Gas Station

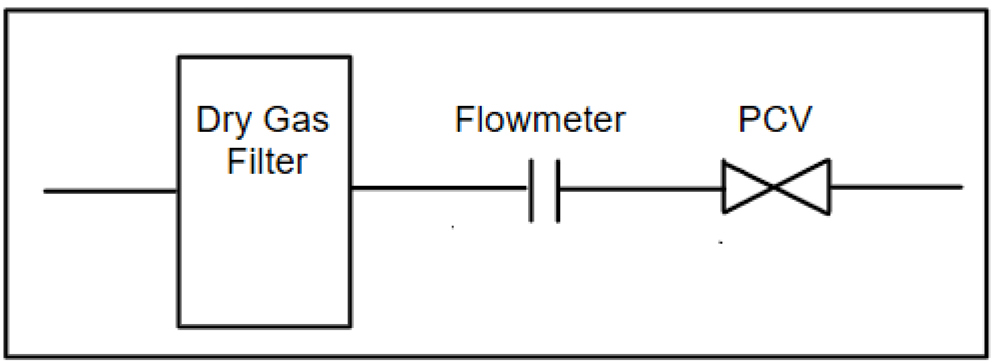
Description and PFD-P&ID Development

The purpose of gas station: to remove particles, do flow measurement, and pressure regulation.

Gas station components

- Filters: simply to remove solid particles in gas stream.
- Flowmeter: since we receive the NG from a nearby company then we have to pay them. Hence, the payment is based on cumulative flow of NG in a period of time. As a result, we need a flowmeter to measure all flowrates properly.
- PCV: we need pressure control valves to control and regulate the pressure of NG based on downstream process demands.

So, the first edition of PFD becomes like this:



Now let's detail it:

1.Flowmeters

- Since the flow here is of significant importance, then, it is normal practice in gas station to have two flowmeters.
- On the surface one might think that the they should be configurated in series. But in gas stations it is typical to have Z-configuration.
- Due to Z-configuration, we should have two runs-two lines- in a way that, in normal operation, the gas flows through one line and when we need to prove the measurement of the flowmeter we use Z-configuration and direct the gas in other line and make the gas pass through the second flowmeter which has not been used. In this way

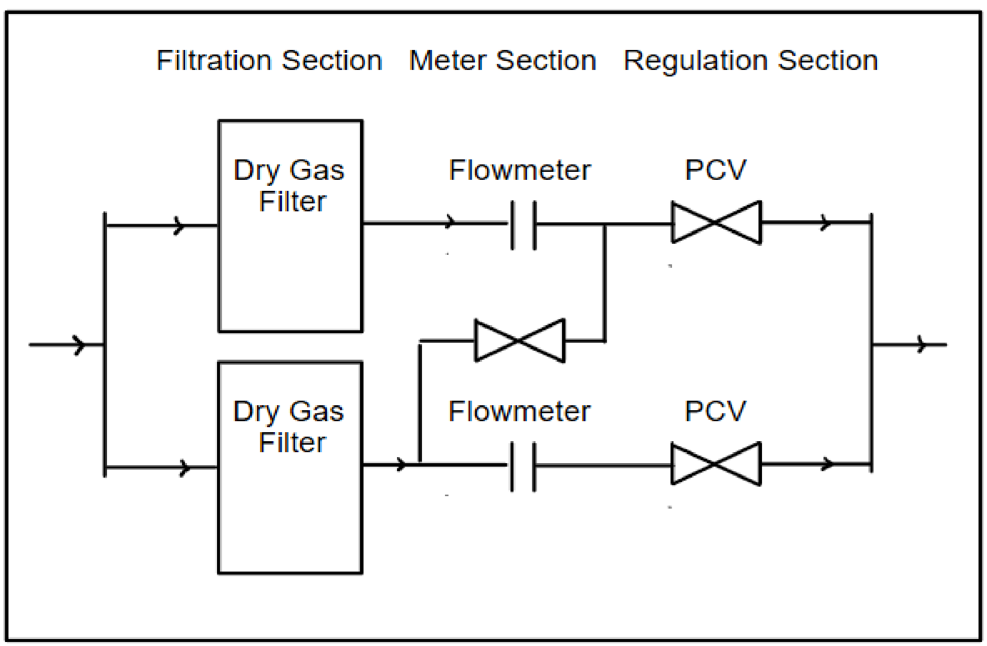
by second flowmeter we prove that the measurement of the normal flowmeter is correct or not.

Based on Day-2 instruction, the best flowmeter for gas station is ultrasonic flowmeter.

2.Filters ——— Since we need two runs, then we need one filter for each run.

3.PCV ——— So far it is clear to us that we need to

If we incorporate all above parameters into our PFD, then it would become like this.



P&ID design for gas station

In creation of P&ID, we should take piping, instrumentation and mechanical design aspects into consideration.

1.Detailed process condition

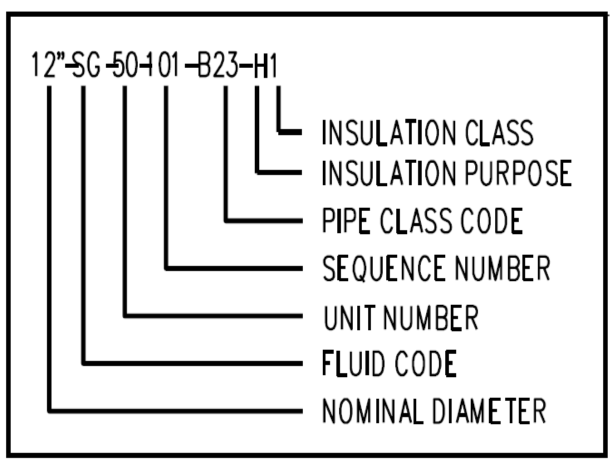
Based on the video for line sizing, we know that the line size should be 14” but as you can remember from the video, it was stated that 12” could be used especially for 3–8-meter length. It is ok if the pressure drop is a little higher than that of 14” but since the length of the line is 3-8 meter, that is not a big deal. More importantly, the lower the size of connecting to equipment, the lower the size of the equipment itself and as a result, the lower the cost.

Design condition: since the operating temperature is 40C, then the design temperature should be 85C. Maximum operating pressure is 62 barg. So based on the design pressure table, due to the fact that the operating pressure is more than 10 barg, then the design pressure would be maximum operating pressure multiplied by 1.1. As a result, the design pressure becomes like below:

$$P_d = 62 \times 1.1 = 68.2 = 69 \text{ barg}$$

2.Piping details

Each line in P&ID should have the following Information:



INSULATION CODES:	
C	COLD INSULATED
H	HOT INSULATED
N	NOT INSULATED
P	PERSONNEL PROTECTION INSULATED

PIPE CLASS CODES:	
FIRST LETTER INDICATES FLANGE RATING:	NUMBER MATERIA
B = class 150	24 = CS
D = class 300	34 = P11
F = class 600	36 = P22
G = class 900	40 = SS304L
H = class 1500	42 = SS316L
J = class 2500	44 = SS321
	50 = SS304
	64 = SS321H
EXAMPLE: B24	66 = SS347H
	70 = MNL
MISCELLANEOUS:	
C1A = CS	class 150 RF
G1A = CS / GALV	class 150 RF
G1B = CS / GALV	class 150 RF
L1A = CS / PVC LINED	class 150 RF
NOA = PVC–U	GRAVITY FLOW
NOC = PE	GRAVITY FLOW
N2A = GRP	class 150 RF
N2B = HDPE	class 150 RF
N2C = PVC–C	PN16 FF
N2D = PP–R	PN16 FF
U1A = CS PTFE COATED	class 150 RF
B24U = B24 FOR UNDERGROUD	

For our case:

1. The line is 14”
2. The fluid is NG
3. We are in first unit which is 100
4. We have high operating pressure and temperature, so the class 600 or F is selected.

5. Material Selection:
   5.1. For services like NG, BFW, CW, LPS/C, MPS/C, Service Water, Nitrogen, Plant Air, Methanol we use CS

   5.2. For services like DMW, Instrument Air, Chemicals, Oxygen, Water containing CO2 or H2 we use SS.

   So based on the above rule, we use CS. Since we are supposed to show the material based on a designation it becomes 24.
6. We don’t need any insulation since we are in atmospheric condition.

   So it becomes like this:

   14-NG-100-S1-F24

Two (2) 12” streams originate from the header. One of them is the “duty” stream, One of them is the “Stand-by” or “master line”.

Duty Streams
Gas flows through the inlet manual ball valve (BV-1911). A 2’’ bypass line containing two isolating ball valves and a globe valve allows pressurization of the station and/or pressure equalization across the valve.

Draining
A 2” pipe originating from the dry gas filter is used to drain any liquid trapped in. A ball valve and globe valve, connected on the line, are used to manually control the draining of the stream. Furthermore a orifice plate (RO-1911) is used for break pressure drain line.

Gas flows downstream the dry gas filter through a -10xD of length- straight pipe section, in order to ensure that the gas enters the ultrasonic flow meter with a laminar flow.

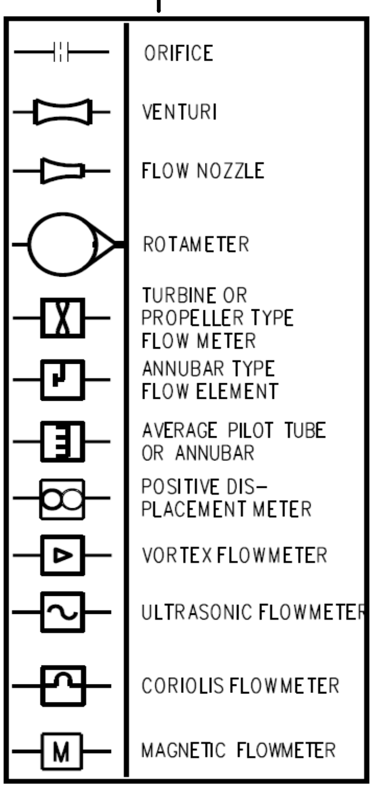
"Z" Configuration
The duty stream has a 12" branch line downstream the ultrasonic flowmeter, used for diverting the flow to master meter stream for proving purposes. A 12" ball valve (BV-1941) is used for isolating the branch connection.

N2 Purging
A 3/4" N2 purging connection with a ball and check valves, are used to injection N2 to purge stream before maintenance and hot working.

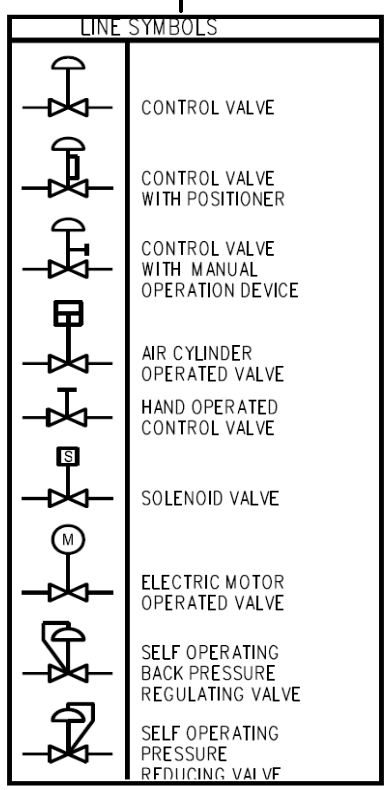
The gas enters the outlet 14" stream through the 12" stream. Three (3) 12" streams originate from the header. One of them is the "duty" stream, One of them is the "Stand-by" stream. One of them is the "Commissioning and maintenance" stream. You will see that in real P&ID.

3.Instrumentation — Symbols

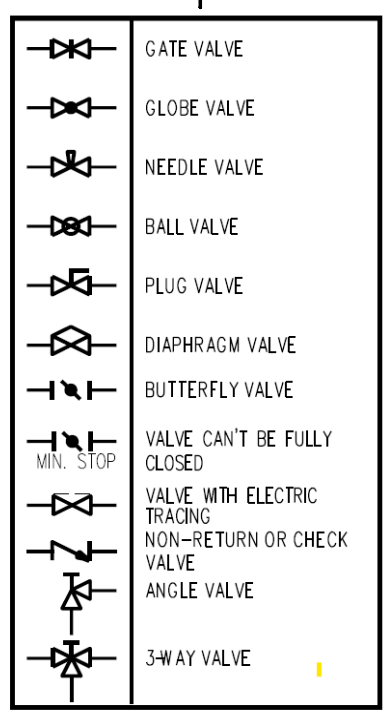
Flowmeter



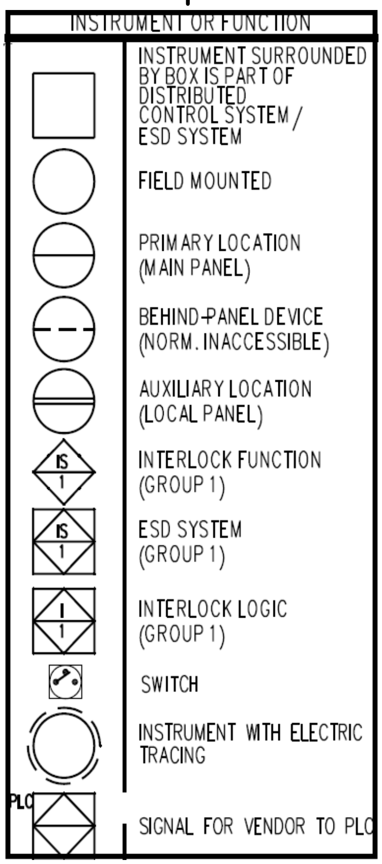
Actuators



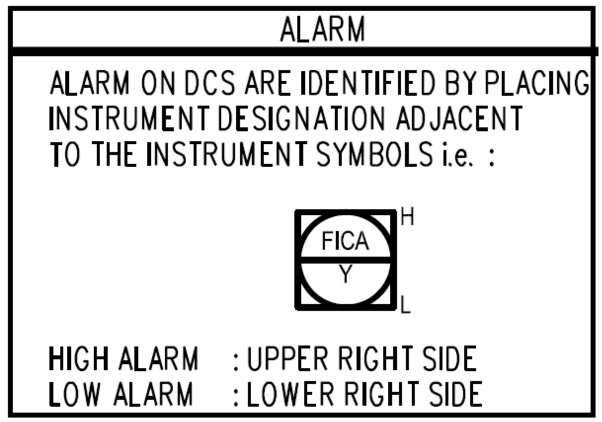
Valves



Functions



Alarms



3.Instrumentation-continued

Let's list where we need instrument devices

1. Site operators need to check the pressure and temperature regularly.

2. We need to monitor filters regularly like their pressure and pressure drop since the pressure drop later would be the criteria for site operators to replace filters with new ones.

3. We have talked about flowmeter but in flowmeter it is a common practice to consider compensation for most flowmeters specially gas and steam flowmeters. Check the appendix to learn about compensation. But for now, regardless of the type of calculation performed for compensation, we need the temperature and pressure of the line so that the compensation is done.

4. Regarding the flowmeter, we need also to specify the way data to PLC should be transferred. As a result, we have to use instrument functions shown above.

5. A simple note:
   The most common way to transfer data

   Fieldbus Foundation for the whole plant
   Hart for important devices used in ESD

   We have different types of packages:

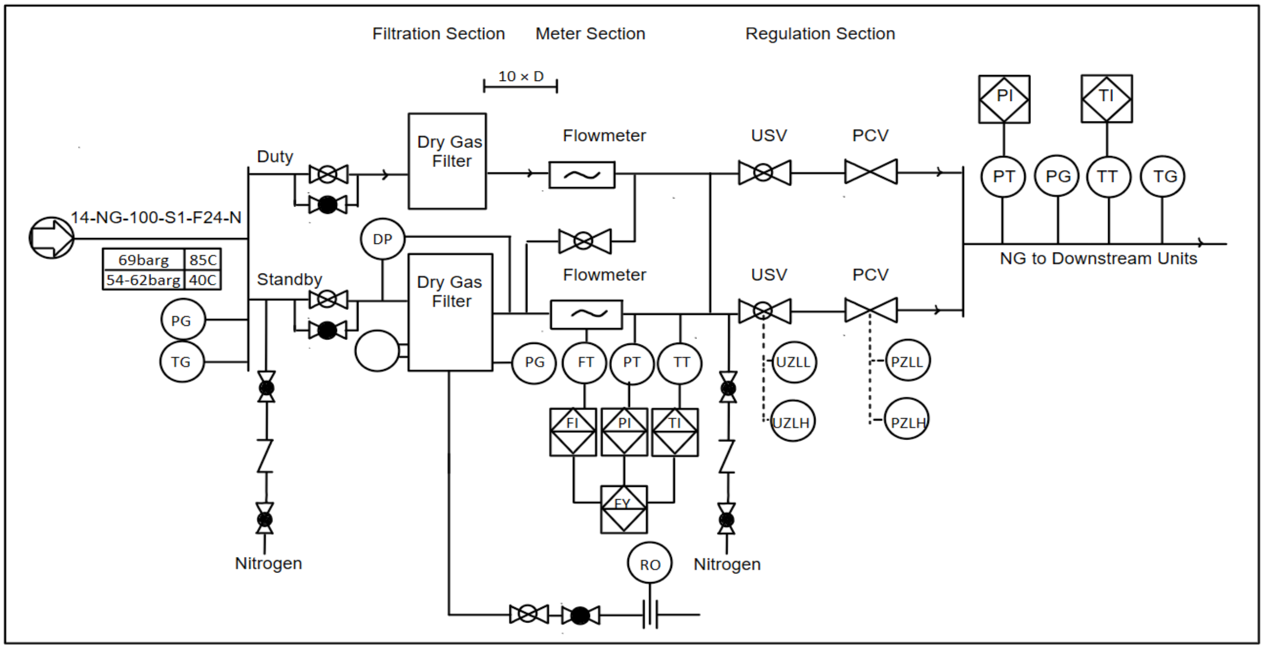
   ESD for emergency shut-down system
   FCS/DCS for controlling system
   PLC for packages like gas station

6. We need to show the open or close status of control valves and USV-unit shutdown valves. Check Appendix.

7. Finally site operators and control operators need to monitor remotely and locally the pressure and temperature of

the line connecting gas station to process unit.

After implementing all these changes, then it becomes like this:



Appendix A: Flow compensation

Where stated, pressure, temperature and mole weight compensation of flow is applied after square root extraction of flow signal with the following algorithm:

$$Q_{CVol} = Q_{RVol} \cdot \sqrt{\frac{Pa \cdot Td \cdot MWd}{Pd \cdot Ta \cdot MWa}} \quad \text{or} \quad Q_{CMass} = Q_{RMass} \cdot \sqrt{\frac{Pa \cdot Td \cdot MWa}{Pd \cdot Ta \cdot MWd}}$$

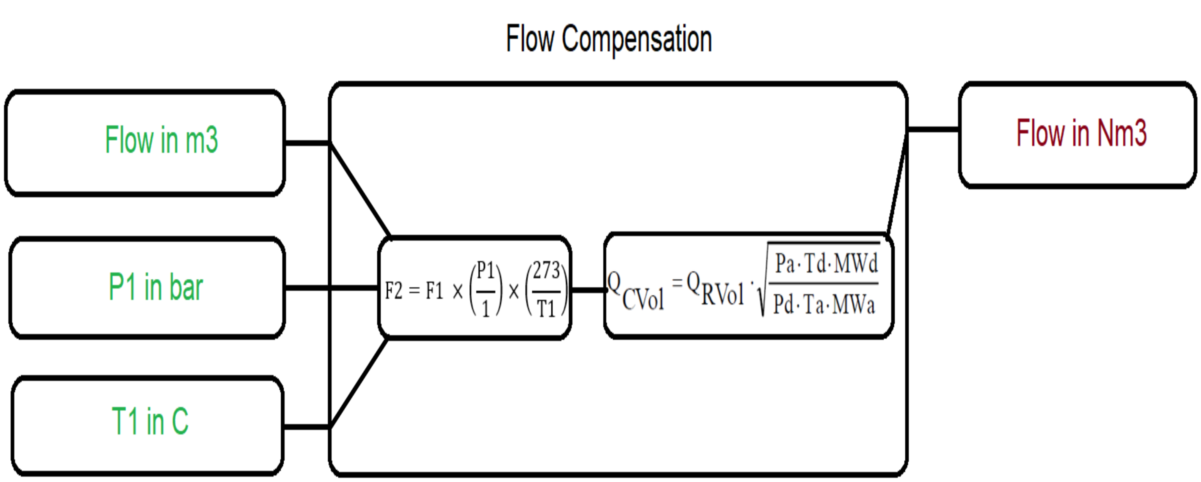
where

		P_a	: Actual Pressure [bar a]
		T_a	: Actual Temperature [K]
Q_{CVol}	: Compensated flow [Nm^3/h]	Mw_a	: Actual Mole Weight [kg/kmole]
Q_{RVol}	: Uncompensated flow [Nm^3/h]	P_d	: Sizing Pressure [bar a]
Q_{CMass}	: Compensated flow [kg/h]	T_d	: Sizing Temperature [K]
Q_{RMass}	: Uncompensated flow [kg/h]	Mw_d	: Sizing Mole Weight [kg/kmole]

Gas and vapor flow measurements based on vortex meters are compensated by one of the following algorithms

$$Q_{CVol} = Q_{RVol} \cdot \frac{Pa \cdot Td}{Pd \cdot Ta} \quad \text{or} \quad Q_{CMass} = Q_{RMass} \cdot \frac{Pa \cdot Td \cdot MWa}{Pd \cdot Ta \cdot MWd}$$

Let’s see how it works:



Appendix B: Valve States

Terminology

CSC: CAR SEALED CLOSED

CSO: CAR SEALED OPENED

FO: FAILURE OPEN

FC: FAILURE CLOSE

FL: FAILURE LOCKED

FLO: FAILURE LOCKED OPEN

FLC: FAILURE LOCKED CLOSED

LO: LOCKED OPEN

LC: LOCKED CLOSE

NO: NORMALLY OPEN

NC: NORMALLY CLOSED

Example 1: FC

Application	Valve Status
Valve downstream of a separator	FC
Valve inlet to the distillation column	FC
Valve controlling the reflux flow and level of the reflux drum	FC

Example 2: FO

Application	Valve Status
Valve controlling protection steam added to oxygen line	FO

Note:

1.To get better understanding of example 2, check day 2 example for oxygen line PFD

2. These are typical status, based on process demand it might change.