

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	CARL SCOURFIELD	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 an extensive range of relevant and credible literature. Consistently accurate application of referencing.	15	11
2. Knowledge and Understanding Skills		
Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.	35	27
3. Cognitive and Intellectual Skills		
Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements	30	22
4. Practical Application Skills		
An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is well considered, and insightful.	10	8
5. Transferable Skills for Life and Professional Practice		
Work is coherent, very fluent and is presented professionally. Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development.	10	7

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)		75%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Process Safety Systems

January 2021

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Task 1

The Process Safety Management system is defined as the application of management systems to identify, understand and control process hazards to prevent injuries related to process incidents. Its purpose is to avert an occurrence of an incident, or to minimise its consequences. Examples of these incidents could be a catastrophic release of chemicals, flammable vapour, toxic gas or liquid. This will apply to Pembroke refinery as it is a tier 4 COMAH site.

Below in Figure 1 the four major areas of PSM are illustrated. Those 4 areas are then further broken up into component parts.

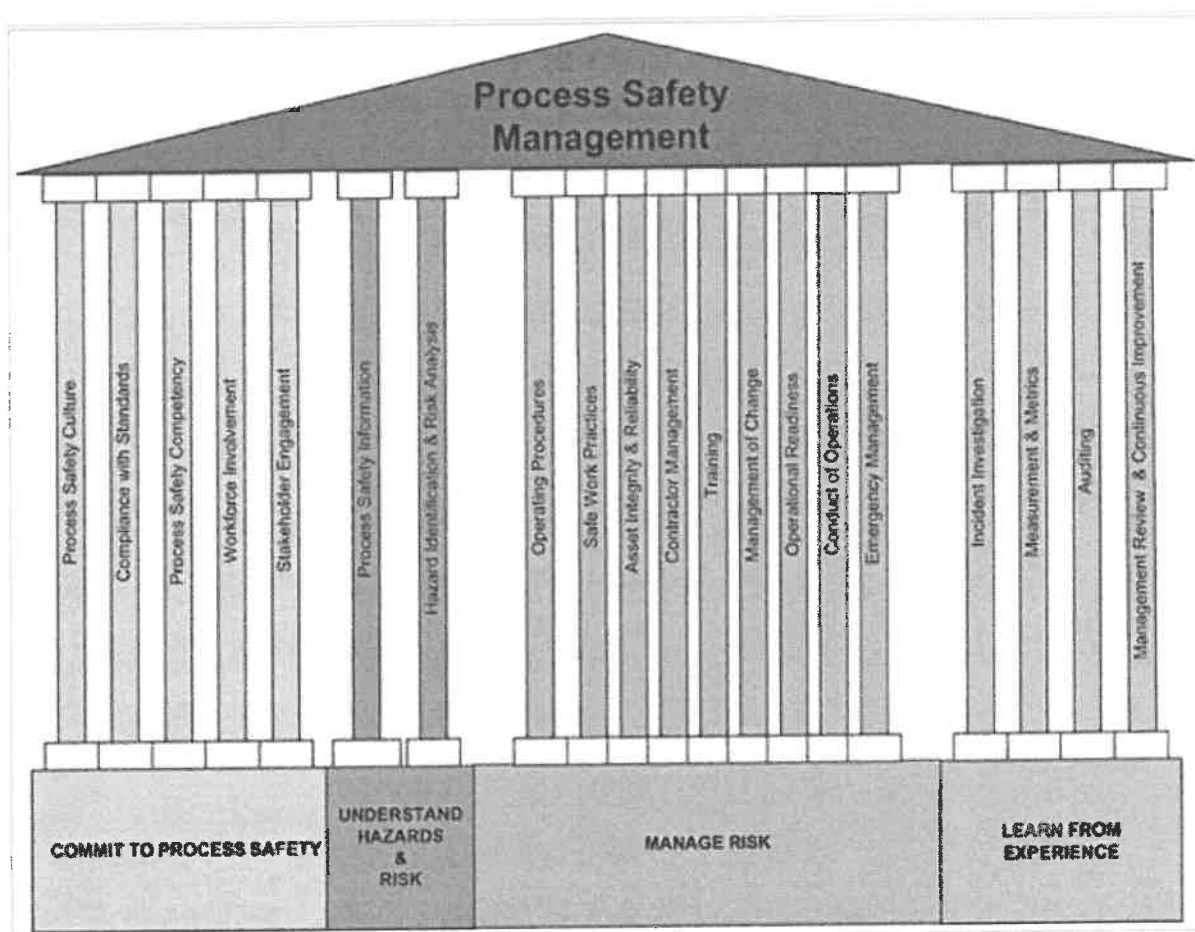


Figure 1 - Process Safety Management

The four major areas of PSM are as follows:

1. System implementation
2. Innocent reduction
3. Incident management
4. System control

System Implementation

It is a very intricate process to implement an effective PSM. It requires significant resources, a great deal of person power and scrupulous scheduling and logistics.

There are two main elements to this area;

- Employee participation
- Trade secrets

Incident Reduction

This area requires the current level of risk to be determined, and then policies and procedures can be implemented to reduce that risk. This requires thorough reviews of the existing process's and implementing changes to those processes and ensuring personnel are fully trained in those changes.

There are seven main elements to this area;

- Process safety information
- Process hazard analysis
- Operating procedures
- Training
- Contractors
- Mechanical integrity
- Safe work practices including permit

Incident management

If/when an incident does occur, the organization must be equipped to deal with it quickly, safely and effectively.

There are two main elements to this area;

- Incident/accident investigation
- Emergency response and planning

System control

For PSM to stay effective the system must be continually re-evaluated and made up to date as changes are implemented at the facility, such as a process unit.

There are three main elements to this area;

- Management of Change (MOC)
- Pre-start-up reviews on safety
- Audits for compliance

Task 2

At Valero's Pembroke Refinery, there are vast number of ways in which incidents are prevented. Some of these measures are proactive actions and systems, and others reactive actions and systems.

The first set of measures that are the proactive type. This type is the primary choice of incident measure as it avoids the entire situation from occurring, rather than only mitigating its effects. The first example of this is the installation of instrumentation and control system. This control measure covers a wide base of systems which can be broken down into multiple parts. Instrumentation is used to monitor and measure process variables so the data can be reported back to the control operator via computer systems. From the control room the operator can adjust process conditions via actuated valves or instructing their plant operator to move valves to ensure process conditions stay within safe parameters. These instrumentation computer systems run through a PLC which can be programmed to shut down predetermined systems should process variables exceed set parameters. This puts the unit automatically into a safe state without any user input. An example of this could be a shutdown valve on a fired heater fuel gas supply closing automatically when a low process fluid flow is detected. This automatic protects the pass flow tubes from overheating and potentially buckling or rupturing. These actuated valves are also installed onto vessels as a form of additional overpressure relief to flare.

The next proactive the use of specific training for operators and the use of standard operating procedures. All operations personnel receive the same training and are to perform tasks following the same operating procedure. This procedure will be risk assessed to ensure it is the most effective and safest way of performing a

task possible. All personnel onsite, which includes operations and maintenance employees, are not to deviate from these procedures. These procedures can either be standard operating procedures or emergency response procedures. Taken from EPA's handbook is the following SOP requirement.

“They document the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and to support data quality.”

Another form of proactive safety measure is the use of analysers and sampling routines. Analysers automatically monitor process components and report that information back to the control operator. This system is usually used for product specification and standards but can have safety implications. For example, some analysers monitor process effluent hydrogen sulphide content, which is a toxic gas. This effluent could be routed to a unit where hydrogen sulphide is not normally present, therefore the indication of the toxic gas presence in the effluent could be reported to the relevant persons who would then have to take additional safety measures. This measure also extends to process and utility sampling. Intermittently the site fuel gas and nitrogen headers are sampled for the contents. Fuel gas is sampled to monitor for H_2S , and the nitrogen is sampled to ensure its purity. As nitrogen is used as a purging medium during planned and emergency shutdowns, it is imperative it remains inert. If contamination of this system did occur and it was permitted to flow into a vessel where combustion was occurring, it could result in an explosion by providing fuel or oxygen. Some units have fixed gas detection analysers scattered within them and around their perimeters. These detectors monitor for LEL, H_2S and HF acid. Once the systems detect the relevant substance they trigger unit alarms to sound and beacons to flash, warning all persons to leave the unit and operations to perform investigational activities.

Another proactive measure is the use of a permit to work system. This helps operation control who is working on each process unit and which work is to be conducted when. Permits to work are only issued when a full risk assessment of the activity is conducted, which included specific hazards such as area, height, process

substances etc. The area is gas tested prior to the work commencing. All work is to be performed under a permit.

The final proactive measure is the planned inspection and testing schedule. Specific systems on the refinery are inspected and subjected to NDT (Non-destructive testing) by trained specialists to ensure that pipe wall thickness remains sufficient for safe operation. NDT methods are included in Figure 2. These personnel also perform welding inspection after the installation of new work.

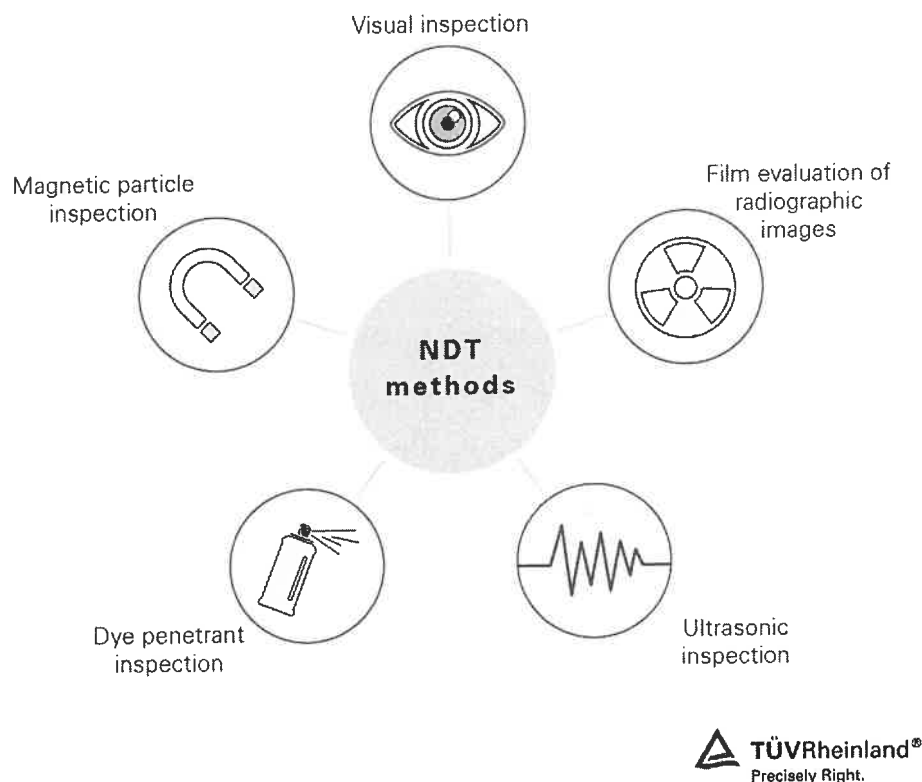


Figure 2 - NDT Methods

Reactive measures are fewer because the plan is not to get to the stage where they are necessary. One method is the installation of hardware such as pressure safety valves. These valves are part of the unit's fixed installation and are pre-set at the required valves to relieve excess process pressure to flare. These systems route to flare as the process fluids contain hazardous substances, e.g. flammable hydrocarbons, toxic gases, or corrosive acids. The liquid sent to flare can be recovered and the excess vapour and pressure burned off at the flare tip. Another hardware system installed is the firewater hydrant system. All the remaining reactive

measures involve operations and fire technician response. Which has been mentioned previously in the emergency procedure section.

Task 3

At Valero's Pembroke Refinery, there are vast amount of hazardous process's that take place which require scrutinous safety measures to be conducted safely without incident. One of these processes is reactor feed heating, which is performed by heat shell and tube heat exchangers and fired heaters. This process uses heat exchangers to recover energy from the reactor effluent, these pre-heat the feed and then the fired heater then performs the final heating process via burning fuel gas to heat the reactor feed to temperatures in excess of 300 °C.

Fired heaters are the single most dangerous piece of equipment on a refinery, this is due to it being the only area on-site where all the elements of the fire triangle are present. Especially considering the pass flow tubes within the heater contain inherently flammable liquids which may be above their autoignition temperatures. This fact is expressed on the "Aiche" website where it states the following

"While any type of process involving combustion carries hazards and safety concerns, the hazards are even greater when a combustible process fluid is heated inside tubes. Hence, fires and explosions are significant risks of fired heater operation."

For visual aid, a fired heater can be seen in Figure 3 below.

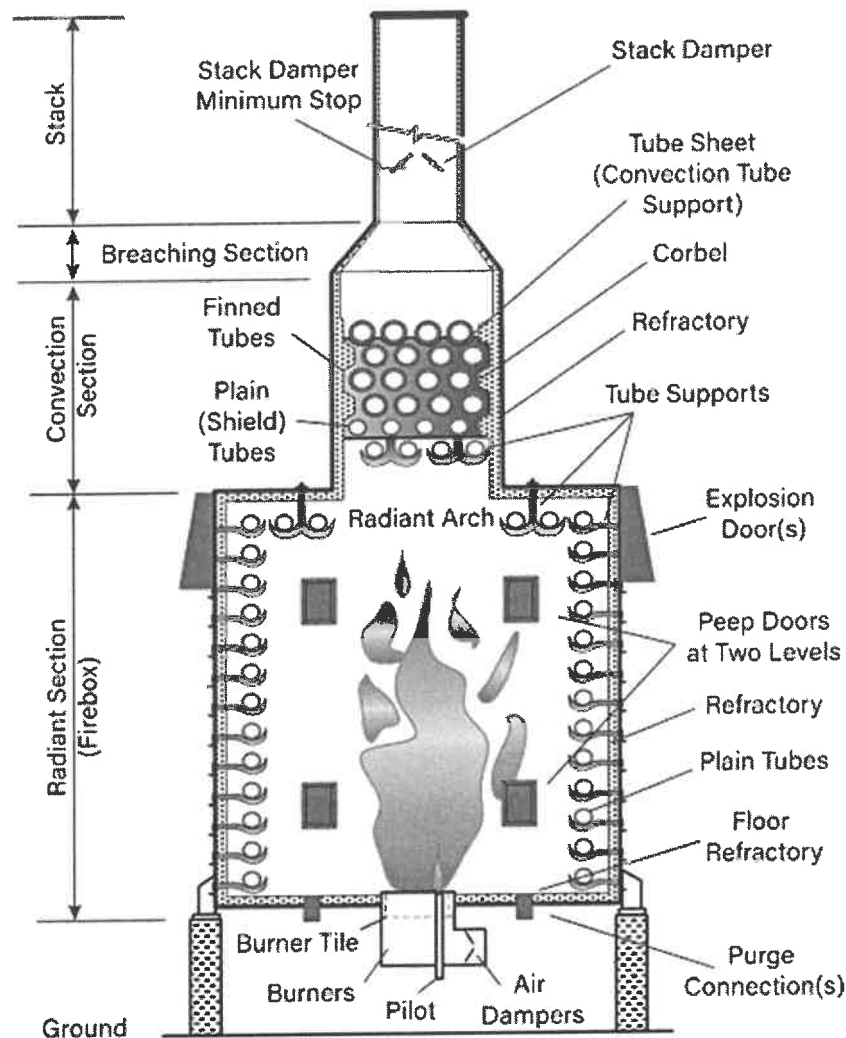


Figure 3 - Fired Heater Cross Section

Due to the aforementioned danger of fired heaters, there is a vast amount of process safety measures ascribed to the equipment. These include instrumentation to monitor specific variables such as heater pass flow rate, fuel gas pressure, draft pressure, heater box and process fluid temperatures etc. There are also process analysers which monitor the O₂, Carbon monoxide and combustible content of the flue gas to ensure level stay within an acceptable tolerance. These instruments and analysers are linked to automatic shutdown systems which “trip” the heater should condition deviate from a safe operating condition. These shutdown systems operate automatic valves which block the supply of fuel gas to the equipment, extinguishing the flame by removing its fuel source.

Another form of process safety measure that is utilised is personnel training and certification. This measure ensures all persons working on site know how to correctly inspect and operate the equipment without causing a dangerous situation.

This safety measure also helps with the mitigation or even the prevention of an incident as trained personnel can identify, thus report, an issue before the equipment fails. An example of this could be an operator recognising poor flame pattern due to clogging burner tips. Also, it helps the operator operate the fired heater safely by knowing in which order tasks are to be performed, and also safe ways of performing each task. For example, when an operator is performing firebox inspections, he is to call the control operator to ensure the box pressure is negative. He is also to use a tinted visor protect his face against the emissivity of the flames. Most of the safety actions performed when checking fired heaters involve using the operators 5 senses, some of them before they even approach the heater. Before an operator can approach a heater, they must look at the stack tip for excessive smoke, which is a sign of unstable combustion, and they must also listen to the noise coming from the equipment, which if there is none it could mean a flameout situation or if the heater is “huffing” there could be unstable combustion. In both the above scenarios the operator must contact the control operator for assistance. All of these details are laid out in the operators on-site training material “Safe Operation Of Fired Heaters”.

Further to the point of training is the implementation of standard operating procedures, especially emergency response procedures, which operators are to be trained on and memorise. Should an incident occur, such as a pass flow tube rupture, it is expected that all plant and control operators respond to the incident in the same way. The way the operators are to respond is by following the risk assessed emergency procedure which has been laid out by management. This procedure would have operational, process, and safety personnel input to ensure the safest and most effective method of dealing with the issue is performed. The details are laid out in Valero’s Emergency Response Procedures 4-OPS-EMP-0004 and 4-OPS-EMP-0009.

The final safety measure implemented is the installation of “hardware” safety systems. The first example of this is the pilot flame. This is a small flame which remains lit at all times, unless there is a fuel gas issue, and is used to light the main burner. Should the heater trip this flame remains lit so that a flammable mixture of fuel gas and oxygen cannot build up within the firebox. A second example for a safety system is the installation of “snuffing” and “purging” steam. These two systems are used to fill either the firebox (snuffing steam) or the pass flow tubes

(purging steam) with an inert medium should an incident occur displacing the combustible mediums such as hydrocarbons. An example of an incident this system would be needed could be a pin hole leak on a pass flow tube. In line with previous points the plant operator will need to be fully trained on the use of this system.

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Figure Sources

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