MISCELLANEOUS COURSES

DIAGRAMS

TRAINING MANUAL
Course EXP-PR-DI010
Revision 0.1

MISCELLANEOUS COURSES

DIAGRAMS

CONTENTS

1. OBJECTIVES

The objective of this course is to allow future operators to understand the theoretical bases required for reading plans and diagrams that he or she will encounter when performing routine tasks on a facility used essentially in the oil industry.

Upon completion of the course, participants should be able to:

- List the different types of plans and diagrams seen by production operators
- Explain the role and function of each of the plans and diagrams
- Identify the symbols used
- Associate each symbol with the corresponding equipment
- Interpret the coding of symbols
- Associate the symbols with the explanatory legends of the diagrams
- Recognise, identify process operation on a diagram
- Follow a path, evolution, transformation of a fluid on a plan/diagram
- Simply, read plans/diagram that will be presented

After having acquired a minimum amount of experience on the site, the course participant/operator should be able to:

- Draw the correspondence between a graphic representation and the equipment on the facility.

  Identify the equipment on the facility
- Walk-through (physically) a process, identifying the pipes and instruments on the plans/diagrams
- Interpret the numbering/codes of the pipes and instruments

2. DRAWINGS

2.1. WHAT ARE DIAGRAMS USED FOR?

Aim:

Diagrams are used to represent all or part of a production unit and to make it easier to understand to obtain a general view or details.

Principle:

Symbols are used to represent:

- chemical engineering equipment, valves and fittings, fluid displacement equipment,
- piping,
- measurement, control and safety instruments.

In France, AFNOR (**A**ssociation **F**rançaise de **NOR**malisation – French Standards Organisation) has produced a standard defining the rules for this diagrammatic representation.

Three main types of diagrams have been defined for the different types of diagrams used. Their definitions are given below, in English, as they are based on *International Standard Organisation* (ISO) standards used in all Total sites for uniformity:

- The **Plot Plan**: This document defines the location of equipment on the installations
  It is also a **Lay-out diagram** which determines the geographic positioning of equipment on a site. It also defines the locations in a horizontal and vertical plane
- The **Block Flow Diagram**: which defines the logical progression of the different production phases. It does not use symbols.
- The **Process Flow Diagram or PFD**: it is generally produced to define or analyse a process. It provides an overview which is sufficient to understand the system.
  In this diagram the equipment, which has an equipment legend, is shown by a symbol or represented in a simplified manner.
  The piping is limited to the main links between the equipment.
  The control, measurement and regulation equipment is limited to the devices essential to understand the system.
  For complex installations, the process flow diagram can be broken down into several diagrams to make it easier to read and understand.

- **Piping and Instrument Diagram** (**P.I.D**.), this document is produced in the project phase, and is a much more complex representation than the PFD, of all of the process lines and vessels and their operating parameters. This is a vital document *(the bible!) for the process operator.*

- **Isomeric Drawings**: drawn up when designing an installation (in the study phase) and to understand the routing of the different pipes on a site.
  An isomeric drawing is a document (or folder, a series of plans) showing the pipe routing in three dimensions, in a single figure.

- The **detailed diagram** or **equipment diagram**: produced to define the equipment and to provide drawings of the piping and its assembly, they are accompanied by parts lists (**Data Sheets**).
  The chemical engineering equipment is shown in a simplified manner and the other equipment is represented by symbols.

- The **Safety Diagram**: it defines the logical sequence of the different phases in an emergency triggering sequence. It does not use symbolic representation.

It is the representation of shutdown sequences, with their different levels (from zero to four) and the actions of the **Fire & Gas** system
Representation:

- **General symbols**: They define an equipment family. They are used on the PFDs when the exact type of the equipment has not been defined.

- **Specific symbols**: They specify a type of equipment in each family. They are used on PIDs.

- **Simplified representation**: It applies to PIDs or PFDs representing chemical engineering equipment. It represents an image of the general aspect of the equipment concerned.

Formats and scales:

- The PFDs are drawn on paper of standardised width and sufficient length.

- The PIDs are drawn on standardised formats and generally limited to A0 (840 x 1188).

- The symbols have no scale. In each case, the size of each symbol is chosen to make it easy to read. In PIDs it is sometimes preferable to define a scale to respect the equipment levels and relative positions, where possible.

- In split diagrams, the incoming and outgoing lines of the common pipes must be placed on the same levels so that they can be placed side by side.

2.2. EXAMPLE

The PID is a typical example of the drawings found on the site. As we will see later, this type of drawing provides a great deal of information about the installation.

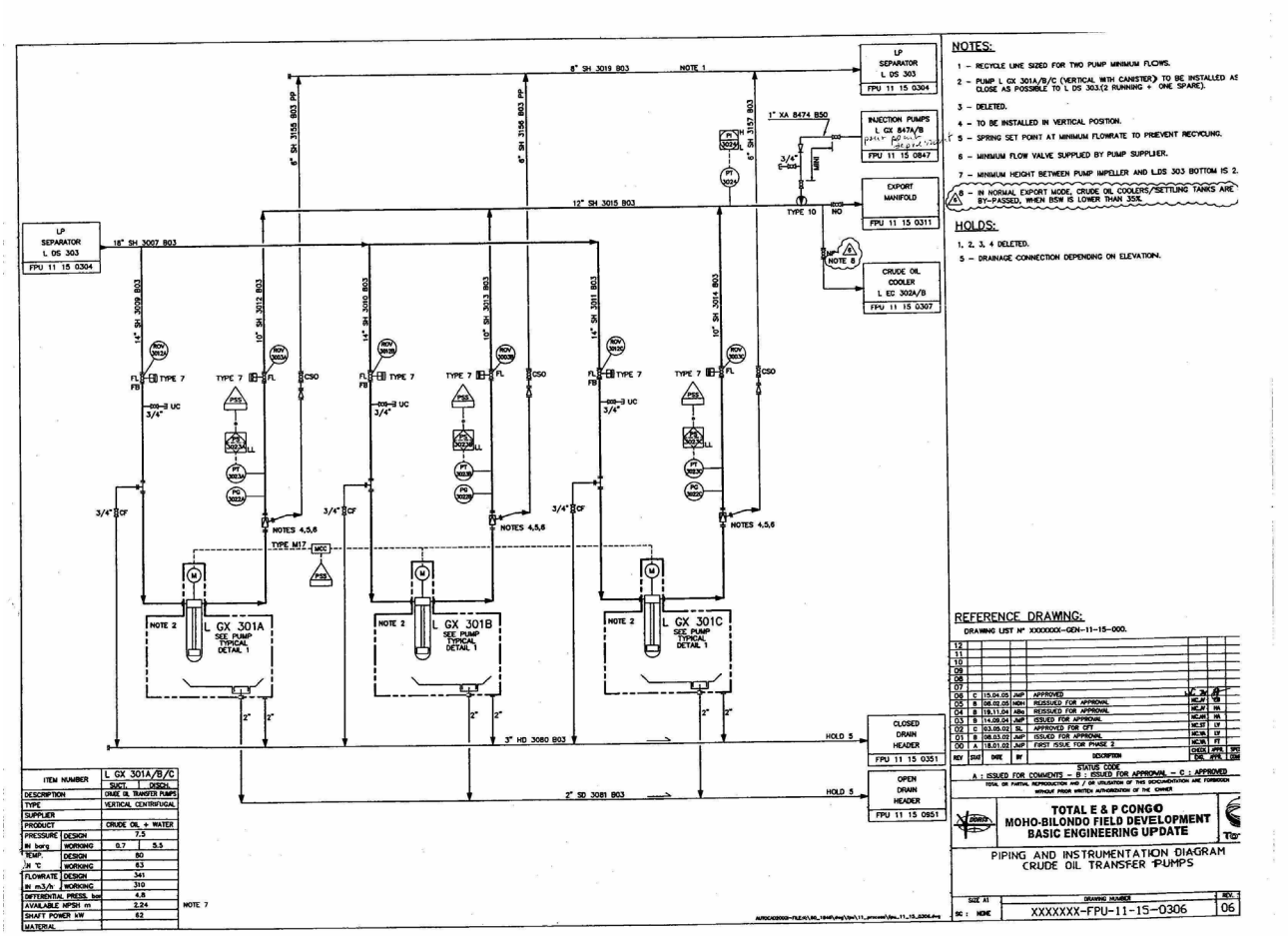


Figure 1: Example of a PID

2.3. EXERCISES

1. Diagrams provide a general view or details to make all or part of a production installation easy to understand.

   ❑ True

   ❑ False

2. Name several types of diagrams AFNOR has defined. What do they represent?

3. THE DIFFERENT TYPES OF DIAGRAMS

There are different types of diagrams concerning an installation. However, it is sometimes difficult to find them. This is why we will try to cover all the drawings which may be found on a site, and particularly those which are useful to an operator.

3.1. BLOCK FLOW DIAGRAM

This diagram explains the operating principle of the whole installation in just a few boxes.

The schematic diagram of the N'Kossa site in the Congo is given below.

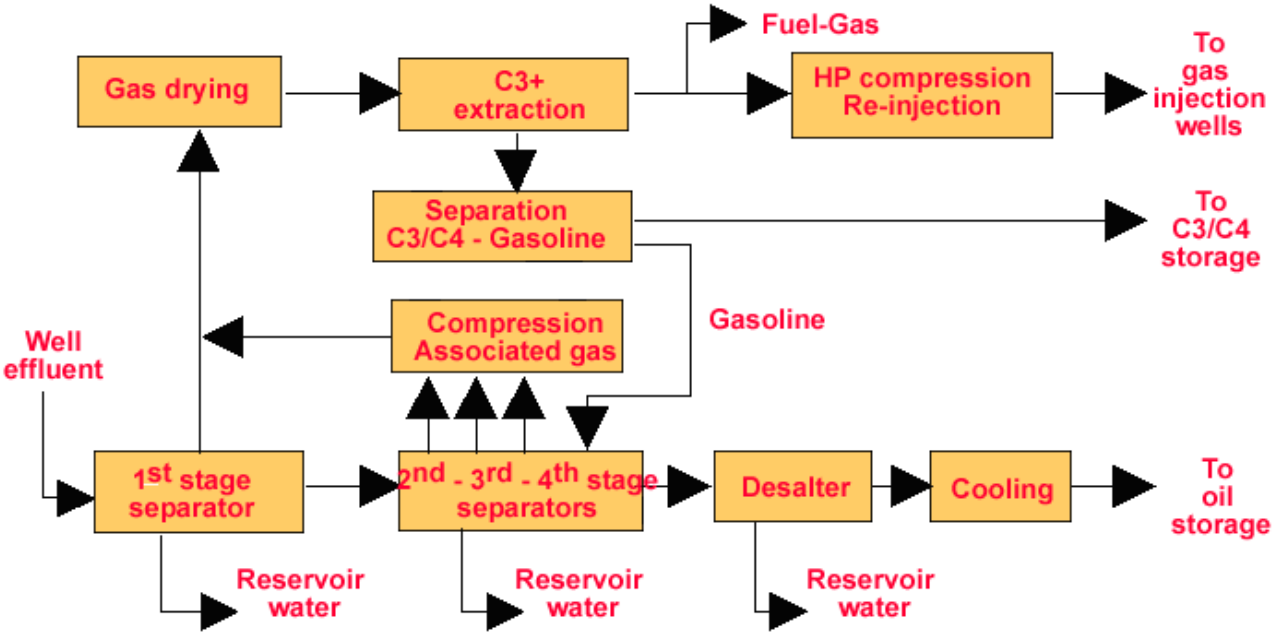


Figure 2: Block flow diagram of the N'Kossa site

3.2. PLOT PLAN

Plot Plan: This plan defines the layout (location) of the equipment in the installations. The following drawing shows the locations of the three separators and two desalters which are part of the Girassol FPSO treatment system in Angola.

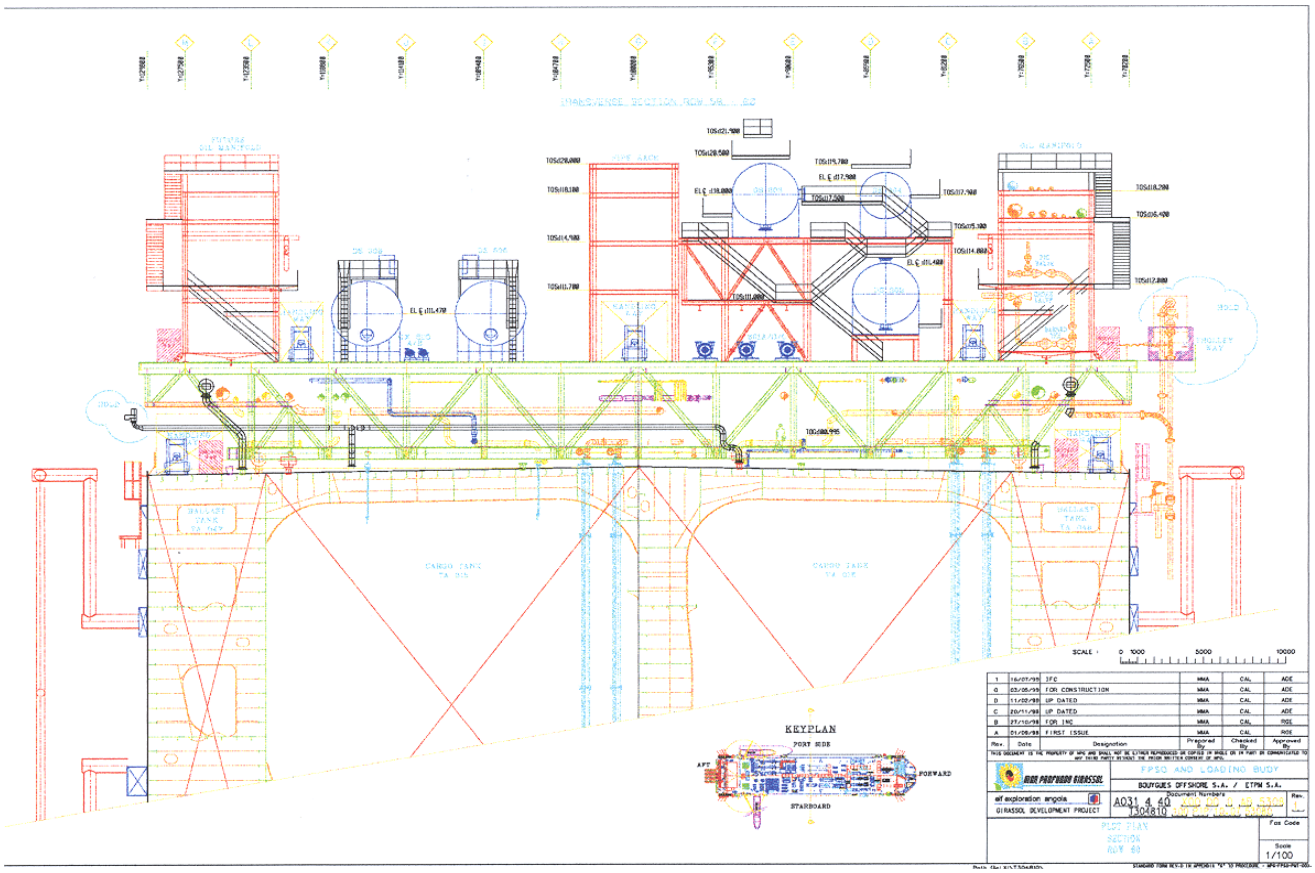


Figure 3: Layout drawing (Plot Plan) of the Girassol separators and desalters

3.3. PROCESS FLOW DIAGRAM (PFD)

The PFD shows the process logic.

This diagram issued during the project phase shows in a simplified format the main process lines and tanks and their main operating parameters.

These diagrams show the process operating parameters in the following form:

	Temperature (°C)		Liquid flow rate (m^3/h)
	Pressure (bar)		Gas flow rate (Sm^3/d)
	Fluid number		Mass flow rate (t/h)

Table 1: Presentation of the operating parameters

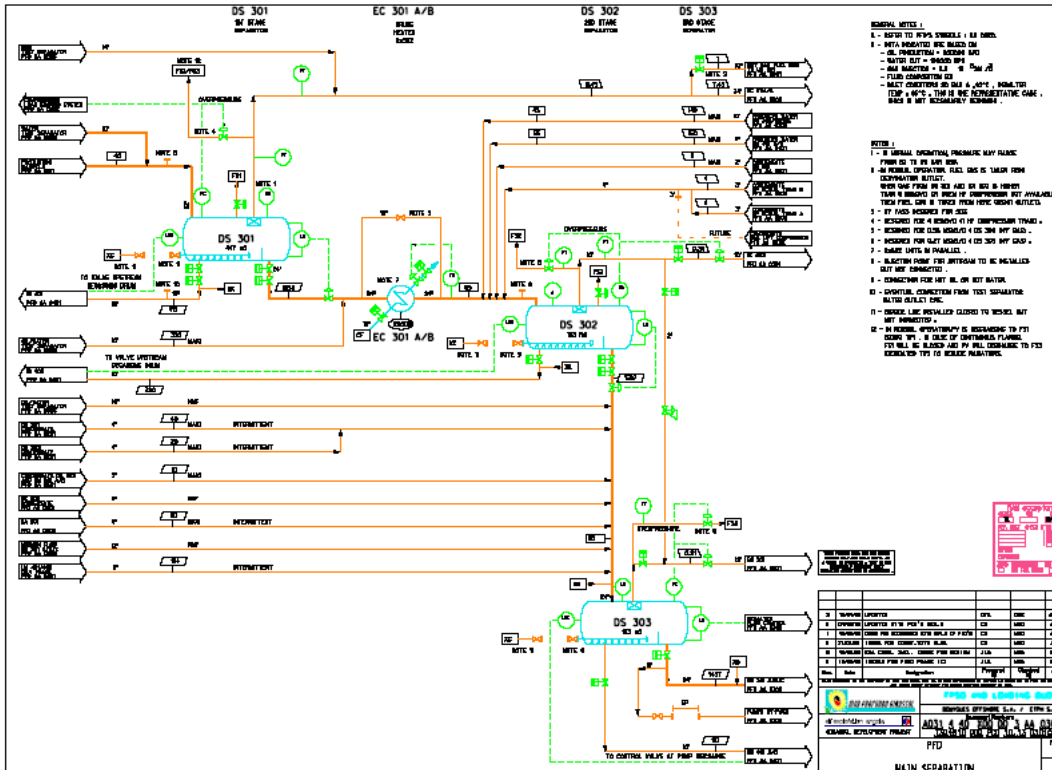


Figure 4: Girassol separation system PFD

3.4. PIPING AND INSTRUMENTATION DIAGRAM (PID or P&ID)

The Piping and Instrumentation Diagram is issued during the project phase. It shows all the pipelines and tanks and their operating parameters in a much more detailed manner than the PFD.

It shows:

- the fluid flow directions
- the main characteristics of the equipment
- the pipeline numbers
- the equipment identification
- the instrumentation, control systems and safety devices.

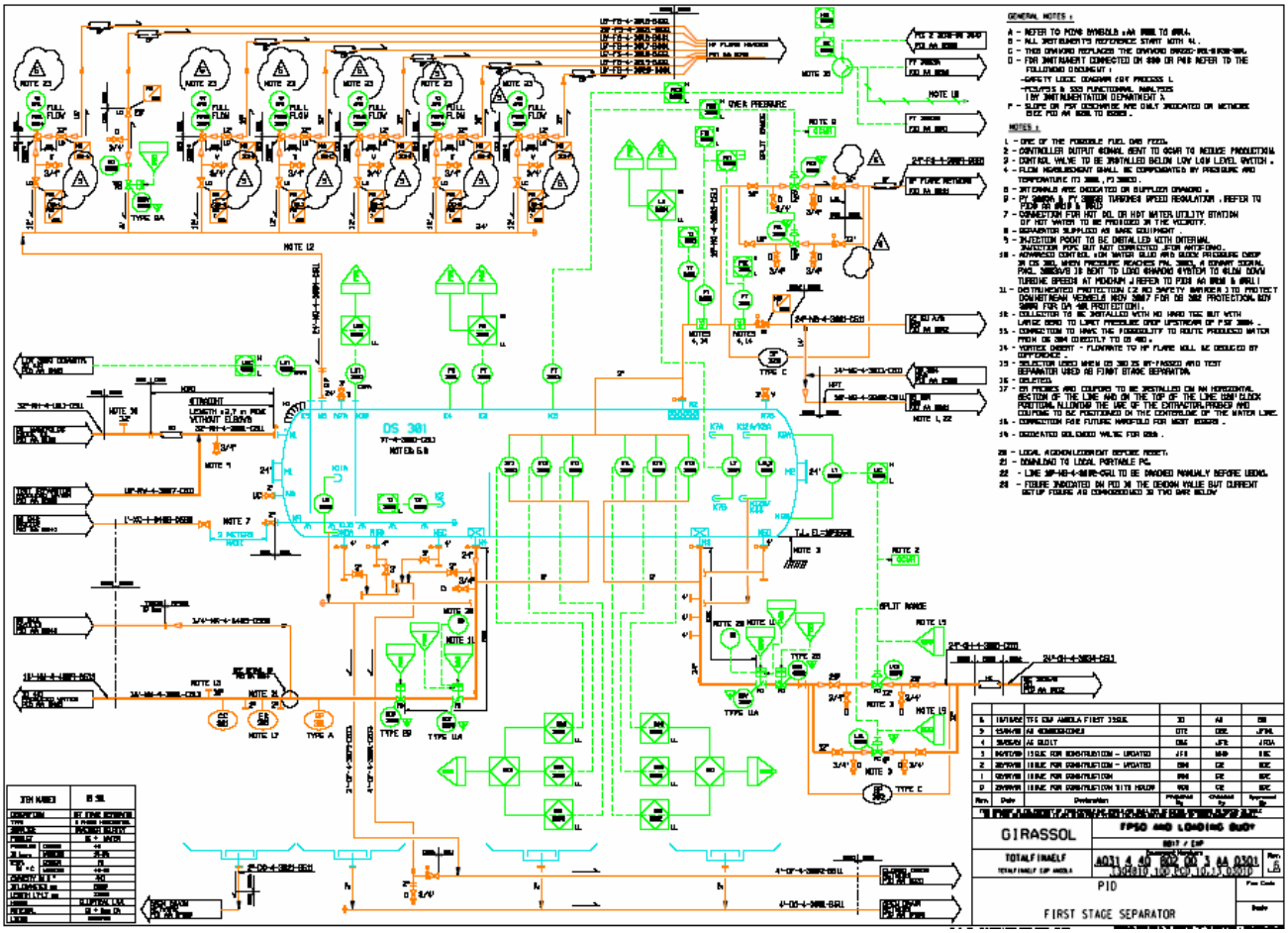


Figure 5: Girassol 1st stage separator PID

3.5. ISOMETRIC DIAGRAM

This type of diagram gives a three-dimensional representation of the installations *(with an indication of the isometric angles, for construction)*, and in particular:

- The pipelines
- The valves
- The equipment

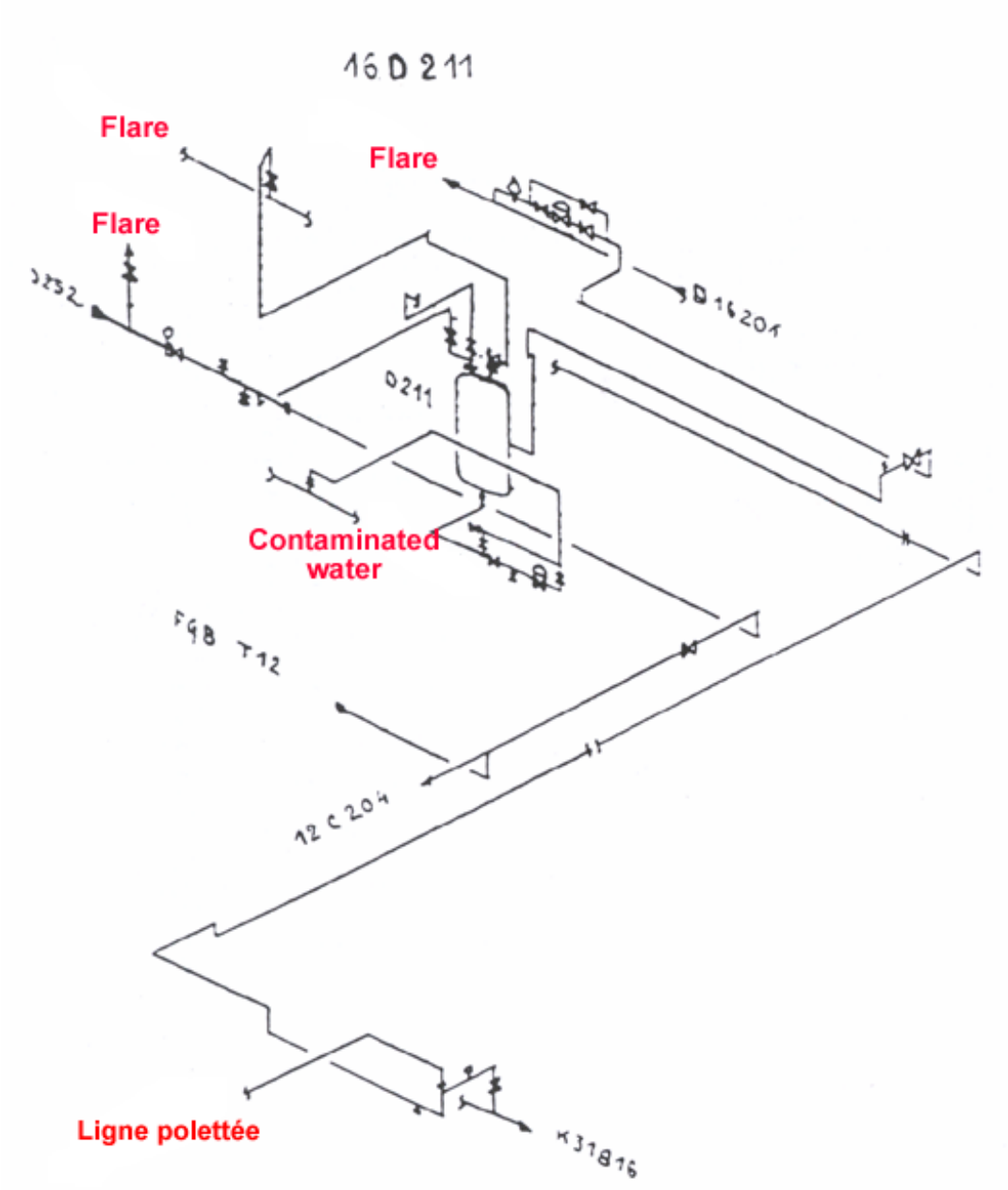


Figure 6 : Isometric drawing

3.6. SAFETY LOGIC DIAGRAM

This diagram show all the safety actions carried out following a process anomaly

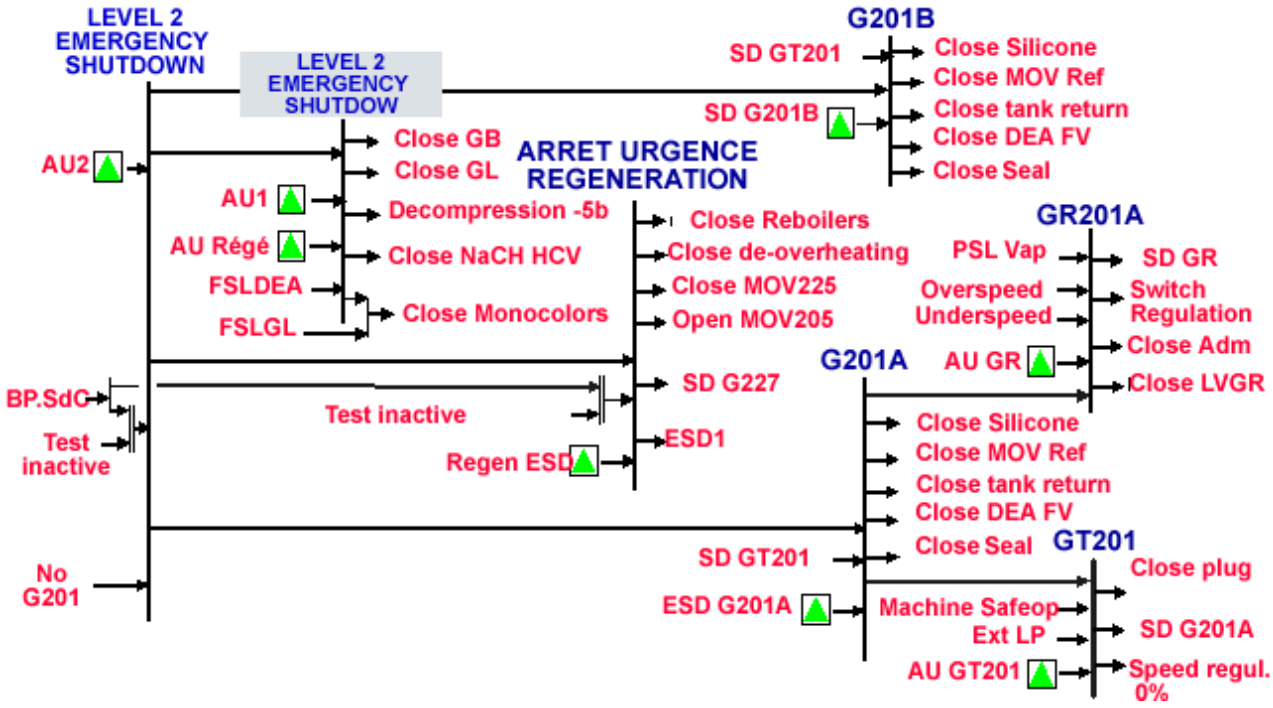


Figure 7: Safety diagram

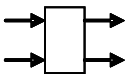
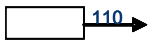
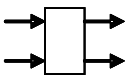
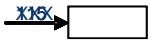
	Safety bar		From safety logic diagram 110
	“OR” function		To safety logic diagram 115
	“AND" function		Time delay
	Action ON "xxx"		Pulse signal
	Trip from "xxx"		

Table 2: Safety logic diagram symbols

3.7. DATASHEET

This type of document provides a great deal of information about an item of equipment.

The following example shows the datasheet for a compressor suction scrubber.

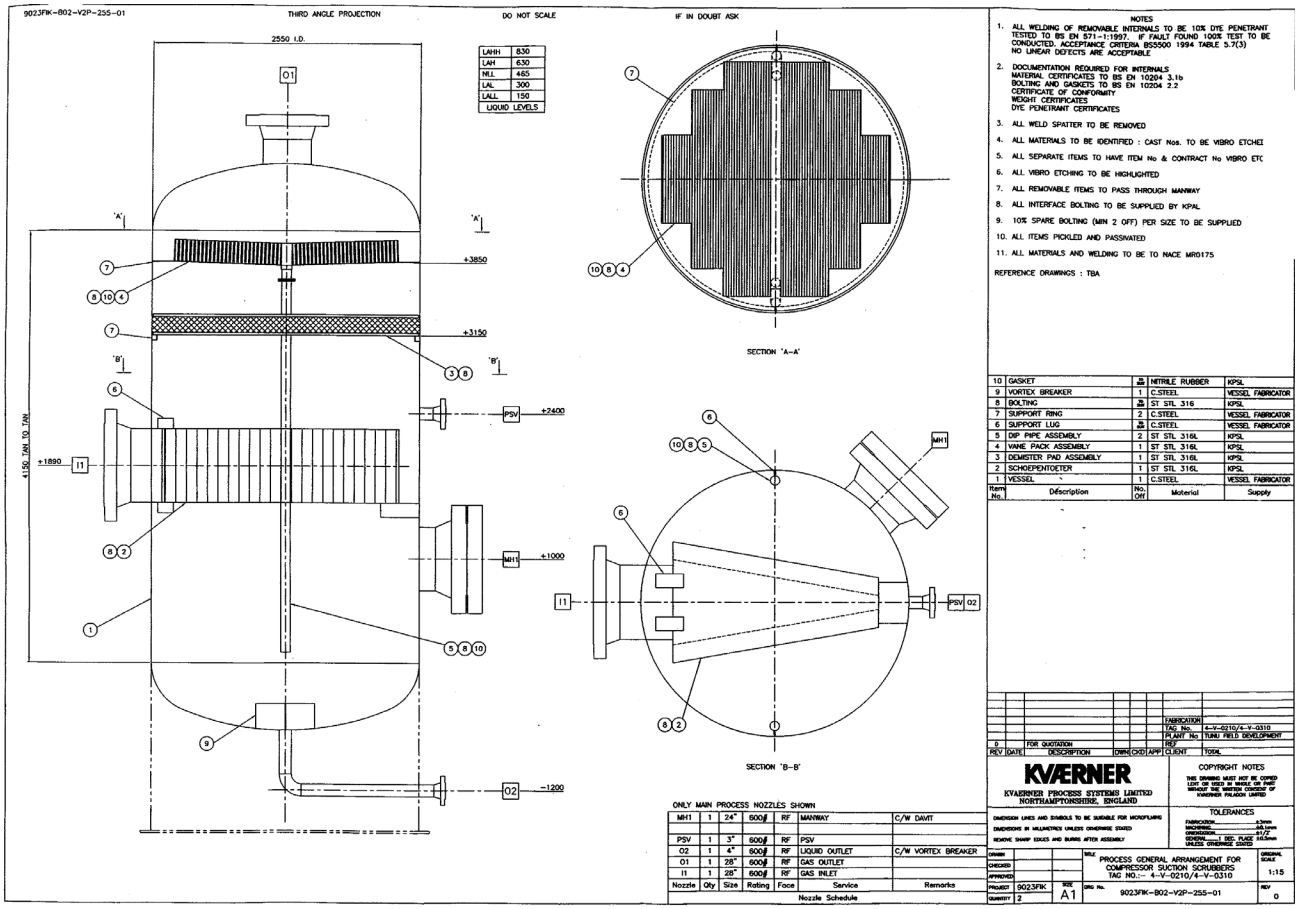


Figure 8: Scrubber datasheet

3.8. EXERCISES

3. It explains the installations overall operating principle in a just a few boxes.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow Diagram
- ❑ Piping and Instrumentation Diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet
- ❑ Plot plan (Layout diagram)

4. It defines the locations of the equipment in the installations.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow diagram
- ❑ Piping and Instrumentation Diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet
- ❑ Plot Plan (Layout diagram)

5. It allows us to read the process logic. This diagram issued during the project phase shows in a simplified format the main process lines and tanks and their main operating parameters.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow diagram
- ❑ Piping and instrumentation diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet

6. This diagram issued during the project phase shows all the pipelines and tanks and their operating parameters in a much more complex manner than the PFD.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow diagram
- ❑ Piping and Instrumentation Diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet
- ❑ Plot Plan (Layout diagram)

7. This type of diagram gives a three-dimensional representation of the installations.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow diagram
- ❑ Piping and Instrumentation Diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet
- ❑ Plot Plan (Layout diagram)

8. This type of document provides a great deal of information about the equipment.

- ❑ Process Flow Diagram (PFD)
- ❑ Block Flow diagram
- ❑ Piping and Instrumentation Diagram (PID)
- ❑ Isometric diagram
- ❑ Datasheet
- ❑ Plot Plan (Layout diagram)

4. CODING PRINCIPLE

To correctly understand the identification markings used there is a coding system which defines the equipment, the pipelines and the instrumentation.

These markings will be detailed in the following chapter.

4.1. EQUIPMENT

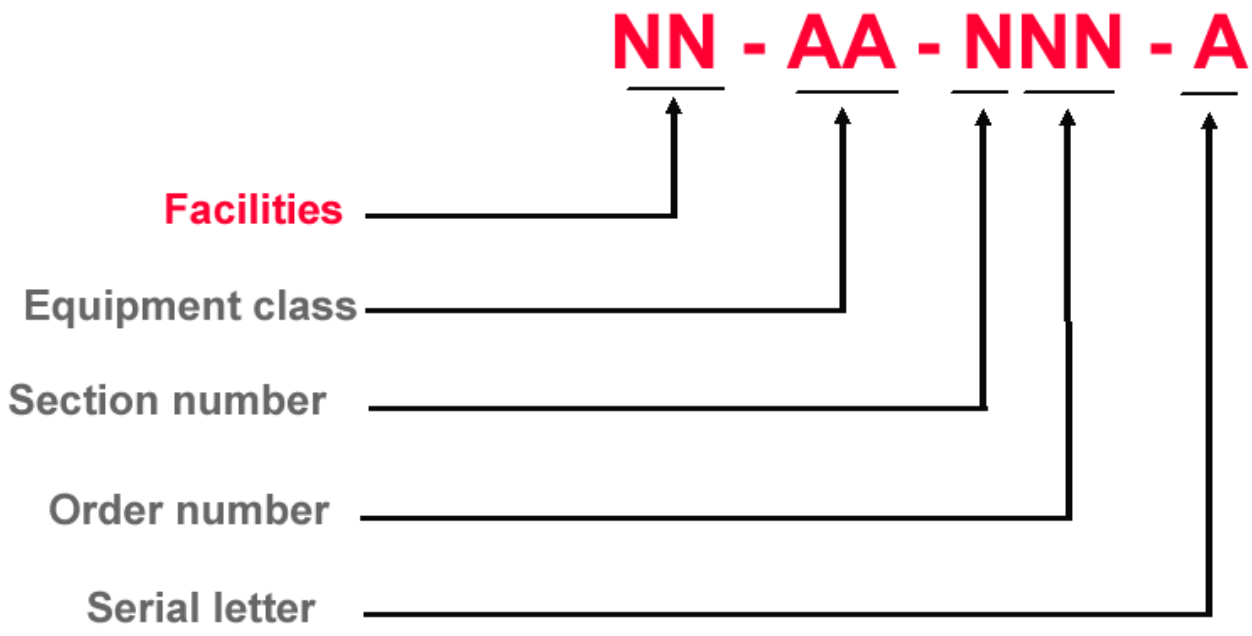


Figure 9: Coding principle - equipment

4.1.1. Facility

It is determined by the project manager.

It can be a letter or a number or both.

Example:

- AMENAM → 40
- COBO → 8F
- N 'KOSSA → D

4.1.2. Equipment class

A Design - Support – Supervision

B Civil works

C Columns and internals

CA Plate towers or packed towers

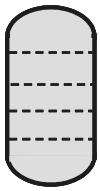
	Packed tower		Plate tower

Table 3: Column symbols

CY Column plates and internals

D Pressurised tanks - Reactors - Separators - Scrubbers

DA Tanks, pressurised spheres, round bottomed storage tanks, drain tanks

DB Mixed or packed process reactors

DC Tubular reactors

DD Lamp reactors

DE Precoat filters

DF Fixed bed dryers (excluding the packages)

DG Pig trap

DS Separators, scrubbers including internal and external equipment

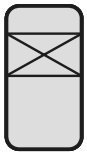
	Horizontal tank		Diffuser
	Vertical tank		Fin package
	Scrubber		Demister grille
	Pig trap		Vortex breaker

Table 4: Tank symbols

E Thermal exchange equipment

EA Cooling tower

EB Air cooler / Air-cooled condenser

EC Exchanger, evaporator, reboiler, condenser

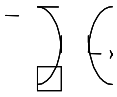
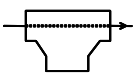
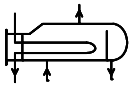
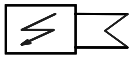
	Cooling tower		Plate exchanger
	Air cooler		Reboiler (Kettle)
	Tube exchanger		Electric heater

Table 5: Thermal exchange equipment symbols

F Thermal equipment: Furnaces - Heaters - Heating equipment - Burners

- **FA** Furnaces, heater
- **FB** Burners, flare tips
- **FC** Heating equipment, chimneys
- **FD** Incinerators

G Pumps - Drives - Ejectors

- **GA** Pumps
- **GB** Injectors, ejectors
- **GC** Special pumps (gas pump, etc.)

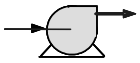
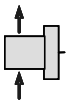
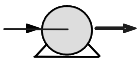
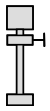
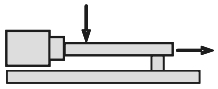
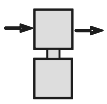
	Centrifugal pump		Metering pump
	Rotary pump		Submersible pump
	Screw pump		Moineau excentric screw pump
	Screw pump		Manual pump
	Reciprocating pump		Ejector

Table 6: Pump, drive and ejector symbols

H Boilers - Driers - Industrial ovens

HA Boilers

HB Driers, industrial ovens (excluding air dryers)

I Various mixing, separation and filtration equipment

IA Stirrers, mixers

IB Crushers, granulators, clod breakers

IC Centrifuges

ID Settling tanks

IE Extruders, machines for transforming plastics

IF Filters, sieves

IG Hydrocyclones, dust separators

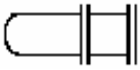
	Hydrocyclone		Stirrer

Table 7: Various equipment symbols

J Fixed packaging, handling and weighing equipment

JA Product packaging and/or weighing equipment

JB Equipment for handling bulk products or packages

JC Bulk loading equipment

JD Fixed handling equipment for dismantling installations: fixed cranes, overhead gantries, monorails, etc.

JE Machine tools and workshop equipment

JF Fixed fire-fighting equipment: fire hydrants, sprinkler, nozzles, hose reels, water screens, etc.

JK Mobile fire-fighting equipment: extinguishers, etc.

K Compressors - Boosters - Fans and drives

KA Fans, Blowers

KB Compressors, boosters, self-driven compressors

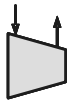
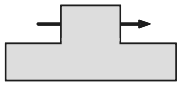
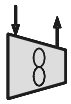
	Fan – Blowers		Screw compressor
	Centrifugal compressor		Reciprocating compressor
	Blade compressor		

Table 8: Compressor, booster and fan symbols

L Pipes - Piping accessories – Valves and fittings

M Metal structures

N Instrumentation

O Protection - coatings and refractory products

P Electricity

PA Electricity generator

PB Power supply transformer

PC Rectifier, Inverter

PD Switchboard

PE Terminal box for motor

PF Electrical lines and cables

PG Auxiliary electrical equipment

PH Buried lines

PK Air conditioning, pressurisation of electrical equipment room

PY Turbogenerator

Q Remote transmission

R Land and developments (infrastructure)

S Buildings

T Storage tanks - Spray tanks - Unit tanks

TA Flat-bottomed storage tank, gasometer (atmospheric pressure, tank)

TB Silos

TC Sump caissons

TD FPSO (Floating storage facility)

TE Ponds, storage pits

U Compact assembly, package

UA Large preassembled units mounted on skids or on metal frameworks, such as: separation/drying/adsorption unit, various modules.

UB Small standard construction assemblies such as: air compressor unit and tank, air dryers, chillers, gas dryers, etc.

UC Offloading buoys

UD Various assemblies

V Initial loads and spare parts

W Equipment for general services

X Motors - Drive machines for non-specific drives

XA Asynchronous motors

XB Synchronous motors

XC Various motors

	Electric motor

Table 9: Electric motor symbols

Y Drive engines (Internal combustion engines, turbines)

YA Diesel engines

YB Petrol engines

YC Gas engines

YD Gas turbines

YE Process expansion turbines

YF Steam turbines

YG Hydraulic turbines

	Diesel engine		Gas turbine
	Gas engine		Hydraulic motor
	Steam turbine		Pneumatic motor

Table 10: Drive engine and motor symbols

Z Transmissions

- **ZA** Coupling
- **ZB** Clutch
- **ZC** Reduction unit and variable speed drive

4.1.3. Section number

100 Wells and manifolds

200 Low pressure gas

300 Oil treatment and export - drain tank - sump - drains

400 Formation water treatment

500 Gas compression

600 HP gas treatment and distribution

700 Water treatment and injection

800 Chemicals, fuel gas, compressed air

900 Ancillary systems (drinking water, industrial water, steam, etc.)

4.1.4. Order number

Two or three digit number for the chronological identification of equipment of a same type.

4.1.5. Serial letter

One letter for the parallel numbering of equipment of the same type.

4.2. PIPING

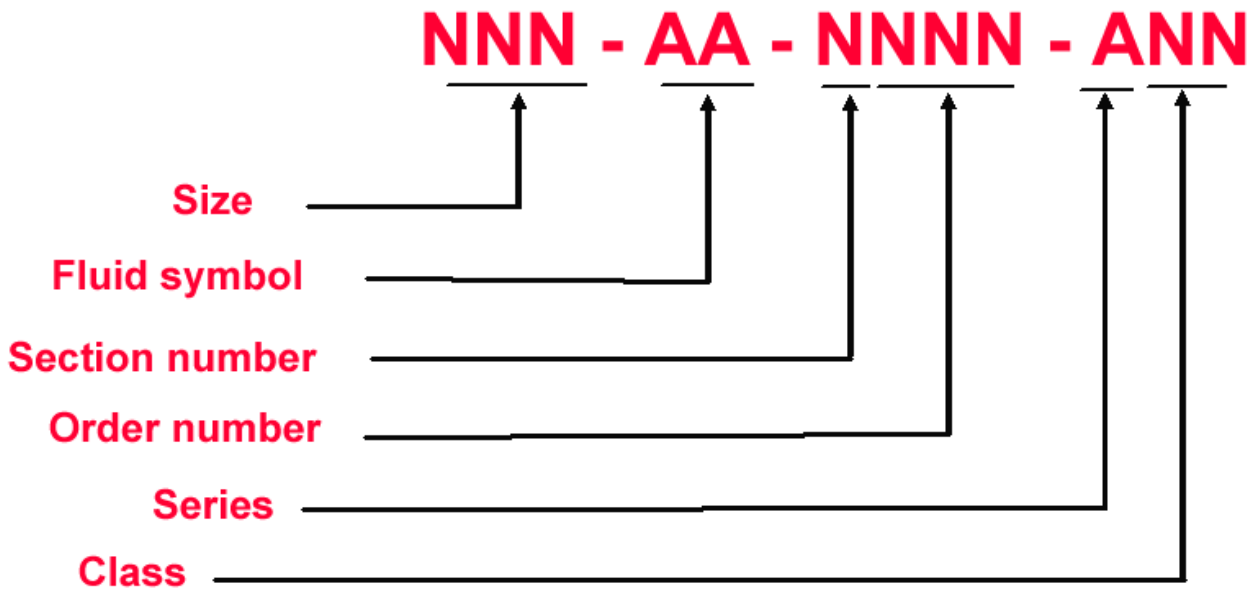


Figure 10: Coding principle - piping

4.2.1. Size

1, 2 or 3 digits for the line diameter in inches (") OR in nominal diameter (ND).

4.2.2. Fluid symbol

AG acid gas

AM methanol

BC butane

BV LP steam (4 bar)

BW distilled water

CD carbon dioxide (CO2)

CG condensate gas

CV steam condensates

CW cooling water

DG sulphur-free gas

EC ethane

FG treated fuel gas

FS flare

FW fire-fighting seawater

GC gasoline cut

GH oily effluent

GN nitrogen

HC oil cut

HD hydrocarbon drain

HS hydrogen sulphide (H2S)

HV HP steam (>40 bar)

HW treated fire-fighting water

IA instrument air

LA Lean amine (DEA)

LC LPG mixture

LE Lean selective amine (MDEA)

LD diethylene glycol (lean)

LT triethylene glycol (lean)

MV MP steam (12-24 bar)

NC raw condensates

NG raw natural gas

NH crude oil

NW formation water

PC propane

PW process water

RG raw fuel gas

SA service air

SG treated gas

WD contaminated water drain

4.2.3. Section number

100 Wells and manifolds
200 Low pressure gas
300 Oil treatment and export - drain tank - sump - drains
400 Formation water treatment
500 Gas compression
600 HP gas treatment and distribution
700 Water treatment and injection
800 Chemicals, fuel gas, compressed air
900 Ancillary systems (drinking water, industrial water, steam, etc.)

4.2.4. Order number

Three digit number for chronological pipe identification.

4.2.5. Series

B for 150 lbs

C for 300 lbs

D for 600 lbs

E for 900 lbs

F for 1,500 lbs

G for 2,500 lbs

H is dedicated to the instrumentation line class

J for 10,000 psi

K for 15,000 psi

4.2.6. Effluent classes

51 Low corrosiveness or non-corrosive liquid or gaseous HCs. Air. Nitrogen. Glycol. Methanol. Formation water. Contaminated water drains. Service gas. Drive air

52 With liquid or gaseous H2S - HC precautions. Formation water

53 Steam. Hot water steam condensate

54 Fire-fighting seawater

55 Distilled water. Freshwater. Drinking water

56 Oxygen-free seawater. Decanted formation water. Process water. Wastewater and rainwater drain. Treated fire-fighting water. Cooling water

57 Instrument air. Instrument gas

58 Bactericide. Oxygen inhibitor. Corrosion inhibitor. Demulslifier. Surfactant. Foam inhibitor. Scale inhibitor

59 Heat transfer fluid

60 Fuel gas combustible after final filter

61 Bleach. Antifouling.

70 Low corrosiveness or non-corrosive liquid or gaseous HCs. Formation water.

	Main pipes		Jacketed or double containment
	Secondary pipes		Heat insulated pipes
	Future piping routes		Heat insulated equipment

Table 11: Piping symbols

	Concentric reduction		Drain
	Cap		Sloping line
	Screw plug	X % X%	Sloping line
	Screw cap		Bird-proof grille
	Quick connection	CC	Corrosion coupon
	Insulating joint	CP	Corrosion probe
	Corrosion sleeve		Air overpressure / Vacuum tank

	Expansion joint		Spectacle blind (open)
	Hose		Spectacle blind (closed)
	Funnel		Spacer
	Noise reduction cartridge		Line blind
	Straightening vane		Connection

Table 12: Pipe accessory symbols

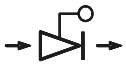
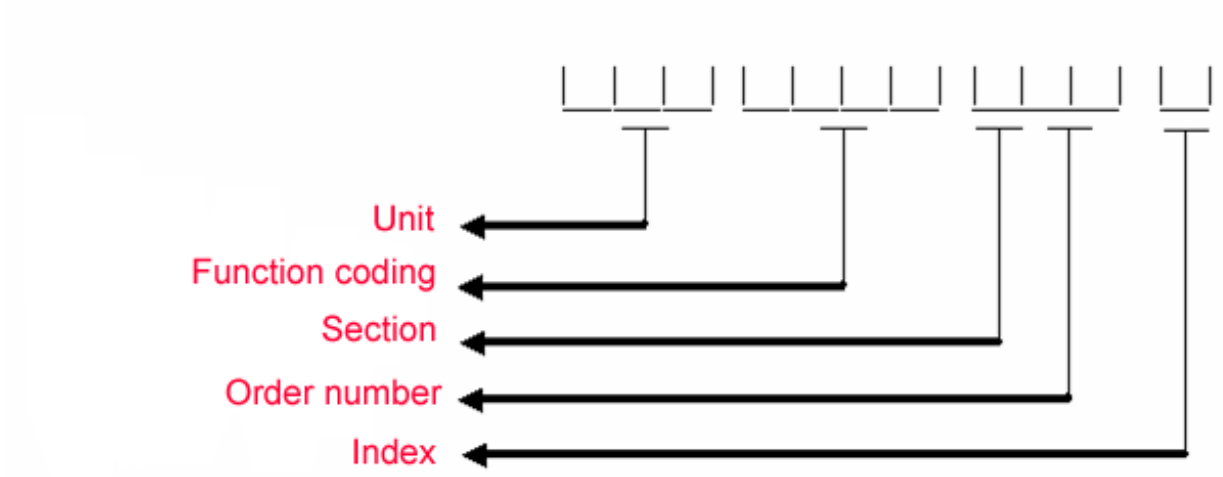
	Gate valve		3-way valve
	Ball valve		4-way valve
	Safety globe valve		4-way choke valve
	Butterfly valve		Diaphragm valve
	Angle valve		Check (non-return) valve
	Needle valve		Check (non-return) valve with counterweight

Table 13: Valve symbols

	Cartridge filter		Pulse damper
	Basket strainer		Calibration pot
	Y-type strainer		Silencer
	T-filter		Flame arrestor
	Temporary filter (between flanges)		In-line mixer
	Air filter		Breather
	Manway, access port		

Table 14: Various accessories symbols

4.3. INSTRUMENTATION



4.3.1. Unit

The unit number is indicated by 2 or 3 digits.

4.3.2. Function coding

The instrument functions are coded by a group of letters as shown in the following table.

The first letter represents the controlled parameter. The following letters indicate the exact function, in the order defined in the table.

	1st row	2nd row	3rd row	4th row
A	Analysis	Alarm	→	
B	Burner: flame detector		→	
C	Conductivity	Regulator	→	
D	Density	Differential, Ratio Interface	→	

E	Electric voltage	Primary element		
F	Flow rate			
G	Gas explosiveness Toxicity	Local indicator		
H	Manually operated		High	High
I	Electric current	Remote indicator		
J	Power			
K	Programmer			
L	Level	Light	Low	Low
M	User's choice			
N	Fire detection			
O	User's choice	Operator Orifice		
P	Pressure or vacuum			
Q	Quantity	Counter Integrator		
R	Remote control	Recorder		

S	Speed	Safety	→	
T	Temperature	Transmitter	→	
U	Multivariable	Multifunction	→	
V	Vibration Stepped displacement Accelerometer	Control valve	→	
W	Weight or force	Thermowell		
X	Unclassified	→	→	→
Y	User's choice	Function relay Converter		
Z	Position switch Axial position	→		

Table 15: Instrument function coding

Example:

VSH: Vibration Safety High

4.3.3. Section

List of sections:

100 Wells and manifolds
200 Low pressure gas
300 Oil treatment and shipping - drain tank - sump - drains
400 Formation water treatment
500 Gas compression
600 HP gas treatment and distribution
700 Water treatment and injection

800 Chemicals, fuel gas, compressed air
900 Ancillary systems (drinking water, industrial water, steam, etc.)

4.3.4. Order number

Two-digit number identifying instruments.

4.3.5. Index

Index number where several instruments with the same function belong to a same loop.

Index letter for instruments with the same function on identical production lines installed in parallel.

4.3.6. Analyser identification

AS Sampler

BSW Water-in-oil analyser

C Conductivity

CHL Chlorometer

CHR Chromatograph

CO CO analyser

CO2 CO_2 analyser

DCO DCO CBO DTO meter

DU Water hardness

H Hydrogen

HC Hydrocarbon

HY Hydrazine meter

M Humidity

O2 Oxygen meter

OP Opacimeter

PH pH meter

RE Refractometer

SG Density

TU Turbidimeter

V Viscosity

VP Vapour pressure

Example:

Recorded and regulated CO2 analyser

4.3.7. Symbols

———	Instrument line	- - - - - -	Analogue or logic electronic signal
//—//—//	Pneumatic signal	—○—○—○—	Digital signal
⊥—⊥—⊥	Hydraulic signal	X—X—X	By liquid or gas expansion capillary

Table 16: Instrument link symbol

	Local instrument		Instrument on local panel
	Instrument in Control Room or front of equipment room cubicle		Instrument on rear local panel
	Instrument in Control Room or on back of equipment room cubicle		

Table 17: Instrument symbols

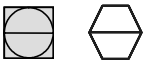
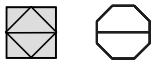
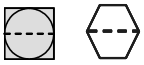
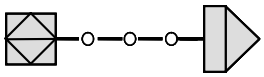
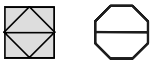
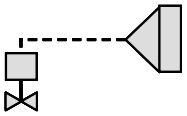
	Process control (accessible to the operator)		Safety process (inaccessible to the operator)
	Process control (inaccessible to the operator)		Safety system input
	Safety process (accessible to the operator)		Safety system output

Table 18: Symbols for instruments connected to the SNCC

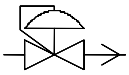
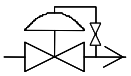
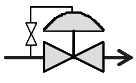
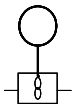
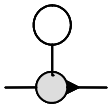
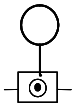
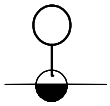
	Pressure reducing valve with internal pressure tap		Dump valve with internal pressure tap
	Pressure reducing valve with external pressure tap		Dump valve with external pressure tap

Table 19: Self-adjusting equipment symbols

	Control valve (manual operation only)		Manually operated diaphragm pneumatic servomotor control valve
	Diaphragm pneumatic servomotor control valve without positioner		Diaphragm pneumatic servomotor control valve with positioner
	On-off valve with piston servomotor or pneumatic or hydraulic cylinder		Valve with electric motor
	2-way valve solenoid		3-way valve solenoid
	Locally rearmed 2-way valve solenoid		

Table 20: Actuator symbols

	Flow rate indicator		Turbine
	Rotameter		Electromagnetic
	Orifice plate between flanges, with taps on flanges		Volumetric meter
	Orifice plate between flanges, with taps on pipes		Ultrasonic meter

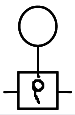
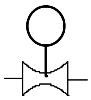
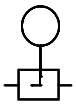
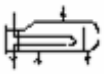
	Orifice holder for quick orifice change		Mass meter
	Venturi		Vortex
	Pitot or Annubar tube		

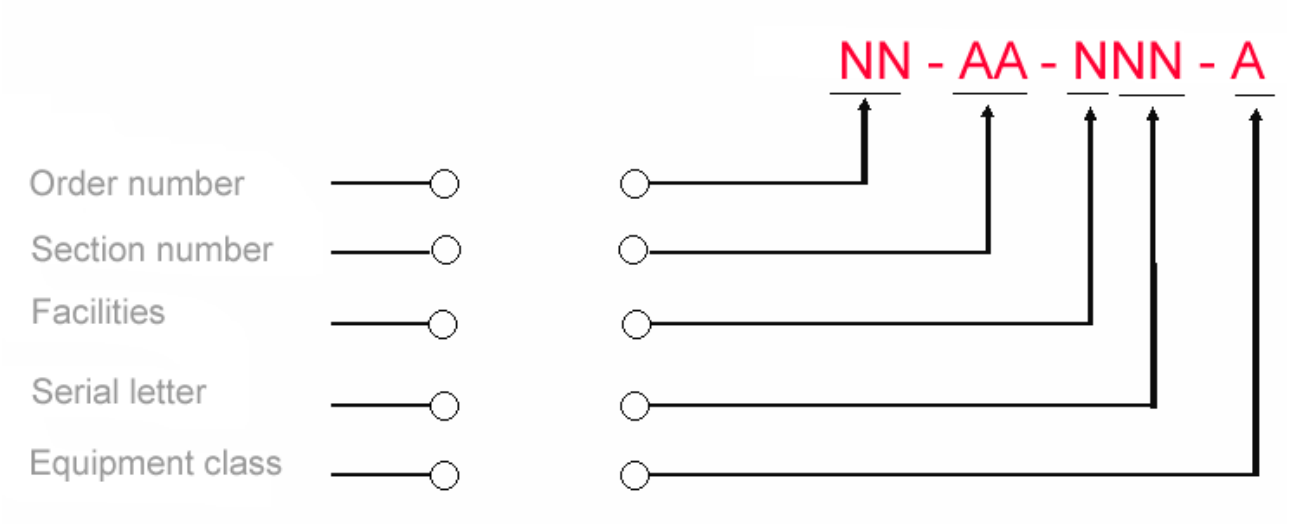
Table 21: Fluid measurement symbols

4.4. EXERCISES

9. Find the definition corresponding to the equipment.

Stirrer	○	○	
Centrifugal compressor	○	○	
Electric motor	○	○	
Packed tower	○	○	
Plate tower	○	○	
Scrubber	○	○	
Pig trap	○	○	
Air cooler	○	○	
Tube exchanger	○	○	
Centrifugal pump	○	○	
Diffuser	○	○	
Plate exchanger	○	○	
Reboiler (Kettle)	○	○	
Electric heater	○	○	
Submersible pump	○	○	
Hydrocyclone	○	○	

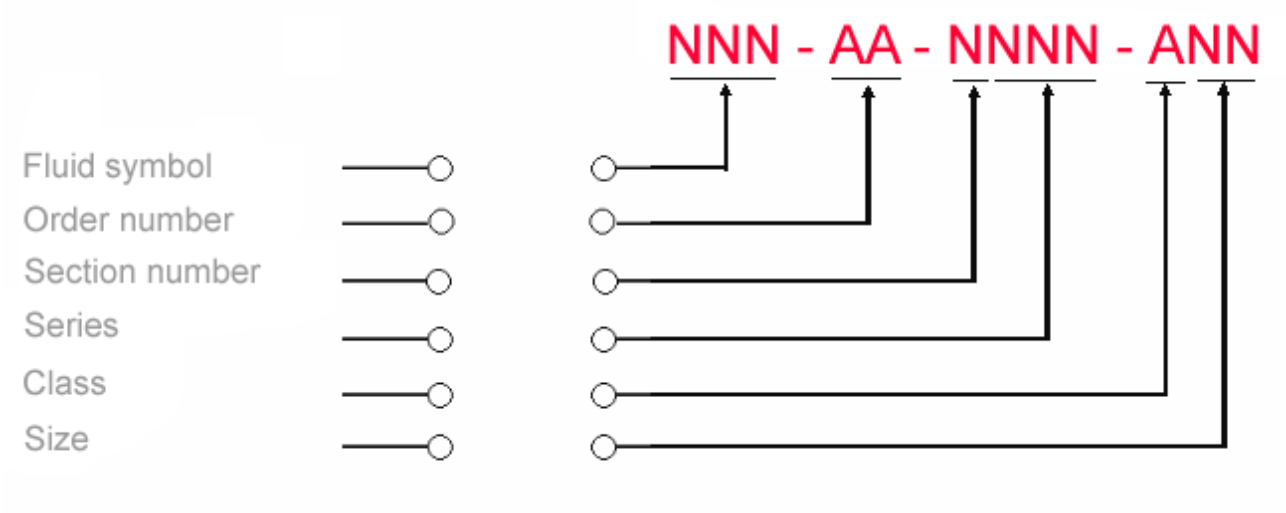
10. Find the correct equipment coding order.



11. Give the section numbers corresponding to these definitions.

100	Formation water treatment
200	Water treatment and injection
600	Wells and manifolds
400	Gas compression
300	LP gas
700	Ancillary networks (drinking water industrial water, steam...)
500	Oil treatment and export - bleed tank - sump - drains
800	HP gas treatment and distribution
900	Chemicals, fuel gas, compressed air

12. Find the correct pipe coding order.


NNN - AA - NNNN - ANN
Fluid symbol
Order number
Section number
Series
Class
Size

13. Find the definition corresponding to the equipment

Cartridge filter ○ ○ 

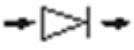
Basket strainer ○ ○ 

Y-type strainer ○ ○ 

T-filter ○ ○ 

Air filter ○ ○ 

Flame arrester ○ ○ 

Manhole ○ ○ 

Gate valve ○ ○ 

Robinet à boisseau sphérique ○ ○ 

Ball valve ○ ○ 

Butterfly valve ○ ○ 

Angle valve ○ ○ 

Needle valve ○ ○ 

3-way valve ○ ○ 

Choke valve ○ ○ 

Check valve ○ ○ 

14. Find the definition corresponding to the equipment.

Main piping ○ ○ 

Secondary piping ○ ○ 

Traced piping ○ ○ 

Double jacketed piping ○ ○

Insulated piping ○ ○ 

Spectacle blind (open) ○ ○ 

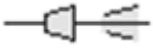
Spectacle blind (closed) ○ ○ 

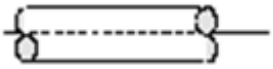
Concentric reduction ○ ○ 

Funnel ○ ○ 

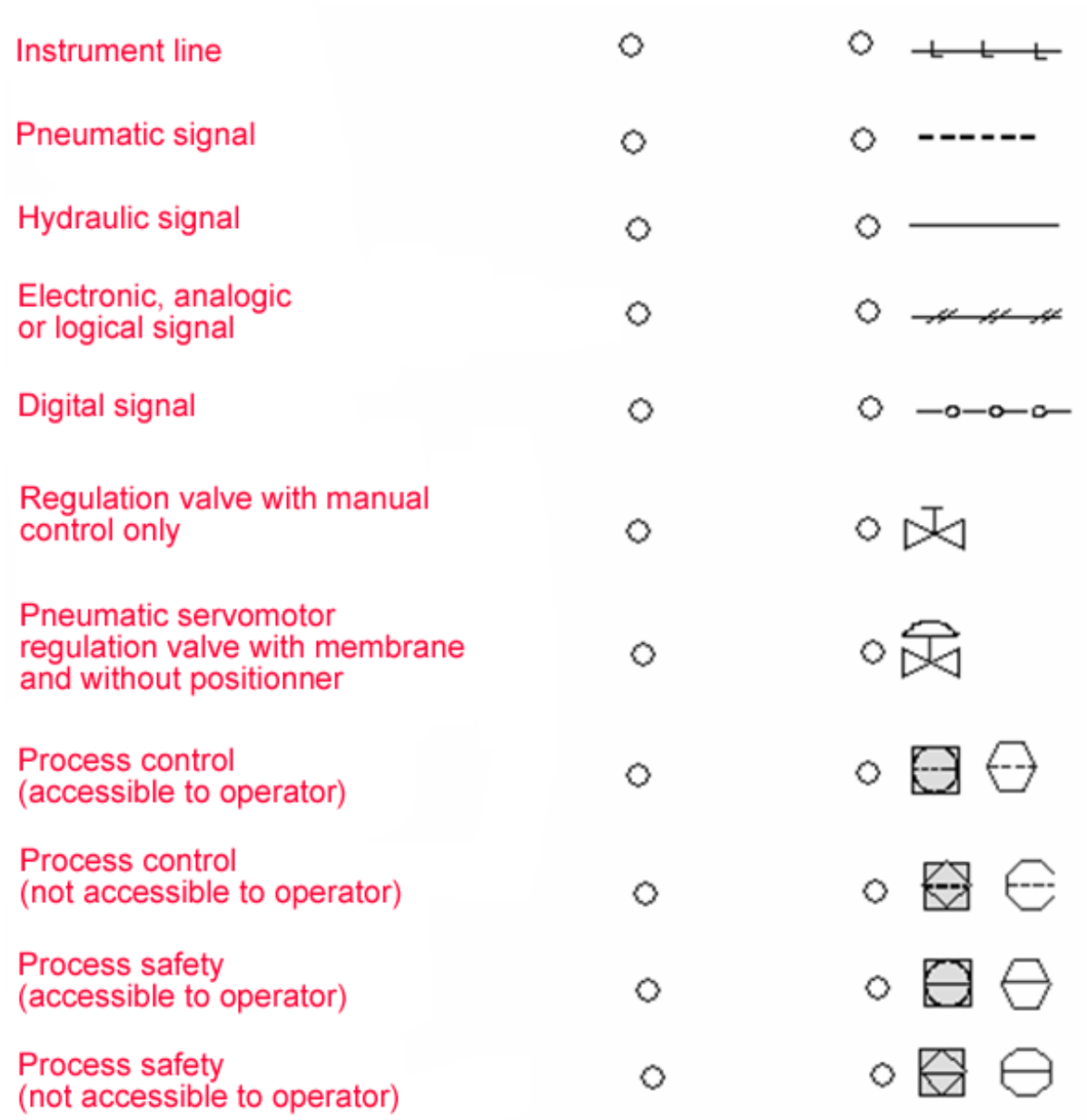
Drain ○ ○

Screw plug ○ ○ 

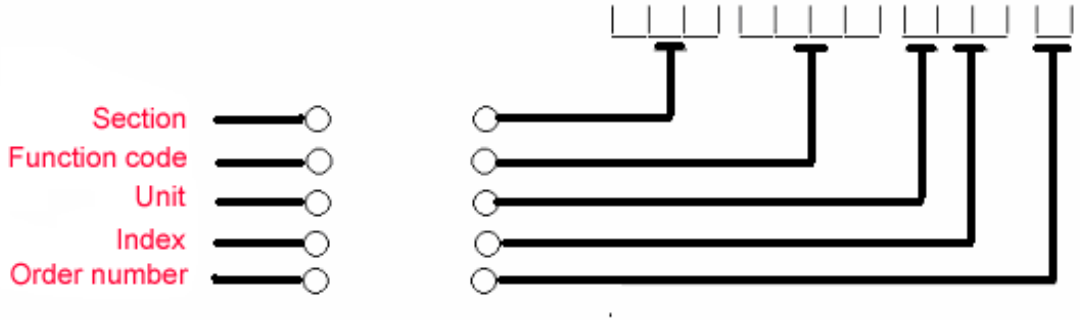
Quick connection ○ ○ 

Hose ○ ○ 

15. Find the definition corresponding to the equipment.



16. Find the correct pipe coding order.



17. Find the definition corresponding to the equipment.

Gate valve with piston servo-drive or motorised pneumatic or hydraulic actuator	○	○ 
2-way solenoid valve	○	○ 
2-way solenoid valve with local reset	○	○ 
3-way solenoid valve	○	○ 
Internal pressure tap expansion valve	○	○ 
External pressure tap expansion valve	○	○ 
Positive displaement meter	○	○ 
Orifice plate between flanges taps on flanges	○	○ 
Orifice plate between flanges taps on pipes	○	○ 

5. HOW DO WE READ A PID?

In this chapter we will develop the principle of how to read a PID. The PID is the drawing the most commonly used by the operators.

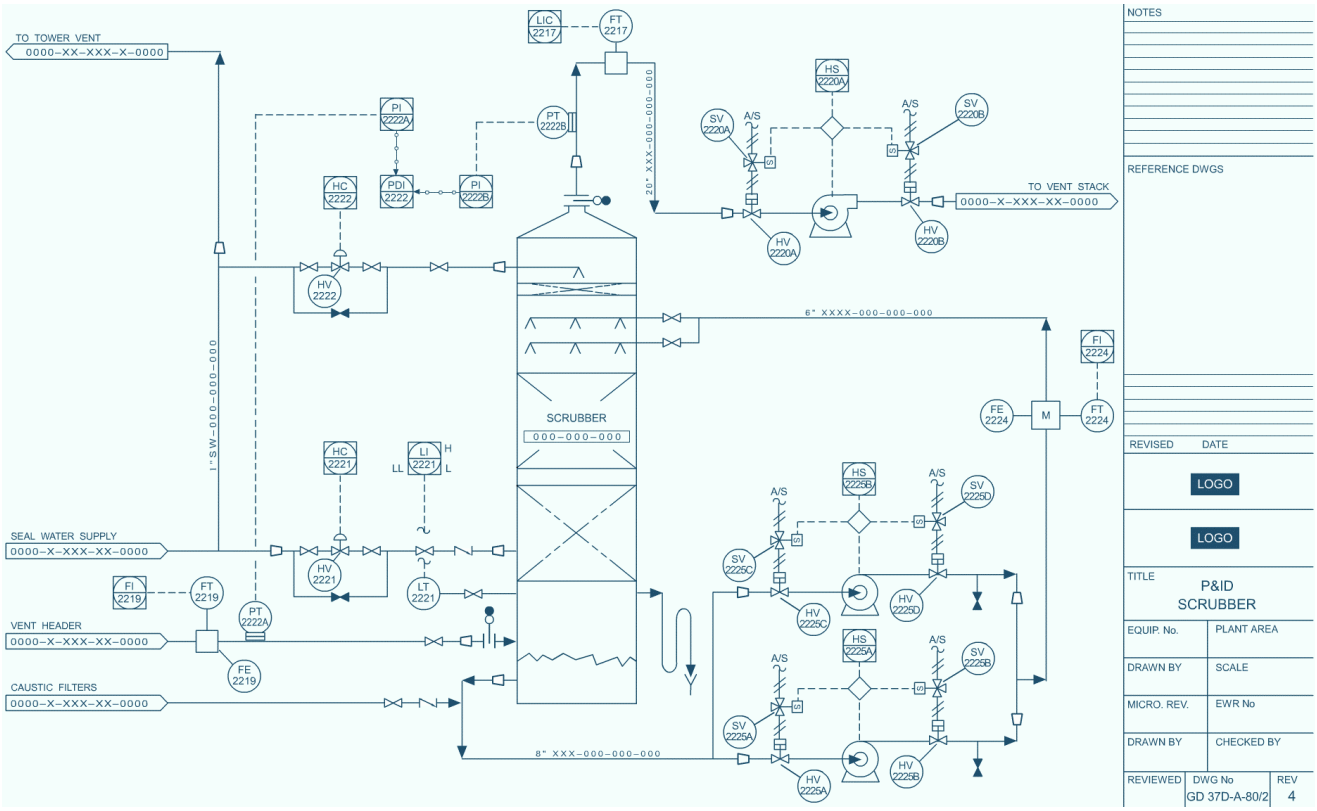


Figure 11: Example of a PID

5.1. LEGENDS AND ABBREVIATIONS

To interpret the PID, see the legends and abbreviations given with it. As shown below, certain symbols might not be “official” ones, but this happens and in that case, just think, compare and everything will be all right.

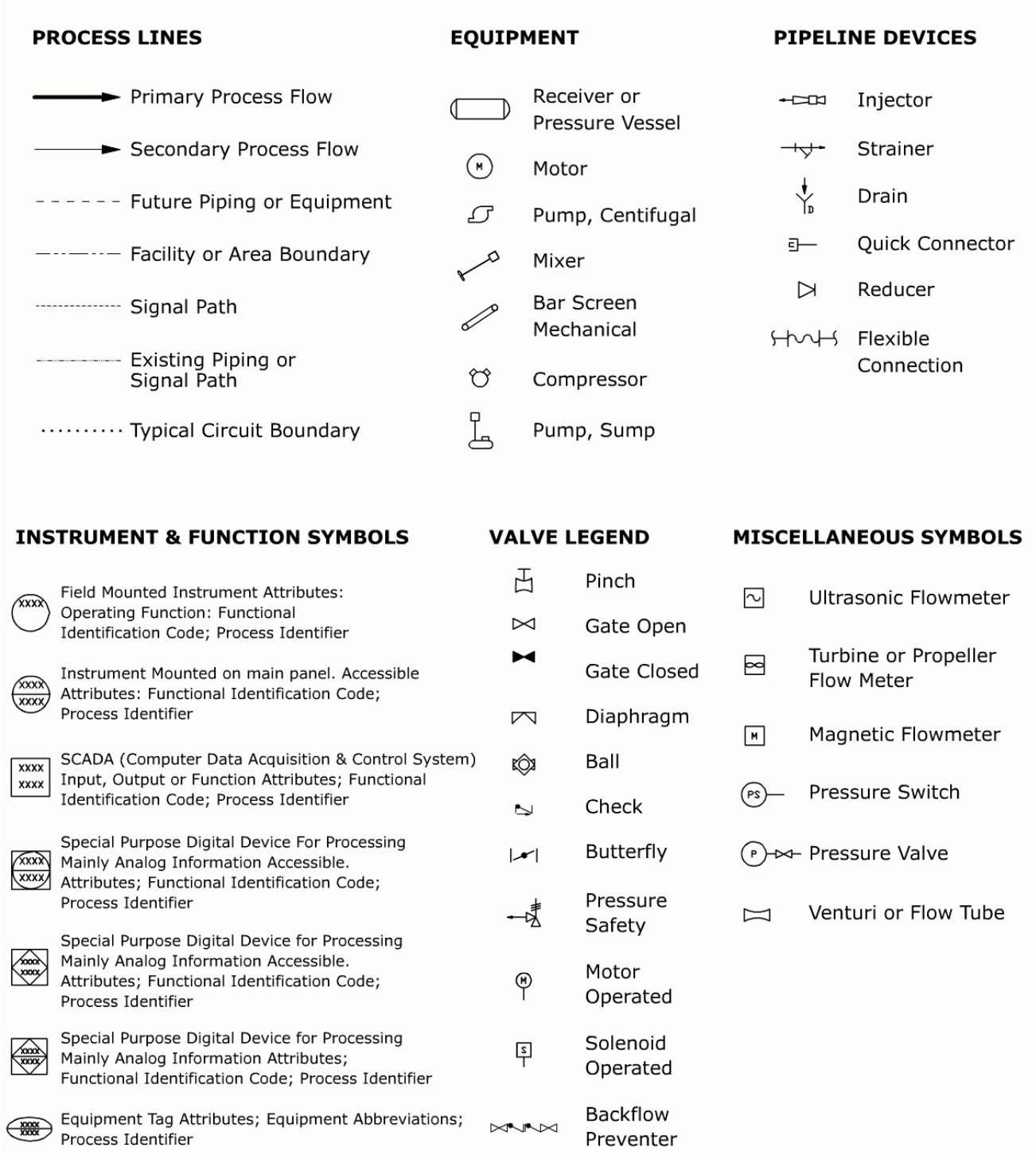


Figure 12: Example of legends

5.2. MARGINS

The margins of the PID give information on the the PID's history, unique PID number, revision history, descriptions and notes.

The PID number is a unique number which identifies the PID. It is located in the bottom right-hand corner of the margin, along with the title, name of the issuer (engineering firm), revision stamp and revision number (or letter). It is very important to always check you have the latest revision.

The changes made to the PID since the last revision are shown in the revision table in the bottom margin.

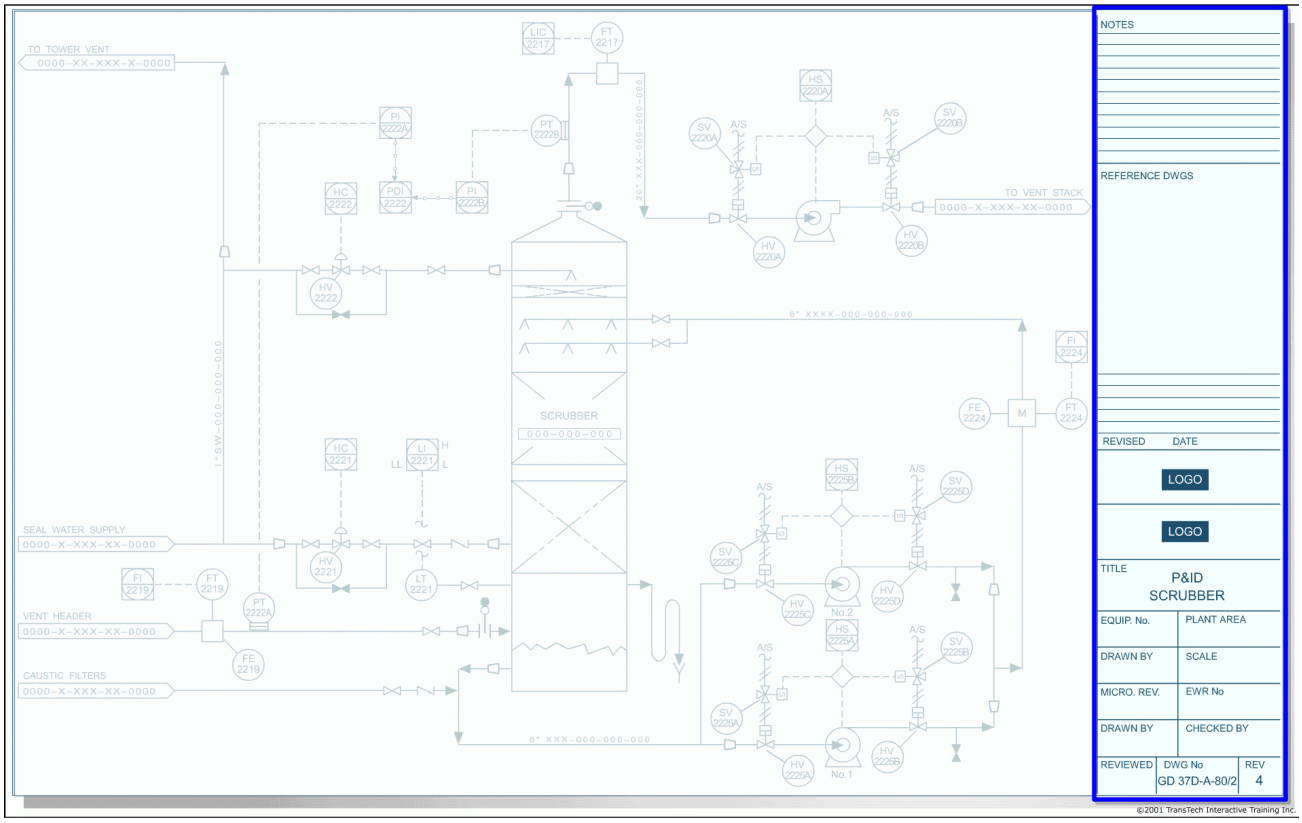


Figure 13: Margins of a PID

5.3. EQUIPMENT

The main items of equipment required to carry out the treatment process are shown in the PID by an icon representing the equipment in a simplified manner. They are normally identified by their name and equipment number.

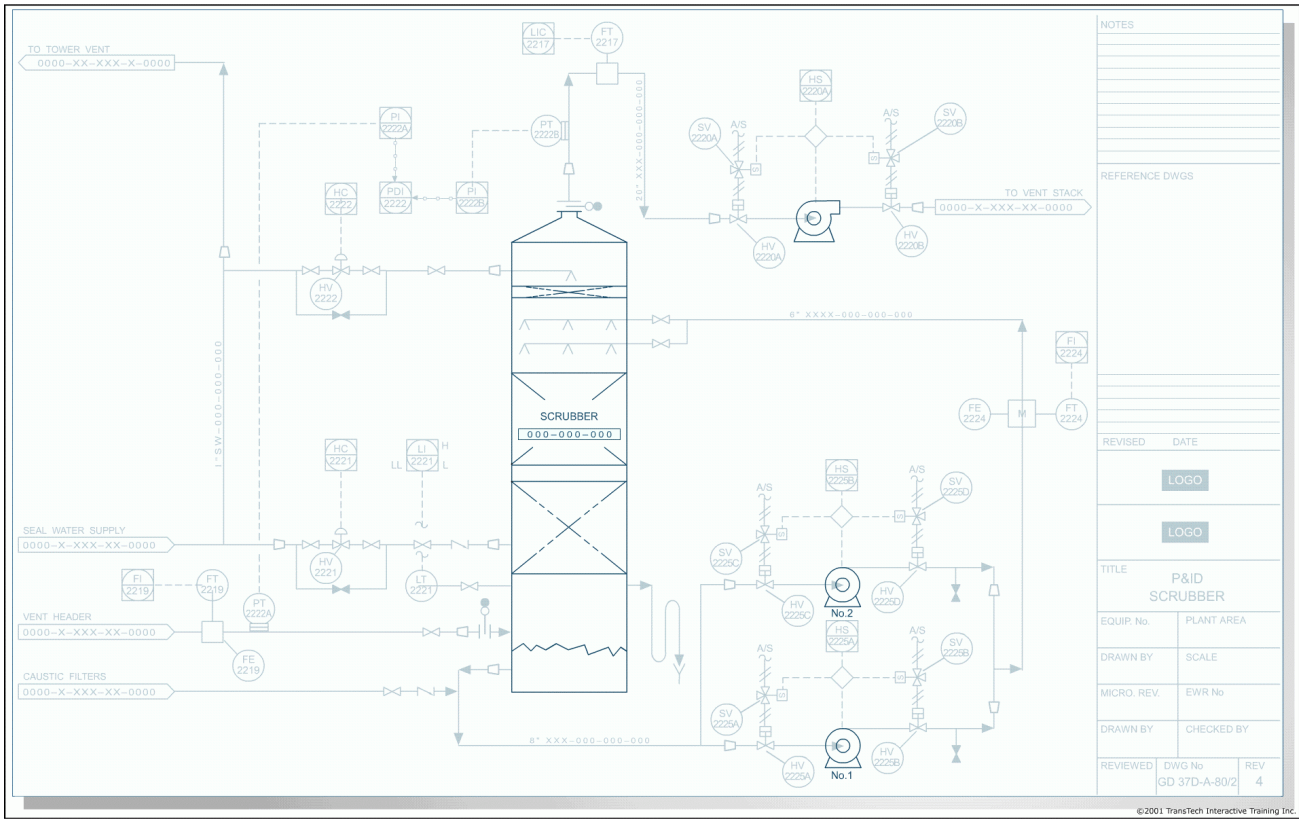


Figure 14: Equipment on a PID

5.4. EFFLUENT ROUTES

The process flows are indicated by the flowlines. Where possible, the incoming flowline is placed on the left and the outgoing flowline on the right. Labels or title boxes at the ends of the lines provide information on the sources and destinations of the flows.

The flows are routed by normally-open valves. The bodies of these valves are normally not filled, whereas the bodies of the normally-closed valves are filled.

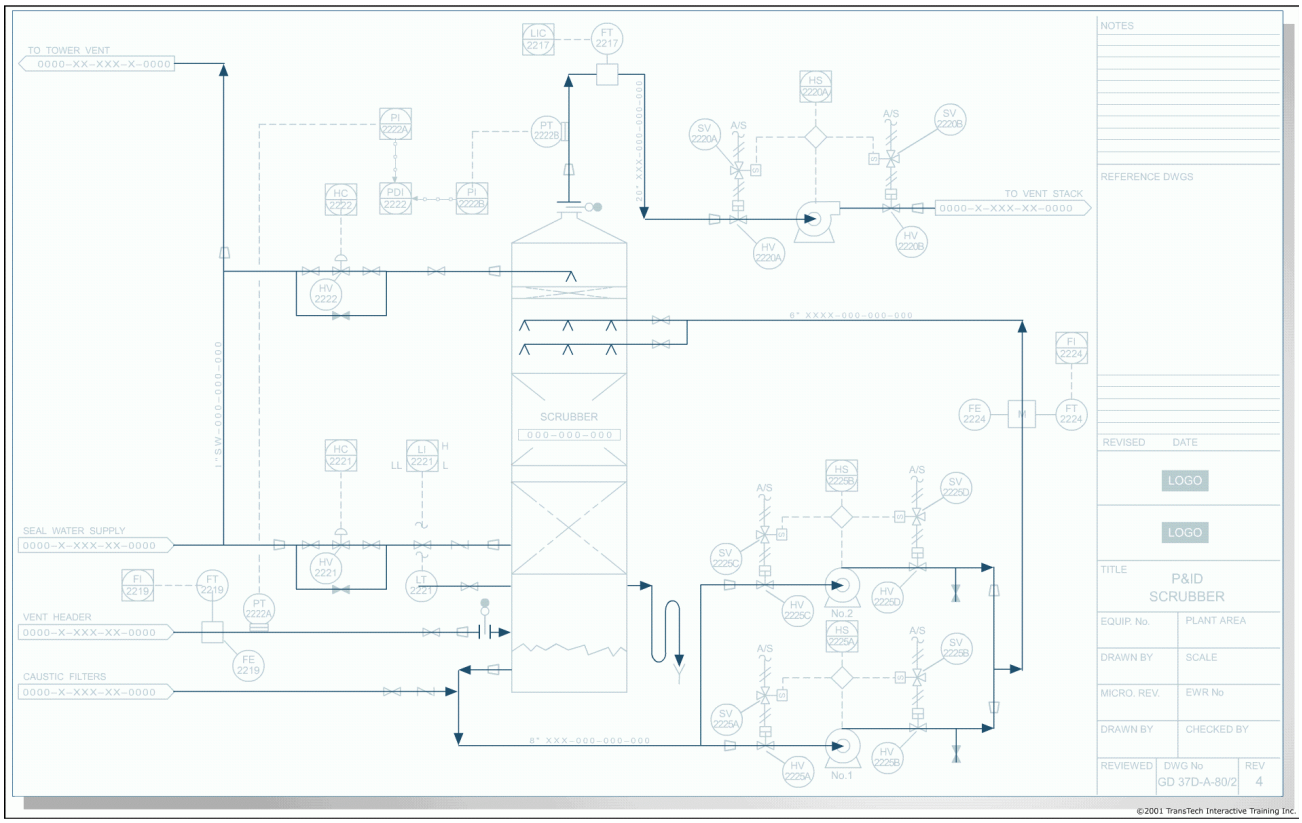


Figure 15: Fluid routes on the PID

5.5. INSTRUMENT LOCATIONS

The following table shows the typical instrument symbols and the parts accessible and inaccessible to the operator.

The most significant feature of the instrument symbols is the difference in their positions. The operator must know the positions of the main local equipment.

An instrument shown in a circle indicates that the instrument is mounted directly on the equipment.

A circle with a horizontal line through it indicates that the instrument is mounted on a local configuration panel. This panel is installed in an accessible location close to the equipment it operates.

A hexagon with a horizontal line indicates a computer function.

Each instrument designation is given a loop number and identification letters.

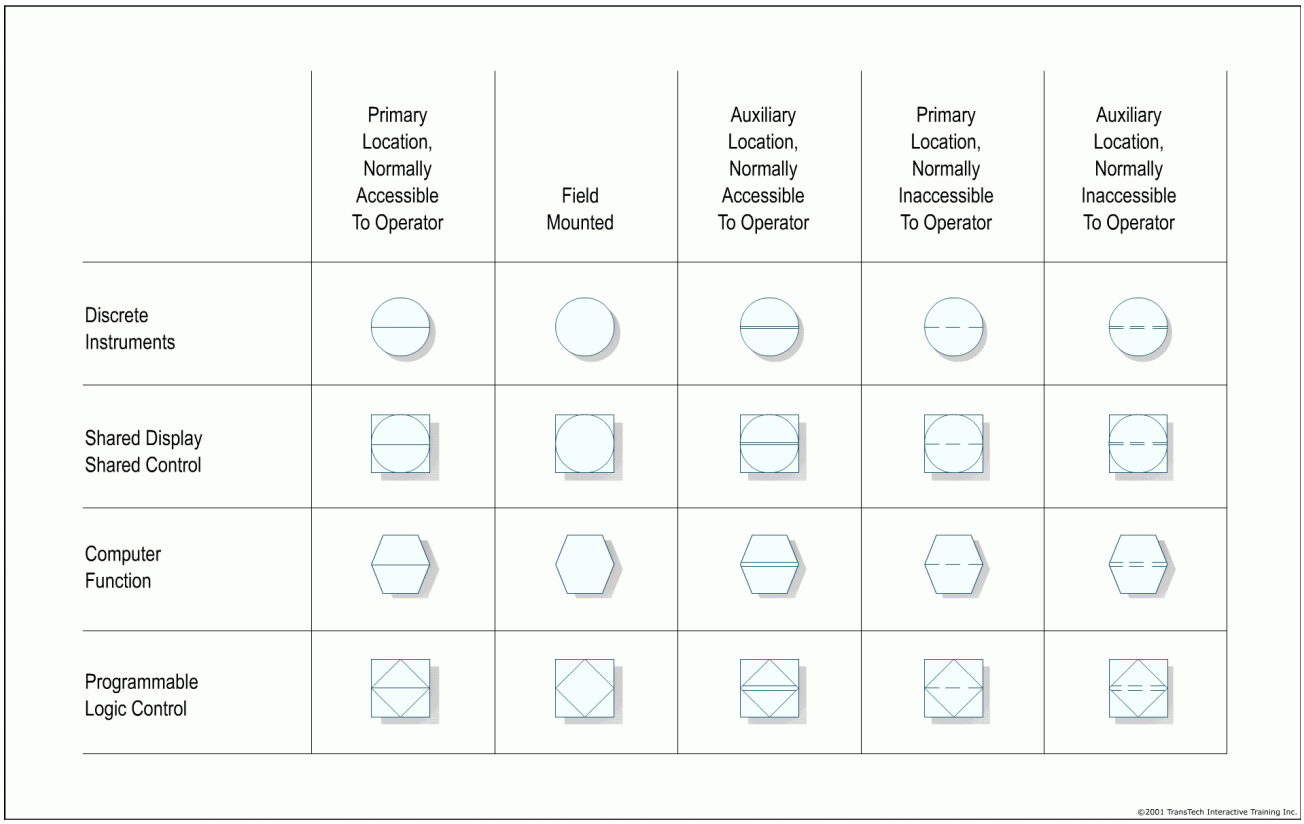


Figure 16: Instrument locations on the PID

5.6. CONTROL LOOP

The control loops are one of the most important parts of a PID. "Control loop" is a general term for all the elements involved in controlling a process parameter, like tank levels or vapour flows. This includes all the hardware and software associated with this control function.

The hardware components in a control loop are called "instruments". It is important to remember that most control loops can be broken down into three parts:

- the measurement element
- the controller
- the control system

A good understanding of a basic control loop will help you to understand more complicated control loops.

The measurement element produces a signal which represents the process variable being controlled. The commonly used process variables are: coherence, pressure, flow and temperature. The measurement element is connected to a transmitter which sends a signal to the controller. The control signal can take the form of an overhead pneumatic signal, an electric signal (milliamps) or even a remote radio signal, depending on the case.

The controller determines the control adjustments needed. This is done by comparing the measured value to a setpoint (SP), which is the required setting for a process variable. The controller adapts the system until the value of the process variable is equal to the setpoint.

A control system is any process equipment which can be modulated to change a measured parameter. The control system changes the measured variable. Valves are the most common control systems. For the temperature control these valves control the vapour flows, for example.

They can also take the form of switches, pumps, fans, or electric heating devices and other control devices. Motor speed controllers are also control systems.

It is important to remember that the adjustments made to the control point will modify the variable measured.

Each control loop is given a unique number for differentiate it from other control loops.

A control loop may consist of a single element (e.g. a local pressure gauge), or it may have many different elements (e.g. an automatic flow controller).

A control loop may include detectors, transmitters, controllers, converter I/P, valves, etc.

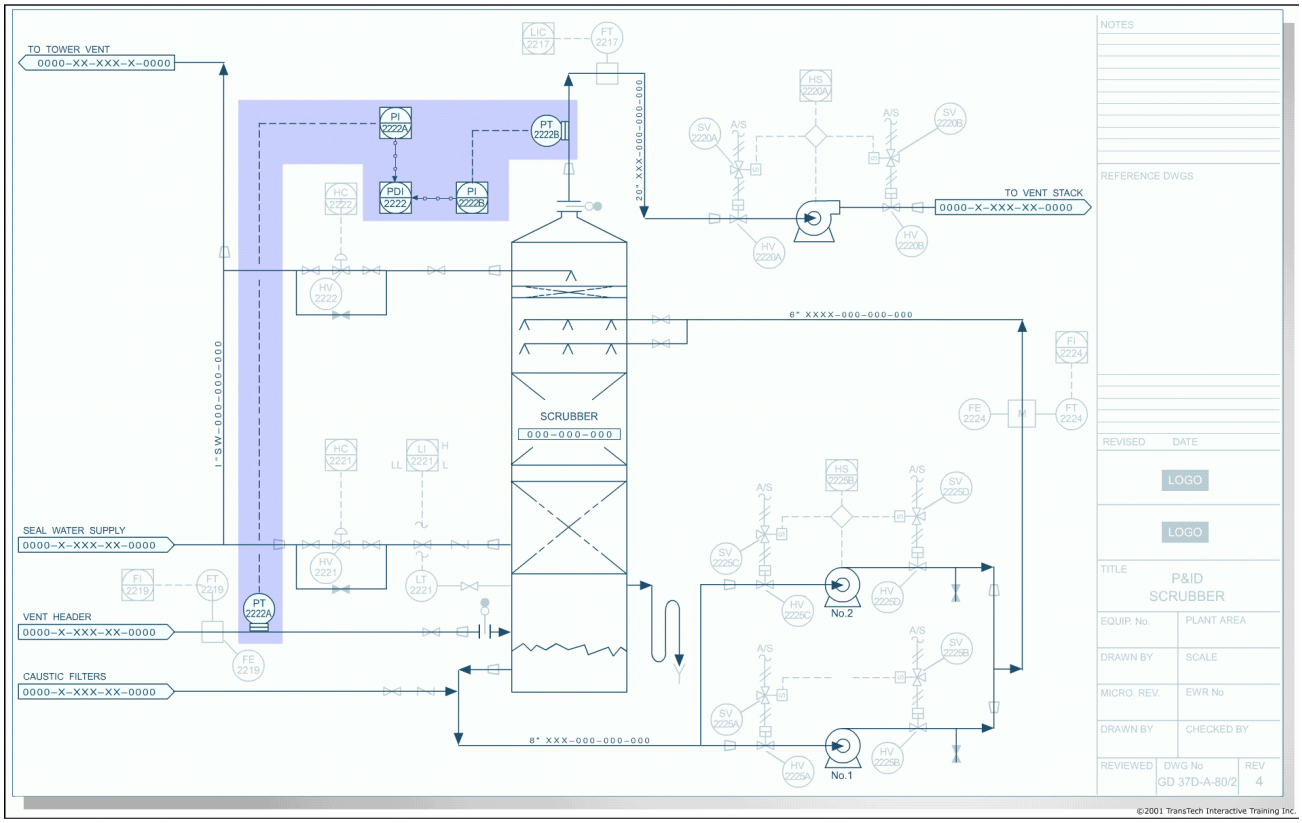


Figure 17: Control loop on PID

The above diagram shows a simple control loop and indicates the site equipment in the process and the controller placed in the DCS.

6. GLOSSARY

7. FIGURES

8. TABLES

9. SOLUTIONS TO EXERCISES

1. Drawings provide a general view or details to make all or part of a production installation easy to understand.

   ☑ True

2. AFNOR has defined three types of drawings. What are they?

   - Schematic diagram
   - Process flow diagram
   - Piping and instrumentation diagram

3. It explains the operating principle of the whole installation in just a few blocks.

   ☑ Schematic diagram

4. It defines the locations of the equipment in the installations.

   ☑ Layout drawing

5. It allows us to read the process logic. This diagram issued during the project phase shows in a simplified format the main process lines and tanks and their main operating parameters.

   ☑ Process flow diagram (PFD)

6. This diagram issued during the project phase shows all the pipelines and tanks and their operating parameters in a much more complex manner than the PFD.

   ☑ Piping and instrumentation diagram (PID)

7. This type of diagram gives a three-dimensional representation of the installations.

   ☑ Isometric diagram

8. This type of document provides a great deal of information about the equipment.

☑ Datasheet

9. Find the definition corresponding to the equipment.

Stirrer ○ ○

Centrifugal compressor ○ ○

Electric motor ○ ○

Packed tower ○ ○

Plate tower ○ ○

Scrubber ○ ○

Pig trap ○ ○

Air cooler ○ ○

Tube exchanger ○ ○

Centrifugal pump ○ ○

Diffuser ○ ○

Plate exchanger ○ ○

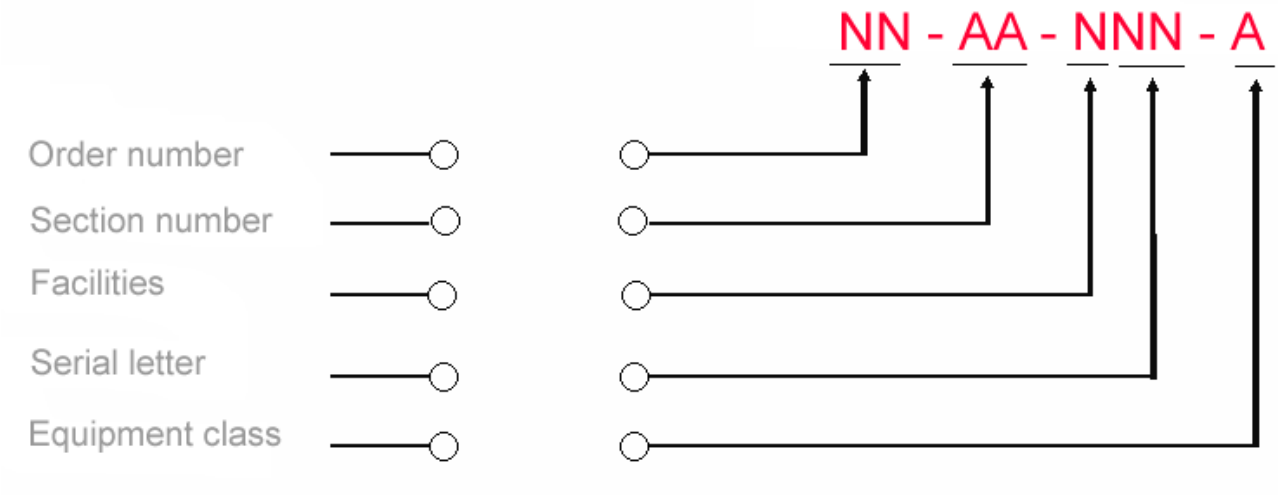
Reboiler (Kettle) ○ ○

Electric heater ○ ○

Submersible pump ○ ○

Hydrocyclone ○ ○

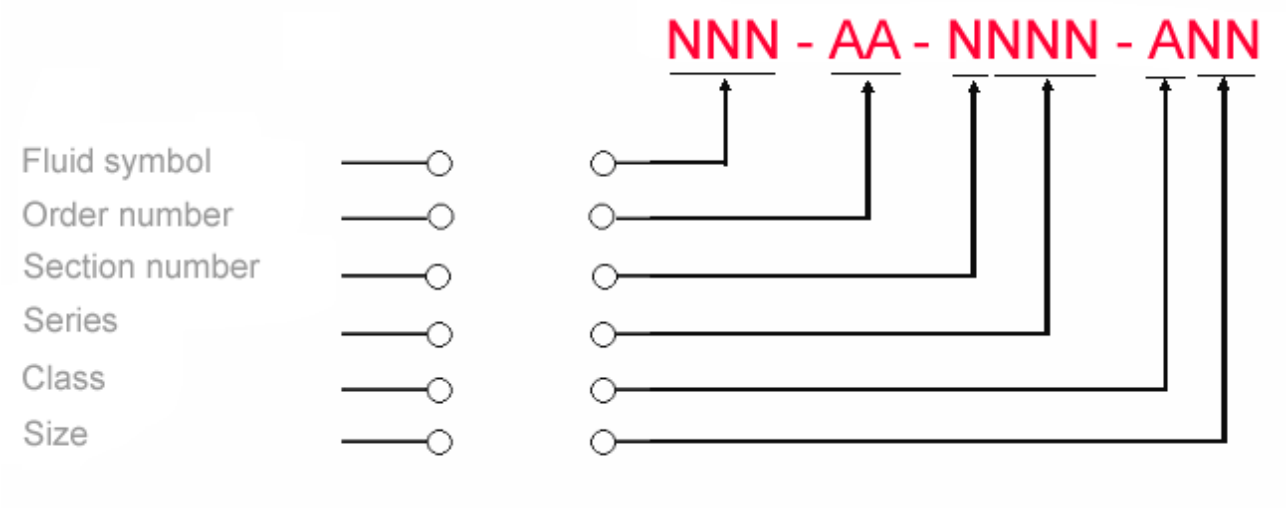
10. Find the correct equipment coding order.



11. Give the section numbers corresponding to these definitions.

100	Traitement d'eau de gisement
200	Traitement et injection d'eau
600	Puits et manifolds
400	Compression gaz
300	Gaz basse pression
700	Réseau annexes (eau potable, eau industrielle, vapeur, ...)
500	Traitement huile et expédition - cuve de purges - sump – drains
800	Traitement et distribution gaz HP
900	Produits chimiques, fuel gas, air comprimé

12. Find the correct pipe coding order.



13. Find the definition corresponding to the equipment

Cartridge filter ○ ○ 

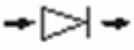
Basket strainer ○ ○ 

Y-type strainer ○ ○ 

T-filter ○ ○ 

Air filter ○ ○ 

Flame arrester ○ ○ 

Manhole ○ ○ 

Gate valve ○ ○ 

Robinet à boisseau sphérique ○ ○ 

Ball valve ○ ○ 

Butterfly valve ○ ○ 

Angle valve ○ ○ 

Needle valve ○ ○ 

3-way valve ○ ○ 

Choke valve ○ ○ 

Check valve ○ ○ 

14. Find the definition corresponding to the equipment

Main piping ○ ○ 

Secondary piping ○ ○ 

Traced piping ○ ○ 

Double jacketed piping ○ ○

Insulated piping ○ ○ 

Spectacle blind (open) ○ ○ 

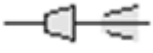
Spectacle blind (closed) ○ ○ 

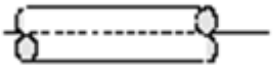
Concentric reduction ○ ○ 

Funnel ○ ○ 

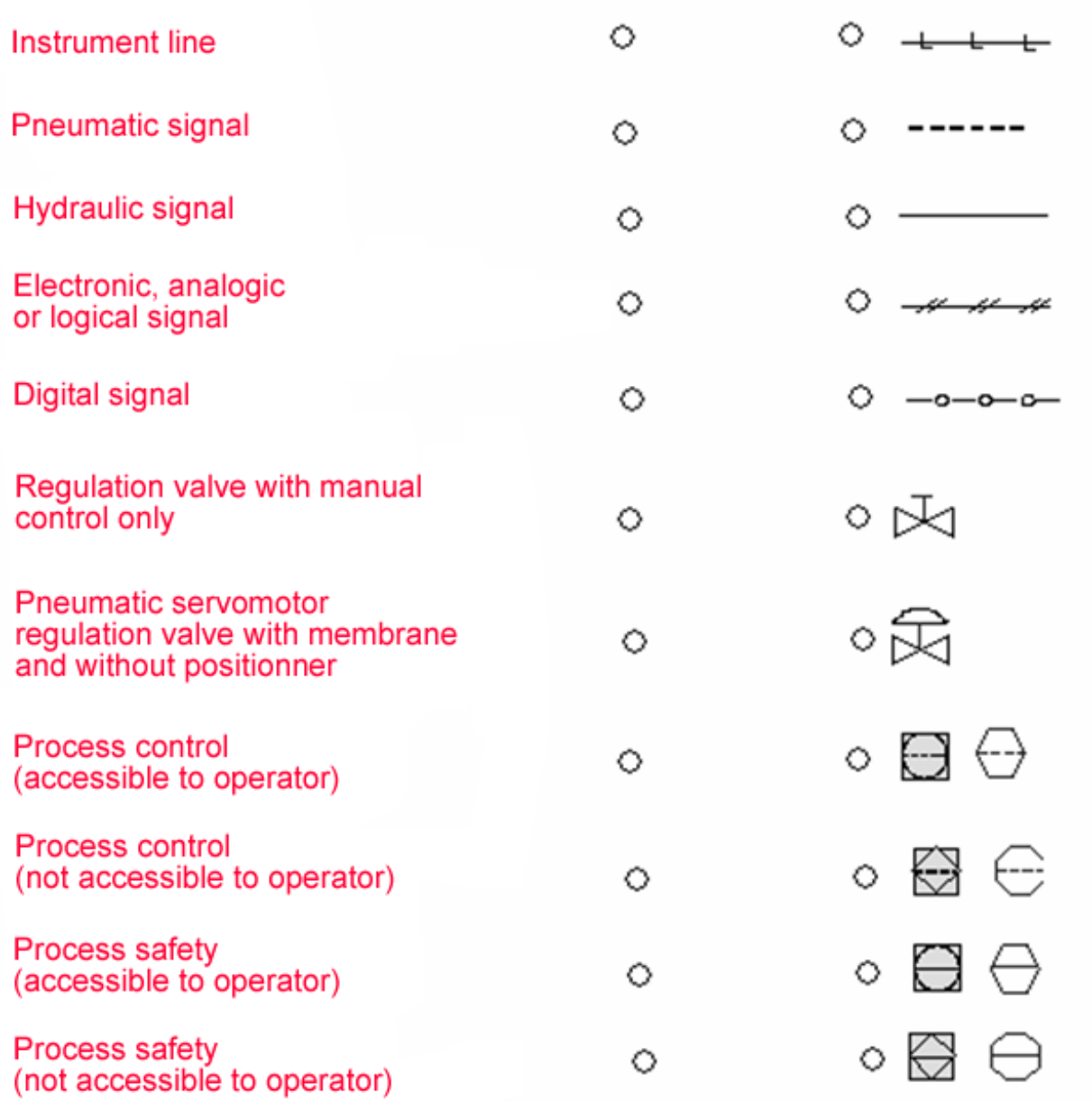
Drain ○ ○

Screw plug ○ ○ 

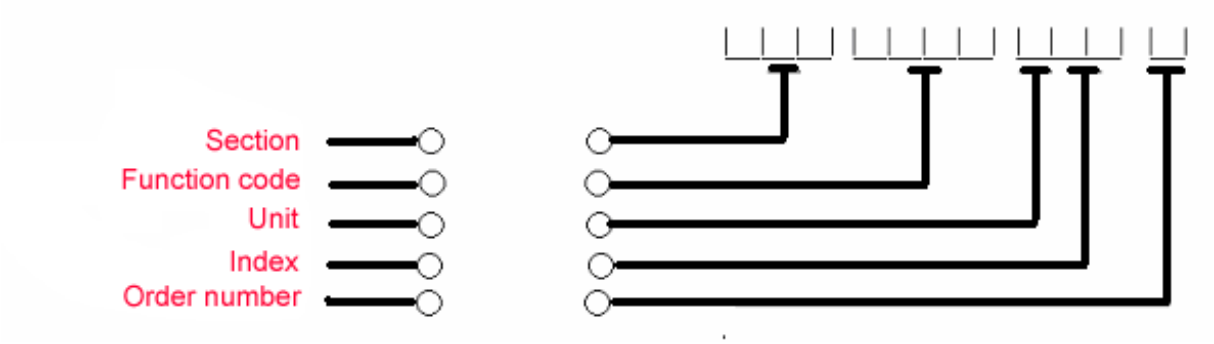
Quick connection ○ ○ 

Hose ○ ○ 

15. Find the definition corresponding to the equipment



16. Find the correct pipe coding order.



17. Find the definition corresponding to the equipment.

Gate valve with piston servo-drive or motorised pneumatic or hydraulic actuator	○	○ 
2-way solenoid valve	○	○ 
2-way solenoid valve with local reset	○	○ 
3-way solenoid valve	○	○ 
Internal pressure tap expansion valve	○	○ 
External pressure tap expansion valve	○	○ 
Positive displaement meter	○	○ 
Orifice plate between flanges taps on flanges	○	○ 
Orifice plate between flanges taps on pipes	○	○