Piping And Instrumentation Diagram

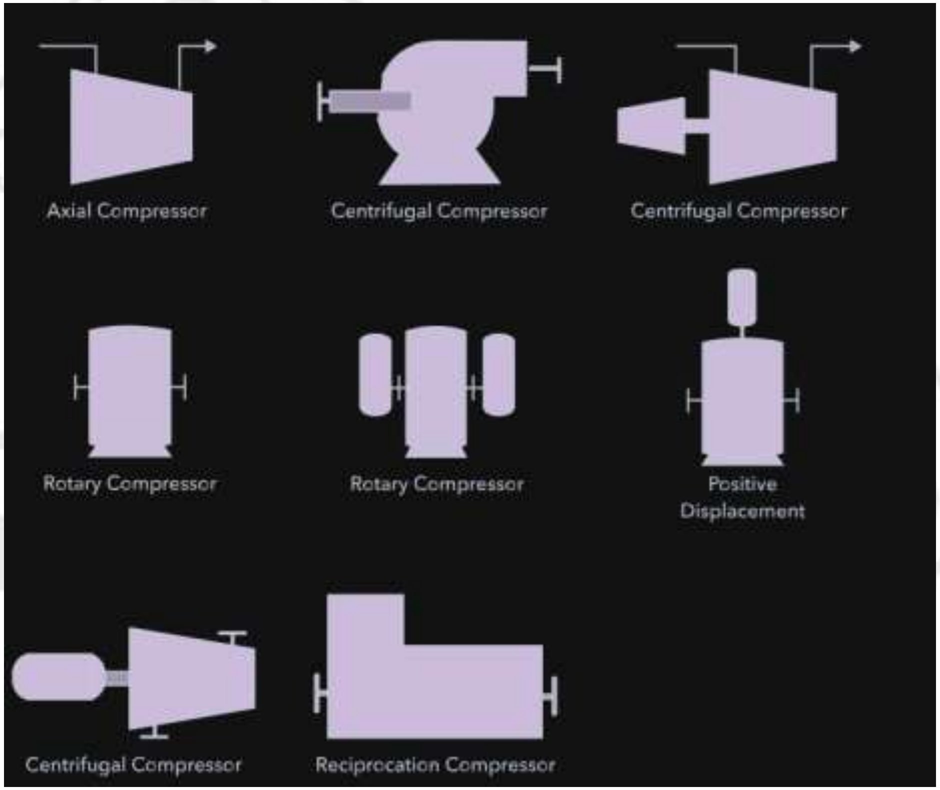
What is P&ID?

- A piping and instrumentation diagram, or P&ID, shows the piping and related components of a physical process flow. It’s most commonly used in the engineering field.

- P&IDS are foundational to the maintenance and modification of the process that it graphically represents. At the design stage, the diagram also provides the basis for the development of system control schemes, like Hazard and Operability Study (HAZOP).

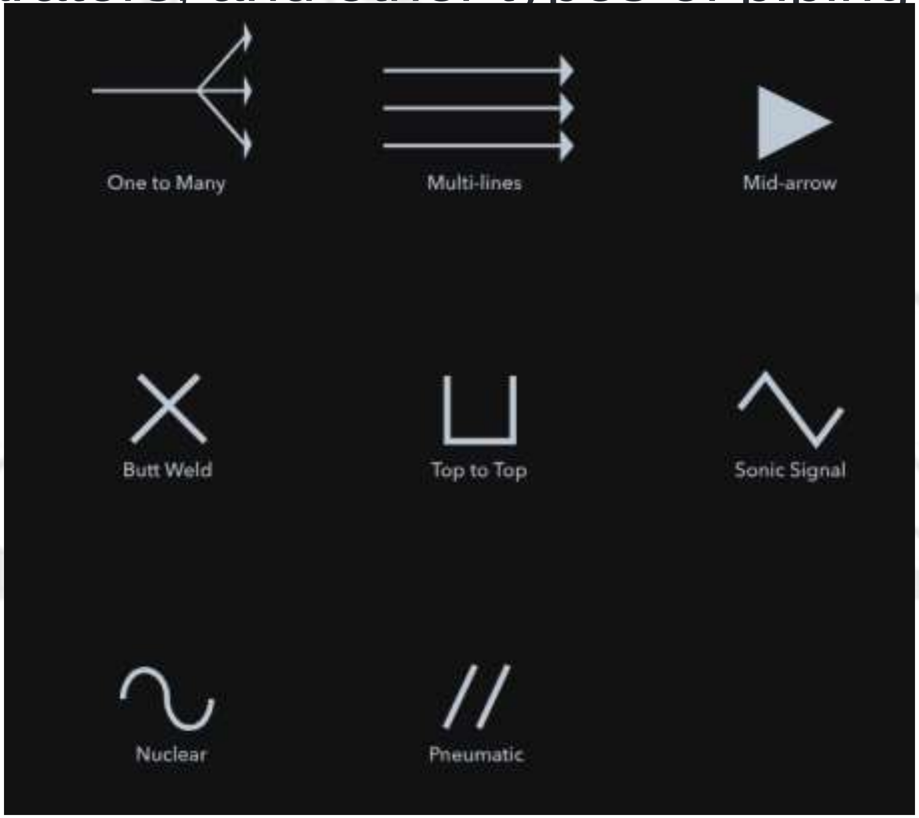
- P&IDs are a schematic illustration of the functional relationship of piping, instrumentation and system equipment components used in the field of instrumentation and control or automation.

Equipment

- Equipment is comprised of miscellaneous P&ID units that don't fit into the other categories. This group includes hardware like compressors, conveyors, motors, turbines, vacuums, and other mechanical devices.
- 

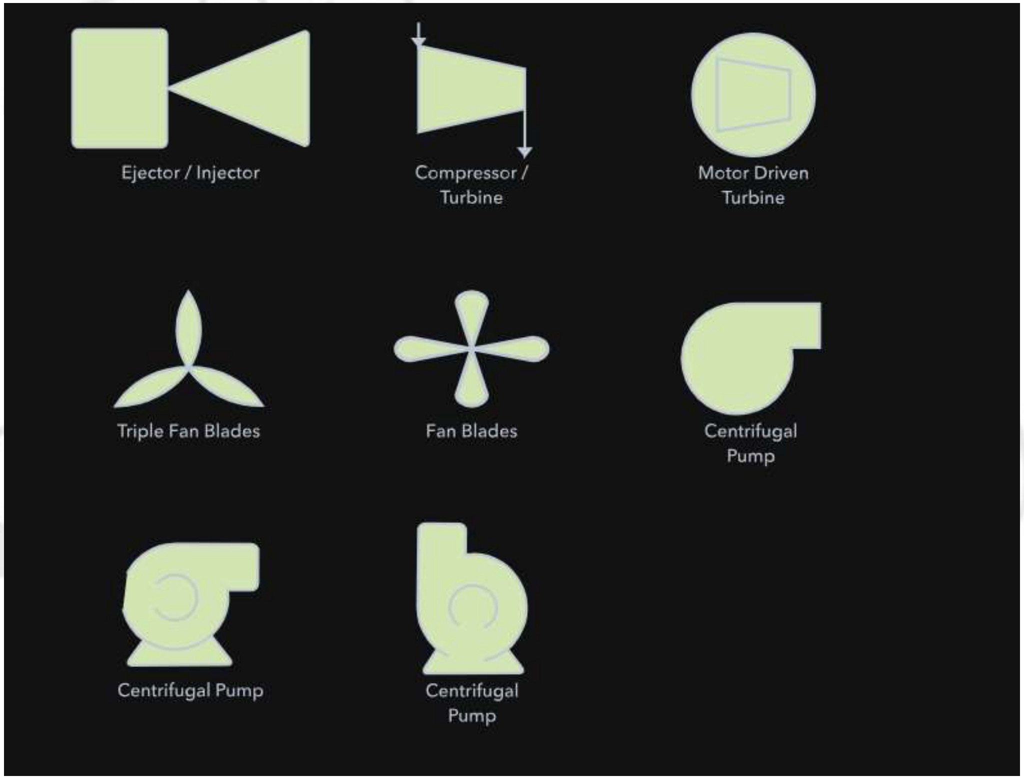
Piping

- A pipe is a tube that transports fluid substances. Piping can be made of various materials, including metal and plastic. The piping group is made up of one-to-many pipes, multi-line pipes, separators, and other types of piping devices.



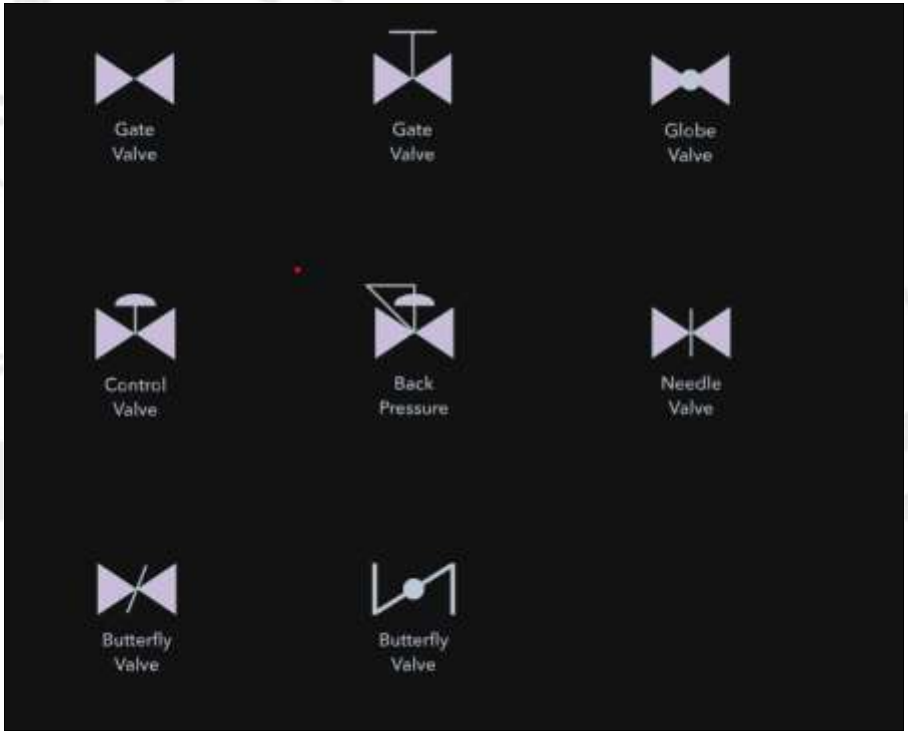
Pumps

- A pump is a device that uses suction or pressure to raise, compress, or move fluids in and out of other objects. This section is comprised of both pumps and fans.



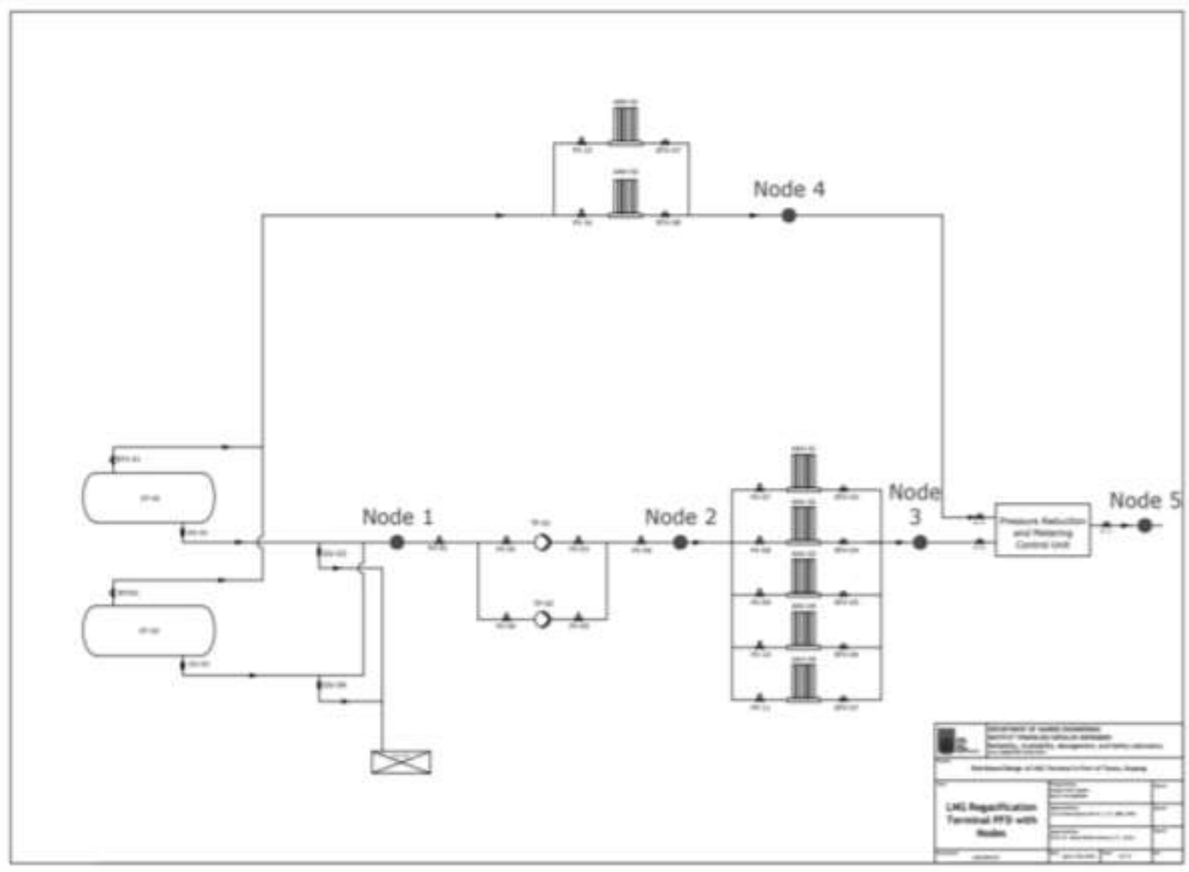
Valves

- A valve regulates, directs, or controls the flow of a fluid by opening, closing, or partially obstructing passageways in a piping system. This category includes rotameters, orifices, and other types of valves.



P and ID in LNG terminal

- Process flow diagram (PFD) is use to show the general flow of the LNG regasification terminal. PFD only include major equipment and exclude minor details such as instrumentations.



- In starting step of hazard identification, the system is divided into 5 nodes based on the function and the severity of the hazard.
  - Node 1- process of containing LNG in ISO LNG Tank and LNG unloading.
  - Node 2-process of LNG transfer to ambient air vaporizers.
  - Node 3-process of regasification of LNG back to natural gas.
  - Node 4-process of Boil Off Gas Treatment
  - Node 5-process of transferring natural gas to pressure reduction and metering unit through pipes.

- The results of HAZOP studies indicated that the potential fire hazard that occurs LNG regasification terminal are gas release that can lead to fire. Afterwards, based on the comment and recommendation in HAZOP sheets, additional safeguards will be added to the previous design resulting P&ID as in figure 5, figure 6, and figure 7

HAZOP Report- LNG terminal

Study Data | Nodes | Deviations | PHA Worksheets | LOPA Worksheets | Check Lists | Recommendations | Safeguards | Parking Lot | Risk Criteria | Premium Tools

Overview

Study Name	L and G Terminal HAZOP Study
Study Coordinator	John Smith
Study Coordinator Contact Info	
Facility	Emily Johnson
Facility Owner	XYZ Corporation
Unit	L and G Termina
Report Number	
Project Number	LT-2021-5678
Description	The HAZOP study aims to identify and evaluate potential hazards and risks associated with the L and G Terminal operations, including storage, loading/unloading, and vapor r
General Notes	The study will be conducted in accordance with industry best practices and regulatory requirements. All relevant stakeholders and subject matter experts will be involved in the study sessions. The findings and recommendations from the study will be used to enhance safety measures and mitigate risks at the L and G Terminal.

Nodes

Description	Intention	Boundary	Design Conditions	Operating Conditions
1 Liquefied Gas Storage Tank	Assess hazards and risks of gas storage	Liquefied gas storage tank and associated systems	Maximum storage capacity, pressure, and temperature limits	Normal storage and handling operations
2 Loading and Unloading Operations	Identify hazards during loading/unloading	Terminal loading and unloading operations	Loading/unloading rates, product specifications	Normal loading and unloading operations
3 Vapor Recovery System	Assess hazards and risks of vapor recovery	Vapor recovery system and associated equipment	Flow rates, VOC concentrations, pressure limits	Normal vapor recovery system operation

Deviations

1. Liquefied Gas Storage Tank

Deviation	Guide Word	Parameter	Design Intent	Comments
1.1	Overfilling	Level	Prevent overfilling	Implement automated level monitoring system with alarms.
1.2	Leakage	Integrity	Prevent leaks and spills	Regularly inspect and maintain tank integrity and fittings.
1.3	Ventilation	Ventilation	Ensure proper ventilation	Assess and improve ventilation system for safe gas storage.

PHA Recommendations

PHA Recommendation	Priority	Responsible Party	Status	Comments
1 Automated Level Monitoring	High	Operations Department	In Progress	Implement an automated level monitoring system with alarms.
2 Regular Inspection and Maintenance	Medium	Maintenance Department	In Progress	Conduct regular inspections and maintenance of tank integrity and fittings.
3 Ventilation System Assessment	Medium	Engineering Department	In Progress	Assess the ventilation system and make necessary improvements for safe gas storage.

PHA Recommendations

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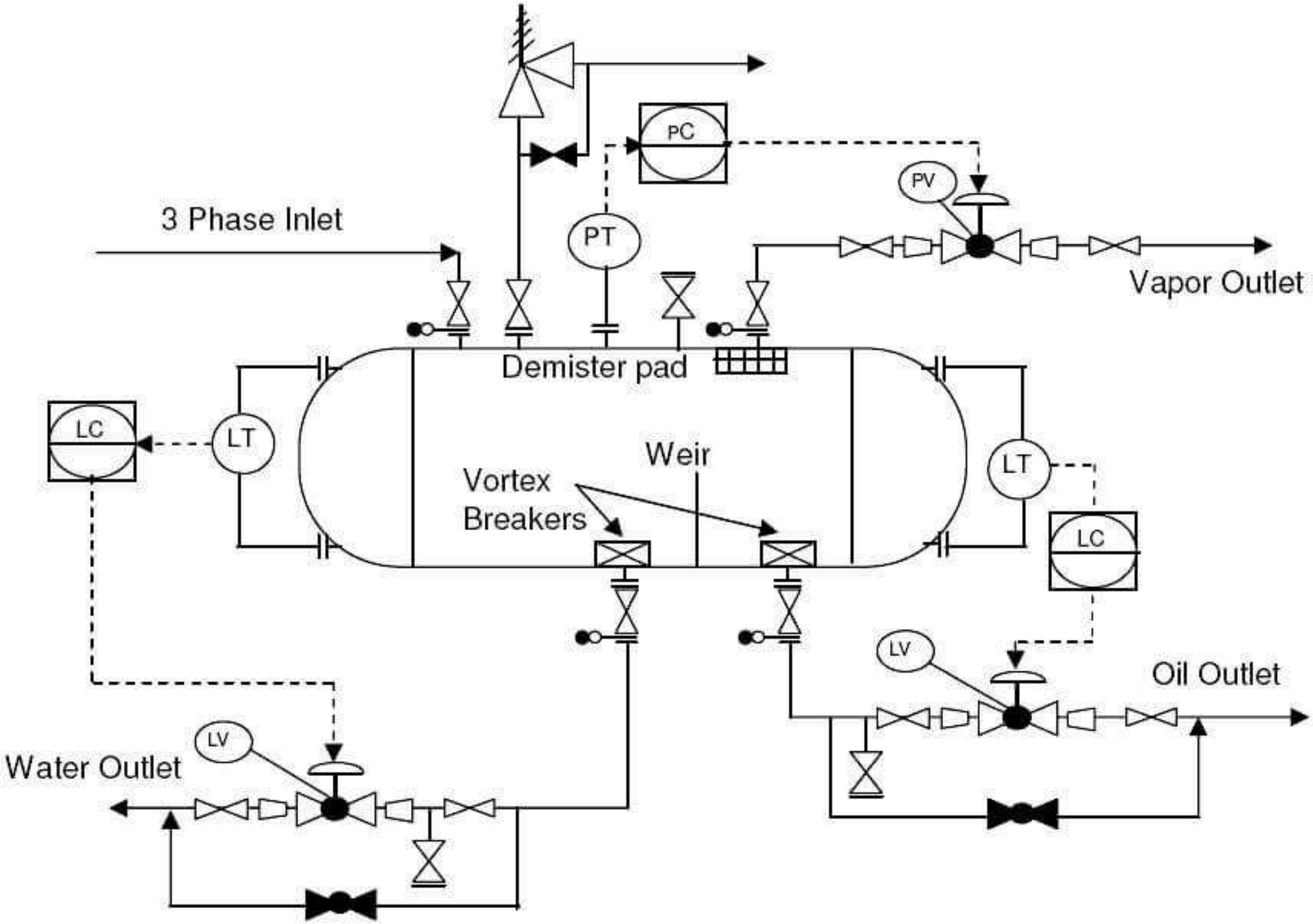
Risk Matrix

Risk Matrix

Safety

Consequence \ Likelihood	VL	L	M	H	VH
VH	1	2	3	4	5
H	1	2	3	4	5
M	2	3	4	4	4
L	2	3	3	4	5
VL	1	1	2	4	5

P and ID in Oil Storage plant



Crude Oil Treatment Process

- There is initial separation equipment in the crude oil treatment process. It functions as a three-phase separator, separating the majority of free water from the crude oil.
- The Heater-Treater separator is the second stage of separation in the treatment process. It combines a three-phase separator with a heating system using fuel gas.
- The Electrostatic-Desalter is the final stage of water and salt removal in the crude oil treatment process. It utilizes an electric field to promote the coalescence of water.
- Fresh well water is injected before the Electrostatic-Desalter to achieve the final dilution required for salt removal and produce treated oil
- The treatment of crude oil offers several benefits. It produces treated oil with reduced water and salt content, improving its quality for further processing and utilization.

Crude Oil Treatment Process

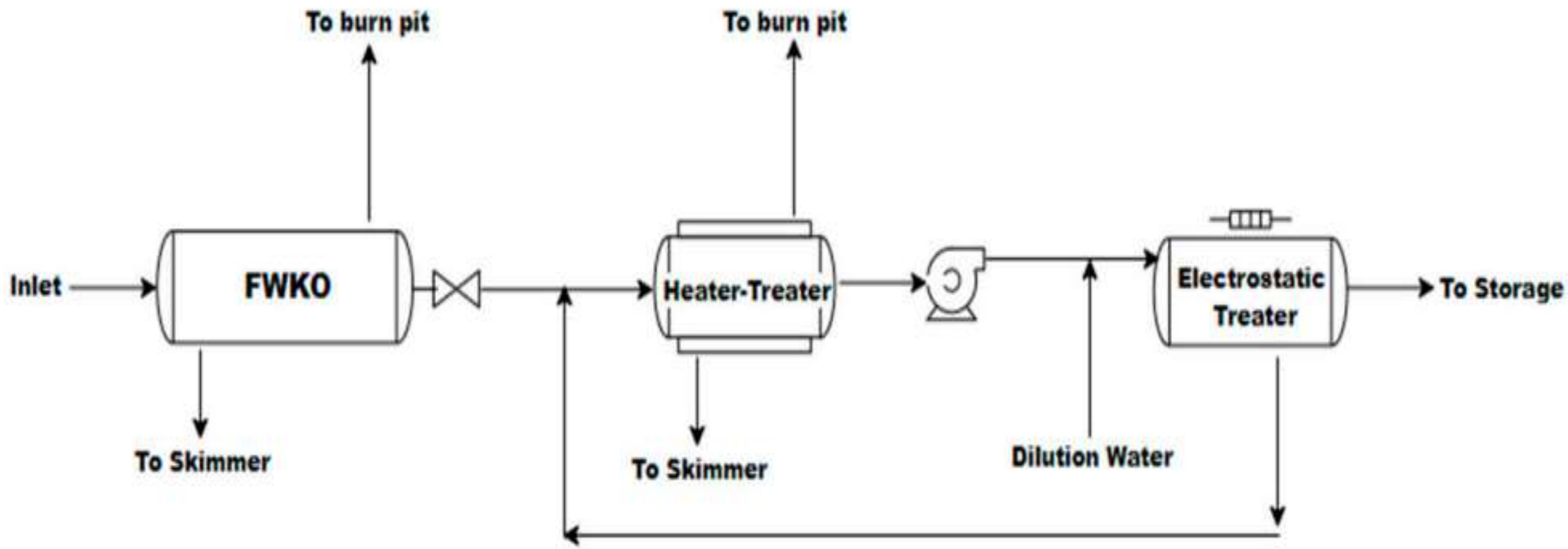


Figure 1. Simplified process flow diagram of crude oil treatment.

HAZOP Report- Oil Storage plant

File View Security Help

Study Data | Nodes | Deviations | PHA Worksheets | LOPA Worksheets | Check Lists | Recommendations | Safeguards | Parking Lot | Risk Criteria | Premium Tools

Overview

Study Name	Design and Operation Study for Oil Storage Plant
Study Coordinator	Arush Gupta
Study Coordinator Contact Info	
Facility	Coastal Oil Storage Facility
Facility Owner	ABC Petroleum Corporation
Unit	Oil Storage Plant
Report Number	
Project Number	P4567
Description	The design and operation study for the oil storage plant aims to develop a comprehensive plan for the construction, layout, and operation of the Coastal Oil Storage Facility in Port City, USA. The study encompasses various aspects such as determining the storage capacity of 500,000 barrels, selecting above-ground fixed-roof tanks for storage, and implementing safety measures such as fire suppression systems and automated leak detection. Environmental impact assessment and compliance with regulatory requirements are integral parts of the study.
General Notes	Compliance with OSHA, EPA, and local regulations is a priority throughout the study. Safety measures include fire suppression systems, automated leak detection, and secondary containment systems.

Nodes

Description	Intention	Boundary	Design Conditions	Operating Conditions
1 Tank Overfilling	Identify hazards	Oil storage tank system	Tank specifications	Process variations
2 Fire and Explosion	Hazard recognition	Facility and equipment	Safety features	Process parameters
3 Structural Integrity	Identify contamination risks	Storage tank system	Environmental protection measures	Handling and transfer processes
4 Environmental Contamination	Contamination prevention	Storage tank and surrounding environment	Leak prevention measures	Handling and storage practices

Deviations

1. Tank Overfilling

Deviation	Guide Word	Parameter	Design Intent	Comments
1.1 Excessive Oil Level	Excess	Oil level	Prevent overfilling and spillage	Ensure that the tank has appropriate level monitoring systems and alarms to prevent the oil level from exceeding the safe limit. Implement measures such as high-level alarms, trip mechanisms, and automated shut-off systems to mitigate the risk of overfilling.
1.2 Insufficient Level Control	Less	Level control	Maintain optimal oil level	Verify that the tank's level control system is designed to maintain the oil level within the desired range. Adequate instrumentation, control valves, and operator training are necessary to prevent the oil level from falling too low, which may impact operations or cause damage to equipment.
1.3 Reverse Flow	Revers	Inlet/outlet flow rate	Ensure proper flow management	Assess whether the tank's inlet and outlet flow rates are appropriately designed to handle the expected volumes. Reverse flow, where the inflow exceeds the outflow, can lead to overfilling. Proper flow control and instrumentation are essential to prevent this deviation and maintain safe operating conditions.

PHA Recommendations

PHA Recommendation	Priority	Responsible Party	Status	Comments
1	High	Operations Department	Implemented	Install high-level alarms and automated shut-off systems to prevent tank overfilling and associated hazards. Regularly test and maintain these systems for their effectiveness.
2	Medium	Maintenance Department	In Progress	Develop and enforce a preventive maintenance program for tank fittings, valves, and pipelines to prevent potential leakages. Regularly inspect and repair any identified issues.
3	High	HSE Department	Proposed	Develop and implement a comprehensive spill response plan, including proper containment measures and spill cleanup procedures. Train personnel on the plan and conduct regular drills.
4	Medium	Engineering Department	Implemented	Conduct regular integrity inspections of the tank's structure, including corrosion monitoring and testing. Address any identified issues promptly to ensure structural integrity.
5	Low	Procurement Department	Pending	Procure and maintain appropriate personal protective equipment (PPE) for personnel working in the vicinity of the tank to minimize potential hazards and ensure their safety.

LOPA Recommendations

LOPA Recommendation	Priority	Responsible Party	Status	Comments
1	High	Operations Department	Implemented	Install a high-level alarm system with automated trip mechanisms to prevent tank overfilling and associated hazards.
2	Medium	Safety Department	In Progress	Implement a fire detection and suppression system to rapidly detect and control fires near the tank.
3	High	Maintenance Department	Pending	Establish a preventive maintenance program for critical equipment to ensure reliability and functionality.

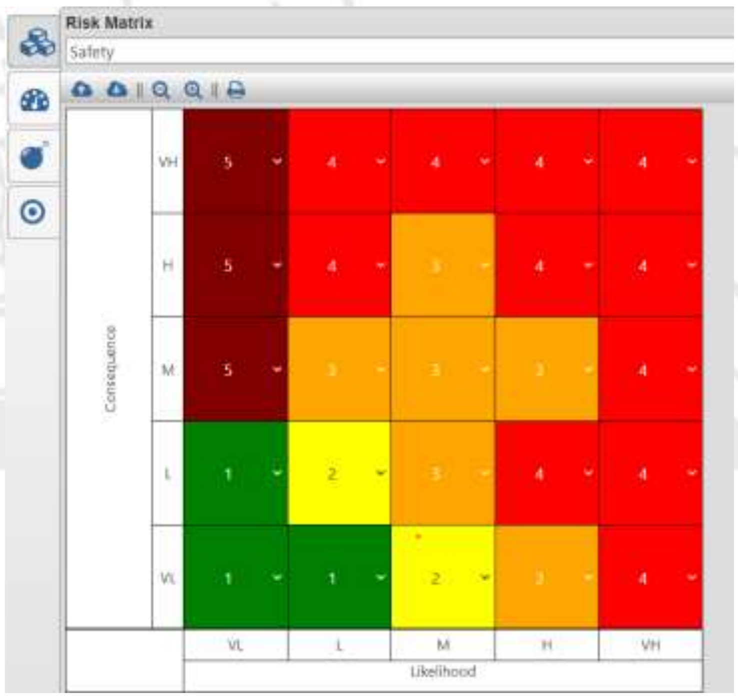
Check List Recommendations

Search Worksheet

Check List Recommendation	Priority	Responsible Party	Status	Comments	Reference
Emergency Shutdown Procedures	High	Operations Department	Implemented	Develop, train, review, and test emergency shutdown procedures.	
Hazardous Material Storage and Handling	Medium	HSE Department	In Progress	Hazardous Material Handling - Establish, train, inspect, and update storage and handling procedures.	

Safeguards

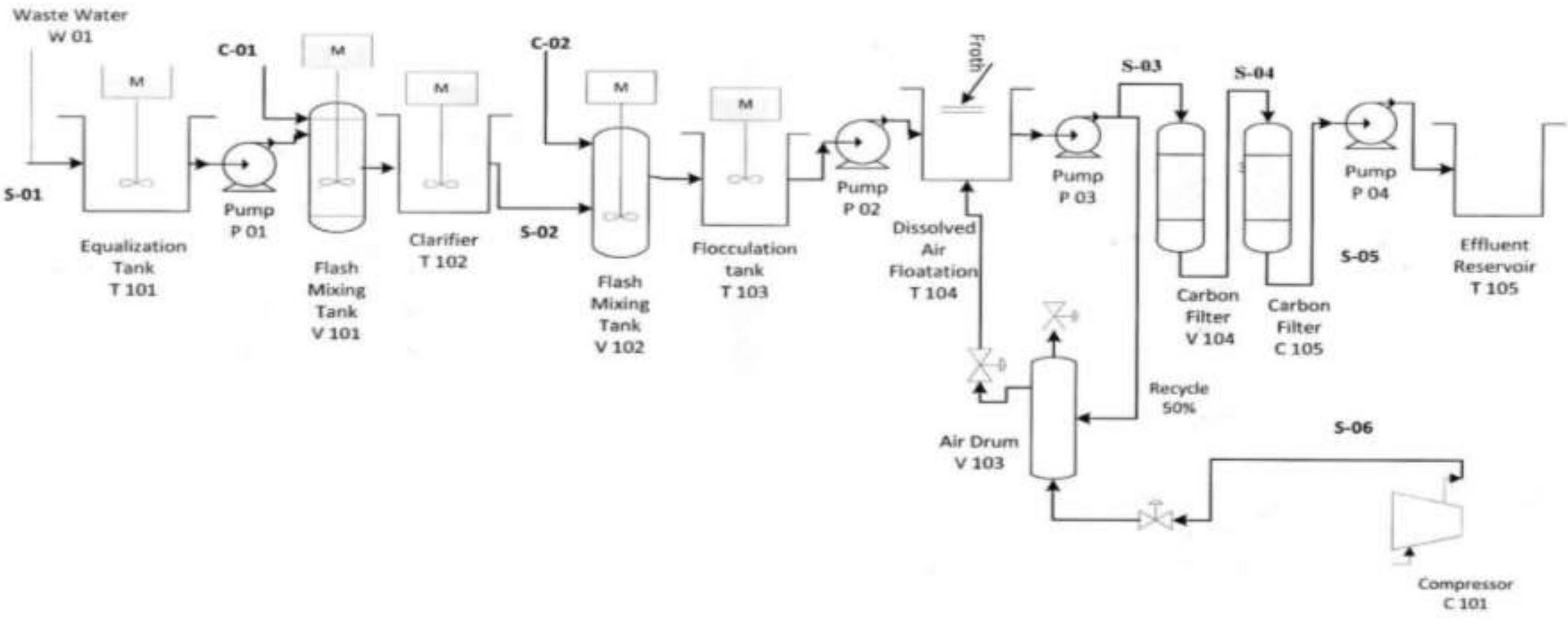
Safeguard	Independent	Auditable	Effective	IPL	PFD	Reference
1 High-Level Alarm System	Yes	Yes	Yes	Yes	Low	
2 Safety Relief Valve	Yes	No	Yes	Yes	Moderate	
3 Fire Suppression System	Yes	Yes	No	No	High	



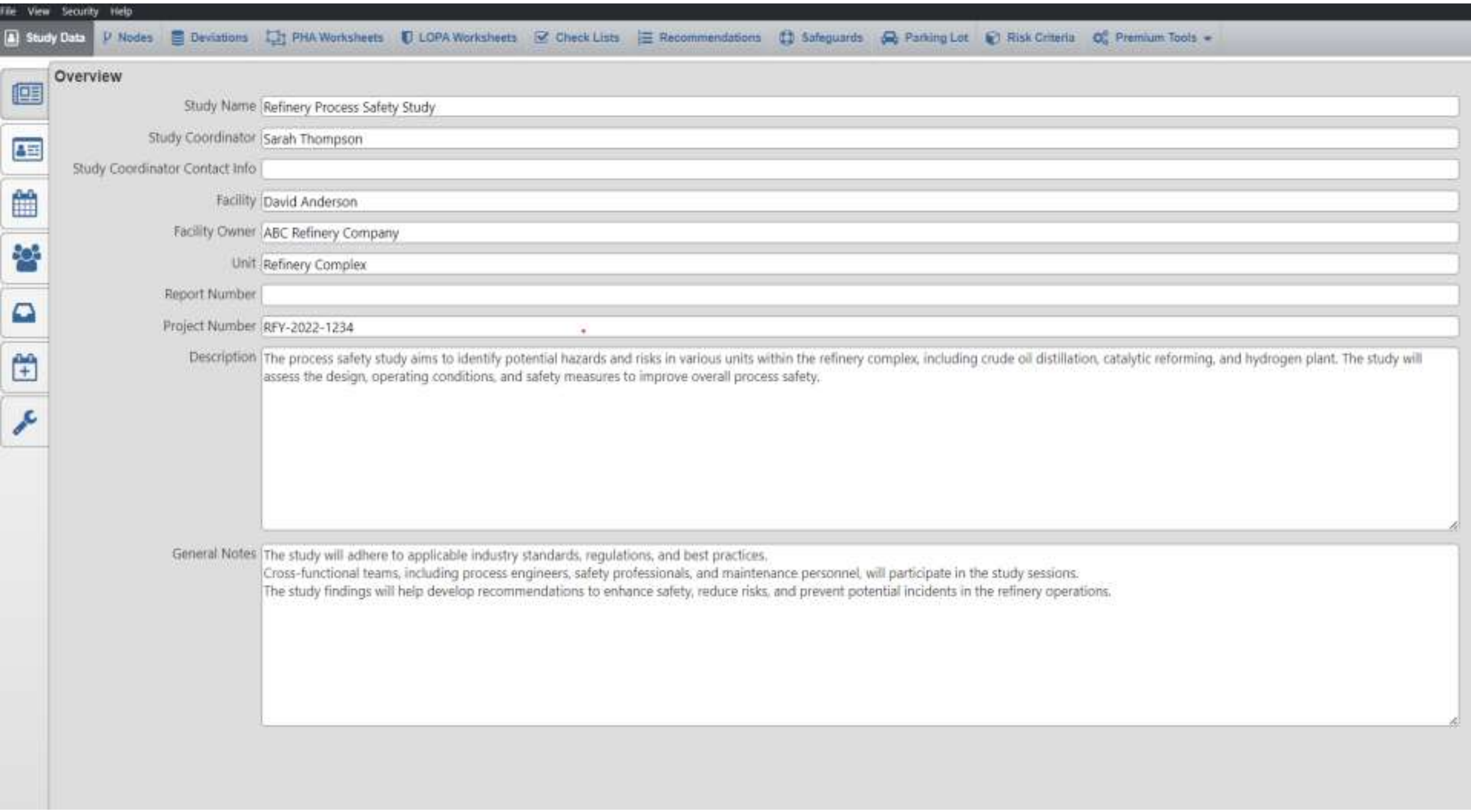
P and ID in Refinery

- The analysis of risk associated with hazard is the main aspect of oil industry. Risk assessment or risk analysis is carried out throughout the use of many suitable methods of study.
- The method involves Qualitative and Quantitative Risk Assessment. Qualitative or Historical risk analysis is preliminary risk assessment, while Quantitative risk analysis i.e. HAZOP is used in severe cases in various industries.
- A petroleum refinery provides the most needed fuels for everyday use for industrial, commercial and domestic purposes. Processing crude oil in refinery requires large percentage of oil which is contaminated and requires some level of treatment.
- The main objective is to identify the hazards only related to oily waste water treatment plant. The disposal of waste water from the refinery is the very serious problem in Pakistan. Therefore oily waste water treatment facility should be hazard free before and after treatment.

- For a safer side with all respect HAZOP study is necessary for all Refineries of Pakistan. The HAZOP study is carried out for safety, reliability and to optimize the instrumentation in the Refinery.



HAZOP Report-Refinery



Nodes

Description	Intention	Boundary	Design Conditions	Operating Conditions
1 Crude Oil Distillation Unit	Ensure safe and efficient crude oil distillation	From crude oil feed to distillate	High temperature, high pressure, corrosive feed	Normal operations, startup, shutdown,
2 Hydrogen Plant	Safely produce and supply hydrogen	From hydrogen production to	High pressure, flammable gas handling	Normal operations, startup, shutdown,
3 Catalytic Reforming Unit	Convert low-octane hydrocarbons into	From feedstock inlet to product	High temperature, catalyst regeneration	Normal operations, catalyst regeneration,

Deviations

1. Crude Oil Distillation Unit

Deviation	Guide Word	Parameter	Design Intent	Comments
1.1 Pressure Exceeding Limits	High	Pressure exceeding limits	Maintain proper pressure control	Install and maintain pressure relief valves, pressure gauges, and pressure control systems to prevent over-pressurization.
1.2 Leaks or Spills	Other Than	Leakage or spillage	Prevent and promptly address leaks or spills	Implement regular inspection, maintenance, and leak detection systems to minimize the risk of leaks or spills.
1.3 Inadequate Heat Exchange	Other Than	Inefficient heat transfer	Optimize heat exchangers and fouling prevention	Regularly clean and maintain heat exchangers to ensure efficient heat transfer and prevent fouling.

Deviations

2. Hydrogen Plant

Deviation	Guide Word	Parameter	Design Intent	Comments
2.1	High	Flammable Gas Leakage	Prevent and promptly address gas leaks	Implement regular inspection, maintenance, and gas detection systems to minimize the risk of flammable gas leaks.
2.2	Other Than	Inefficient Hydrogen Production	Optimize hydrogen production process	Conduct process optimization to improve hydrogen production efficiency and reduce energy consumption.

Deviations

3. Catalytic Reforming Unit

Deviation	Guide Word	Parameter	Design Intent	Comments
3.1	High Temperature	High	Temperature exceeding limits	Ensure proper temperature control and monitoring
3.2	Pressure Exceeding Limits	High	Pressure exceeding limits	Maintain proper pressure control

PHA Recommendations

PHA Recommendation	Priority	Responsible Party	Status	Comments	Ref
1 Safety Training	High	Operations Team	In Progress	Provide appropriate safety training to all employees to ensure awareness and compliance with safety procedures.	
2 Preventive Maintenance	Medium	Maintenance Team	In Progress	Establish a preventive maintenance program to regularly inspect and maintain critical equipment for optimal performance.	
3 Resource Allocation	High	Management Team	In Progress	Allocate sufficient resources and budget for safety initiatives, equipment upgrades, and ongoing maintenance activities.	

Safeguards

Safeguard	Independent	Auditable	Effective	IPL	PFD	Reference
1 Pressure Relief Valve	Yes	Yes	Yes	Yes	High reliability, very low probability of failure	
2 Fire Detection System	No	Yes	Yes	No	Moderate reliability, moderate probability of failure	
3 Emergency Shutdown System	Yes	No	Yes	Yes	Relatively high reliability, low probability of failure	

Risk Matrix

Risk Matrix

Safety

Consequence	VL	L	M	H	VH
VH	1	2	3	4	5
H	1	2	3	4	5
M	2	3	4	4	5
L	2	3	2	3	4
VL	1	1	2	5	4
	Likelihood				

What are the limitations of P&ID?

- Since P&IDs are graphic representations of processes, they have some inherent limitations. They can't be relied on as real models, because they aren't necessarily drawn to scale or geometrically accurate.

- There's also no generally accepted universal standard for them, so they may look different from company to company—or even within the same company—based on internal standards, the type of software system being used, and the preferences of the creator.

Thank you