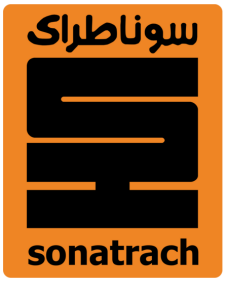


Ministry of Higher Education and Scientific Research

National Polytechnic School of Algiers

Automation Department

Academic Year 2025/2026

Internship Report

Contents

Introduction

*In this file are all the details about my internship, that took place in the company of Sonatrach, in the region of Hassi R'Mel, Oued Noumer.From **13/12/2025** to **21/12/2025***

An overview of the area

*This area is a production area where they extract both **oil** and **gas** form the wells onsite, where the gas passes through a sepration process of several phases, before being transported while the oil is to be transported right after being seperated from the gas and water, which are all collected together at first when exctracted form the well.*

Expression of Gratitude

I would like to express my gratitude to all the people that helped me through out this journey and for their assistance and consistency, by which, I could get the knowladge and informations that will be mentioned in this report, and for that I give all my thanks to: ***Mr.AMROUCHE Nassim,Mr.MAAMERI Wahid, Mr.BOUSSEGAA Youcef, Mr.BOULEFRAKH, Mr.BOUROUBI Abdennour***

1 Instruments of Measurement

1.1 Pressure Transmitter

It is a pressure sensor that measures the value of the pressure in a given area and converts its value to a the corresponding electrical value (4-20mA electrical signal) through a piezoelectric. And the opposite happens for the command, an I/P converter, where it converts the electrical command signal(4-20mA) emmited by the LC(Logic Controller) into a corresponding pneumatic signal (0.2-1Bar) which controls a specefic valve.

(a) Pressure Transmitter

(b) I/P converter

(c) I/P converter

1.2 Pressostat

It's an ON/OFF instrument that takes action (by sendinh an electrical signal to the local PLC in our case) when the given pressure reaches a set point value. In well described in the SCADA section, we use two **Pressostats**, one set to **53[Bars]** and the other is set to **9[bars]**.

1.3 Thermocouple

It is a measurement instrument that generates a voltage (in μV to mV) when temperature increases. And by amplifying that small voltage we can get a 1-5V analog signal. However, it is usually as a Digital signal in security systems(if the temperature reaches a certain value, trigger fire alarm...). because it is relatively less accurate.

Thermocouple

1.4 Resistance Temeperature Detector(RTD)

It is a temperature measurement instrument, which is a temperature sensetive resistance that varies along with the temperature, the temperature value is extracted by measuring the value of the resistance, to be then treated by the PLC.We use this instrument to supervise the variations of temperature thanks to its high precision, therefore it is moslty used in regulation loops.

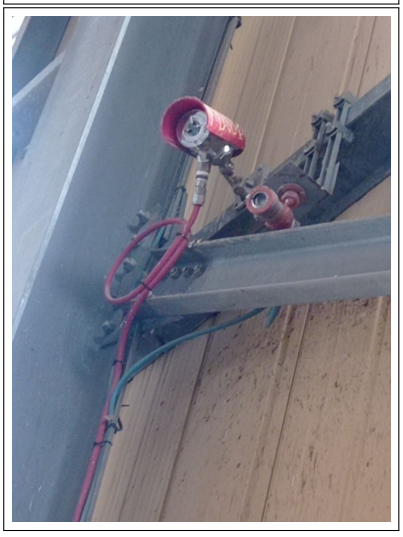
RTD PT100

RTD PT100

at 0 °CR = 100 [Ohms]

1.5 Flame Detector

It is a falme detection instrument that works using UV waves (Ultra Violet waves), mostly used in fire security systems, it is also used in the Gas Turbines, to indicate whether the combustion has occured or not.



1.6 Limit switch

A limit switch indicates the position of a given valve(open or closed) and it works only with All-or-Nothing type of valves, in here there are two types, a mechanical limit switch(standard), a beam linked to the valve moves along with the valve making an electrical contact at the end/begining of the path, which sends the corresponding electrical signal.And the other type of limit switches is a proximity limit switch that works using eddy current, where a magnetic field is continuously generated and if a metal comes across the field it will be magnified which gnerates an eddy current in the metal itself leading to losses in enegy indicating that the beam passed by, there are two tarnsmitters, and two states (open = 11/ close = 00), if the transmittors indicates (01), it means that the valve is half way open, therefore we inteven.(the state 10 is impossible).

mechanical limit switch

1.7 Level Transmitter

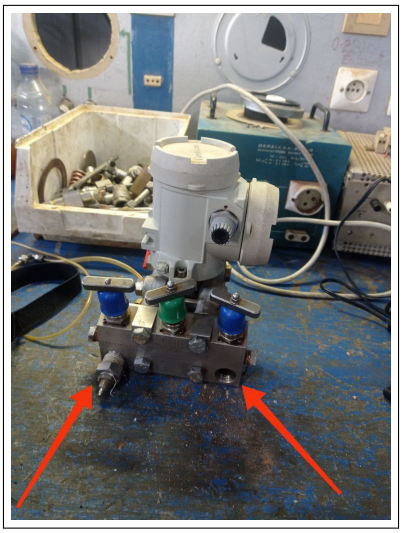
It is an instrument that measures the level of a given fluid (Oil in our case), in the seperation balloon, it doesn't measure the level directly but it measures the pressure in two different levels(top&bottom), and using the basic equation of fluid statics we can get the level of the fluid.

$$p_2 = p_1 + \rho g H$$

1.8 Flow Transmitter

The most used flow transmitter in this manufactory is called the differential orifice flow transmitter, where it actually measures the difference of pressure between two points, one before and another right after an orifice that we implement in order to create the pressure drop, and using **Bernoulli's principle** we can calculate the flow in the corresponding pipe.

$$Q = \sqrt{\left(\frac{\rho}{2}\right)(P_1 - P_2)\left(\frac{S_1^2 S_2^2}{S_1^2 - S_2^2}\right)}$$



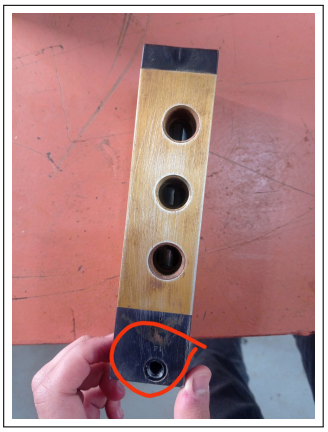
2 Instruments of Control

2.1 Pneumatic Command Distributor

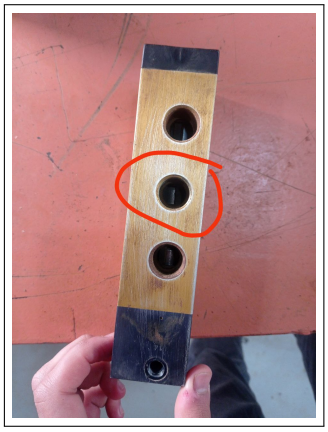
It is an All-or-Nothing control instrument, this pneumatically commanded instrument allows us to control heavy loads using high pressure air(3 to 5[Bars]), in our case it's usually used to open and close a gas valves where the command can be done using a relativaly low pressure air(0.5 to 1[Bars]).

Figure 7: Pneumatic Command Distributor

The little hole in the black band part is the input command entry, where we send a **HIGH**(1 Bar) or a **LOW**(0.2Bar) pneumatic signal, to then guide the supply pressure(the required pressure to open or close the valve, and it is the second entry in the golden area) to one of the outputs(closing or opening), which are indicated in the figure below.



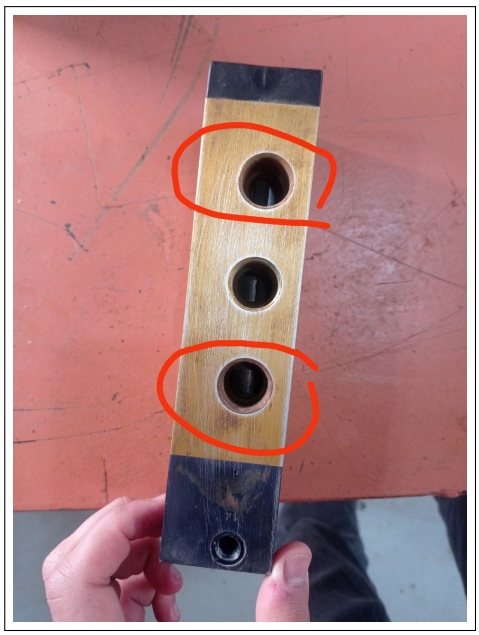
(a) command Input of the PCD



(b) supply air entry

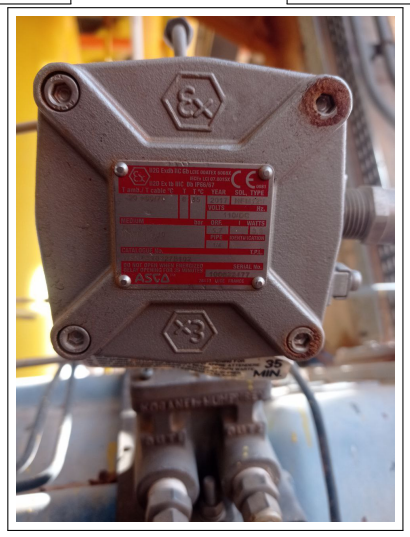
(c) closing&opening outputs

However, the switch of the position of the valve meets a problem, where the previous position is satisfied by applying the supply pressure to the piston controlling the valve,so when switching the position, that pressure is blocking the way for the piston to move in the other direction and that's because the pressure applied is the same, therefore we need to release that compressed air, and we can do that thanks to air purging, and the combination between the outputs and the air purging occurs thanks to the shape of the internal beam that is the on responsible for the switching.



2.2 Solenoid valve

It is an All-or-Nothing instrument that opens and a closes a given valve, it works using electromagnetic field generated by a current circulating throught a coil, which pulls a metlaic barrier and lets the supply high pressure air flows and opens/closes the valve(it depends on the rest position of the valave), making us able to control the opening and closing the valve.



2.3 Pressure Safety Valve(PSV)

It is a security instrument used in high pressure spots, to make sure that the pressure is kept under a given point(for us to set) in a certain gas line, it works mechanically using a spring, that blocks the way out(to the flare stack), when the pressure exceeds the set point the pressure force becomes greater than the spring force opening the way for the gas to be realeased(to the flare stack).

2.4 Positioner

This instrument is a regulation instrument, it gets Feedback about the current position of the valve, therefore when the I/P sends a certain pneumatic signal, the positioner differentiate the previous state(current postion of the valve) from the desired state(mechanically) which allows the adequate pressure for the valve to meet the desired position, ensuring rapidity and precision.

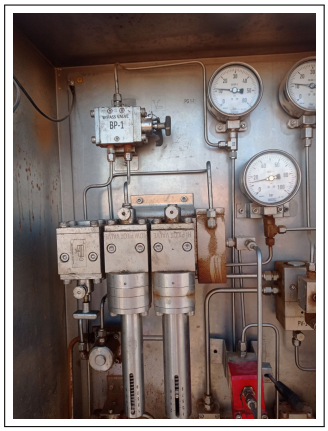
Mechanical positioner

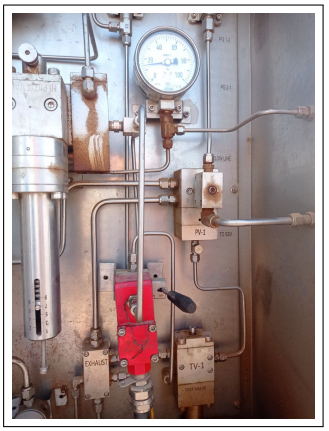
Mechanical positioner

Electrical positioner

3 Supervisory Control And Data Accusation (SCADA)

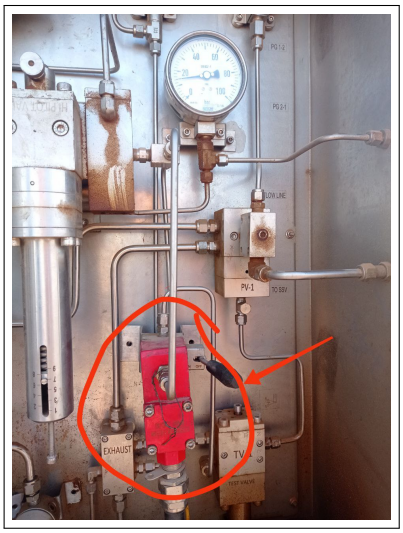
For long distance wells, where the distance between the well and the **DCS** can reach more than 100[Km], the standard communication system (Ethernet, Copper wires) is expensive and less reliable, we use another way of communication&control, Radio waves, and that's where the SCADA comes in, where we equip each well with the needed measurement instruments (Pressure, Temperature) and a local PLC (AKA slave), while the Principle PLC(Master) is located somewhere near the control room and connected to the HMI via optic fiber, the measurements data of each equiped well, is communicated by radio waves through the set frequency band 25[KHz], meaning the well is locally controlled but in case it's mislead we can interven immediatly(change a given set point, close/open a given valve, shut down the well ...), and if the communication failed, a local security box is placed where it takes action immediatly in case of a malfunctioning. The same cause that we can't use standard communaction methods(long distances), to supply the SCADA system we use batteries and solar Panels. And like that we can Supervise and Control the long distance wells, hence we can say that the **DCS** is for the Short distance units, and the **SCADA** is for the long distance units(the different wells in our case).



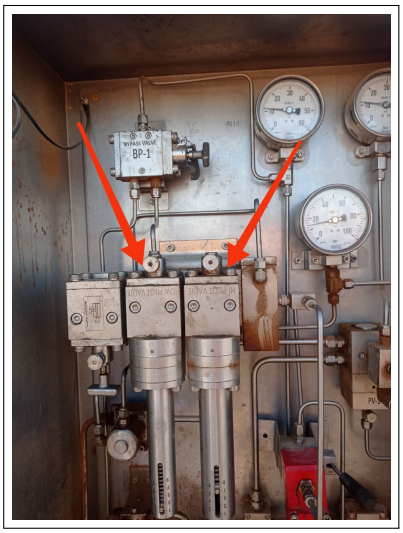


Security box

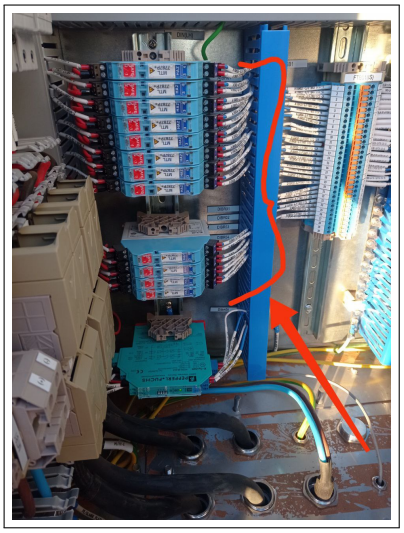
In this security box there's a solenoid valve, and two pilot valves;a Low Pilot Valve(LPV) and a High Pilot valve(HPV), these pilot valves purges the line Gas when the set point pressure value is exceeded(HPV) or underpassed(LPV).



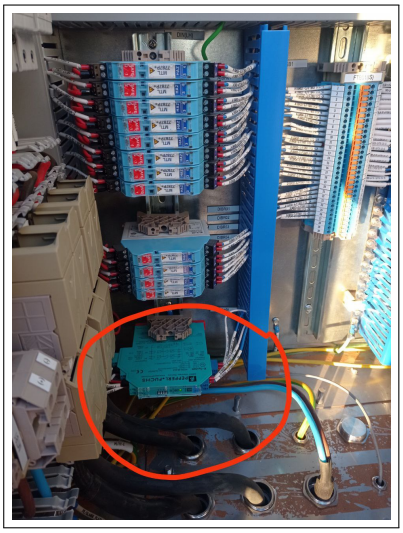
Solenoid Valve



High/Low Pilot Valve

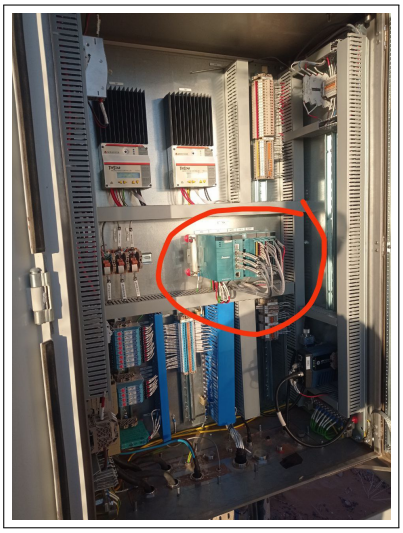


zener barriers

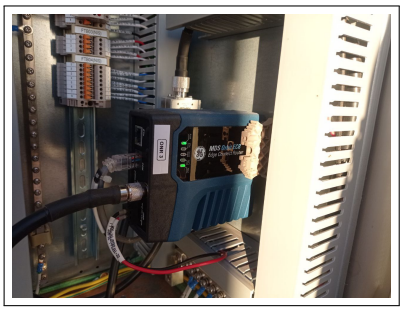


zener barrier + amplifier

Resistance Temeperature Detector



Local PLC

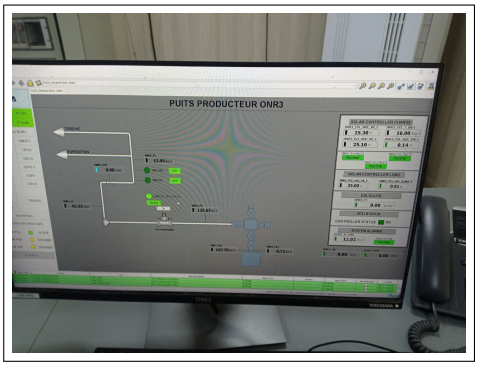


data encrypter (for radio communication)

Remote Terminal Unit(RTU)

Antenna + Solar panel

Oil&Gas well

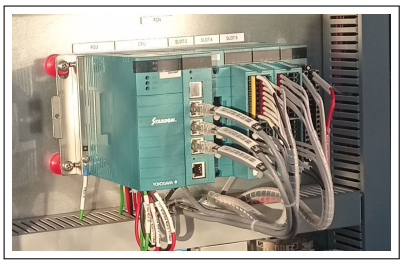


HMI well display

4 Programable Logic Controller(PLC)

It is the innovation of control, back in the day, automated systems where mechanical, or the so called: differential regulator.But a differential regulator couldn't always meet the required needs, on the other hand a PLC is an electical automation device that can handle a more complicated systems, where we can implement the logic of the process that we want to regulate in this device using a specefic language of programing, and we can control more than only one machine, where we can manage to regulate a given machine's behaviour depending on other's. A PLC is composed of: PSU(Supply unit 24[Volts] DC), CPU(Central processing unit), and inputs/outputs slots(analog/digital)

Differential Regulator



PLC

DC Power supply

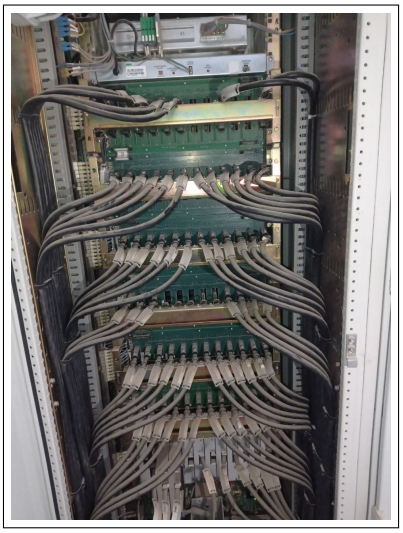
5 Distributed Control System(DCS)

It is the highest system in the hierarchy of control systems, where it can control a whole unit of the manufactory, it is the same as a PLC, but it's larger and can handle more data where it doesn't have input/output slots only, and it has one or more electical cabinet called the **Marshalling cabinet** for that, meaning that a DCS is composed of many electrical cabinets unlike PLCs that usually needs only one electrical cabinet, and it has a couple of CPUs that are robust and faster than a CPU of a PLC.

CPUs of the DCS

marshalling cabinets

marshalling



marshalling

one of the CPUs

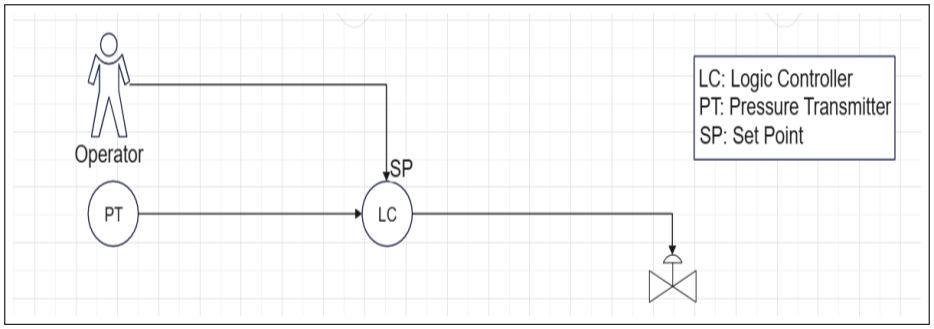
Input/output cards

6 Regulation loops

In an automated system comes regulation, which is rectifying the errors, fluctuations that occurs during the systems work, an efficient regualtion must optimize three parameters: Stability, Rapidity, Minimum steady state error.In this manufactory the most used regulation loops are:

6.1 A Simple loop

This loop is composed of a differential regulator, where it simply measures the difference between the real value with the desired value(Set point) of our variable (Temperature, Pressure, Flow, Level), then it closes/opens the corresponding valve dependig on the difference.The type of regulation in this loop or every other loop depends on the process variable to regulate.



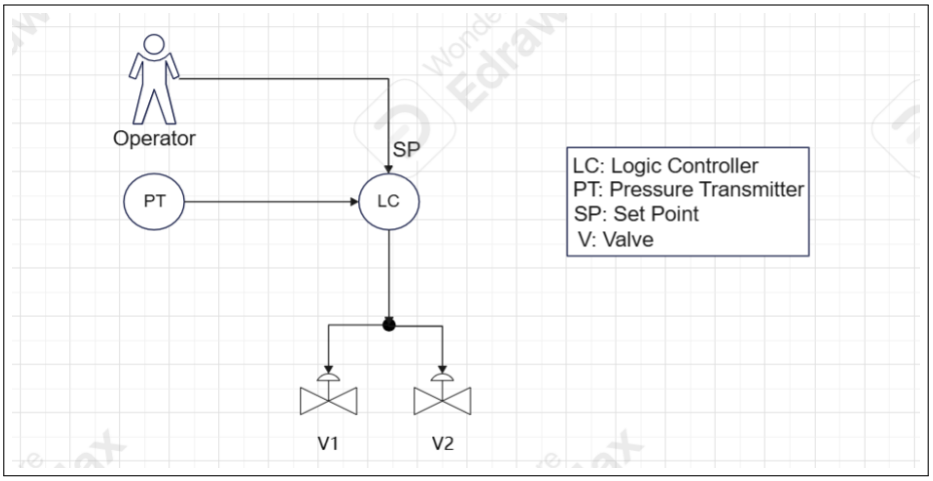
A Simple Loop

6.2 A Split-Range loop

It is a loop that consists of regulating two outputs through one controller.

Example:

In one of the Gas seperation balloons, the gas pressure must be 12[Bars], but since the Gas flow is unstable, we need regulation to keep the pressure and level as required (Set Point); for that, we control the valve of the pipes coming out of the balloon(going to another unit and to the Gas flare), if the pressure increased we open the valave of the other unit even more(because on serivce it's already open to a certain point), if the Gas pressure still increased, we keep opening the valve until it reaches 100% if still increasing we start opening the Gas flare valve until we drop the pressure to 12[Bars] in our case, and that's why it's called a split range loop, the first valve works in the range of 0-50% and the second valve works in the range of 50-100% of the regualtors command.



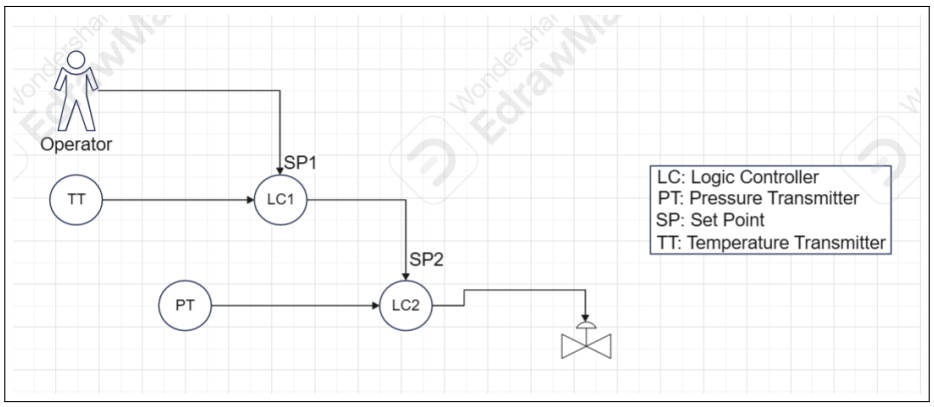
A Split-Range Loop

6.3 A Cascade loop

It's basically two simple loops in one loop, where the set point of the first regulator is set by the operator(us), and the set point of the second regualtor is commanded by the first regulator's output,where finally the second regulator's output is the to command the valve, it's two inputs / one output loop.

Example:

In the Oil heating oven, we need to increase the Oil temperature to around 40 °C, and since the Oil's pressure is not stable, the temperature of the oil will be changing over time, meaning to maintain the required flame to heat up the oil to the desired temperatue, the Fuel Gas pressure must change along with the measured Oil's temperature, thus, we have two input varibles, (Oil's temperature, Oil's pressure) and one output (Fuel Gas' pressure).



A Cascade Loop

Conclusion

In the end, even though this internship was a short time internship, However, I've learnt a lot thanks to the instrumentation team that helped me get more knowledge about the Oil&Gas industry and see the transition from the theoretical aspect to the practical aspect.

end.