



PROCESS SAFETY MANAGEMENT

A course book for the NEBOSH HSE Certificate in Process Safety Management



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Foreword



The NEBOSH HSE Certificate in Process Safety Management is the perfect qualification for those who need to understand the principles of process safety management as part of their job. By studying for this qualification you will be able to contribute to the effective management of process safety and be able to profile the major risks present in a typical process installation.

The qualification is particularly relevant to the following people working within a process environment:

- Team leaders, supervisors and managers
- Process operators
- Newly qualified health and safety advisors

The qualification is not designed for chemical and process safety engineers experienced in the specification, design and maintenance of the integrity of process plant.

This course book has been structured to match the NEBOSH syllabus. It has been written by process safety experts, who take you step-by-step through the content of the qualification. The information is divided into distinct sections, each of which starts by listing the learning outcomes for that particular section. It isn't full of jargon or confusing terms and offers useful examples, mock exam questions and helpful tips throughout to aid your learning.

Using this book as part of your course preparation and study could improve your chance of success. How you use this book is entirely up to you however, we would definitely recommend that you use it as a revision aid as part of your formal course leading to the qualification. You may feel you want to read it from cover to cover, or you may simply want to read certain chapters where you would like to concentrate your studies. You will also find it useful as a source of reference when you are back in your workplace.

The NEBOSH HSE Certificate in Process Safety Management is intended to be suitable for students working anywhere in the world. The content is based on recognised international best practice. Knowledge of specific legislation, either in the UK or in any other country, is not a requirement of the qualification.

Further information, including the Guide for the qualification can be found on the NEBOSH website at www.nebosh.org.uk.

The NEBOSH HSE Certificate in Process Safety Management also complements other NEBOSH qualifications such as the NEBOSH National or International General Certificate in Occupational Health and Safety.

We hope you find this book useful and thank you for taking the time to learn more about process safety management.

A guide to the symbols used in this course book

ELEMENT 1

THOUGHT PROVOKER

These ask you to think about what you have been learning, to relate it to your own experience.



ELEMENT 2

ACTIVITY

Carry out an activity to reinforce what you have just read.



EXAMPLE

Real or imagined scenarios that give context to points made in the text.



ELEMENT 3

KEY TERMS

Definitions of key process safety terminology.



ELEMENT 4

Process safety leadership



HSE inspectors inspect an offshore oil platform.
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This element will explore what process safety is and will look at the importance of leadership in the process industries. It will also introduce organisational learning, management of change, and how worker engagement can be managed.

Learning outcomes

On completion of this element, you should be able to:

- 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.

Process safety management meaning

1. The distinction between process safety vs personal safety

When we think about 'safety', we naturally think about the personal safety of individuals who could be affected, and the various, often more traditional actions that can be taken to reduce the risk of injury and ill health. Many types of personal accidents are quite common, simple and therefore reasonably foreseeable; their control measures are often well established and straightforward to implement. These include machine guarding, fire precautions, equipment checks, managing slips and trips and the use of personal protective equipment (PPE). We probably think about low personal accident rates or number of days without an accident as a measure of success.

By comparison, process safety (safety in high-hazard process industries) is rather more complicated. So-called high-hazard process industries include chemical and oil and gas sectors. While they obviously suffer personal accidents like all other workplaces, there is also the potential for a major incident. This is because they deal with dangerous chemicals in large amounts and operate processes that, if not well monitored and controlled, can easily go spectacularly wrong, resulting in major fires and toxic releases, for example. Major incidents like these are very infrequent events and can be difficult to predict (before they happen) because of the multiple causes and complexity of what leads to them. Neglecting seemingly small things (like an intermittently faulty alarm or general maintenance) can end up causing a major accident. In process safety, the emphasis is on the prevention of major disasters that have been historically an issue for the industry. Process safety needs both complex technical controls (on the plant itself) as well as a robust safety management system. It requires a good deal of specialist technical engineering and management skill to get right. Leadership is important to give suitable high priority to process safety even though the standards and controls mean that incidents should be rare and may be outside the experience of operators.

Personal safety and process safety do link together (clearly, there is a risk of slips, trips and falls occurring in any workplace); however, in process safety, the emphasis is on the prevention of the high-risk, large scale catastrophic events that, though thankfully rare, could have devastating consequences.

2. A definition of process safety

You will find various definitions of process safety but the one that we will use here 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." (Energy Institute, adapted from the Center for Chemical Process Safety of the American Institute of Chemical Engineers¹).

As you can see, it has all the elements of what we have discussed earlier.



St. Fergus gas terminal, Scotland.
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Process safety leadership

There have been a number of incidents in the process industry that have called into question the way that safety is managed; specifically, in relation to inadequate leadership and poor organisational culture.

EXAMPLE



Focus has historically been on the engineering solutions and design improvements that could be made; however, the hydrocarbon explosions at Texas City and Buncefield in 2005, as well as the more recent Macondo blowout (explosion of BP's Deepwater Horizon offshore drilling unit) highlighted the need to focus on not only the physical controls but also the leadership actions that will prevent such events. As a result, in the UK the Process Safety Leadership Group (PSLG) was established in 2007 to work with the regulators in order to form guidelines on the management and leadership actions that are needed.

In the PSLG final report² into the Buncefield disaster, the importance of leadership was acknowledged. Appendix 7 of that document contains their "Principles of Process Safety Leadership²" that we will broadly cover in this section.



After effects of the fire at Buncefield oil storage facility.
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ACTIVITY



We will be discussing Buncefield at several points through the element, so it would be useful for you to be aware of the incident. The report into the HSE's prosecution of companies involved in the Buncefield explosion, together with photographs and video evidence, can be viewed on the HSE's website (at <https://www.hse.gov.uk/comah/buncefield/index.htm> at the time of writing.) Review some of the evidence and familiarise yourself with the case.

ELEMENT 1

1. Hazard and risk awareness of leadership teams

Leaders need to be competent and actively engaged. Indeed, the earlier referenced PSLG report states that "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 within the organisation and of the process safety implications of board decisions".

History has shown that if process industry leaders do not fundamentally understand the hazards and risks inherent in their business, unless they are extremely lucky, ignorance may ultimately lead to disaster. Lack of understanding may arise from things such as lack of technical knowledge or simply lack of data on which to base a decision (lack of reporting). Leadership teams are key decision-makers. If, through ignorance, they do not fully appreciate the consequences of their decisions (such as delaying plant maintenance on an already elderly plant or cutting critical workers), they will make poor decisions that may make a major accident inevitable (just a matter of time). To appreciate this, leaders need to be involved, competent and actively engaged - it does not happen by chance. They need to be fully aware of the hazard and risk potential of their processing activities and the potential consequences that decisions to do (or not do) things may lead to. Though a major incident may never have happened to the organisation in question, the major accident potential of its processes needs to be treated seriously alongside other business risks, since it is far more likely to have an impact on reputation and the survival of the business as a whole.

ELEMENT 2

ELEMENT 3

ELEMENT 4

Process safety leadership

Clearly, leadership teams must therefore be aware of the hazards and potential impacts of their plant and sites (at every stage of their life cycle, from design to decommissioning). These impacts could not only result in life-threatening safety events but also reputational damage and business losses.

EXAMPLE

In the 1988 Piper Alpha oil rig disaster, 167 lives were lost, insured losses reached £1.7 billion and impacted 10% of North Sea oil and gas production. Nearly 30 years on, the name "Piper Alpha" symbolises a monumental failure of process safety and the reputation of the Occidental organisation was tarnished forever.



ACTIVITY

Piper Alpha will be discussed several times in the course, so it would be useful to have an understanding of the disaster. Use the HSE website, search engines and public access video sites to understand (in no great detail) what happened and why the incident had such a profound impact on the industry and process safety as a whole.



Further, they of course need to understand the criticality of the layers of preventive and protective measures that prevent, detect and mitigate such undesirable events.

For those board members still unsure as to the importance of managing process safety, the publication Corporate Governance for Process Safety - Guidance for Senior Leaders in High Hazard Industries³ contains the following statement:

"Safe operation and sustainable success in business cannot be separated. Failure to manage process safety can never deliver good performance in the long term, and the consequences of getting control of major hazards wrong are extremely costly... Major accidents may not just impact on your bottom line profitability - they could completely wipe it out. Major incidents in recent years have shown that the consequences for capital costs, income, insurance costs, investment confidence and shareholder value can all be drastically affected. So why take the risk? However, getting it right pays large dividends."

THOUGHT PROVOKER

Consider the organisation or environment that you work in - how confident are you that leaders and managers are fully aware of the hazard potentials of the process?



2. Board level visibility and promotion of process safety leadership

The Principles of Process Safety Leadership also place emphasis on board level visibility to promote process safety.

Directors and senior managers play a key role in promotion of process safety - they provide leadership, set direction and assign priorities, establish the health and safety 'tone' of the organisation and ensure that the organisation's legal responsibilities are met.

As such, their actions are noted by workers and their visible leadership is essential in the development of the safety culture of the organisation. Of course, leaders need to reinforce personal safety, such as wearing PPE, but also need to discuss and question the more complex issues such as resourcing and the process operations. The actions taken at leadership level establish the level of commitment to process safety that, in turn, helps to achieve the desired positive health and safety culture. Part of being visible is personally leading initiatives, challenging the organisation (asking difficult questions) and actually being physically present (visiting sites). In short, they need to be role models.



Process safety responsibilities need to be defined.
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3. The need to define process safety responsibilities

It is not only directors who have a role to play in process safety. Top management will delegate (even though they will retain overall responsibility and accountability) to their subordinates. So, other managers and workers will also have process safety critical roles and responsibilities as part of their duties. Obviously, such responsibilities should only be delegated to those who are competent to carry them out (or where that competence is actively being developed). These should be clearly defined at all levels; from the board through to the maintenance workers who look after the installation, everyone has a role to play in process safety. This is especially so for those with Process Safety Management (PSM) critical positions. For example, the engineering manager may be responsible for the management of change process, which ensures that modifications to plant or process are carried out only after consideration of the safety implications; the maintenance manager may have accountability for the development and implementation of the preventive maintenance and breakdown strategies, while the engineers, electricians and fitters may be responsible for contributing to the risk assessments and following the permit-to-work process and locking off equipment before work commences.

THOUGHT PROVOKER

How confident are you that you understand your process safety responsibilities? What about your colleagues and senior managers?



4. The reasons for holding to account all individuals with PSM responsibility

It is clear that if new plant is installed without due consideration to safety, then the potential for injuries is high, eg if everything is correct and an electrician simply takes shortcuts and does not isolate the system before work, the potential for injury is also high. Everyone with process safety responsibilities has a role to play and therefore should be held accountable for their actions, regardless of their organisational level. In the context of an adequately resourced, competent workforce, holding people accountable also encourages engagement. However, it is very important for process safety to look for root causes of incidents rather than blaming an individual. Root cause analysis finds wider failings in the systems, management and leadership. Also, in the example above, a 'just' culture would encourage the electrician to report near misses and contribute to the development of safer working systems, without fear that a single mistake will lead to disciplinary action or even sacking. So, we might ask ourselves how such a culture is created, the answer is simple; senior managers play a pivotal role. Senior managers set 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. Effective senior managers dedicate resources to safety rather than paying lip service to it, and ensure that true root causes are identified after incidents. This theme is returned to under 'Organisational Learning' below.

In the previously referenced Corporate Governance for Process Safety - Guidance for Senior Leaders in High Hazard Industries publication, the following suggestions are made with regard to organisational competence and responsibility. CEOs and leaders assure their organisation's competence to manage the hazards of its operations; they:

- understand which questions to ask their workers and know which follow-up actions are necessary;
- ensure there are competent management, engineering, and operational workers at all levels;
- ensure continual development of process safety expertise and learning from new regulation and guidance;
- provide resources and time for expertise-based hazard and risk analyses, effective training and comprehensive scenario-planning for potential accidents.

Process safety leadership

- defer to the expertise of workers, and do not dismiss expert opinions. They 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;
- ensure that the organisation monitors and reviews the process safety competency of contractors and third parties;
- are capable of openly communicating critical aspects of process safety with all internal and external audiences.

5. The provision of adequate resources

Process safety needs to be adequately resourced; ensuring adequate resources are in place is the responsibility of the leadership of the organisation. Again, returning to the PSLG leadership principles, we find the following: "Appropriate resources should be made available to ensure a high standard of process safety management throughout the organisation and workers with process safety responsibilities should have or develop an appropriate level of competence." These resources can be:

- human - the right number of people with the right skills and experiences;
- financial - this may include capital expenditure and operational budgets to allow the plant to operate safely;
- physical - such as equipment, buildings, offices, rest facilities, etc.

Under-resourcing process safety is a risky business. While it may be unreasonable to expect an unlimited budget or unlimited pool of workers to draw on, it is entirely reasonable to expect a high-risk process operator to take its responsibilities seriously. The impacts of a process safety incident can be catastrophic - in September 2001, an explosion in the AZF fertiliser factory in Toulouse, France resulted in 29 deaths, 30 serious injuries and 2,500 other casualties. Total compensation paid by the insurance group exceeded 1.5 billion Euros. As well as the financial implications of such failures, there are huge moral expectations placed on employers, that was clear after the Deepwater Horizon explosion in 2012 that saw the chair of BP in the spotlight for the organisation's failings and huge public backlash. There are also legal implications in many countries that place accountability clearly at the feet of the leaders to ensure safety (including process safety) is adequately managed.

6. Reasons for establishing process safety objectives and targets

There is an old adage that states "if you aren't measuring, you aren't managing" and this is as true for the process industry sector as it is for any other. The meaning of process safety objectives and targets is that effective organisations, serious about making safety improvements, will establish a clear set of objectives (overarching process safety aims) and targets (short term goals) that are cascaded to workers throughout the organisation at all levels. Leading and lagging process safety indicators (things that you would measure to indicate progress towards your objectives and targets) should be established in order to take the organisation towards its goal. We will discuss these indicators in the context of a process safety management system in Element 2.

There are sound reasons for establishing effective process safety objectives, targets and indicators. An organisation could adopt a 'wait and see' approach to safety management, assuming that 'no news is good news'. However, a lack of incidents is no guarantee of safety, it could be the result of good old-fashioned luck. Effective process safety indicators identify safety critical controls and actions, and monitor these to ensure that operations are running as intended, controls are robust and the site is therefore under control.

Once these 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. For many organisations (such as those appearing on the London Stock Exchange), this will be included in the annual report to shareholders and therefore is publicly available.

ACTIVITY

Identify three process safety indicators that are used in your workplace to monitor process safety. Write these down, as we will come back to them in Element 2.



7. Commitment to continuous improvement

Leaders should not only actively and effectively monitor the safety performance; they should also seek to continually improve, eg by benchmarking against other organisations.

Ultimately, process safety, like the personal safety we explored at the start of this element, is a never-ending story. Organisations develop, plants change and the desire for further safety improvements is therefore a continual process, rather than being disheartening, this is enlightening as it acknowledges that the best organisations strive continually for the injury-free workplace or the incident-free plant and acknowledge that it is achievable with the right level of commitment.



HSE inspectors discussing work carried out on a chemical plant.
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