Phase 1 Fabrication

Carousel 1

Engineering Drawing

Practice and Standards

Part 2 – Flow sheets/Line diagrams and symbols

ENGINEERING DRAWING – Part 2

FLOW SHEETS, LINE DIAGRAMS AND PIPING ISOMETRIC DRAWINGS

INTRODUCTION

During their research, the chemists may come across a promising process. If this is the case then more research is done into the possibility of manufacturing on a large scale and also if it will be an economical success.

The decision is then made whether to go ahead or not.

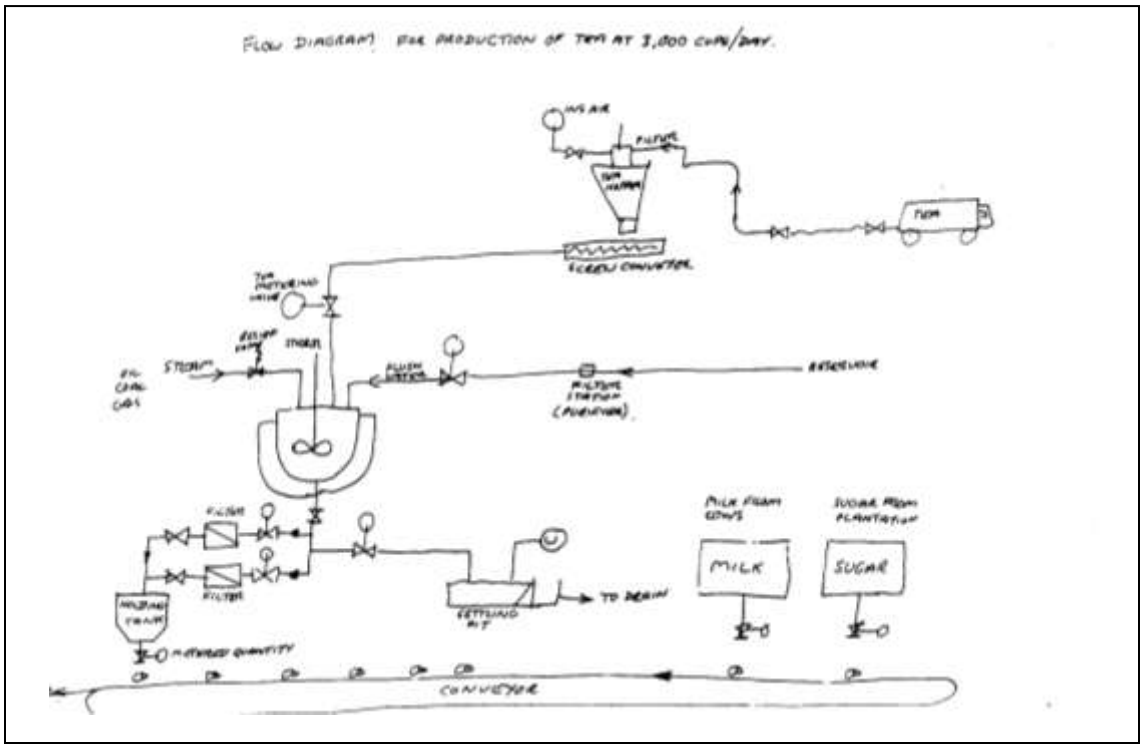
If the plant is to be built, then the first step is the production of a FLOW SHEET by the Chemical Engineer.

THE FLOW SHEET

Is a diagrammatic representation of the chemical process to be used and is an indication of the various stages to be built into the plant system.i.e. reaction, distillation, scrubbing, etc.

It is a basic mass balance diagram with relevant information about quantities, temperatures, pressures and chemicals to be used.
This flow sheet has no formal vessels, valves or instruments indicated on it.

Example of a basic flow sheet for the production of a cup of tea at a rate of 3,000 cups/hr.



Using information from the flow sheets it is now the responsibility of the Mechanical Design section to produce a line diagram, this is to include all requirement equipment, pipes and valves.

Also at this stage the instrument section will decide on the instrument control that the process requires.

The line diagrams will start to take shape.

THE LINE DIAGRAM

Basically the line diagram is a two dimensional, pictorial arrangement of the chemical plant, showing all process equipment, pipework, valves, fittings and instruments, which are required for operating the plant.

The uses of the Line Diagram

1. In the drawing office; to develop the design of the plant,

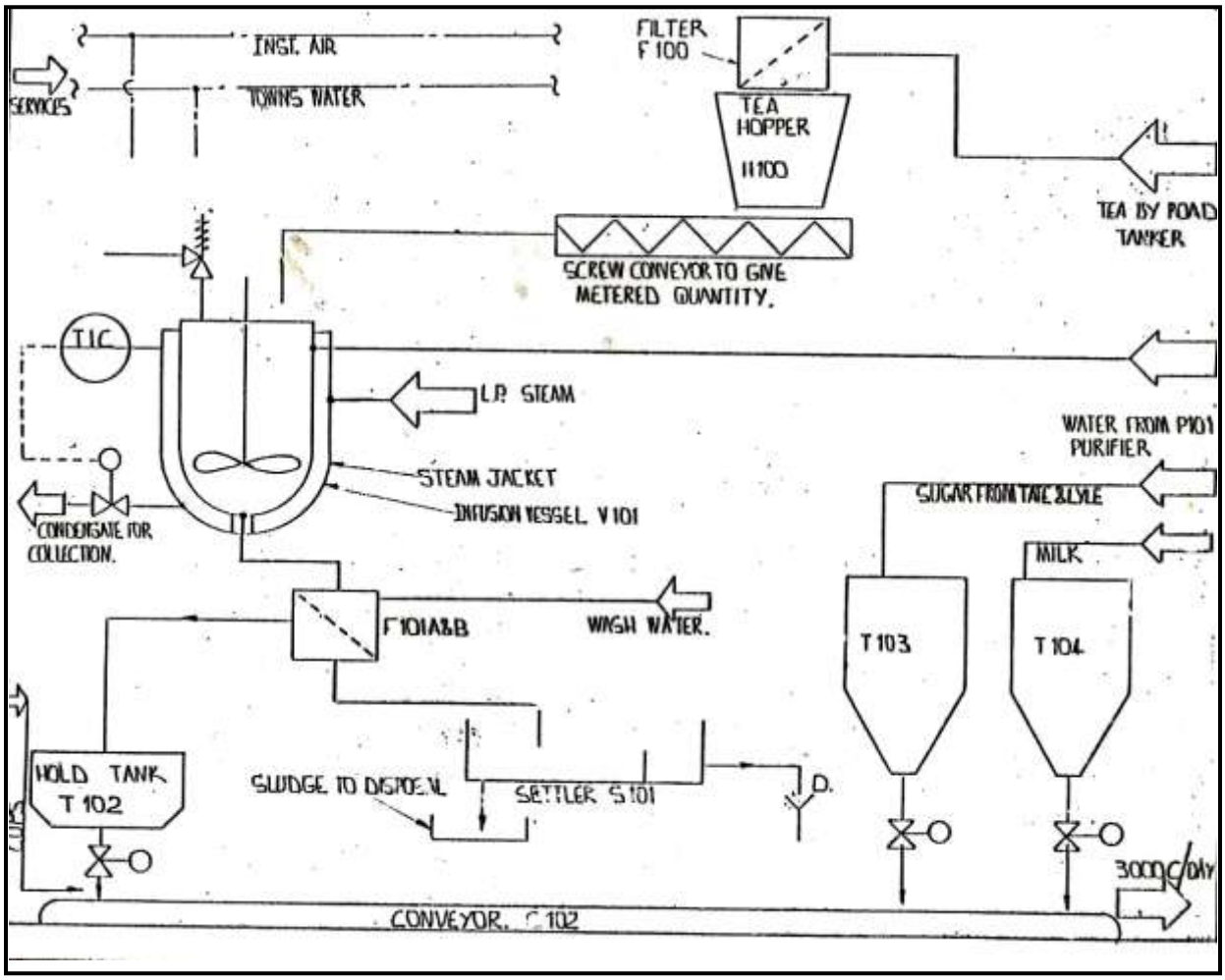
    : Line diagram working parties
    : Layout design
    : Construction of models
    : Determining equipment levels
    : Pipework design

2. In the works:

    : Operator training
    : Numbering valves
    : Commissioning
    : Possible fault finding
    : Selection of system
    : Source of information about equipment, i.e. Vessel, Construction, material, manufacture, test pressures etc.
    : Planning work and time management.

3. Others:

    : Planning section
    : Vessel section
    : Machinery section
    : Electrical section
    : Instrument section
    : Estimating section
    : Civil section



PLANT ITEMS

a) Number equipment as described in Company Engineering Procedures.

b) Names of equipment to be agreed with Process/Plant Engineers.

c) Fill in equipment data table, obtained from copy orders.

d) Existing items or repeats from other line diagrams should be shown chain dotted. This also applies to pipes.

e) Draw new items in bold so that they stand out.

f) Keep details to minimum but show all branch sizes and reference numbers on vessels.

How many line diagrams doe we draw?

Is it normal to divide line diagrams into process sections?

These can also be split up if they become congested.

SERVICE LINE DIAGRAMS

Individual service line diagrams may be required such as:

a) Instrument/mask/general purpose air

b) Power supplies

c) Water, Steam and condensate, waste removal.

These service lines may be common through the site and managed independently.

SUMMARY OF LINE DIAGRAMS

A line diagram must be:-

a) Comprehensive:- include all relevant information on PI's pipes etc.

b) Concise:- simple, direct, economical

c) Conventional:- be readily understood (use standard symbols)

d) Contemporary:- be always up to date.

e) Confidential:- Since it contains all the essential features of a process do not give copies out without authority and then only to names on the circulation list.

How do we draw line diagrams?

We refer to Design Specifications for procedures and standard symbols. We also use a pre-printed drawing sheet issued from the print room. All print should be 4mm high to ensure that microfilm copies are legible.

Use standard symbols for mechanical equipment.

CONVENTIONS

a) All horizontal lines continuous, all vertical lines looped.

b) Flow sequence from left to right.

c) Plant items to scale if possible.

d) Vertical scale most important.

e) Show levels where possible.

f) Spread drawing out so that there is space for later additions.

e.g. vessels, pipes, valves with codes and line references.

g) Cross reference to other line diagrams.

PIPELINES

a) Heavy lines for main process flow.

b) Show arrow heads at line junctions not in middle of lines.

c) Indicate flow and fall.

d) Indicate all 'in line' items such as valves, spades, filters, etc.

e) Lines continued on other line diagrams should match.

f) Show lagging, tracing, jacketing, line references

LINE REFERENCE

All pipelines need to be identified therefore a referencing system will be devised. Below is an example for a compressed air system **AGXD 01**

First letter. Where possible this is nemonic for the fluid in the pipeline, e.g. "A" for air, "C" for chlorine, "S" for steam.

Second letter. For pure substances which can be defined with a meaningful first letter, the second letter attempts to define the fluid in more detail. I = instrument, M = Mask or L = Low pressure. This results in combinations such as:-

AG - General Purpose Air
AI - Instrument Air
AM - Mask Air
SL - Low Pressure Steam

When the pipeline contains a mixture and/or trace elements then X, Y or Z is used for the first letter and any letter from A to Z as the second letter so that impure products are listed as XA, YZ, ZB etc. These references are derived to suit process requirements and are project orientated.

Third letter. Where possible, this is nemonic for the material of construction, e.g. M for monel, C for copper etc. For carbon steel, the most commonly used material, the letters X, Y and Z have been allocated.

X - for class I fabrication
Y - for class II fabrication
Z - for class III fabrication

Fourth letter. This is used for variations on the third letter to completely define the fabrication method, e.g:

XH - class I fabrication, ANSI 300
XD - class I fabrication, ANSI 600
XF - class I fabrication, ANSI 150

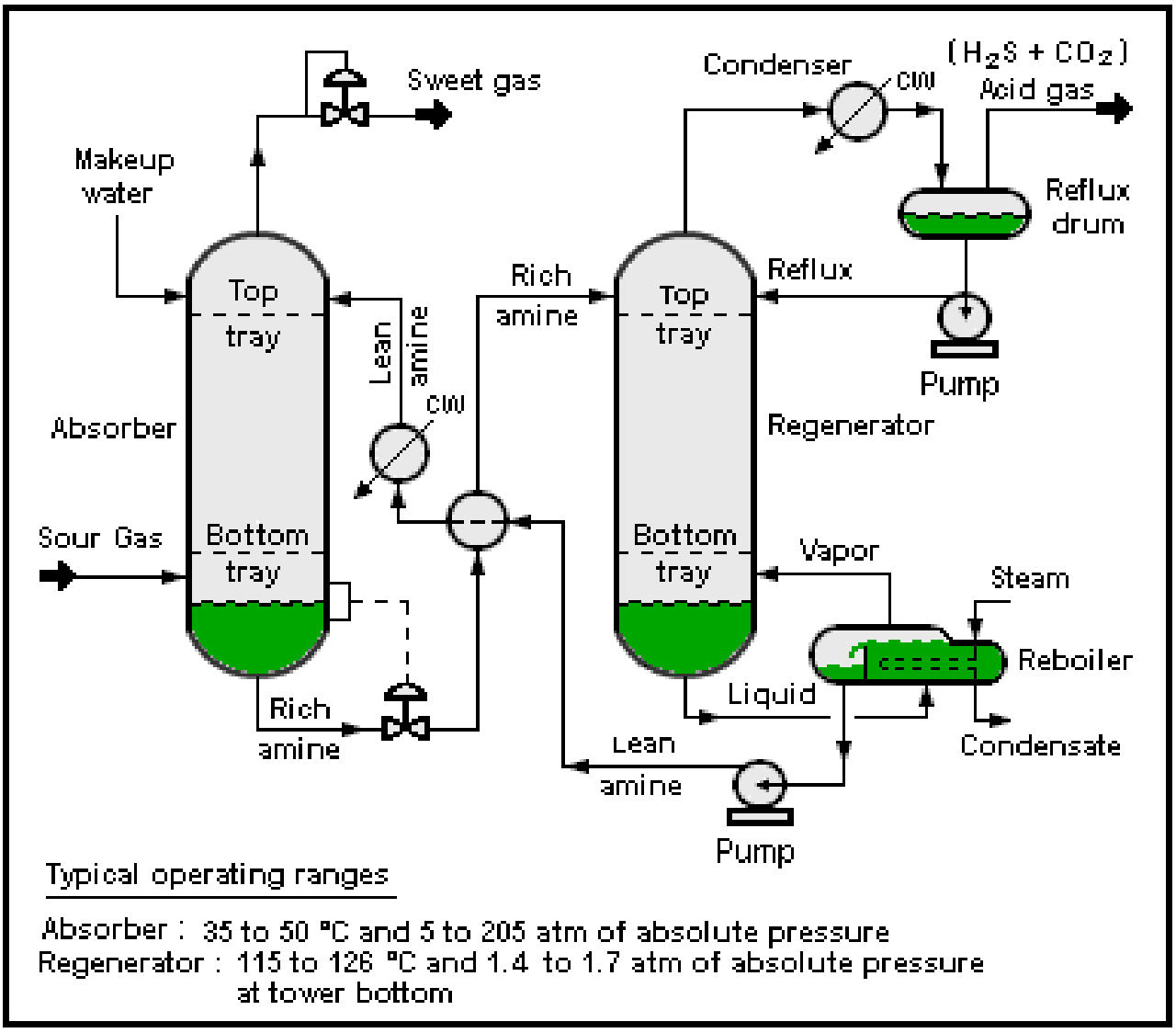
Thus the complete pipeline specification consists of two sheets. The first sheet, containing variables carries the full alpha character reference (maximum 5 characters) and is based on the fluid. The middle letter is used to better describe the fluid.

This will describe the process fluid, its temperature, pressure, flow rate. Normal and test rates for these variables.

The second sheet, containing no variables carries only the last two characters and is based on materials of construction and fabrication details.

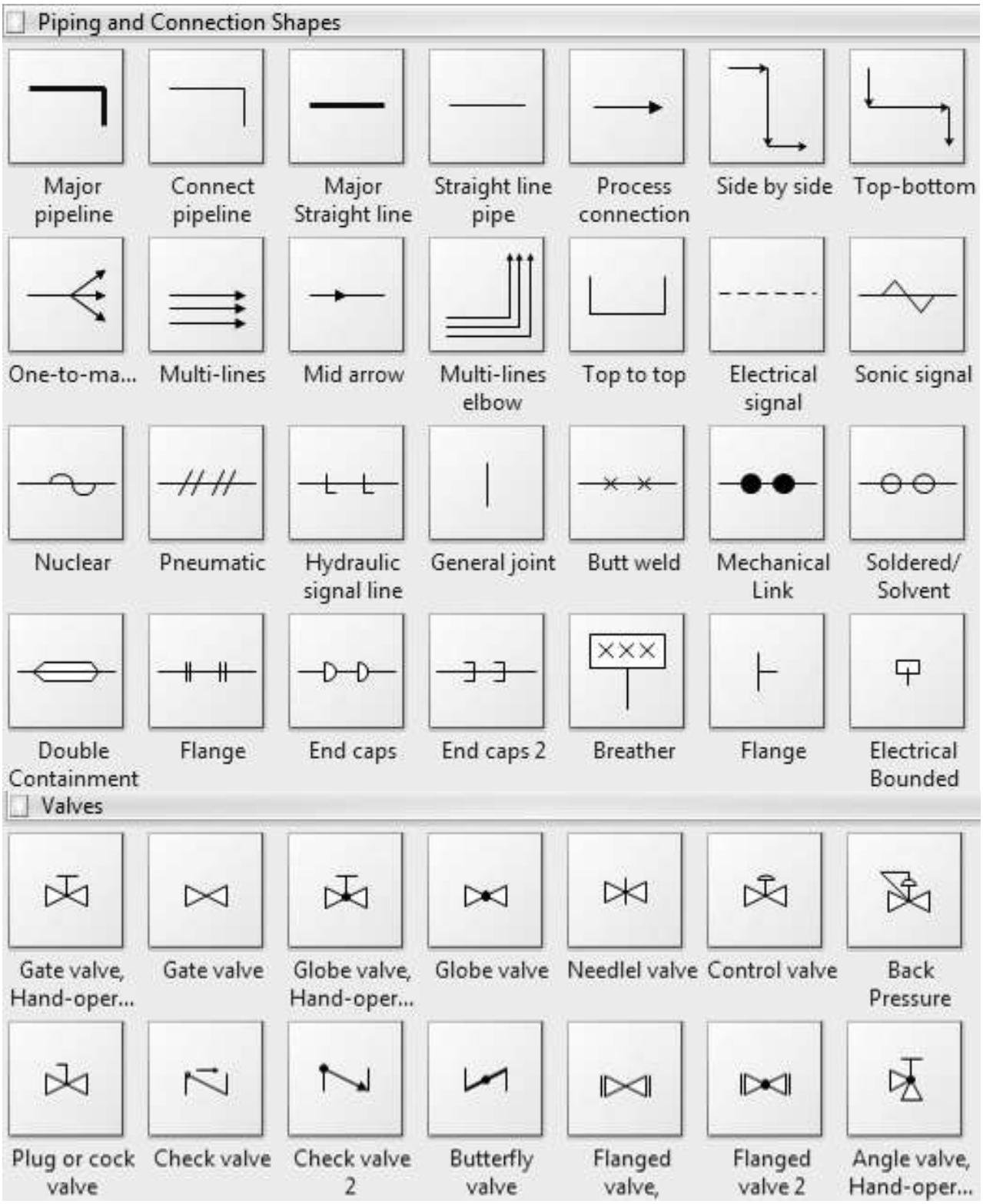
On this sheet will be stated the standard of pipe the system is to be made of, types of valves, fittings gaskets etc.

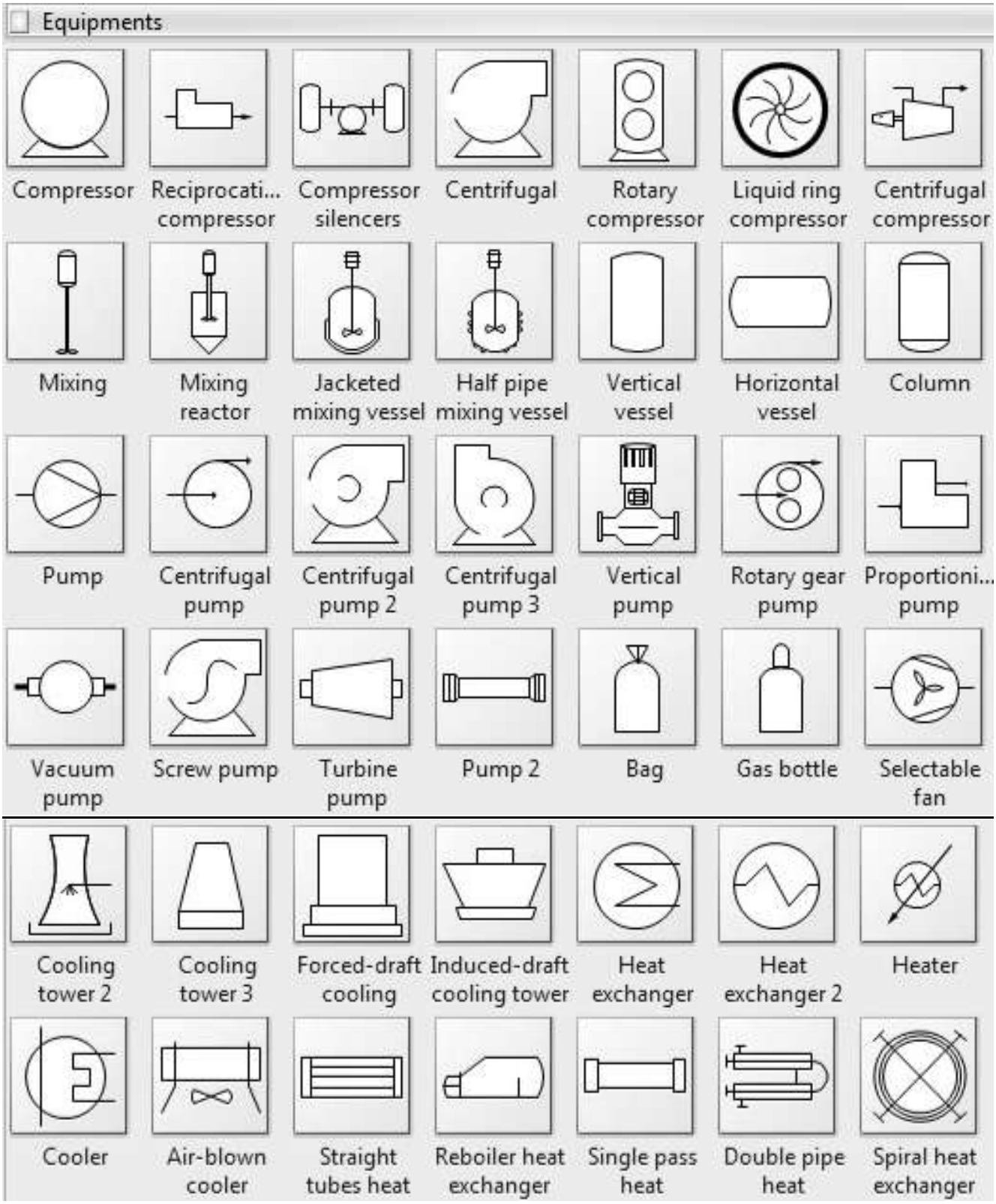
These specifications also support maintenance and inspection when carrying out routines, statutory inspections or even minor modifications.

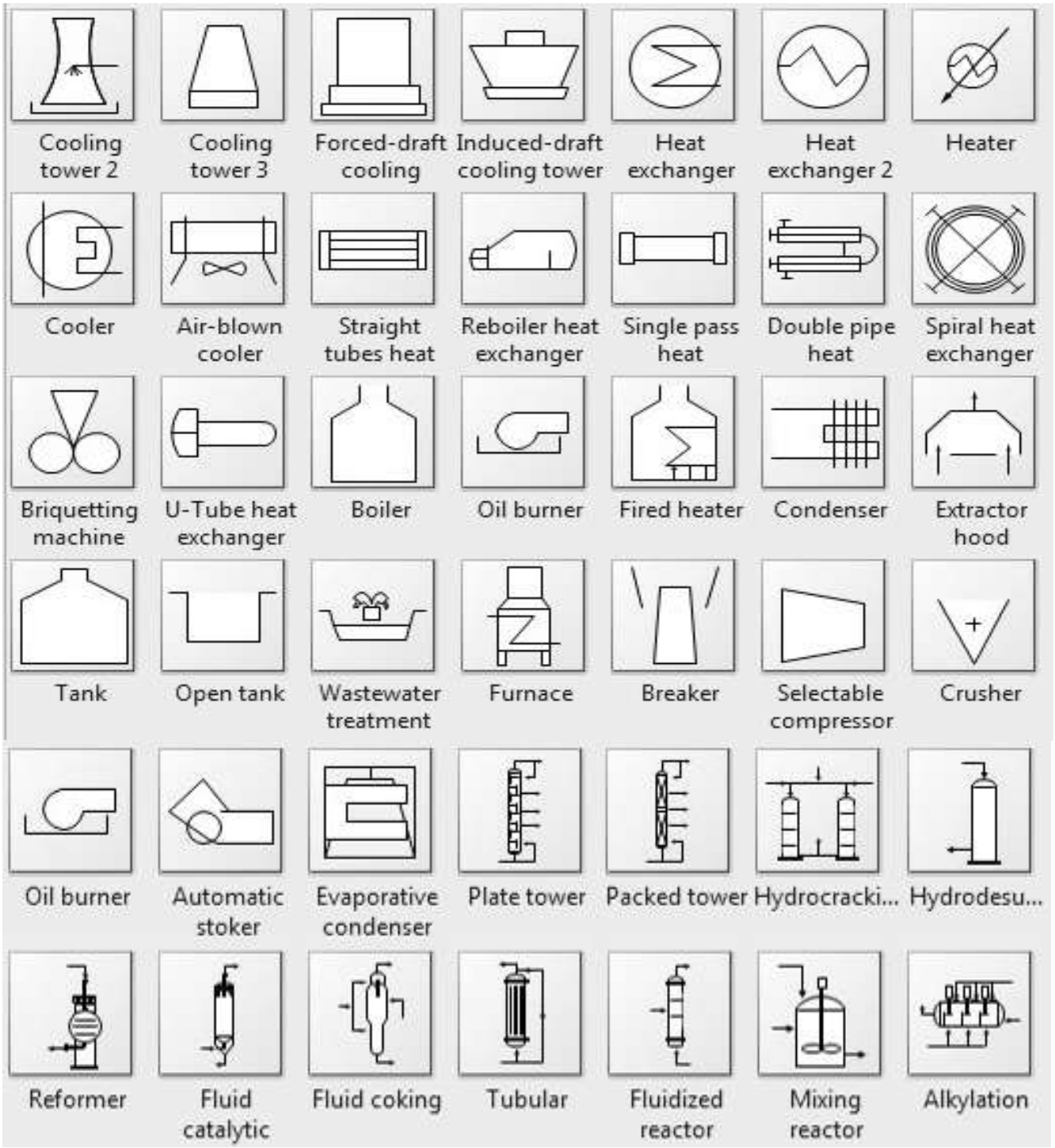

Sweet gas
Condenser
CW
$(H_2S + CO_2)$
Acid gas
Makeup
water
Reflux
drum
Top
tray
Rich
amine
Top
tray
Reflux
Lean
amine
CW
Pump
Absorber
Regenerator
Sour Gas
Bottom
tray
Bottom
tray
Vapor
Steam
Reboiler
Liquid
Rich
amine
Lean
amine
Condensate
Pump
Typical operating ranges
Absorber : 35 to 50 °C and 5 to 205 atm of absolute pressure
Regenerator : 115 to 126 °C and 1.4 to 1.7 atm of absolute pressure
at tower bottom

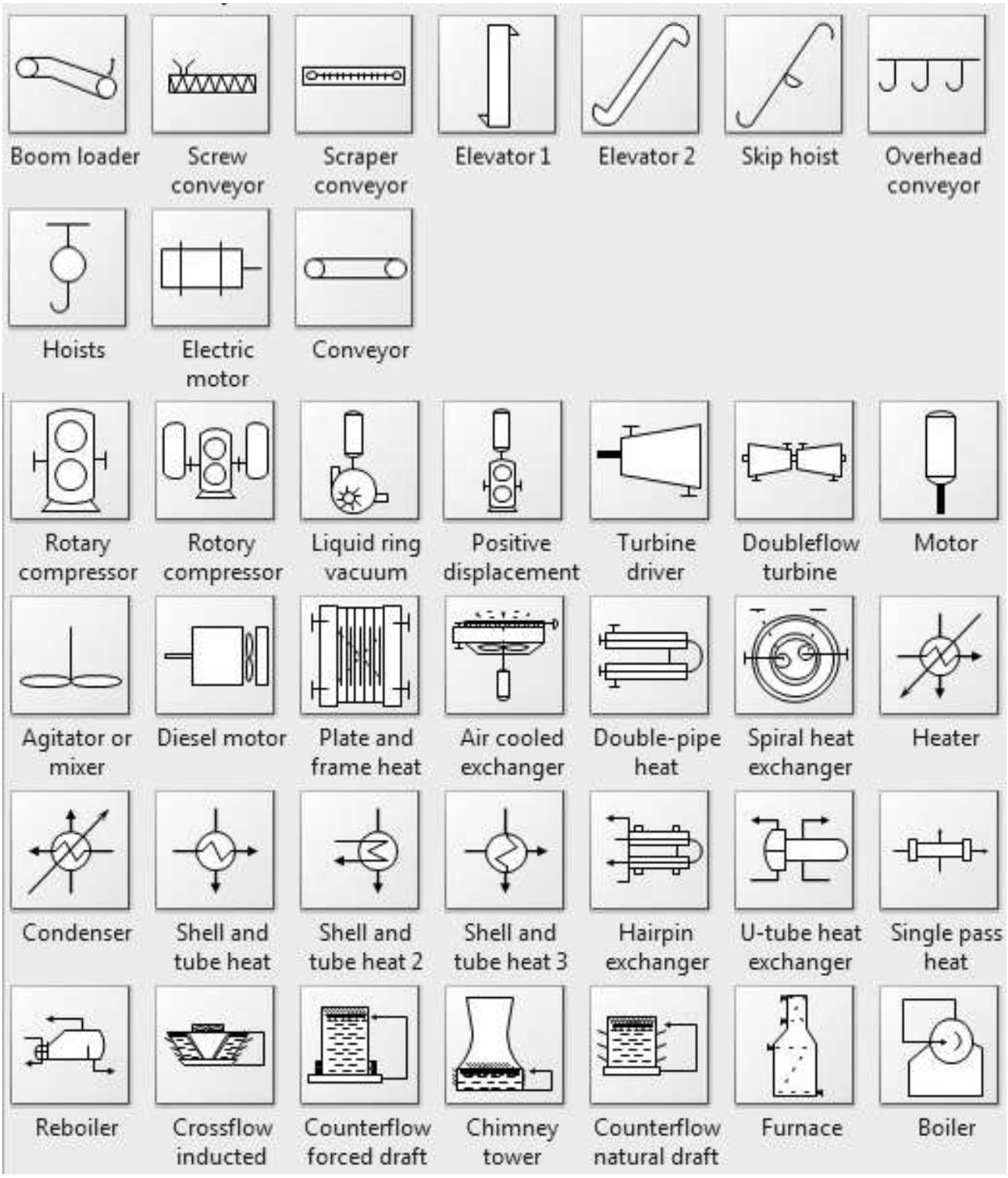
LINE DIAGRAM SYMBOLS

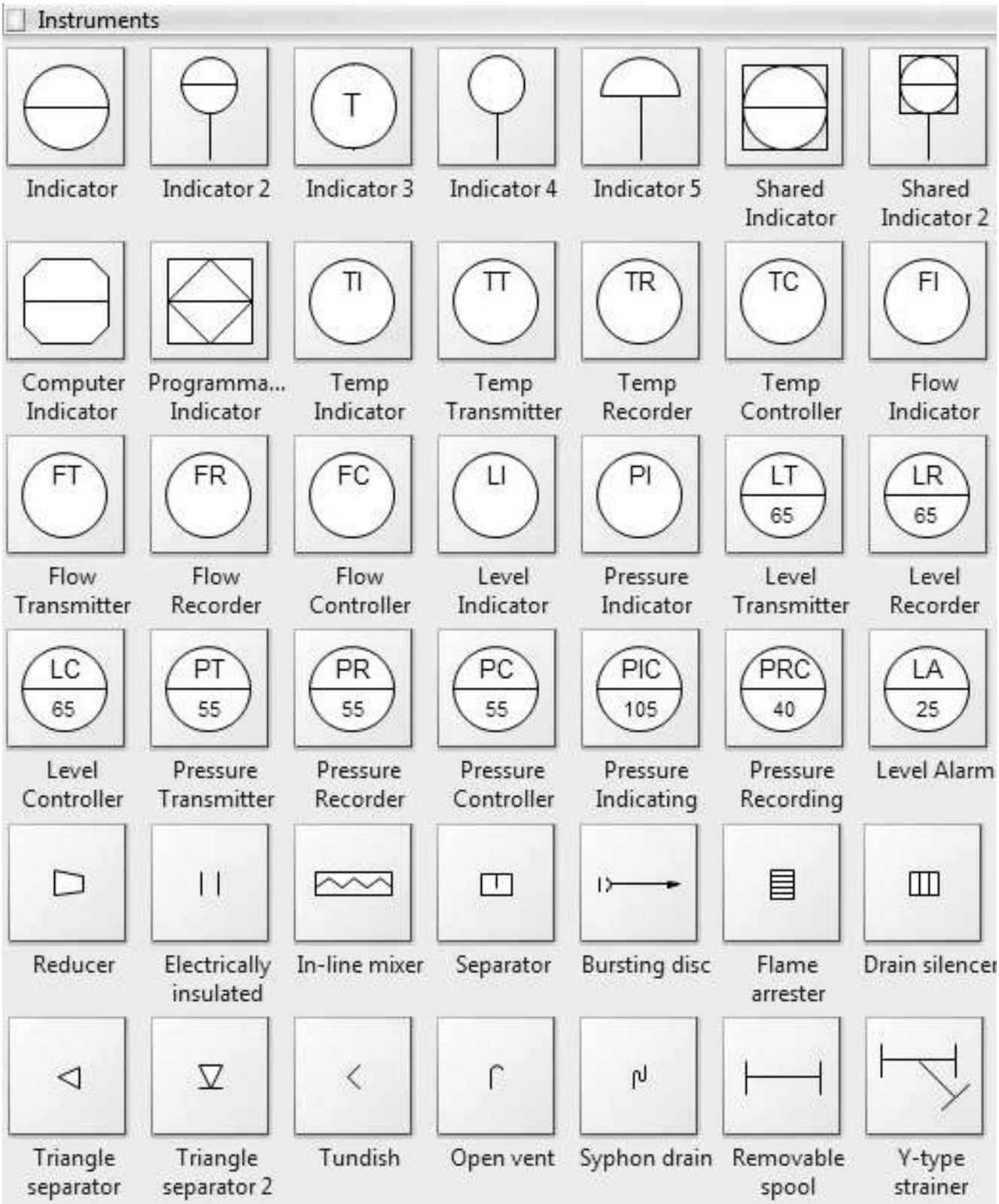
PLANT ITEMS, PIPEWORK AND INSTRUMENTS

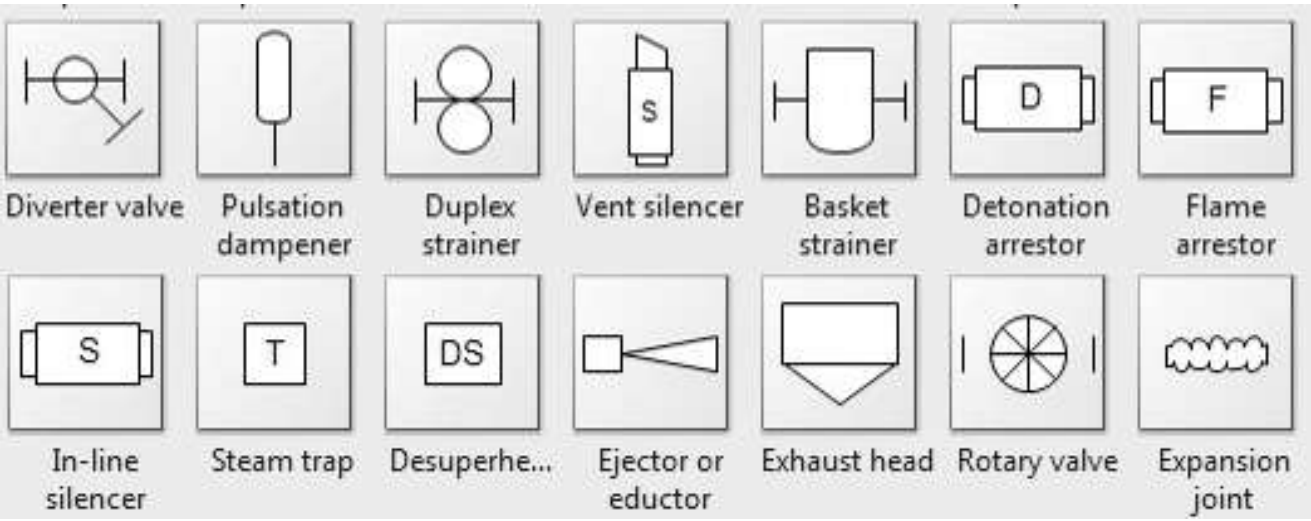



Equipments
Compressor
Reciprocati... compressor
Compressor silencers
Centrifugal
Rotary compressor
Liquid ring compressor
Centrifugal compressor
Mixing
Mixing reactor
Jacketed mixing vessel
Half pipe mixing vessel
Vertical vessel
Horizontal vessel
Column
Pump
Centrifugal pump
Centrifugal pump 2
Centrifugal pump 3
Vertical pump
Rotary gear pump
Proportioni... pump
Vacuum pump
Screw pump
Turbine pump
Pump 2
Bag
Gas bottle
Selectable fan
Cooling tower 2
Cooling tower 3
Forced-draft cooling
Induced-draft cooling tower
Heat exchanger
Heat exchanger 2
Heater
Cooler
Air-blown cooler
Straight tubes heat
Reboiler heat exchanger
Single pass heat
Double pipe heat
Spiral heat exchanger


Cooling tower 2
Cooling tower 3
Forced-draft cooling
Induced-draft cooling tower
Heat exchanger
Heat exchanger 2
Heater
Cooler
Air-blown cooler
Straight tubes heat
Reboiler heat exchanger
Single pass heat
Double pipe heat
Spiral heat exchanger
Briquetting machine
U-Tube heat exchanger
Boiler
Oil burner
Fired heater
Condenser
Extractor hood
Tank
Open tank
Wastewater treatment
Furnace
Breaker
Selectable compressor
Crusher
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
Rotary compressor
Rotory 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 inducted
Counterflow forced draft
Chimney tower
Counterflow natural draft
Furnace
Boiler


Instruments
Indicator
Indicator 2
T
Indicator 3
Indicator 4
Indicator 5
Shared Indicator
Shared Indicator 2
Computer Indicator
Programma... Indicator
TI
Temp Indicator
TT
Temp Transmitter
TR
Temp Recorder
TC
Temp Controller
FI
Flow Indicator
FT
Flow Transmitter
FR
Flow Recorder
FC
Flow Controller
LI
Level Indicator
PI
Pressure Indicator
LT
65
Level Transmitter
LR
65
Level Recorder
LC
65
Level Controller
PT
55
Pressure Transmitter
PR
55
Pressure Recorder
PC
55
Pressure Controller
PIC
105
Pressure Indicating
PRC
40
Pressure Recording
LA
25
Level Alarm
Reducer
Electrically insulated
In-line mixer
Separator
Bursting disc
Flame arrester
Drain silencer
Triangle separator
Triangle separator 2
Tundish
Open vent
Syphon drain
Removable spool
Y-type strainer



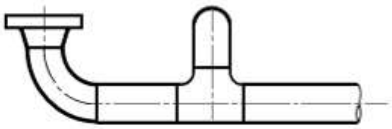
SINGLE LINE, DOUBLE LINE AND PIPING ISOMETRICS

Drawings of piping systems may be either single line, double line or isometric.

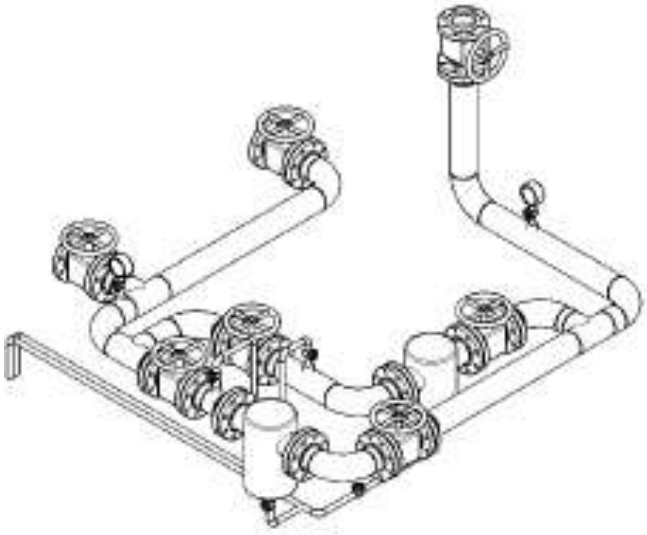
They are drawings of pipe runs shown pictorially with all necessary detail including dimensions, with symbols indicating valves etc. to allow them to be fabricated and installed.

DOUBLE LINE DRAWING

A double line drawing is basically an orthographic projection of a system showing a great amount of detail giving an almost true to life view drawn to scale.



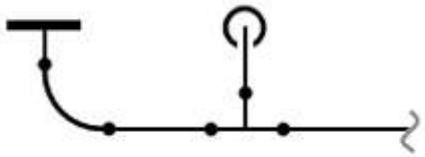
Double-line drawing of pumping station



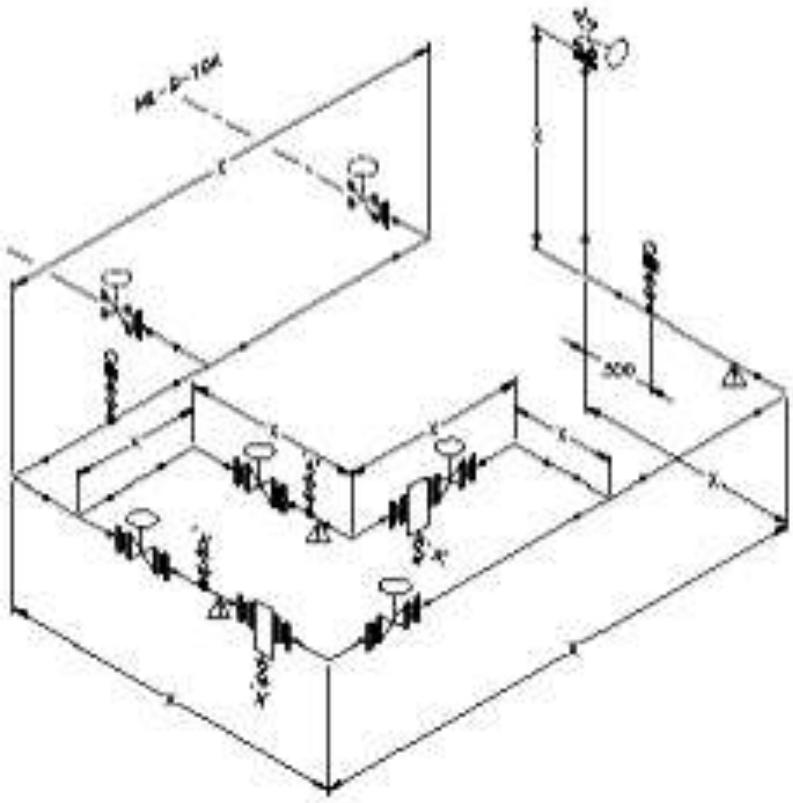
SINGLE LINE DRAWING

A single drawing does not look as realistic and uses symbols to show fittings and sizes.

Once the symbols are understood, a lot of information can be gained very quickly from the drawing.



Single-line drawing of pumping station



ISOMETRIC DRAWING

This is an angular view of a piping system as shown above to give a three dimensional appearance and aiding the installation by giving an undertaking of direction, position and shape. Note that isometric drawings are not to scale or in perspective but give an overall view, therefore particular attention should be paid to the dimensions given.