NEBOSH
Process Safety Management (PSM)

pmpec

ELEMENT 1

PROCESS SAFETY LEADERSHIP

Course Content

Learning outcomes

1-1 Outline the meaning of process safety and how it differs from personal safety
1-2 Explain the role of leadership in process safety management
1-3 Explain the purpose of organisational learning, the sharing of lessons learnt and sources of information
1-4 Explain how 'change' should be managed to effectively reduce risks to people and plant
1-5 Outline the benefits, limitations and types of worker participation and engagement
1-6 Outline what is meant by competence and its importance to process safety.

E1-1 Process safety Management meaning

"At the Chemical Safety Board's investigation, BP established its own independent panel to review its safety procedures and find ways to improve them. That panel, chaired by former U.S. Secretary of State James Baker III, issued its report a few months before the Chemical Board report in 2007. The Baker panel was no more charitable in its assessment.
The panel found that BP management had not distinguished between occupational safety concern over slips, sprains, and other workplace accidents—and process safety: hazard analysis, design for safety, material verification, equipment maintenance, and process change reporting. The panel further concluded that BP was not investing leadership and other resources in managing the highest risks."

President's Report on BP Deepwater Horizon Oil Spill and Offshore Drilling, 221

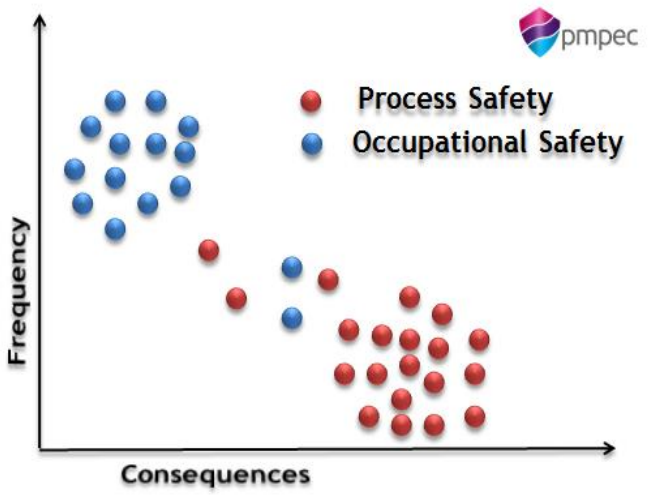
THE DISTINCTION BETWEEN PROCESS SAFETY VS PERSONAL SAFETY

The main concern with distinction between personal safety and process safety is regarding the domain of the process safety and catastrophic consequences of it. Occupational safety concern over slips, falling from height, and other workplace accidents and process safety main concern is, hazard analysis, design for safety, material verification, equipment maintenance, and process-change reporting.

PROCESS SAFETY INCIDENTS HAPPEN AT A LOWER FREQUENCY

Process safety incidents happen at a lower frequency; occupational safety incidents happen at a higher frequency. This is often a problem as a proactive approach to safety means that you may focus on the highest occurrences of incidents, rather than focus on the most serious ones.
Process safety in recent years following the major explosions and fires at BP's Texas City refinery and the Buncefield storage depot in the UK alerted the authorities.

The PSM system included both technical and organizational elements as specified in the OSHA CFR 1910 for PSM, and the UK HSE's HSG 65 successful Health and Safety management. The latter is used as the framework for demonstrating that UK COMAH sites comply with the requirements of the Seveso II directive.



The diagram above shows how process safety generally deals with high severity and low likelihood major accidents, whereas personal or occupational safety deals with more routine 'slips, trips and falls'.

Both aspects of safety are equally important but process safety consequences are much higher and most of the times lead us to catastrophes. So the techniques to control related hazards must be more precise and more engineering. Furthers differences discussed in the table below.

Process Safety	Occupational Safety
Process safety protects workers and the public alike	Occupational safety protects workers
The consequences of not implementing process safety can be far reaching, affecting people living locally to the site or even consumers.	The consequences will impact person(s) directly in contact with the source
Process safety considers the consequences of accidents at the human, environmental and business level	Occupational safety considers consequences at a human level only
Process safety focuses on changing system design in which behaviour occurs rather than bringing in new equipment	Occupational safety focusing on changing an individual's behaviour
Process safety is more expensive to implement	Occupational safety is normally cheaper
Process safety can be complicated to understand by people external to it and needs clear and concise communication to succeed	Occupational safety is easier to understand because it affects us all
Process safety addresses major hazards that are more likely to result in major incidents with big consequences	Occupational safety addresses incidents involving personal safety at an individual level with small consequences.
Process safety deals with mitigating big incidents such as fire, explosions, pollution etc	Occupational safety mitigates small incidents such as cuts and broken bones
Process safety needs to focus on educating your boss	Occupational safety needs to focus on educating your staff
Process safety should be on the agenda at all board meetings;	Occupational safety needs to be on the agenda at team meetings.

PROCESS SAFETY DEFINITION

There are some definitions given about process safety:

"Process safety is protection of people and property from episodic and catastrophic incidents that may result from unplanned or unexpected deviations in process conditions."

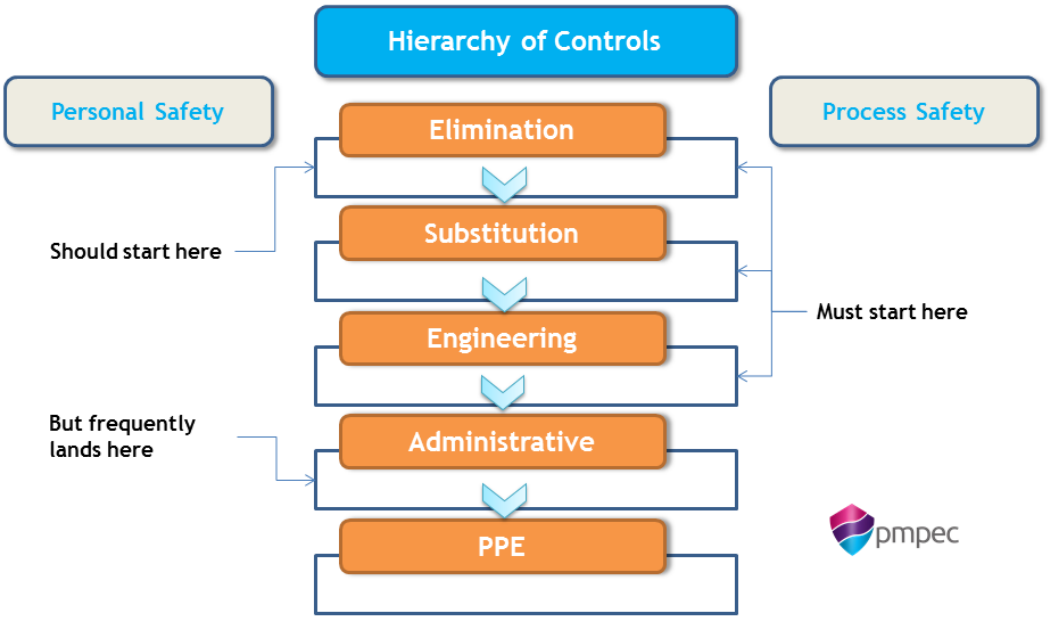
Guidelines for Auditing Process Safety Management Systems, 2nd ed. [New York: Center for Chemical Process Safety, 2011

"Process Safety is a blend of engineering and management skills focused on preventing catastrophic accidents, particularly explosions, fires, and toxic releases, associated with the use of chemicals and petroleum products."

"A Canadian Perspective of the History of Process Safety Management Legislation"

"Process safety is a blend of engineering and management skills focused on preventing catastrophic accidents and near misses, particularly structural collapse, explosions, fires and toxic releases associated with loss of containment of energy or dangerous substances such as chemicals and petroleum products. These engineering and management skills exceed those required for managing workplace safety. "

Energy Institute definition adapted from the Center for Chemical Process Safety of the American Institute of Chemical Engineers



E1-2 Process safety leadership

Minimum standards and legal requirement of risk and safety without the drive and support from the board and senior managers is unlikely to protect against major hazards and risks in process industries. Leadership from board level is fundamental to achieving best practice in robust protection measures of our people and assets, the enhancement of our businesses and the sustainability of our industry.
The main commitment of the process safety leadership is to improve process safety in related industries. Considering the vital and critical role of PSL following principles has to established, implemented and maintained:

- Clear and positive managing a major hazard;
- Board level involvement and competence;
- Board active engagement;
- Board level visibility and promotion of process safety leadership;
- Engagement of the workforce is needed in the promotion and achievement of good;
- Monitoring performance based on both leading and lagging indicators;
- Publication of process safety performance information for public; and
- Sharing best practice across industry sectors, and learning and implementing lessons to maintain the currency of corporate knowledge and competence.

LEADERSHIP TEAMS AWARENESS OF THE HAZARD AND RISK

There is no doubt that the leadership teams must be aware of the hazards and risk with high potential consequences in all stages of their plant life cycle from concept, design and engineering to decommissioning and phase out.
Consequences of major hazards in process industry are significant. It can include but not limited to the following issues:

- Catastrophic life-threatening
- Considerable asset loss
- High environmental negative impact
- Damage image and reputation of the organization

BOARD LEVEL VISIBILITY AND PROMOTION OF PROCESS SAFETY LEADERSHIP

The Chemical Industries association and The Principles of Process Safety Leadership place emphasis on board level visibility as one of the best practices to promote process safety. Directors and senior managers play a vital role in motivating employees and promotion of process safety. They demonstrate leadership, set direction and assign priorities, establish the health and safety of the organisation and ensure that the organisation's legal responsibilities are met. This is the way setting the right tone within the organization.
Visibility of board-level management to risk and safety issues can be a means of showing interest in and commitment to a high level of control of major accident risks that many process businesses potentially engage with.

As such, their actions are noted by workers and their visible leadership is essential in the development of the safety culture of the organisation. Leaders' commitment to safety can be visible thru actions such as:

- Be pioneers and leading by example such as: wearing PPE
- Resource allocation to process risk and safety
- Personally leading initiatives;
- Participating in site visit, inspections and audits.
- Personal site visit and control room visit
- Face to face talk with employees
- presentation of major hazard risk in the board and senior management meeting
- presentation to group of staff
- Challenging the organisation (asking difficult questions) and
- Understanding the criticality of the layers of preventive and protective measures that prevent, detect and mitigate undesirable outcomes, boards need to make robust policy on how visibility can best be achieved.

THE NEED TO DEFINE PSM CRITICAL RESPONSIBILITIES

Process safety leadership is not only the board responsibility and accountability. All level of management and employees play effective and vital roles and responsibilities in process safety.
Clear responsibilities have to delegate to those who are competent to carry them out at all levels of an organisation; from the board through to the maintenance workers who look after the installation, everyone has a role to play in process safety.
It is necessary to organize people in process safety with considerations such as:

- Define accountabilities to Board members, senior executives and managers for process safety leadership and performance.
- At least one board member should be fully conversant in process safety management in order to advise the board of the status of process safety risk management
- Engage the engineering manager for the management of change process to ensure plant modification considered process safety management
- Define the maintenance manager accountability for the development and implementation of the preventive maintenance and breakdown strategies,
- Involve the engineers, electricians and fitters for contributing to the risk assessments and following the permit-to-work process and locking off equipment before work commences.

THE REASONS FOR HOLDING TO ACCOUNT ALL INDIVIDUALS WITH PSM RESPONSIBILITY

Clearly process safety management success and failure depend on chains of factors that need to be in place in a systematic manner. If new plant is installed without planned consideration to safety, then the chance of injuries is high. Let's imagine everything is correct and an electrician simply takes shortcuts and does not appropriately isolate the source of energy before initiating the work, there will be chance for serious injury.
As mentioned above all in organization have roles and responsibilities dealing with process hazards. Therefore they should be held accountable for their actions, regardless of their organizational level. Holding to account all competent workforces with PSM responsibility encourages engagement.
It is very important to do not misuse accountability of individual for occurrence of process undesired event. It will lead organization toward a blaming culture.
The root causes of major accidents highlighted failings in organizational and job factors leading to individual failure and accidents. This is why we need a 'just' culture to encourage the people to report unsafe act and condition contribute to the development of safer working systems, without fear that a single mistake will lead to retribution and disciplinary action. Promoting such positive and fair culture need senior managers commitments and setting the standards for the design of plant, the operational standards that are acceptable and conversely reinforce the fact that corner cutting and taking shortcuts is totally unacceptable in process safety.
Organisational competence assessment and enforcement by senior managers for control and manage process hazards depends on:

- Establish follow-up action system for employees;
- Ensure competent management, engineering, and operational workers at all levels are available;
- Ensure continual professional development of process safety expertise such as legal and technical issues;
- Communicate and learn about new regulation and guidance;
- Provide resources and time for expertise-based hazard and risk analyses;
- Provide effective training and comprehensive scenario-planning for potential accidents;
- Defer to the expertise of personnel, and do not dismiss expert opinions;
- Provide a process or system to ensure company leaders get expert process safety input as a critical part of the decision making process for commercial projects or activities;
- Establish system to ensure that the organisation monitors and reviews the process safety competency of contractors and third parties;
- Assess the capability of communicating critical aspects of process safety with all internal and external audiences.

THE PROVISION OF ADEQUATE RESOURCES

The success of process safety highly depends on the board plan endorsement for improvement and ensures appropriate and adequate resource is committed to its delivery.
PSLG leadership principles in organition and resources section, well mentioned that appropriate resources should be made available to ensure a high standard of process safety management throughout the organisation and staff with process safety management responsibilities should have or develop an appropriate level of competence.
Organizational Resources represent all resources available to the organization and necessary for process safety establishment and implementation. The resources consist of:

- Human resources – represent all people (as well as their qualifications and capacities regarding process safety management) that cooperate with the organization and in professional organizations considered as assets;
- Material and technological(physical) resources – include all of the equipment and tools used by the organization, the manufacturing and administrative facilities, technologies and processes used in the production and management, among many others;
- Financial resources – represent the monetary funds held by the organization (or the capacity to obtain them) and that can be used in the financing of the current process safety controls;

- Image and credibility abroad – represents the positioning of the organization and its brands, that is, what the outsiders think about the major hazards controls.

Spending resources for process safety management is a considerable investment comparing with the cost of a potential catastrophe. Here is the list of human and financial loss of well-known process accidents:

Accident	Injuries	Financial loss
Bhopal disaster December 1984	Fatal: At least 3,787; over 16,000 laimed Non-Fatal: At least 558,125	• Not specified
PIPER ALPHA on July 6, 1988	Fatality: 167 crewmen	Property damage: • 1.7 billion
Deep-water Horizon On 20 April 2010	Fatality: 11 crewmen	• Transocean agreed to pay US$1.4 billion for violations • BP faced penalties that range from $5 billion to $20 billion • Halliburton agreed paying $1.1 billion • BP pay roughly $7.8bn (£6.1bn) to compensate victims

Reasons for establishing process safety objectives and targets

Without objective and target we are leading to nowhere. Process safety management systems are designed to maintain process safety excellence and facilitate continual improvement. The process safety objectives and targets are good means to demonstrate the continual improvement of an organization.

Organisation will identify and establish a clear set of objectives (overarching process safety aims) and targets (short term goals) based on internal and external inputs which influence their process safety. The objectives and targets have to communicate to staff throughout the organisation at all levels to motivate them to work safer.

The main reason for introducing objectives and targets which based on measuring process safety performance is to provide ongoing assurance that risks are being adequately controlled. Directors and senior managers need to monitor the effectiveness of internal controls against business risks. For major hazard installations and chemical manufacturers, process safety risks will be a significant aspect of business risk, asset integrity and reputation.

There are proactive (leading) and reactive (lagging) process safety indicators that showing organisation progress towards its process safety objectives and targets. There are sound reasons for establishing effective process safety objectives, targets and indicators.

Robust process safety indicators identify success and failures toward our goals and highlight our strong points and weaknesses. Once process safety indicators and targets have been established, the board should review progress on a regular basis (often quarterly) and, on an annual basis, the performance against these targets should be published in order to celebrate success and highlight areas of opportunity.

Commitment to continuous improvement

Measuring and monitoring process safety performance is a tool to compare our performance with our previous years and same industries. This comparison or benchmarking should convince leaders to continually improve process safety performance. As it mentioned in Chemical Industries Association (CIA) best practice guideline there is no room for complacency with regard to health, safety and risk. Organisations with horizon zero policy develop, plants change and the desire for further safety improvements, rather than being disheartening. Such organisations never stop and never satisfy with existing condition for ever.

E1-3 Organisational learning

Clearly organisational learning is a key aspect of health and safety management. If an inadequate reporting and tracing systems are in place, for example a blame culture instead of a just culture, retribution and so on, then valuable and significant knowledge will be lost.
If the underlying and root causes of an accident, are not identified and communicated throughout the organisation, there is no doubt it will lead us to recurrence of the same scenario.
In many cases, barriers within an organisation - where different departments operate in 'silos' - , inhibit organisational learning. We have to ensure knowledge sharing happens internally and externally to prevent corporate amnesia.

THE SIGNIFICANCE OF LEARNING LESSONS FROM INCIDENCES

An estimated 2.3 million people die every year from work-related accidents and diseases. More than 160 million people suffer from occupational and work-related diseases, and there are 313 million non-fatal accidents per year. The suffering caused by such accidents and illnesses to workers and their families is incalculable. In economic terms, the ILO has estimated that more than 4% of the world's annual GDP is lost as a consequence of occupational accidents and diseases. (ILO)
Costs show that for every £1 a business spends on insurance, it can be losing between £8 and £36 in uninsured costs. What we said here can be good financial reasons for reducing accidents and ill health.

Analysis of major incidents in high-hazard industries, with different technical causes and work contexts, has identified several common factors involved when things go wrong. These factors are related to:

- Leadership;
- Attitudes and behaviours;
- Risk management and oversight.

When these aspects of an organisation become dysfunctional, important risks can become 'normalised' within it, leading to serious consequences.
Major incidents always have severe consequences. These consequences, are not only property damage, or environmental impact, but also can be fatalities which are the worse consequence of a major incident. Incidents often stem from management and cultural failure resulting from technical, organisational or behavioural causes. So a comprehensive understanding of the basic causes of an incident is vital to prevent them happening again.
Of primary concern are fire, explosion, and toxic gas release, e.g. The Piper Alpha disaster in the North Sea, Flixborough in the UK, Seveso in Italy, The toxic gas release in Bhopal, India, where 2500 people died as a result of a Methylisocynate escape from a storage tank, and others.

PIPER ALPHA DISASTER 26TH JULY 1988

167 out of the 229 people on board were killed

Piper Alpha was originally designed as an oil rig and was later converted for gas and oil production. At its height, Piper Alpha was a spectacular producer of North Sea oil, being responsible for over 10% of the UK's daily production, amounting to over £3 million per day.
Within a three-hour period during the night of the 26th July 1988, the Piper Alpha platform, towering some 100 feet above some of the fiercest waters in the North Sea, was reduced to a blackened smouldering wreck, with the majority of the platform having sunk into the sea. More importantly of the 229 men on board 166 men had lost their lives, one more died of his injuries the next day.
The catastrophe shocked the oil industry into realising that the dangers on a rig like Piper Alpha were worse than they had possibly imagined.
The disaster began, with a routine maintenance procedure. On the morning of the 6th of July, a back-up propane condensate pump in the processing area that had been isolated for routine maintenance under the permit-to-work procedure also needed to have its pressure safety valve checked. A second permit-to-work was issued for the work on the pressure safety valve. As this work could not be completed the workers asked for, and received permission to leave the remainder of the work until the next day.
Later in the evening, during the next work shift, the primary condensate pump failed. None of those present were aware that a second permit-to-work had been issued for the pressure safety valve to be removed, and decided to reinstate and start the back-up pump. Gas products escaped from the hole left by the valve.
Gas audibly leaked out at high pressure, ignited and exploded, blowing through the firewalls. The fire spread through the damaged firewalls, destroyed some oil lines, and soon large quantities of stored oil were burning out of control. The automatic deluge system, which was designed to spray water on such a fire in order to contain it, or extinguish it, was never activated since it had been turned off because divers were in the water.
About twenty minutes after the initial explosion the fire had spread and become hot enough to weaken, and then burst the gas risers, from the other platforms. These were steel pipes of a diameter from 24 to 36 inches, containing flammable gas products at two thousand psi. When these risers burst, the resulting jet of fuel dramatically increased the size of the fire.
People congregated in the accommodation block and as conditions got so bad in the accommodations area some people realised that the only way to survive would be to escape the station immediately. They, however, found that all routes to lifeboats were blocked by smoke and flames, and in the lack of any other instructions, they jumped into the sea hoping to be rescued by boat. Sixty-two men were

saved in this fashion; most of the other 167 who died, suffocated on carbon monoxide and fumes in the accommodation area.

The generation and utilities module, which included the fireproofed accommodation block, slipped into the sea. The largest part of the platform followed it.

LESSONS LEARNED:

- Regulatory control of offshore installations: The accident was instrumental in bringing about the Offshore Installations (Safety Case) Regulations. A safety case is a written document, in which a company must demonstrate that an effective safety management system (SMS) is in place on a particular offshore installation. The implementation and regulation of this was handed over to the Health and Safety Executive (HSE) in 1991.

- Adherence to permit-to-work system: This was a system of paperwork designed to promote communication, between all parties affected by any maintenance procedure done on the platform. The system on Piper Alpha had become too relaxed. Employees relied on too many informal communications, and communication between shift changes, was lacking. If the system had been implemented properly, the initial gas leak never would have occurred.

- Quality of safety management is critical: The Piper Alpha Cullen Inquiry report was highly critical of the management system in the company. Managers had minimal qualifications, which led to poor practices, and ineffective audits.

- Disabling of protective equipment by explosion: The firewalls on Piper Alpha could have stopped the spread of a fire. They were, however, not built to withstand an explosion. The initial blast blew the firewalls down, and the subsequent fire spread unimpeded.

- Need for safety training: The workers on the platform were not adequately trained in emergency procedures, and management was not trained to make up the gap, and provide good leadership during a crisis situation.

- Auditing is vital: Occidental Petroleum who operated the platform had regular safety audits of its facilities, but they were not performed well. Few, if any, problems were ever brought up, even though there were serious issues with corrosion of deluge system pipes, and heads and many other issues. When a major problem was found, it was sometimes just ignored.

- Proper isolation of plant for maintenance: The disaster would not have occurred if the pump where work was being done had been positively isolated. Isolation is not achieved by shutting a valve, but requires means such as insertion of a slip plate, or removal of a pipe section, and use of multi-hasp locks.

- Limit inventory on installation and in pipelines: The large inventory of the pipelines connected to the platform fed the fire. Despite technical problems, it should be a design objective - to reduce the amount of hydrocarbons.

- Emergency shutdown valves: Proper location of emergency shutdown valves and backup valves are essential to cutting off fuel supply in case of a fire; above water positioning provides testing accessibility for vigilant maintenance.

- Fire and explosion protection: Protection against, and mitigation of fire and explosion, as well as fire fighting are of particular importance, as there is no possibility to rely on outside assistance such as the fire brigade.

- Temporary Safe Refuge (TSR): TSR on each installation should have a breathable atmosphere, through prevention of smoke ingress, and provision of fire protection; escape routes, and embarkation points, should be determined through safety cases. Prevention of smoke ingress into TSR is available through smoke and gas detectors that initiate smoke dampers and prevent circulation of smoke throughout the TSR.

- Evacuation and escape: More than one route to helicopters, and lifeboats, must be present at any given time, to ensure evacuation of the platform in a crisis situation. To facilitate escape from a hazardous situation, luminescent strips, and heat shielding, provide visibility in smoke and protection from flames, respectively. Secondary escapes, such as ropes, ladders, and nets, are also available as backup, for the more sophisticated escape methods.

BP TEXAS, USA 23RD MARCH 2005

15 fatalities

The incident occurred during the start-up of an isomerisation (ISOM) unit, when a raffinate splitter tower was overfilled, and over-heated. When liquid subsequently filled the overhead line, the relief valves opened. This caused excessive liquid and vapour to flow to the blow down drum, and vent at the top of the stack.
An explosion occurred, which killed 15 people and injured many others. All of the fatalities occurred in or near office trailers located close to the blow down drum. Houses were damaged as far away as three-quarters of a mile from the refinery.

LESSONS LEARNED:

- Leadership: There should be a clear commitment to process safety by articulating a clear message on its importance, and following through - with related policies and actions.

- Safety culture: A positive safety culture requires good process safety leadership. A positive, trusting and open process safety culture that involves all relevant stakeholders should be developed.

- Accountability: There should be clearly defined expectations, and accountability, for process safety at all levels.

- Process Safety Management: An integrated and comprehensive process safety management system that systematically identifies, reduces, and manages process safety risks should be established and implemented.

- Competence: Personnel should have appropriate level of process safety knowledge and expertise.

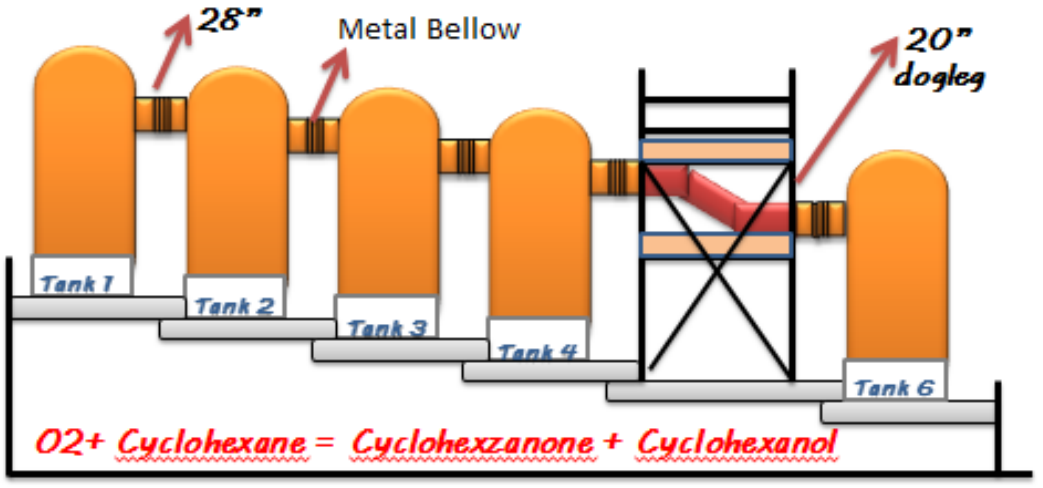
- Process Safety Indicators: Leading, and lagging indicators, should be implemented, maintained and periodically updated for more effective monitoring of the process safety performance.

- Audit: An effective system to audit process safety performance should be established, and implemented.

FLIXBOROUGH (NYPRO UK) 1ST JUNE 1974

28 fatalities and 36 injured. Offsite consequences resulted in 53 reported injuries

The cyclohexane plant consisted of a train of six reactors in series. Prior to the explosion, on 27 March 1974, it was discovered that a vertical crack in reactor No.5, was leaking cyclohexane. The plant was subsequently shutdown for an investigation, which identified a serious problem with the reactor. The decision was taken to remove it, and install a bypass assembly, to connect reactors No.4 and No.6 so that the plant could continue production.



During the late afternoon on 1 June 1974, a 20 inch bypass system ruptured, which may have been caused by a fire, on a nearby 8 inch pipe. This resulted in the escape of a large quantity of cyclohexane. The cyclohexane formed a flammable mixture, and subsequently, found a source of ignition. There was, subsequently, a massive vapour cloud explosion which destroyed the control room where the majority of fatalities occurred, caused extensive damage, and started numerous fires on the site.

Lessons Learned:

- Plant modification: A plant modification occurred, without a full assessment of the potential consequences. Only limited calculations were undertaken, on the integrity of the bypass line. No calculations were undertaken for the dog-legged shaped line, or for the bellows. No drawing of the proposed modification was produced.

- Maintenance procedures: No pressure testing was carried out on the installed pipe work modification.

- Plant layout: Those concerned with the design, construction, and layout of the plant, did not consider the potential for a major disaster happening instantaneously.

- Control room design: Control rooms should be designed to withstand major hazards events. 18 fatalities occurred in the control room.

- Operating procedures: The incident happened during start up, when critical decisions were made under operational stress. In particular, the shortage of nitrogen for inerting would tend to inhibit the venting of off-gas as a method of pressure control/reduction.

- Limit inventory in plant: The large inventory of flammable material, in the plant, contributed to the scale of the disaster. Limiting inventory is part of the inherently safer design principle.

THE REASONS FOR ACCIDENT AND INCIDENT INVESTIGATIONS

Most of incidents (accidents and near misses) have multiple, interrelated causal factors. These causal factors are the results of significant deficiencies, oversight, errors, omissions, unrealistic assumptions of the hazards and risks.
The findings of a thorough incident investigation will be helpful to improve health and safety management systems. There are many reasons to carry out an incident investigation:

- Determine the causes and prevent a recurrence
- Identify weaknesses in management systems
- Identify weaknesses in risk assessments
- Demonstrate management commitment and concern
- To comply with legal requirements
- Collect data to establish trends
- To prevent future business losses
- To provide information for any subsequent criminal/civil action
- Provide information for the insurance company

DOCUMENTED MANAGEMENT PROCESSES

Major oil and gas accidents, such as Piper Alpha demonstrate that improper document controls can have unpredictable and severe consequences. Documented management processes in place to ensure the holding of corporate knowledge for effective process safety management.
International and national laws often require the management of health, safety and environmental risks. In high risk industries such as oil and gas industry where there is a potential for a major disaster these requirements are reflected by the requirement to record:

- A **Safety Case**, e.g. as required by the Offshore Installations (Safety Case) Regulations 2005 in the UK
- A **Major Accident Prevention Policy** (MAPP) and a **Safety Report**, e.g. as required by the Control of Major Accident Hazards Regulations 1999 (COMAH) in the UK

Documented management process dealing with live documents and removing obsolete documents in systematic manner to ensure all major hazards controls. The content of the documents well explained in safety case, safety report and MAPP in elemen2.
Documents and records in brief consist of:

- A description of the safety management system
- Organisation and personnel, including a roles and responsibilities of personnel involved in the management of major hazards and arrangements
- training of personnel to ensure their competence to work with major hazards
- Arrangements for carrying out the identification of major hazards and the assessment of associated risks
- Operational control, including design specifications for critical plant, procedures for safe operation, and management of contractors
- Management of change
- Emergency planning
- Arrangements for testing and reviewing emergency procedures
- Procedures for monitoring compliance, auditing and reviewing
- Critical equipment threats and controls.

LESSONS LEARNT AND KNOWLEDGE SHARING

Leaders and managers have to be aware about the importance of capturing lessons learned; it is good for the team, organization, existing and future projects, the other organisations with the activities and risks.

Lessons learned are the documented information that reflects both the positive and negative experiences of a project. They represent the organization's commitment to project management excellence and the project manager's opportunity to learn from the actual experiences of others. However, we are all at different levels of lessons learned utilization. Some of us do not routinely capture lessons learned because there is no defined lessons learned process in place. Or we capture lessons learned at the end of a project and never do anything with them. Or finally, we capture lessons learned, review them prior to starting new projects but we do not generate metrics addressing the frequency of key word occurrence in failed or successful projects.

Converting 'lessons identified' to 'lessons learned' is a problem difficult to deal with. Facilitating the process of learning from an accident, leading an organisation toward a remedy as a first step to more effective control and barriers. An organization have to establish arrangements with other relevant organisations in the sharing of lessons learnt and the adoption of such learning within process safety management systems.

PURPOSE AND USE OF BENCHMARKING

Health and safety benchmarking is a planned process by which an organization compares its health and safety processes and performance with others to learn how to:

- Reduce accidents and ill-health;
- Improve compliance with health and safety law
- Cut compliance costs
- Identify best practices
- Improve process safety
- Manage changes effectively
- Maintain asset integrity
- Promote safety culture

Health and safety benchmarking is a five step cycle aimed at ensuring continuous improvement.

- Deciding what to benchmark
- Analysing where you are
- Selecting partners
- Working with your partner
- Acting on the lessons learned

Benchmarking is not just about comparing data or copying your competitors. Benchmarking is more about continuously learning from others, learning more about your organisation's strengths and

weaknesses in the process, and then acting on the lessons learned. This is what leads to real improvement. Benchmarking is a means to an end, not an end in itself.
Benchmarking health and safety helps the organization to:

- Improve reputation
- Increasingly important in getting and keeping contracts
- Avoid 're-inventing the wheel' – learn from others' experience and pick up on others' good
- Develop relationships with customers and suppliers, including contractors
- Find out where you stand - you may think you're better than average
- Save money and help keep your completive edge.
- Savings can come, for example from reduced insurance premiums
- Increased productivity and reduced staff turnover;
- Improve overall management of health and safety
- Reduce risks to people's health and safety.

SOURCES OF PROCESS SAFETY MANAGEMENT INFORMATION

Sources of health and safety information can be extracted internally or borrowed externally.

INTERNAL TO THE ORGANIZATION

- Risk assessments
- Accident and ill-health statistics
- Accident/ill health/absence records
- Investigation reports, maintenance records
- Consultation with the workers themselves who from their experience could be in a position to offer information on procedures that could be followed to reduce the risks
- The inspections carried out of work place, equipment or process
- The internal and external audits of management system
- Safe Operating standards
- Piping and instrument diagrams
- Process safety diagrams
- Process concepts such as F&G systems pressure and temperature controls and so on.

EXTERNAL TO THE ORGANIZATION

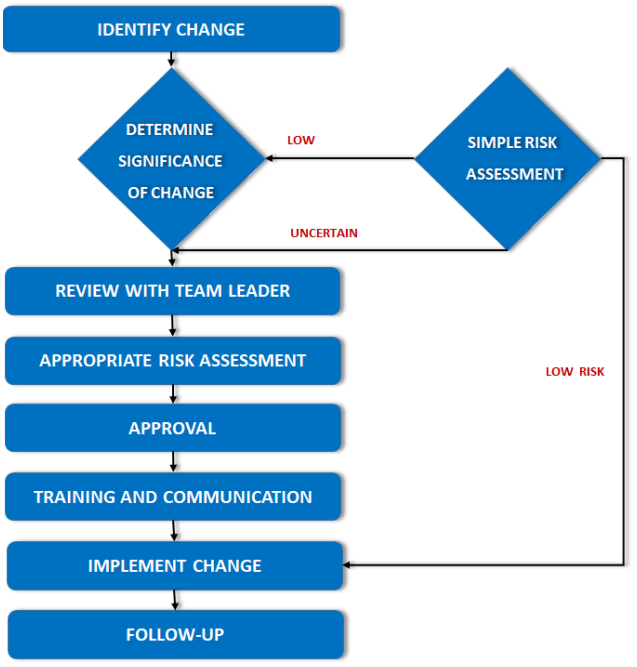
- International agencies such as the ILO
- National enforcement agencies such as the Health and Safety Executive
- Employers organisations
- Trade associations
- National and international standards making bodies such as ISO
- Information from manufacturers such as SDS
- Professional publications
- Legislations, code of practices
- EU (European Union) Directives
- Information from other organisations carrying out work of a similar nature
- Professional health and safety bodies such as IOSH and OSHA
- Occupational health services
- HSE (Health and Safety Executive) publications
- International, European and British Standards
- Occupational Safety and Health Administration (USA),
- Worksafe (Western Australia) and other authoritative texts,
- IT sources

E1-4 Management of change

MANAGEMENT OF CHANGE CONTROLS

"*In industry, as elsewhere, change often brings progress. But it can also increase risks that, if not properly managed, create conditions that may lead to injuries, property damage or even death.*"
Chemical Safety and Hazard Investigation Board (CSB)

Any changes in any part of the organisation consist of the personnel, equipment, processes and procedures of the company have the potential for adverse effects on health, safety and the environment. All changes should be managed properly. The process of changes need to consider all HSE impact arising at all stages of the development, to ensure that risks or adverse environmental effects are minimised by effective planning and design.
The statistics shows that 80% of all large scale accidents in the process industries trace their origins back to "Change". Change is essential to a company's survival. Companies have to be able to continuously improve their process and keep up with industry standards. By successfully managing change you can reduce the number of incidents while still allowing, even encouraging, change to occur.



The above diagram illustrates a possible flow chart for the operation of a MOC program - it is based on a flowchart used by Brian Kelly.
The program starts with the identification of a change. The change is then subjected to a risk ranking procedure (discussed later). High and medium risk changes continue down the path, while low risk changes can skip to the implementation step.

The change must be reviewed by a team leader/manager at this point to provide approval for the process to continue.
Further risk assessment is conducted at this point (as determined in the risk ranking procedure) and approval must once again be obtained to continue.
The change has now been approved for implementation. Prior to implementation, the change must be communicated to all who could be affected. This should include training employees and updating documents when necessary.
The change can now be implemented. Following implementation there must be some follow up to ensure that the change was successful.

Companies need standard procedures for managing changes to process chemicals, technology, equipment and procedures. Each change also requires the following considerations:

- The technical basis for the change
- Formal documented system developed to identify required modifications
- Full hazard and risk analysis exercise on implications of change
- Prevent the introduction of new hazards or unknowingly increasing the risk of existing hazards
- The impact of the change on worker safety and health
- Necessary modifications to operating procedures
- The necessary time period for the change.
- Process for all changes to be authorised by competent persons and where safety critical devices are to removed, sanctioned and signed off by senior management
- All changes to process plant and/or design correctly documented for process knowledge retention
- Consult and inform those affected by the changes (both operational and changes of key workers)
- Training programmes implemented where necessary.

Change and management of change totally different and what we need for new installations or modifications to processes and plant a risk assessment which is heart of the MOC, to cover all stages of the development, from feasibility studies, through planning and design, to construction, commissioning, operation, maintenance and eventual decommissioning and abandonment.
All changes after assessment should be reviewed prior to implementation, and any necessary amendments made to the HSEMS to ensure that their introduction does not prejudice sound HSE performance.
The requirements for management of change were added into section 4.3.1 of OHSAS 18001. Management of change is also an explicit requirement for safety management systems implemented to comply with the Seveso II Directive 96/82/EC "the control of major-accident hazards involving dangerous substances".

Roles and Responsibilities – Making the Change

As it is highlighted in all HSE management system roles and responsibilities shall be clearly defined and any changes in role and responsibilities need to be communicated and the person has to be ready for new roles. There are many items new to be considered regarding changes in roles and responsibilities consist of:

- Job Description
- Pre-qualification(level of Skill, Experience and Knowledge and health condition for new role)
- Training related to the new role and so on.

All of roles and responsibility has to be defined properly by an internal procedure in an organization. The procedure has to include pre-qualification for new role and some more issues to prevent

inappropriate change in an organization and to ensure transfer is made safely and the competence of new person is matched to the level and phase of the change.

By Careful management of changes in line management and functional responsibilities, gaps and shortages can be prevented. As it is mentioned above Personnel and their skills must be compliance with the requirements of the job description and qualification.
The need for further training has to recognized and implemented prior to any changes in the role and responsibility.

The UK HSE Loss of Containment Manual, originally published to help inspectors, suggests that the opportunity for initiating changes should be widely available to people associated with process systems. It should be done by using a purpose-designed change proposal document that gives a full description of the proposed change, the date the proposal is made, and the reasons supporting the change, including all health, safety and welfare issues.

The proposal document should clearly identify those persons who can authorise different types of change, and should involve personnel with suitable backgrounds and experience to make sure that changes will not result in operations outside established safe limits, e.g. if changes are proposed for an offshore installation, onshore guidance may be necessary.

Good monitoring needs to ensure that application of the procedures is not short-circuited nor any of the elements missed out. Independent auditing of safety management systems should take place with good communication and feedback, particularly where proposals for change are not approved.

E1-5 Worker engagement

The Control of Major Accident Hazards Regulations 1999 (COMAH Regulations) require employers to take all necessary measures to prevent major accidents and limit their consequences to people and the environment. The Regulations demand the application of explicit management systems to prevent and mitigate the effects of an accident. The COMAH Regulations now act as a driver for some companies to review current management arrangements and make workforce involvement more effective.
Companies required preparing COMAH safety reports should agree and prioritise with the workforce the major accident scenarios they are trying to prevent. Engaging the workforce in this way should ensure that a 'reality check' is applied to the measures given in the safety report for preventing major accidents. 'The workforce' means all who work at the company, including employees, contractors and agency workers. In the context of this guide 'involvement' means active participation where the workforce and their representatives participate in the key elements of health and safety management such as setting targets and reviewing performance. Involvement, therefore, goes beyond the provision of information to the workforce or simply consulting them on management proposals. The process requires management to work with others throughout the company to:

- Involve the workforce as equal partners;
- Actively seek their views;
- Value the positive contribution they can make;
- Enable effective involvement to occur in all areas of health and safety management;
- Be ready to change how things are done and challenge previous management practices; and
- Nurture, support and sustain the partnership

THE BENEFITS AND LIMITATIONS OF CONSULTATION

In defining "consultation" and "participation" we must ask two questions:

- First, do managers relate to workers individually or collectively through their representatives?
- Second, are workers passive recipients of information about the practice of health and safety management or can they actively influence its direction?

The answers lie in two different approaches. One has its origins in the idea of collective worker rights, the other in the idea of advancing a co-operative dialogue between workers and managers. While the former was behind campaigns that led to specific legislative measures on worker representation on health and safety in some countries, the latter has been dominant in their implementation.
To understand these differences it is necessary to first consider so-called "direct participation" before discussing the meaning of collective representation.
This key term, consultation, embraces the legislated rights of workers' health and safety representatives to undertake inspections investigate complaints and receive training.
Employers are often required to consult workers and contractors in good time on matters relating to their health and safety such as:

- Process hazards and associated controls
- Policy development and
- Process safety performance

Research evidence demonstrates that worker representation and consultation increase their participation and effectively improve health and safety outcomes in relation to management practices and safety culture, as well as safety performance in terms of injury rates.

In effectively involving your workforce you are likely to produce benefits by:

- Demonstrating leadership and commitment
- Developing a positive health and safety culture;
- Reducing accidents and ill health and their costs;
- Create opportunity for improve employees' knowledge;
- Improve co-operation of the employees;
- Meeting customer demands and maintaining credibility; and
- Complying with legal requirements.

Certainly there is some limitation in consultation with workforces such as:

- The organization cannot consult on all matters
- Consultation will take time and in some cases may need to take decision in urgent basis
- The consultation has to be effective and genuine otherwise it has negative impacts

TYPES OF CONSULTEES AND THEIR ROLE / RESPONSIBILITIES

SAFETY COMMITTEES

MEMBERSHIP

The membership and structure of a Safety Committee is a matter for agreement between the employer and, if it exists, a workers union at the particular workplace. If there is no workers union the employer may ask for volunteers.
There is no set structure for a committee.
The committee should be a competent body representing the interest of employees and management alike. The number of management representatives should not exceed the number of Safety Representatives and should include line managers, engineers, HR managers, Safety Officers as well as supervisors.

CONDUCT OF SAFETY COMMITTEES

The frequency of meetings depends on local conditions and the degree of risk. Meetings should be planned well in advance to avoid postponements and cancellations.
The minutes of each meeting should be distributed amongst each member of the committee, with additional copies made available for general distribution or by displaying in prominent locations.

OBJECTIVES AND FUNCTIONS

The objective of every Safety Committee must be to promote co-operation between employer and employees to ensure employees' health and safety at work. A Safety Committee should consider drawing up agreed objectives and terms of reference.
An important part of making Safety Committees work is to ensure that there is a clear agenda for the meeting and this is followed so that the committee discusses only the items on the agenda.

Other tools for consultation with employees or their representatives includes but not limited to the following:

- Discussion groups
- Safety circles
- Departmental meetings
- Email and web-based forums

NEEDS OF WORKERS INVOLVEMENT IN DEVELOPMENT

The companies studied agree that the benefits of workforce involvement in health and safety far outweigh the cost of its introduction and maintenance. Employees interviewed share this view.
Effective workforce involvement together with visible leadership by management discussed before, promotes a positive health and safety culture.
This is a need to involve workers in process safety management development. Here are areas that senior management can involve employee or their representatives actively:

- Where the COMAH Regulations apply, the workforce involved in the development and review of your major accident prevention policy (MAPP)
- Involve employees and contractors in permit to work continuous improvement
- Provide resource enable staff to carry out their health and safety functions
- Provide arrangements to enable effective, active workforce involvement in safety committees and other meeting
- Establish good communication involving workers throughout the organisation

- Involve employees actively in the design and delivery of health and safety training
- Employees involvement in setting and health and safety objectives, targets
- Involving relevant workers carry out the risk assessments
- Workforce actively involve when new equipment, materials, services or contractors are being procured
- Workforce actively involved in the design of, or changes to your equipment, work layout, systems of work, rules and procedures
- Workforce engagement in problem-solving activities
- Where the COMAH Regulations require the preparation of a safety report, the workforce involved in its preparation
- Involving the workforce in active monitoring
- Involving the workforce in the investigation of accidents and ill health
- workers involvement in the review of risk controls
- workforce active involvement in the audit and inspection process

THE IMPORTANCE OF WORKERS ENGAGEMENT BY SENIOR MANAGEMENT

Workforce involvement is of particular importance where there is a small management team and more reliance is placed upon the workforce to fulfil some health and safety management functions. But management cannot pass on to others their legal responsibility for managing health and safety. In effectively engaging workforce senior management are likely to produce benefits that well explained above.
The Workers involvement will help better understanding of the hazards and proposing solutions. The workers' engagement is so important that organisation has to consider the following issues:

- Always considering engagement as a priority
- The consultation has to be managed by well planned meeting and committed participation from both parties
- The workers' representative concerns has to be listened and accounted for furthers actions

If we consider the worker involvement as an essential finding in recently introduced management systems, then it has to be monitored periodically through a thorough examination tool such as audit. This audit may include:

- Method of the engagement such as meetings and their intervals;
- The level of attendance and departments representations;
- The effectiveness and relativeness of the meeting and any other forms of gathering;
- The balance presence of employers and workers representative;
- Appropriate and effective communication methods
- Quality and extent of workers' involvements.

E1-6 Competence

UNDERSTANDING 'COMPETENCE'

Process safety management is highly relied on appropriate preventive and protective programme, an effective programme needs high levels of:

- Skill;
- Knowledge; and
- Experience.

Process safety managers must ensure that they and all their staff understand all performance standards for each safety critical element included in the asset integrity management (AIM) plan. People that their work can affect process safety critical element integrity and performance must be able to demonstrate their competence, including all contractors, and maintenance and technical support teams. The demonstrations consist of but not limited to the following issues:

- The ability to undertake responsibilities and to perform activities to a relevant standard, as necessary,
- To ensure process safety and prevent major accidents.
- A willingness and reliability that work activities will be undertaken in accordance with agreed standards, rules and procedures' source

THE ROLE OF COMPETENCE IN SAFE WORKING AND BEHAVIOURS

Analysis of many incidents shows that necessary knowledge or competence is not available at the right time in the right place. PSC often also has a role in ensuring that the correct actions are taken when an incident occurs and may be critical to reducing the impact of the event and preventing escalation. The table below shows how competency influences of employees behaviors:

Process Major Accident	Competency and behavior
Flixborough (UK, 1974) Explosion due to release from a temporary bypass assembly of inadequate design	Operated by insufficiently competent people (Health and Safety Executive 1975)
Piper Alpha (UK, 1988): the public enquiry into the Piper Alpha explosion in 1998	The operating company failed to ensure that a key supervisor was sufficiently competent in the operation of the PTW
Longford (Australia, 1998)	Failure to identify hazards and properly train operators. Insufficient understanding led to a critical incorrect valve operation (Hopkins 2000)
BP Texas City (USA, 2005)	A lack of supervisory oversight and technically trained personnel during the start-up, an especially hazardous period
Buncefield (UK, 2005)	There should be a clear understanding of major accident risks and the safety critical equipment and systems designed to control them

Process safety competence plays a vital role in preventing or mitigating process incidents:

- Competent people are less likely to initiate situations that could lead to an incident
- Competent people can detect the early signs that an incident is possible and prevent it from occurring
- Competent people can mitigate the impact of an event to reduce the potential for harm

THE DEVELOPMENT AND IMPLEMENTATION OF SYSTEMS TO IMPROVE PROCESS SAFETY KNOWLEDGE AND EXPERTISE

Considering the importance of process safety competence, an organization has to develop a holistic and systematic approach to manage personal competencies. With a holistic approach, we can include the influencing factors on behaviors such as organization, job and individual factors on our consideration.

It should be aligned with the other parts or even designed as part of an Integrated Safety Management System. Such integration is crucial for a successful and sustainable implementation of the PSC-MS. In the following sections elements of a PSC-MS have been described.

TRAINING AND DEVELOPMENT PROGRAMMES APPLICABLE TO PROCESS SAFETY RISK

As it is mentioned in the table above maintaining competence training and development is a vital need for process safety competency. The training management has to consider the following issues:

- The different roles need specific training
- Refresher training must be provided at an appropriate frequency to maintain the required PSC level over time.
- Skills and knowledge need to be refreshed especially where they are used rarely
- Training content has to be defined individually because each person has different requirements
- Training "on the job" is most important it should be supported by other forms of training, e.g. online, classroom, and simulation.
- Training and procedures should cover when people must request assistance
- PSC requirements and knowledge should be kept current by following developments in research and industry experience

SPECIAL COMPETENCE REQUIREMENTS FOR EMERGENCY SITUATIONS

People in emergency situation are under excessive pressure and making proper decision is not easy as in normal situations. Abnormal situations are a major challenge with regard to process safety competency. In process safety, anticipated emergency scenarios have to be identified and well planned for facing with in advance. To manage unplanned events situational awareness and the ability to cope with stress is important. All actions should reflect a hierarchy of importance with

potential impact to humans first and foremost, then the environment and after this material losses and business interruption. The availability both of general and specialised PSC not only enables adequate reactions in emergencies but also reduces stress. Systems must be in place to have competencies for dealing with emergencies at all times even though we hope that they will never use.
For better confront with emergency situation we have to consider following factors in our planning:

- Define PSC requirements for emergency situations in advance
- Ensure the PSC defined in the minimum PSC requirements is available at all times by use of back up and contingency plans
- Have specific PS information for emergencies readily available
- Define actions for situations in which the necessary PSC is not available
- Train for emergency situations by realistic drills or simulations
- The success of drills and simulations should be assessed upon completion to ensure that any opportunities for improvement are adopted

Sample questions

Q1: Process safety mainly deals with:		
A	High frequency, high severity risks	
B	Low frequency, high severity risks	
C	Low frequency, low severity risks	
D	High frequency, low severity risks	

Q2: Within a management of change procedure, final approval for removal of a safety critical device should be given by a:		
A	Senior manager	
B	Lead operator	
C	Chemical engineer	
D	Process technician	

Q3: Benchmarking is used to identify good practice across similar:		
A	Committees	
B	Organisations	
C	Techniques	
D	Procedures	

Q4: What is the most important benefit of involving workers when carrying out risk assessments?		
A	To reduce resistance and conflict when risk assessments are introduced.	
B	To make sure there is a balanced representation of workers and managers.	
C	To enable employer and employees to comply fully with legal requirements.	
D	To gather detailed practical knowledge about workplace hazards and risks.	

Q5: Which of the following is the most direct evidence of worker competence?		
A	Consistently performing a work-related task correctly to the required standard.	
B	Signing a document to confirm that a procedure was read and understood.	
C	Completing an attendance form following a process safety toolbox talk.	
D	Carrying out a work-related task without harming themselves or others.	

Element 1:
Process safety leadership
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