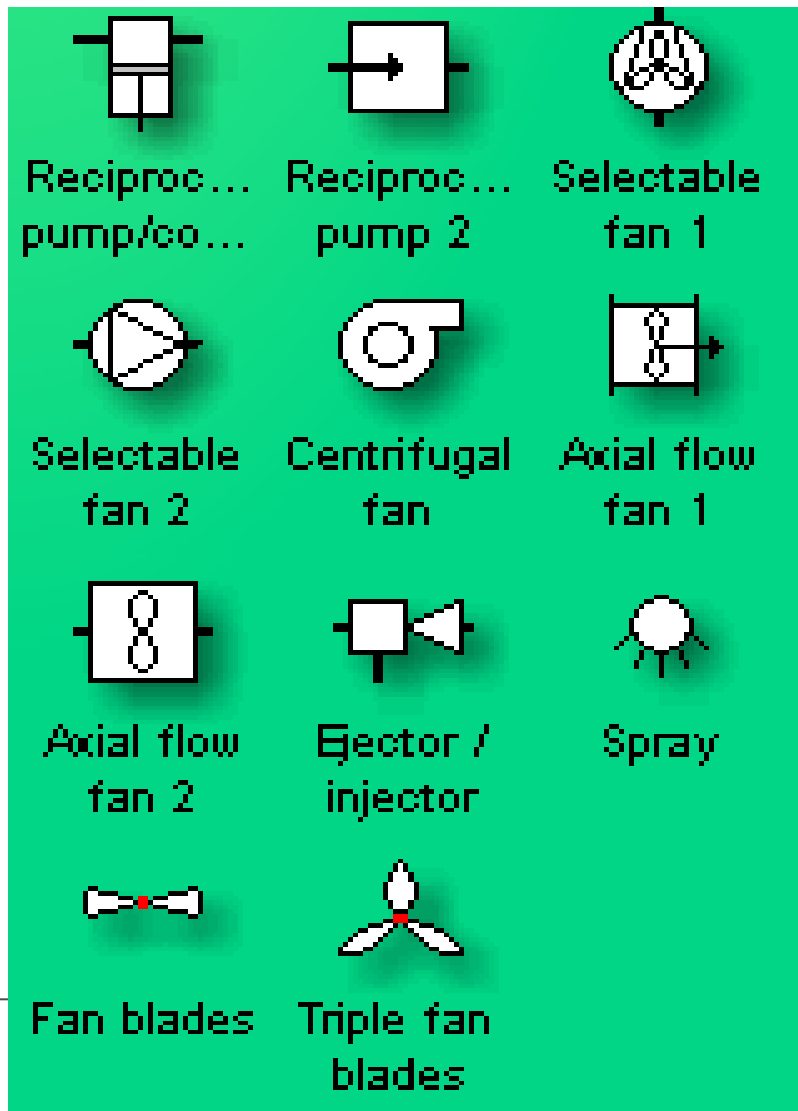


Tank truck

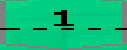


Tank car

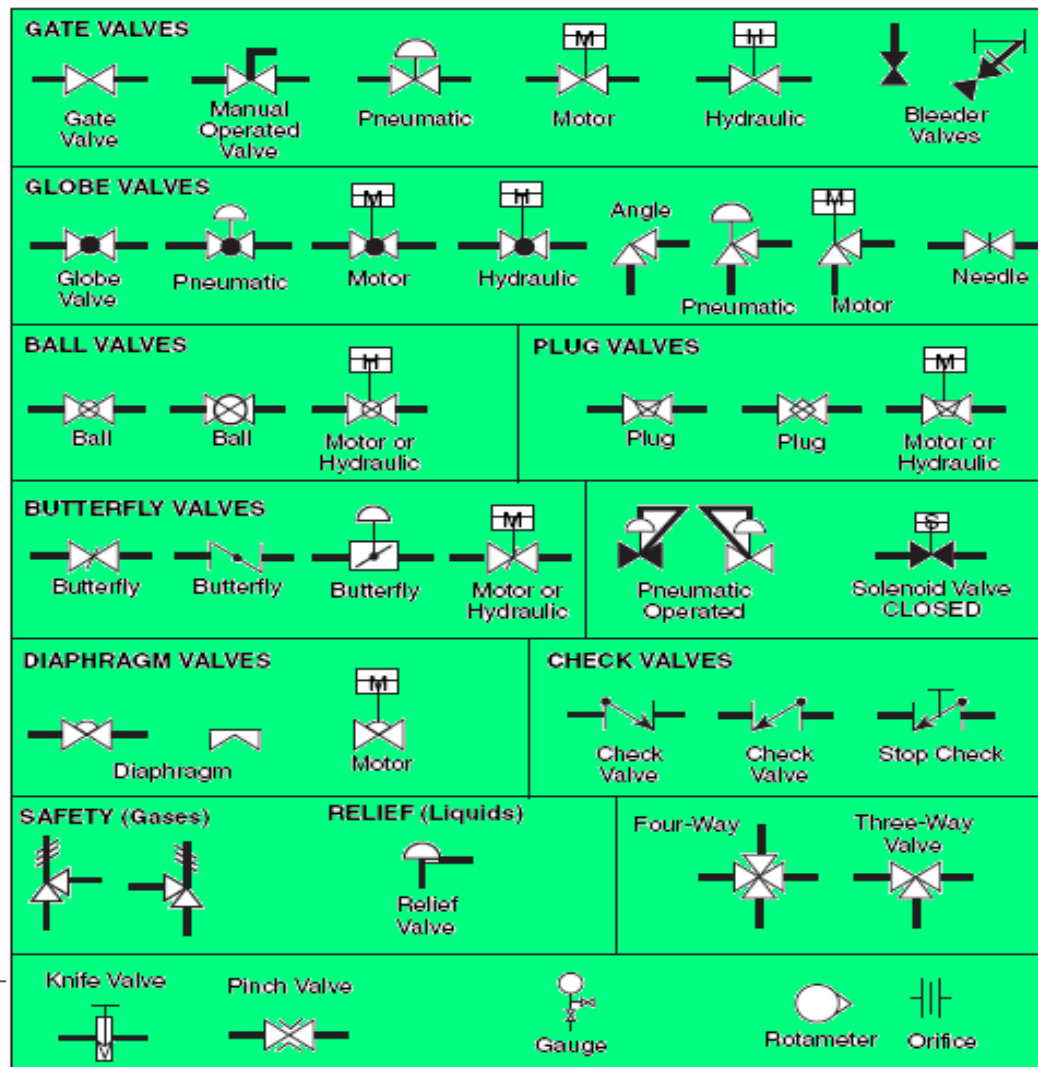
Standard symbols for fluid motive machinery



Standard symbols for vessels

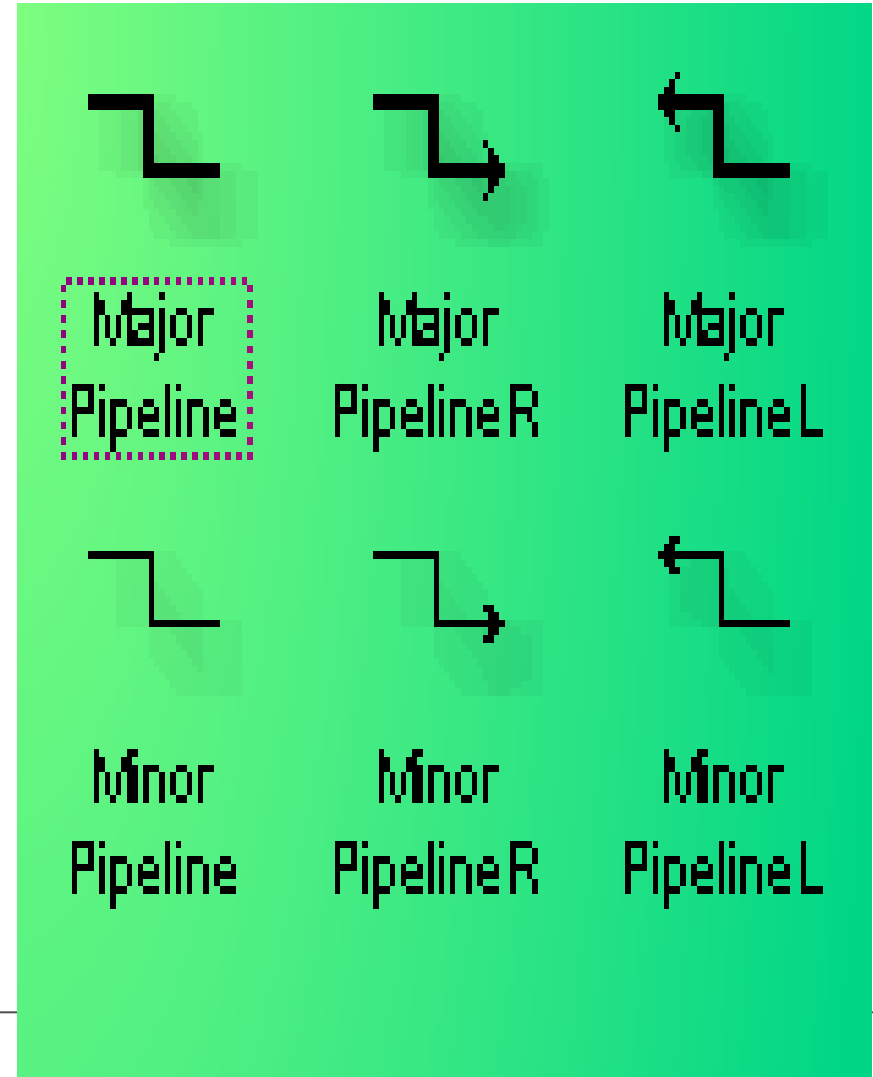
		
Vessel	Column	Tray column
		
Fluid contacting	Reaction vessel	Open tank
		
Clarifier	Closed tank	Covered tank
		
Gas holder	Storage sphere	Bamel
		
Gas cylinder	Bag	Carrying vessel
		
Autoclave	Tank	Tray (dashed)
		
Tray (solid)	Water surface	Branch fitting
		
Access point	Flanged access	

Standard symbols for valves



Standard symbols for lines

	Y-type Strainer		Removable Spool
	Duplex Strainer		Flexible Hose
	Basket Strainer		Expansion Joint
	Detonation Arrestor		Breather
	Flame Arrestor		Vent Cover
	In-Line Silencer		In-Line Mixer
	Steam Trap		Vent Silencer
	Desuperheater		Diverter Valve
	Ejector / Eductor		Rotary Valve
	Exhaust Head		Pulsation Dampener
	Future Equipment		Flange
	Major Process		Electromagnetic, Sonic, Optical, Nuclear
	Minor Process		Electric
	Pneumatic		Connecting Line
	Hydraulic		Non-Connecting Line
	Capillary Tubing		Non-Connecting Line
	Mechanical Link		Jacketed or Double Containment
			Software or Data Link



DIRECTION OF FLOW



AIR CONDITIONING

BRINE RETURN

— — — — — BR — — — — —

BRINE SUPPLY

— — — — — B — — — — —

CIRCULATING CHILLED OR HOT-WATER FLOW

— — — — — CH — — — — —

CIRCULATING CHILLED OR HOT-WATER RETURN

— — — — — CHR — — — — —

CONDENSER WATER FLOW

— — — — — C — — — — —

CONDENSER WATER RETURN

— — — — — CR — — — — —

DRAIN

— — — — — D — — — — —

HUMIDIFICATION LINE

— — — — — H — — — — —

MAKE-UP WATER

— — — — — — — — — — —

REFRIGERANT DISCHARGE

— — — — — RD — — — — —

REFRIGERANT LIQUID

— — — — — RL — — — — —

REFRIGERANT SUCTION

— — — — — RS — — — — —

HEATING

AIR-RELIEF LINE

— — — — — — — — — — —

BOILER BLOW OFF

— — — — — — — — — — —

COMPRESSED AIR

— — — — — A — — — — —

CONDENSATE OR VACUUM PUMP DISCHARGE

— O — — O — — O — —

FEEDWATER PUMP DISCHARGE

— OO — — OO — — OO — —

FUEL-OIL FLOW

— — — — — FOF — — — — —

FUEL-OIL RETURN

— — — — — FOR — — — — —

FUEL-OIL TANK VENT

— — — — — FOV — — — — —

HIGH-PRESSURE RETURN

— # — — # — — # — —

HIGH-PRESSURE STEAM

— # — — # — — # — —

HOT-WATER HEATING RETURN

— — — — — — — — — — —

HOT-WATER HEATING SUPPLY

— — — — — — — — — — —

The ISA standards and symbols are important for the P&IDs

Process Variable	Symbol	Type of Instrument	Symbol
Analyses	A	Alarm	A
Burner	B	Users Choice	B
Combustion	B	Controller	C
Users Choice	C	Control valve	CV
Users Choice	D	Trap	CV
Voltage	V	Sensor (primary element)	E
Flow Rate	F	Rupture disc	E
Users Choice	G	Sight or gage glass	G
Current (electric)	I	Monitor	G
Power	J	Indicator	I
Time	K	Control Station	K
Level	L	Light (pilot/operation)	L
Users Choice	M	Users Choice	N
Users Choice	N	Flow Resistance Orifice	O
Users Choice	O	Test point (sample point)	P
Pressure / Vacuum	P	Recorder	R
Radiation	R	Switch	S
Speed (or Frequency)	S	Transmitter	T
Temperature	T	Multifunction	U
Multivariable	U	Valve/Damper	V
Vibration	V	Well	W
Weight (force)	W	Unclassified	X
Unclassified	X	Relay	Y
Event	Y	Driver	Z
Position, dimension	Z	Actuator	Z

Example: ISA Symbols for a Level Indicator

LI

"L" for the process variable "Level", and
"I" for the "Indicator" type of instrument.

LI 08

the code for level indicator no. eight

Flowmeter - Indicating

FI 001

Temperature - Transmitter

TT 001

Control Valve

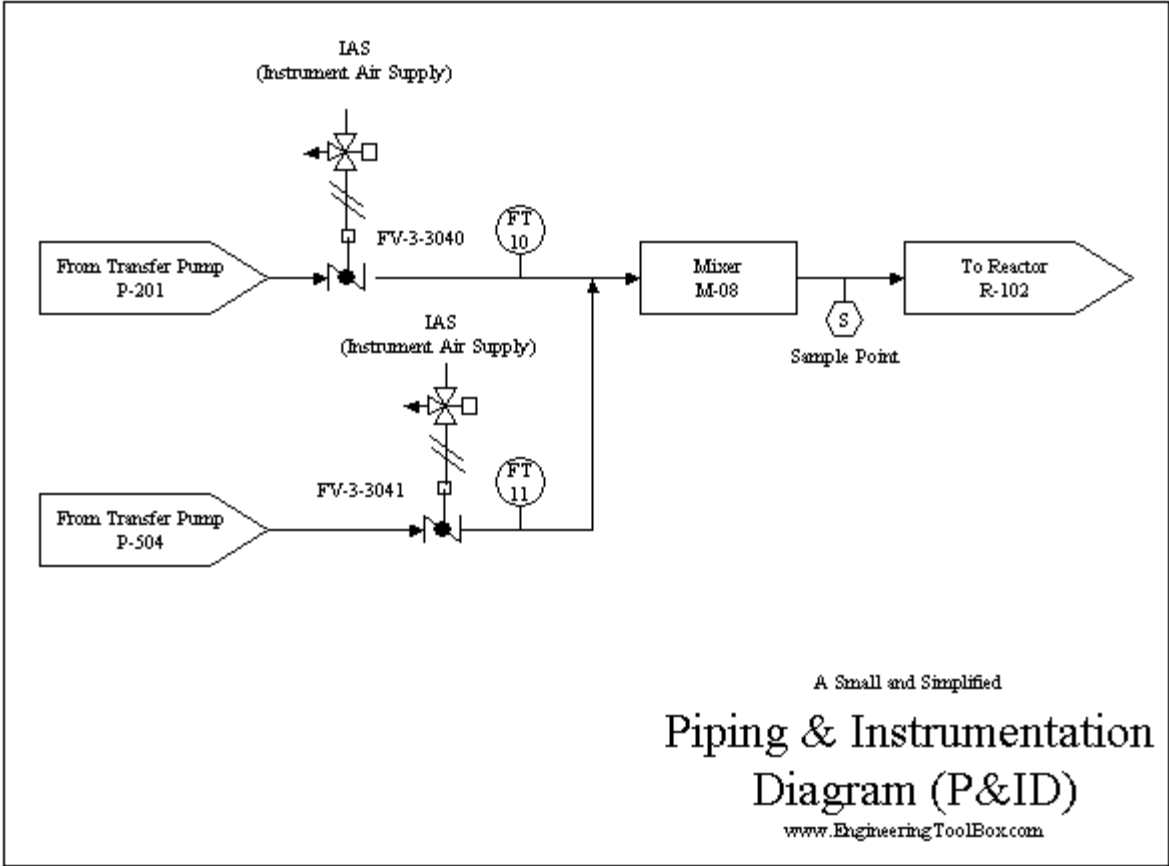
FV 001

Position Switch - High Level

ZSH 001

Instrument identification by
P & ID

- Instruments are identified by a tag number in P & ID. For example,
 - TIC 103 shows instrument identification or tag number
 - T 103 shows loop identification
 - 103 shows loop number
 - TIC shows functional identification
 - T shows first letter
 - IC shows second letter.
- The first letter dictates the control device involved in a process. And second letter dictates the parameter the device is intended to control.



- ✓ **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 etc.**
- ✓ **Permanent start-up and flush lines**
- ✓ **Flow directions**
- ✓ **Interconnections references**
- ✓ **Control inputs and outputs, interlocks**
- ✓ **Interfaces for class changes**
- ✓ **Seismic category**
- ✓ **Quality level**
- ✓ **Annunciation inputs**
- ✓ **Computer control system input**
- ✓ **Vendor and contractor interfaces**
- ✓ **Identification of components and subsystems delivered by others**
- ✓ **Intended physical sequence of the equipment**

1. Format & Sheet Size: A0 or A1 (ISO)

202 Chapter Eleven

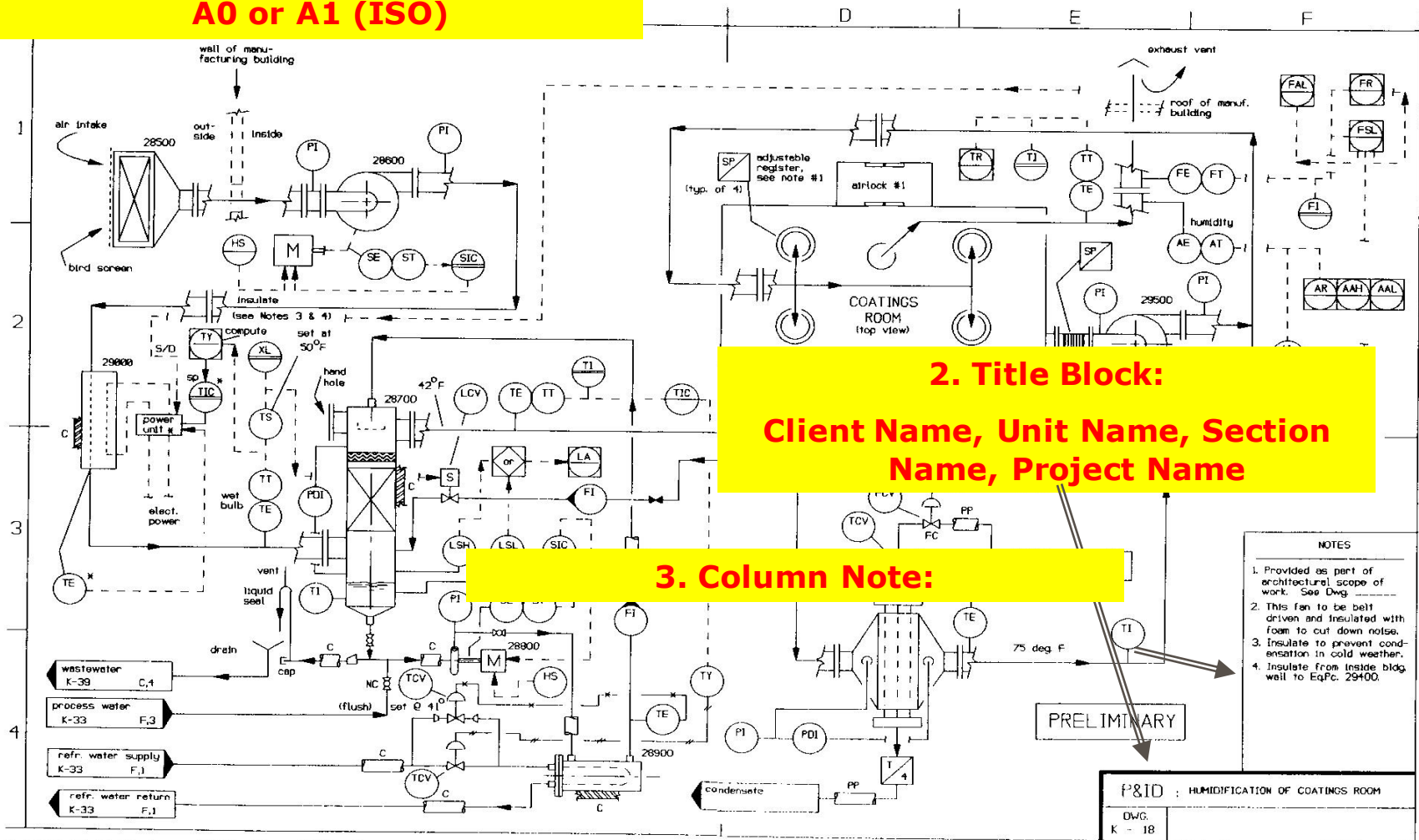


Figure 11-26 Preliminary P&ID of humidification equipment.

4. Equipment Design Data

Pumps

- 1.Item no.
- 2.Service number
- 3.Design Capacity
- 4.Differential pressure
- 5.Driver power

Vessels

- 1.Item no.
- 2.Service number
- 3.Diameter x Length
- 4.Design pressure. /Temp.
5. Operating pressure/Temp
- 6.Insulation thickness

Heat Exchangers

- | | | |
|-----------------------------|----------------------------|--------------|
| 1. Item no. | 2. Service number | 3. TEMA Type |
| 4.Diameter & Tube length | 5. Duty | |
| 6. Shell design press./temp | 7.Tube design press./Temp. | |
| 8. Insulation Thickness | | |

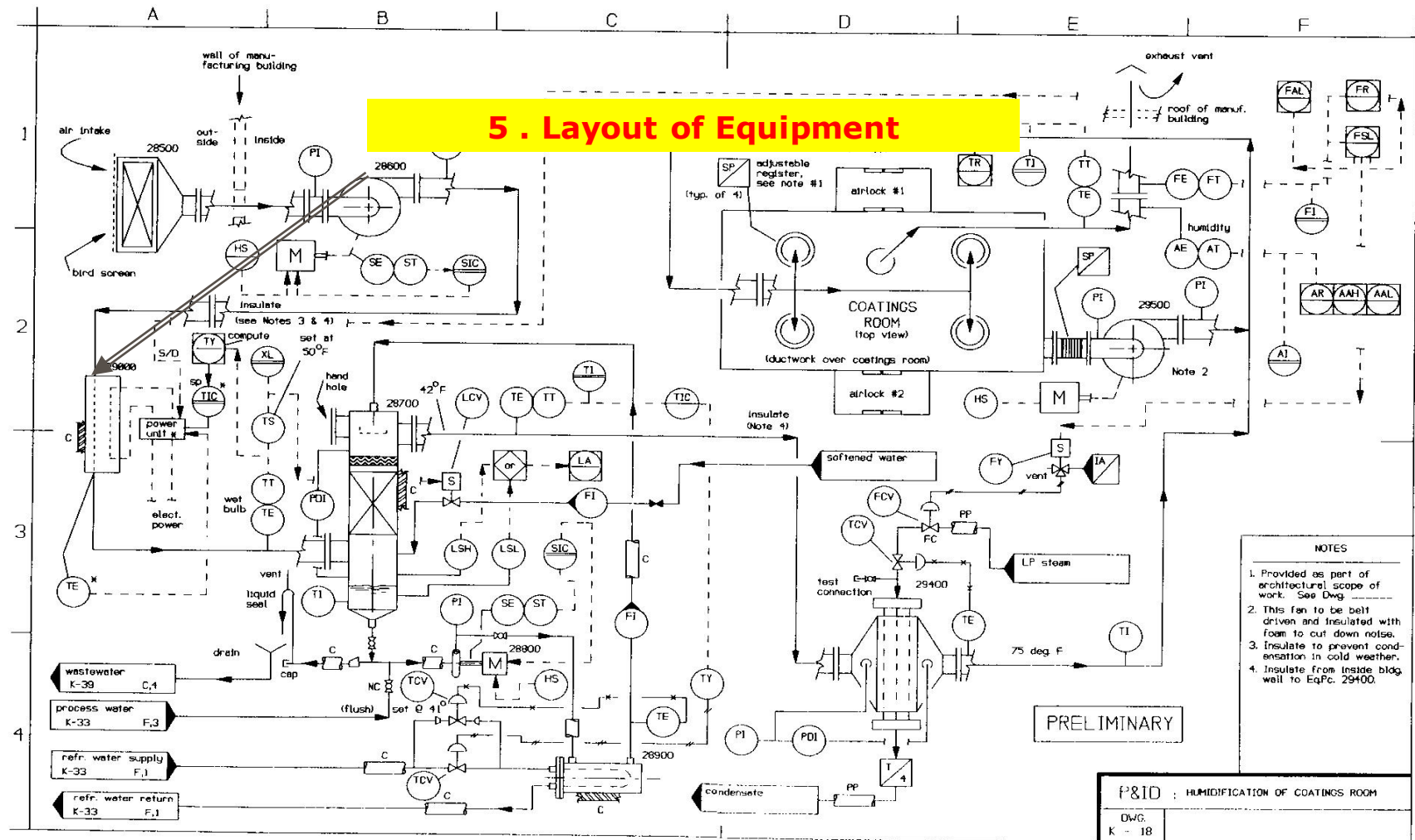


Figure 11-26 Preliminary P&ID of humidification equipment.

Layout and symbols	1
Hand sketching	6
CADD drafting, 1st	8
<i>Gedanken</i> experiments and revisions	4
Review by instrumentation department	8
CADD update	2
In-house reviews	9
Incorporation of review information	2
CADD update	1
Client reviews	(15)
Miscellaneous client input	(8)
Incorporation of review information	3
CADD update	<u>1</u>
Total	45
(Total including client)	(68)

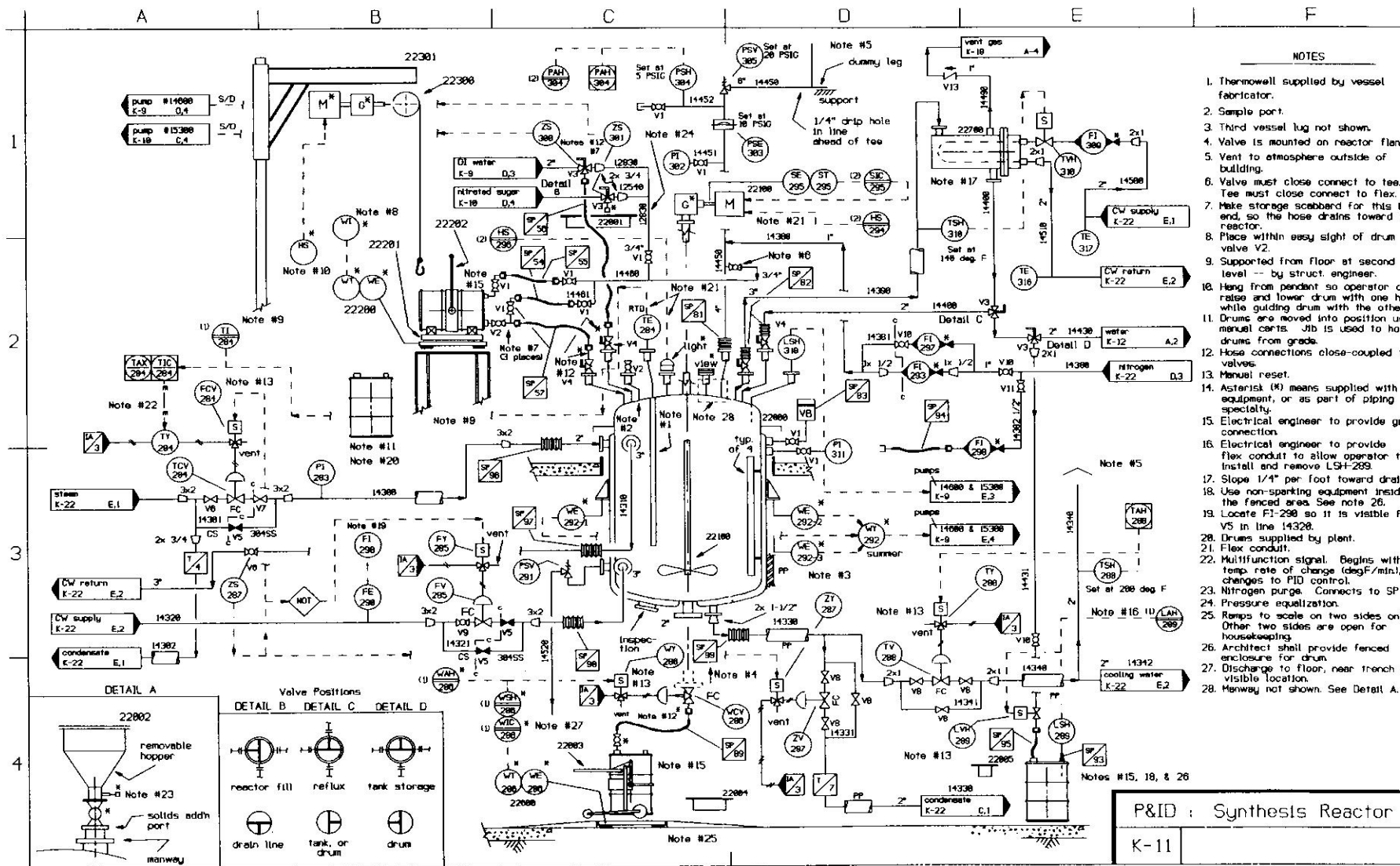


Figure 11-31 Construction grade P&ID of synthesis reactor.



● Questions ???

