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# Options for teaching Operational Process Safety

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## Abstract

Over several years the IChemE Safety Centre (ISC) has been working with universities around the world to drive improvement in how process safety is taught. This has seen the ISC release guidelines on desired learning outcomes for graduate engineers. This introduced the need for operational experience, which has received some challenge from universities, as they felt academia was not an operational environment. This led to the development of some useful materials for use by universities to assist their education needs. One part of this was to develop a simplified process safety management system (PSMS) that could be applied to university laboratory activities, highlighting operational process safety requirements. The PSMS is written to fit within existing university safety management systems, which often focus on occupational health and safety. This paper will discuss the development of the PSMS including specific details of elements, and how they can be applied. This PSMS will be freely available to any university who would like to access it.

**Keywords:** Initial training, safe practices

## 1 Introduction

It is widely accepted that the academic environment is quite different to an operational environment. Academia is a place of research and learning, an operational environment is a place that aims to produce a product safety and consistently, around the clock. When a student graduates university and enters an operational environment they can often experience a culture shock due to the constant demands of operations. Often accompanying this is the significant safety demands put on employees, which may be very different to their academic experience. For example the new employee may need to do a task in the field that requires a permit to work to be issued. This may be their first experience of these systems, and this can create frustration as they work through what appears to be a bureaucratic system. This may then lead to thinking that safety systems do not always add value, sometimes they get in the way of the "real job". It is because of these experiences

that the ISC developed a simplified PSMS (ISC, 2019) that can be applied to university laboratory work, highlighting the application of safety as part of the "real job". It is believed that this will produce more rounded graduates who have an emerging practical understanding of operational safety.

## 2 Developing the simplified PSMS

A working group of academics, process safety specialist from operating companies and consulting engineers came together to define the requirements based the ISC Guidance document 'Undergraduate Learning Outcomes' (ISC, 2018). This document described the following learning outcomes for the 'Process Safety in Practice' element:

- Apply, adapt and/or create Process Safety Management System (SMS) elements as part of laboratory, practical or pilot plant activities.
- Research, investigate and summarise the application of Process Safety Management System elements as part of industrial training placements.
- Develop and apply regulations, standards, risk assessments, inherent safety techniques and risk-based decisions during Design Projects.
- Identify and evaluate causal factors in process safety incident case studies.

The PSMS was designed to address the first item in this list. Other resources are available or being developed for the remaining three elements.

As a starting point for development the working group considered by the Center for Chemical Process Safety Risk Based Process Safety Guidelines (CCPS, 2007) and the Energy Institute Process Safety Framework (Energy Institute, 2010). From these two resources a list was made of the most applicable elements that could be applied in the academic environment of the laboratory. While the overall structure of the existing management systems is logical when applying it to a workplace, it was determined that a modified structure would assist in the use at an academic institution and better align with the stated learning outcomes in the 'Undergraduate Learning Outcomes' (ISC, 2018) document. For this reason the sub-elements were grouped under the following elements:

- Induction and competency.
- Risk identification and management.
- Operations.
- Review.

## 3 Overall structure of the PSMS

Within the four elements of the PSMS, there are 17 sub-elements. The PSMS is laid out as shown in Table 1.

| Element | Sub-element |
|---|---|
| Induction and competency | Culture |
| | Standards |
| | Workforce involvement and working with others |
| | Introduction to procedures |
| | Training in equipment use |
| | Emergency response and preparation requirements |
| | Incident reporting requirements |
| Risk identification and management | Hazard identification |
| | Risk assessment and identification of controls |
| | Implementation of controls and control validity |
| | Management of change |
| Operations | Working with procedures |
| | Safe work practices – Permit to Work |
| | Safe work practices -Isolations |
| | Pre-start up safety review |
| | Handover and logging |
| Review | Post activity review |

**Table 1. Elements and sub-elements of the PSMS**

To support the application of the PSMS, a series of examples have been provided in appendices. These serve to show how the system can be used and what should be included in the elements if they are to be adopted. They are not comprehensive lists but show how the information could be used. The examples for each element are listed below in Table 2.

| Element | Example |
|---|---|
| Induction and competency | Example health safety and environment policy |
| | Example laboratory safety rules |
| | Example take 5 or hazard identification card |
| | Example induction checklist |
| | Example applicable standards list |
| | Example applicable legislation list |
| | Example chemical inventory and safety data sheet register including infographic of incompatible materials |
| | Example organisation chart showing responsibilities |
| | Example position description for students |

| | |
|---|---|
| | Example procedures register |
| | Example training register |
| | Example emergency response plan |
| | Example emergency response evacuation diagram |
| | Example incident report |
| | Example incident database |
| | Example root cause analysis |
| Risk identification and management | Example hazard identification methods |
| | Example infographics to show the hazards |
| | Example risk matrix |
| | Example team-based risk assessment forms |
| | Example management of change process |
| | Example management of change form |
| Operations | Example management of a procedure |
| | Example procedure review checklist |
| | Example permit to work procedure |
| | Example permit to work checklist |
| | Example isolation procedure |
| | Example isolation sign off form including P&ID |
| | Example infographic showing different isolation equipment available or use |
| | Example pre-start up safety review form |
| | Example of a safety moment, including notes and presentation materials |
| | Example process log |
| | Example handover checklist |
| Review | Example post activity review |

**Table 2 Example materials included in the PSMS**

## 4 How the PSMS can be adopted

The PSMS is available as a free download from the IChemE Safety Centre website (https://www.icheme.org/knowledge/safety-centre/publications/publications/) and written so that users can review what is contained in the document and see examples of how to apply it in practice. While the ISC does not warrant the information, it is copyright free and designed for open access. It contains a section describing how to use the document. This is quoted below (ISC, 2019):

"This document can be used in whole or in part, depending on the needs to the university. It is important to note that the resources contained here are examples only for the university to use for structure, not necessarily accurate details for direct application.
The following steps offer a guide to using this document:

- perform a gap analysis between the current management system in place and the suggested sections in this document. Note: some aspects may be addressed in different ways, the outcome need not be achieved by following this model rigidly
- determine if the gaps that emerge need to be closed
- develop an action plan to close the gaps. This may include:
    - determine which documents or systems need to be developed
    - prioritise the actions
    - develop necessary documents or systems based on the resources in this document, the resources here are templates only and not comprehensive examples
    - implement the systems or documents, including training of personnel as required and
    - review the implementation periodically to ensure it is still functioning and providing the desired outcome"

## 5 Additional resources

To support the release of the PSMS, the ISC has also developed a case study on laboratory incidents. This follows the same format at the previously released ISC Case Studies, where a story is told from the beginning without disclosing the actual outcome. The participants then make decisions based on the information that have been given. This case study starts following a demonstration of the rainbow experiment, then moves to an experiment performing impact testing on an explosive and finally an experiment using a pyrophoric chemical. The decision points in between focus on what elements of the PSMS may be useful to improve safety where these experiments are being undertaken. The final video in the case study discloses the actual outcomes from the incidents discussed. This case study, along with the PSMS is available as a free download from the IChemE Safety Centre website. The production of this case study was generously funded by Saudi Aramco.

## 6 Conclusion

Implementation of a PSMP will not achieve an improvement in laboratory safety and teaching of operational process safety on its own, but it is a useful tool to assist in this endeavour. Helping to show students that the use of a management system is standard in the workplace will aid in their introduction to their first role after university. Following defined processes and taking into account standard risk management practices and systems may also assist in producing safer laboratories for all concerned. This is because the hazards will be better understood and managed. It is for these reasons that the PSMS has been created and made freely available to universities around the world.

The next challenge to is assist the university lecturers in how to implement the elements they need. This may require education for the educators. An excellent way this is currently being done is through the American Institute of Chemical Engineers CCPS Faculty Workshops (CCPS, 2019). When we have an opportunity to engage with local faculty, as industry people we should always seek to assist and share our knowledge and experience.

## 7 References

CCPS. (2007). Risk Based Process Safety Guidelines. New York: Wiley.

CCPS. (2019). https://www.aiche.org/ccps/resources/conferences/events/faculty-workshops. New York: AIChE.

Energy Institute. (2010). Process Safety Framework. London: Energy Institute.

ISC. (2018). Undergraduate Learning Outcomes. London: IChemE.

ISC. (2019). ISC Guidance Sample University Laboratory Process Safety Management System. London: IChemE.