

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	SAM SHARP	Student ID number:	
Programme:	HNC Process Operations Engineering		
Module:	Process Safety Systems		
Module code:	PCPO4006	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Yan Mills	Internal Verifier:	L. Rutherford
Assignment Title:	Process Safety Management	Word count (or equivalent):	2000
Submission deadline:	17/02/2022	Return date of provisional marks & written feedback:	10/03/2022
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

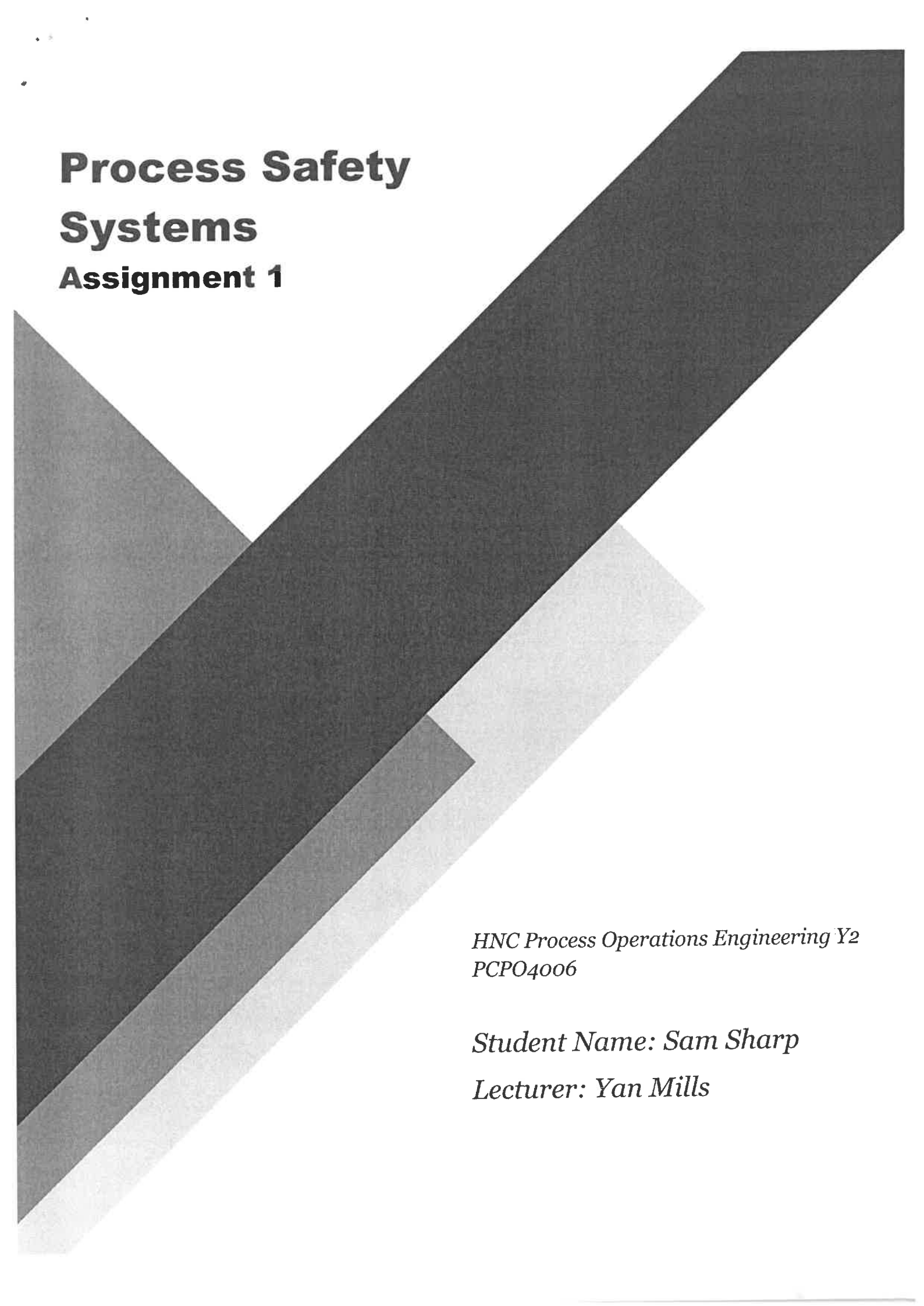
Module Learning Outcomes (from module syllabus)

- Explain the elements required to ensure the safe operation of an industrial process.
- Explain the strategies and procedures required to ensure an industrial process meets legal and regulatory requirements, and how safe systems of work are established.

STUDENT FEEDBACK FORM

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few inaccuracies or inconsistencies.	15	10
2. Knowledge and Understanding Skills		
Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	35	23
3. Cognitive and Intellectual Skills		
Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.	30	23
4. Practical Application Skills		
A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Very good evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions.	10	7
5. Transferable Skills for Life and Professional Practice		
Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	10	6

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		66%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		



Process Safety Systems

Assignment 1

*HNC Process Operations Engineering Y2
PCPO4006*

Student Name: Sam Sharp

Lecturer: Yan Mills

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Introduction

This report will discuss the elements of a process safety management system with relation to the four pillars of risk-based process safety. More specifically to deal with loss of containment events that might lead to catastrophic incidents. This will be related to the procedures and working practices that are employed at Pembroke Valero Refinery.

Furthermore, task 2 will analyse how different control measures are used to prevent incidents in a process plant environment.

Finally, the third task will highlight a specific industrial process, and explain some of the process safety measures that are used in that process required to ensure safe operation of the plant and minimize/ reduce the effects of a malfunction or failure.

Task 1

Any company whose operation encompasses situations where things can go wrong, hazards are present, and dangerous substances are in use, require a process safety management system in order to try and ensure that the hazards that are found in the workplace and as a result of the operations carried out can be controlled and the consequences of which can be minimised. This can be done through the four pillars or 20 elements of risk-based process safety (As shown in figure 1). All of these elements can be implemented into a company's operations so that they can be more equipped to deal with emergency events such as a loss of containment and prevent the event leading to a catastrophic incident.

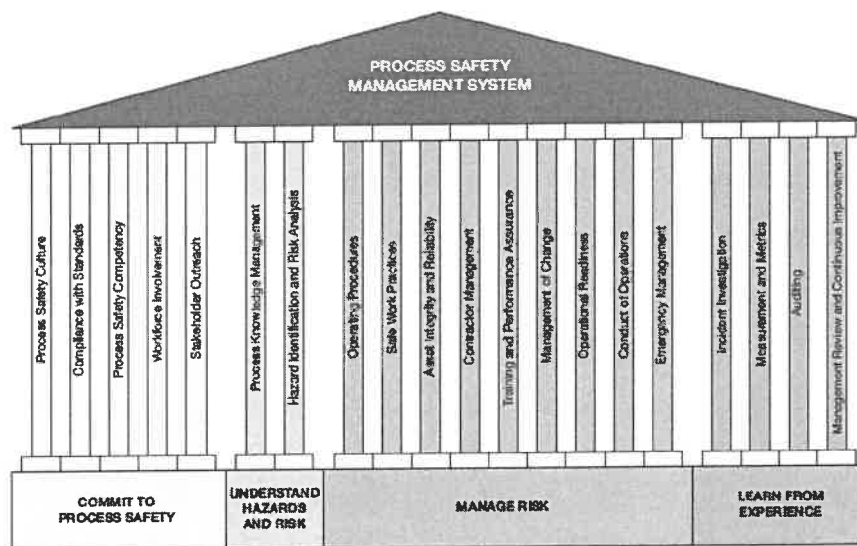


Figure 1 – The Four Pillars of Risk-based Process Safety

Commitment to Process safety

The commitment to process safety pillar refers to the core values of the company and how their attitude towards process safety can resonate through the whole workforce. This is done through the leadership team and management of the company making the same commitment to workplace safety as they would like to see throughout the whole workforce so that it becomes a workplace safety culture is followed and rewarded.

This pillar aims to have everyone's behaviour be consistent all of the time, even when nobody is watching and scrutinising them. This allows the company to have more focus and put more effort into the technical aspects of the process and the business of the company to gain more profitability from their production.

Sam Sharp

The implementation of process safety standards to the work carried out in the company makes it clear what the expectations are in regards to safety and what should and shouldn't be carried out in order for everybody to stay safe and to avoid accidents and possible catastrophic events occurring. Valero Energy provides a good example of a commitment to process safety and the schemes that are implemented from the leadership and management that are followed throughout the whole company. Valero have a "work safe home safe" scheme that promotes the safe working practices of everybody in the workplace so that everybody can return home without injuries or any work-related incident that can affect their lives. There are rewards for following the Valero safety procedures, but also disciplinary action if there is a breach of the safety practices on the site. Furthermore, the Valero Protection Program (VPP) is a way of continuous improvement with regards to health and safety within the workplace and there are also rewards (VPP star player) for having a proactive role and outlook to health and safety in the workplace. The refineries are voluntarily submitted to rigorous safety audits and inspections so that it can be graded a "VPP star site". With the recertification being every three years.

Understand Hazards and Risks

The second pillar of Process Safety Management is to understand the hazards and risks that are present within the workplace. This is accomplished through the correct supply of process knowledge to everybody working within the company and having them documented and available. This includes documentation such as technical documents and specifications; engineering drawings and material safety data sheets. As well as having these documents available and on hand when needed, it is imperative that they are able to be understood and interpreted by everybody that uses them. The other aspect of this pillar includes the hazard identification and risk analysis. At Valero, they implement the Hazard Identification Tool (HIT) in order to give information and classification to the different types of hazards that can be found at work. This tool aids with carrying out LPSA's (Loss Prevention Self Assessments) when on the job and identifying dynamic hazards unique to the job being carried out. These classifications include:

- Mechanical
- Electrical
- Pressure
- Temperature
- Chemical
- Biological
- Radiation

- Sound
- Gravity
- Motion

As well as the classifications, it also gives a hierarchy of controls:

1. Remove the energy source
2. Prevent the release of energy
3. Protect from the release
4. Use stop work authority

Furthermore, risk assessments are used for every job that are carried out to identify what can happen as a result of a hazard, who/ what it can affect and how severe the consequences of the hazard can be. Risk assessed method statements (RAMS) are provided before every job so that it is understood what the hazards of the job are and the control measures that are put in place to try to mitigate the hazards.

Managing Risks

The third pillar of Process Safety is the management of risks by a company. This is likely done within a company through their operating and maintenance procedures and practices. At Valero, the work procedures that are in place are reviewed and sometimes amended every 1/3/5 years depending on the level of procedure. This is done as more is learned about the way that the job is carried out and new hazards that are associated with the job.

Furthermore, new risk assessments are carried out for every individual job that is carried out at Valero to ensure that every hazard is accounted for at the time that the job is to be carried out and they are just using a risk assessment that was used for the same job previously.

The correct training for the employees is also paramount in the management of risks, not only to ensure that everybody is aware of the company's procedures with regards to hazard identification and management, but so that everybody is aware of what to do in the event of an emergency on site and the relevant people to contact so that the consequences of the hazard can be minimised.

Finally, the operational readiness and emergency management part of this pillar refers to the shutdown procedures; ensuring that they are in a safe condition for restart, as well as planning for possible emergencies and having full emergency response procedures to deal with any sort of emergency that occurs on site. This is imperative as it aids to ensure that the consequences of the emergency situations are minimised and reduces the risk of injury to personnel/ damage to plant equipment.

Learning from Experience

The final pillar, learning from experience, involves the company being ready to learn from mistakes that are made from an operational standpoint and use them to improve procedures and safety efforts in order for them to improve for the future. This also includes the experiences of other organizations and how they can be used to improve the operations of their company.

This is done through means of incident investigation. For example, at Valero, the Loss Prevention System includes a hierarchy of controls including near loss investigations (NLI) and loss investigations (LI). NLI's are for the incidents where something has gone wrong which could have led to injury or damage whilst an LI is the investigation of an incident where loss has occurred. Both of these are carried out to ensure that these situations do not occur again, and if they do, the consequences will not be catastrophic.

Task 2

There are lots of control measures that are implemented on a hazardous environment such as Valero's refinery that are used to prevent incidents such as a loss of containment or injury to personnel on the site. This task will detail some of these control measures and how/ why they are used.

Instrumentation/ Sensors

The instrumentation and sensors that are found all around the site on lots of different types of equipment. These are used to monitor the operating parameters and output of the equipment to ensure that they are functioning as intended.

These instruments include:

- Temperature sensors
- Pressure gauges
- Flow sensors
- Level sensors
- Vibration monitors

The instrumentation is often also linked to the control panel where the values that are being recorded from the sensors can be displayed and understood by a panel operator and alarms sounded when the levels being recorded become dangerously out of specification. This aids greatly in preventing incidents occurring in the workplace, especially at a workplace such as Valero as there are so many different pieces of equipment that would be very difficult to monitor without the use of these instruments. As they result in the sounding of an alarm when reaching a potentially dangerous level, it allows the operators to communicate this and prevent the equipment causing harm to personnel or causing further damage to plant.

Figure 2 - Instrumentation



Temperature Sensor



Pressure Gauge



Level Gauge

Procedures

Procedures are made for all of the jobs that are carried out on a site such as Valero's and allow for the job to be carried out fully, safely and adequately. The procedures used at Valero include all of the relevant steps that both the operations and maintenance personnel must carry out to ensure that everything has been accounted for and nothing has been left out during the process. It must also be signed by whoever carried out the work so that if it needs to be referred to in the future, the relevant people that are aware of what had happened previously can be contacted.

Furthermore, these procedures are review and often amended either annually, every 3 years or every 5 years depending on the importance of the procedure to see if anything can be added to these procedures that has been learned through the practical work carried out, further improving the work practices performed sitewide and further reducing incidents.

Safety Systems

Incorporated onto a lot of the pieces of the equipment found on Valero's Pembroke Refinery, are safety systems that are in place to reduce the effects of a failure of the equipment that cannot be controlled. These are often governed by instrumentation that indicate when a dangerous situation is to occur. For example, the fire safety systems found on pumps across several units on the site are in place to detect when a fire is occurring from the pumps and to release firewater from the pipework above to reduce the effects of this incident.

Moreover, there are trip mechanisms incorporated into steam turbine as part of their design. This mechanism restricts the supply of steam to the turbine by the T&T (trip and throttle) valve when the turbine reaches a speed that is a certain point higher than its specified running speed (often 10% higher than the running speed). This prevents the turbine from spinning out of control, causing catastrophic damage to the turbine itself and losing power to the equipment that it is driving, as well as preventing further damage to other pieces of equipment in the surrounding area.

Task 3

Fluid Catalytic Cracking Process

The Fluid Catalytic Cracking Unit (FCCU) at Valero Pembroke Refinery takes the hot resid from the Crude Distillation Unit (CDU) and the Vacuum Gas Oil (VGO) from the Vacuum Distillation Unit (VDU) and breaks them down into lighter, more valuable components.

The hydrocarbons are cracked in the presence of a fluidized catalyst within the reactor and the effluent stream is then separated into its fractions within the fractionator column.

As a result of the chemical reaction, the used catalyst develops “coke” or excess carbon that attaches to the catalyst and needs to be burned off. This is accomplished within the regenerator column where air is added to increase the heat and burn off the coke.

Figure 2 shows the configuration of the three main columns within the FCCU at Valero Pembroke Refinery.

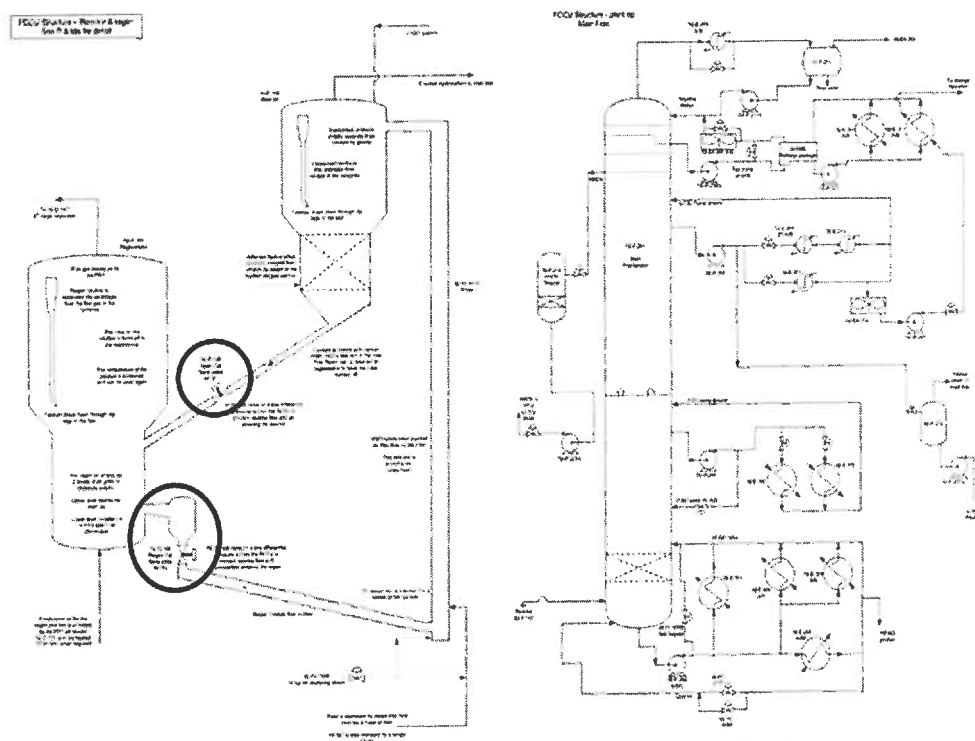


Figure 2 – FCCU Structure

With a process such as this, it is important that there are many safety systems in place to reduce both the number of incidents that occur, as well as the severity of the incidents if they do occur.

The main concerning incident that can occur as a result of this process is the flammable hydrocarbons from the reactor flowing to the regenerator and the air side of the unit as this can

produce an extremely explosive atmosphere. This can occur due to there being a lack of catalyst flowing through the unit and providing a gap for the hydrocarbons to flow through.

In order to prevent this incident from occurring, there are two slide valves that connect the regenerator to the reactor column that are used to maintain a catalyst barrier between the columns and prevent the backfilling of hydrocarbon vapour. These can be found circled in the FCCU structure shown in figure 2. The slide valve that is used to restrict the flow of catalyst from the reactor back to the regenerator is particularly important, as discovered in the 2015 explosion at ExxonMobil refinery in Torrance, California.

As this slide valve had failed, it had allowed the catalyst to empty into the regenerator; therefore, removing the catalyst barrier and allowing the hydrocarbons to backfill and meet an ignition source found at an "*electrostatic precipitator*". This caused the flammable hydrocarbons to ignite and resulted in the explosion.

There are many more safety measures put in place on the FCCU, including those mentioned in task 2. There are instruments to record the parameters of certain pieces of equipment as well as the process, there are also fire water systems for emergency use around pumps that contain flammable and unstable substances.

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Task 1

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Task 3

Much of the information found in task 3 was obtained from the FCCU Structure manual from Valero.

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Figure 3 – Obtained from Valero FCCU Structure manual

