

## PSM Education and Training: Turkey Case

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In parallel to rapidly growing industrialization, the efforts for improvement of Process Control, Process Safety and Process Safety Management (PSM) have also been accelerated all over the world. Studies for preventing all undesired incidents and keeping them under control are dealt within PSM context and the studies within PSM have just recently started in Turkey. With the purpose of prevention of the major industrial accidents in Turkey there have been legislative regulations which are adopted from Seveso Directives and entered into force gradually. It is expected to complete required preparedness until 2016 within the framework of Seveso II. When it comes to PSM practice, there have been a few confusing issues. One of the problems is the lack of qualified labour for PSM, which is a multidisciplinary working area, in industry, government and consulting firms. Unfortunately, PSM courses are not included in engineering programs in our country and training for the engineers in the field is not common. In this study, chemical engineering programs at national levels are benchmarked. A survey was conducted with senior undergraduate and graduate students in engineering programs about their expectations from PSM education and proficiency of PSM.

### 1. Introduction

There have been many accidents including releases of toxic, reactive, or flammable liquids and gases in process industries involving highly hazardous chemicals reported for many years. These accidents can affect not only workers but also residential areas, property and environment and cause catastrophic consequences. Simply, low probability high consequences events are known as major accidents. Major accidents have been defined by CCPS as “an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment ... and leading to serious danger to human health and/or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances.” In recent years, there have been valuable efforts to prevent major accidents under the name of “process safety” and “process safety management (PSM)”.

Process Safety have been defined by AIChE as “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. There have been various approaches to process safety management. The principles of PSM have been listed by different organizations such as API, OSHA and EPA in Table 1, 2 and 3(CCPS, 1994).

Table 1: American Petroleum Institute (API) PSM elements

Process Safety Management Elements
Process Safety Information
Process Hazard Analysis
Management of Change
Operating Procedures
Safe Work Practices
Training
Assurance of the Quality and Integrity of Critical Equipment
Pre-Start up Safety Review
Emergency Response and Control
Investigation of Process-Related Incidents
Audit of Process Hazards Management Systems

*Table 2: Occupational Safety and Health Administration (OSHA) PSM elements*

Process Safety Management Elements
Process Safety Information
Process Hazard Analysis
Management of Change
Operating Procedures
Safe Work Practices
Training
Assurance of the Quality and Integrity of Critical Equipment
Pre-Start up Safety Review
Emergency Response and Control
Investigation of Process-Related Incidents
Audit of Process Hazards Management Systems

*Table 3: Environmental Protection Agency (EPA) Risk Management Program Components*

Risk Management Program Components
Hazard Assessment
Prevention Program
—Management System
—Process Hazards Analysis
—Process Safety Information
—Standard Operating Procedures
—Training
—Maintenance (Mechanical Integrity)
—Pre-Start up Review
—Management of Change
—Safety Audits
—Accident Investigation
Emergency Response Program
Risk Management Plan

The aim of this study is to introduce the current situation of PSM education & training in Turkey. A survey was conducted with undergraduate & graduate students in chemical engineering programs about their expectations from and proficiency of PSM education. Legislative regulations were also mentioned.

## 2. Legislations

As a result of Seveso accident in 1976, the adoption of legislation on the prevention and control of such accidents were prompted. In Europe, Seveso Directive (Directive 82/501/EEC) was entered into force on 24 th of June 1982. Then the directive was amended considering the lessons learned from later accidents such as Bhopal, Toulouse or Enschede resulting into Seveso II (Directive 96/82/EC). After the review process, on 4 July 2012 the new Directive 2012/18/EU (Seveso-III) which repeals the Seveso II Directive by 1 June 2015 was adopted. Seveso II Directive was harmonised with our national legislations via "On the Regulation of Prevention of Major Industrial Accidents" as of 30 December 2013 (Official gazette No 28867). Other related regulations mentioned are as follows: Regulation on the Protection of Employees from Explosive Atmosphere (Gazette dated 30 April 2013, numbered 28633), Occupational Health and Safety Risk Assessment Regulation (Gazette dated 29 December 2012, numbered 28512), Communiqué of Safety Report Preparation Concerning Major Industrial Accidents (Gazette dated 24 January 2015, numbered 29246).

## 3. Literature

There have been valuable researches on chemical engineering education and safety issues. Perrin and Laurent (2008) described an overview of the curricula concerning the safety and loss prevention courses delivered in the three French departments of chemical engineering. The two main ways to teach safety, health and loss prevention concepts were announced as teaching in a part of all chemical engineering courses and as a separate course on safety. The second one is found more preferable by the authors. Chen et al. (2015) emphasized the importance of integration of process safety engineering and fire protection engineering for better safety performance. Marlin (2010) discussed the operability in chemical engineering design education. Key topics in operability were listed as operating window, flexibility, reliability, safety, efficiency, operation during transitions, dynamic performance, and monitoring and diagnosis. Saleh and Pandley (2012) discussed multi-disciplinary engineering education and safety. A model was offered for the structure and

content of an introductory course on accident causation and system safety. Learning from accidents was introduced as a key issue.

In Turkey there have been limited studies on safety and engineering education. Balıkcıoğlu and Deniz (2004) researched Occupation Health and Safety (OHS) Education at technical departments of universities in Turkey. It was stated that OHS education was limited with only four universities. Deniz (2011) introduced current state of OHS education in Chemical Engineering Departments in Turkey. It is reported that 19 departments have 23 OHS courses through 31 chemical engineering departments and OHS education is delivered in the Labor Law courses at 8 departments. Ercan Kalkan and Deniz (2015) investigated the actual situation of OHS graduate education in Turkey. There have been 63 graduate programs countrywide of which are 43 non-thesis and 20 thesis. Since the number of programs seems encouraging, the student per lecturer was found to be high; the authors have the opinion that the quality of that education became disputable.

## 4. Method

### 4.1 Web page survey

In this study, a web page survey was conducted firstly to determine current situation of PSM education in Chemical Engineering Departments, in Turkey. For this purpose, web page of the Council of Higher Education was investigated to specify chemical engineering departments through registered 193 universities. It was assumed that declared data were updated and exact. Undergraduate & graduate courses of the Chemical Engineering departments were analyzed.

### 4.2 PSM education questionnaire study

A survey was conducted with undergraduate & graduate students to gather information about PSM awareness. A questionnaire was conducted via face to face interview and internet. In the first part of the questionnaire, participants were asked about their personal information. In the second part, there have been PSM education related questions. Questionnaire both includes yes-no, yes-no-partially and open ended questions.

## 5. Results

### 5.1 Results of web page survey

As a result of The Council of Higher Education web page survey, it was determined that there had been 50 chemical engineering departments through 193 universities. As it can be seen in Table 4, there have been 9 chemical engineering undergraduate, 2 graduate programs having exact PSM courses and in the 5 chemical engineering programs PSM were considered as a subtopic of OHS courses.

### 5.2 Results of PSM education questionnaire study

A survey was conducted to determine PSM knowledge & awareness. Participant profile consists of 3% associate's degree, 31% of bachelor, 27% of master of science. 88.5% of the participants graduated from an engineering program, whereas 3.3% science/ technology, 1.6% administrative sciences, 6.6% other.

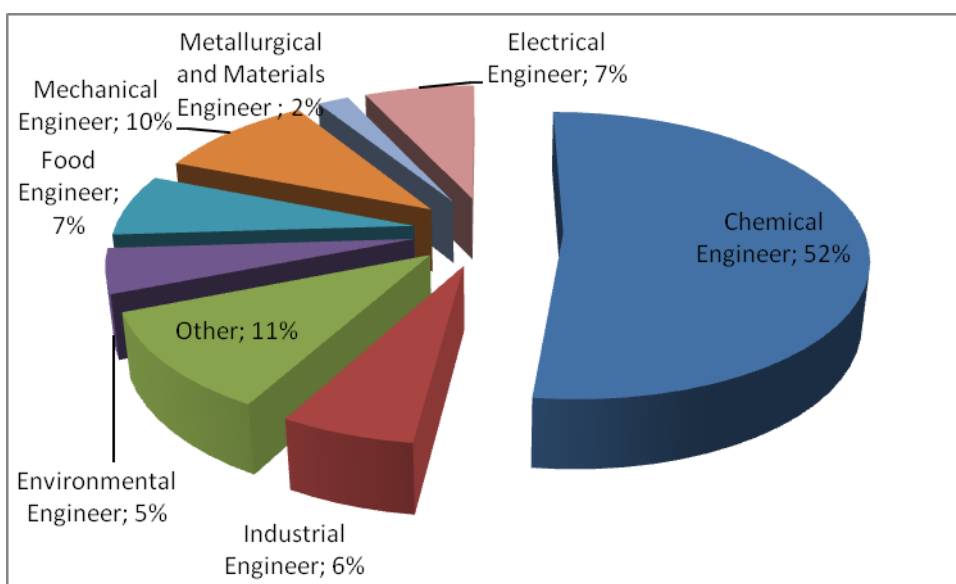


Figure 1: An overview of participants profile

Table 4: List of universities which deliver PSM or related courses in undergraduate and graduate level, in Turkey

University	Faculty	Department	Undergraduate PSM/PSM related courses	Graduate PSM/PSM related course
Ankara University	Engineering	Chemical Engineering	Industrial Safety (elective)	
Beykent University	Engineering	Chemical Engineering	Chemical Process Safety (compulsory)	
Bilecik Şeyh Edebali University	Engineering	Chemical and Process Engineering	Occupational Health and Safety (elective)	
Boğaziçi University	Engineering	Chemical Engineering	Operational and Environmental Safety of Chemical Plants (elective)	
Ege University	Engineering	Chemical Engineering	Process Safety And Hazards Prevention (compulsory)	
Gazi University	Engineering	Chemical Engineering	Occupational Health and Safety (elective)	
Kocaeli University	Engineering	Chemical Engineering	Occupational Health and Safety in Chemical Engineering (compulsory)	Process Safety Management (elective)
Middel East Technical University	Engineering	Chemical Engineering	Chemical Process Safety (elective)	
Osmaniye Korkut Ata University	Engineering	Chemical Engineering	Occupational Health and Safety (compulsory)	
Selçuk University	Engineering	Chemical Engineering	Environment and Safety Engineering (elective)	
Süleyman Demirel University	Engineering	Chemical Engineering	Process Safety and Hazard Prevention (compulsory)	
Uşak University	Engineering	Chemical Engineering	Industrial Safety (elective)	
Yeditepe University	Engineering	Chemical Engineering	Occupational Health and Safety (elective)	
Yüzüncü Yıl University	Engineering Architecture	Chemical Engineering	Process Safety and Risk Analysis (elective)	Chemical Process Safety (elective)

11% of participants stated that they had studied PSM during undergraduate education whereas 5 % of participants studied PSM during graduate study. The number of participants that received PSM education from in-company training course was 21 %, consulting firms 13%. 49 % of participants pointed out that they have never had PSM education in anyway.

Participants were also asked to grade PSM education from 1 to 10, if they studied during undergraduate education. 57 % of respondents gave 4 points whereas each of 2, 5 and 7 points 14%. Participants were asked concerning Seveso status of their organization as lower tier, upper tier or out of coverage. 63% of participants stated that they didn't know current status of their organization.

Participants were asked about Seveso related legal requirements. 65% of participants explained that they didn't have information about legal requirements.

Only 26 % of participants found themselves as competent and 33% of partially competent to take responsibility in PSM area.

Participants were asked to remark OSHA PSM elements which they have basic knowledge on. The result of this inquiry is given below in Table 5.

Table 5: Knowledge level of participants about OSHA PSM element

OSHA PSM elements	%
Employee Participation	43
Process Safety Information	41
Process Hazard Analysis	44
Operating Procedures	44
Training	36
Contractors	10
Pre-Start up Safety Review	38
Mechanical Integrity	8
Hot Work Permit	31
Management of Change	16
Incident Investigation	36
Emergency Planning and Response	52
Compliance Audits	23
Trade Secrets	25

The participants were also asked about their expectation from undergraduate and graduate PSM education. These expectations were expressed for undergraduate education as follows: Courses should be application oriented and include P&ID reading, emergency planning and response, hazard analysis, legislations, HAZOP risk analysis method, lessons learned from past accidents, risk control measures (RCM), risk based inspections (RBI), process control and safety equipments, equipment management, safety culture, accident investigations, domino effect, land use planning, basic principles of control equipments, the relation between hazardous material and equipments, simulation programs and software, ATEX, critical equipment selection and preparation of safety report. Some participants have also offered expanding PSM education to a few course periods.

## 6. Conclusions

There have been many accidents in process industries involving highly hazardous chemicals reported for many years. These accidents can cause catastrophic consequences. As a result of Seveso accident in 1976, the adoption of legislation on the prevention and control of such accidents were prompted. Seveso II Directive was harmonised with our national legislations via "On the Regulation of Prevention of Major Industrial Accidents and Mitigation of Effects" as of 30 December 2013. It is expected to complete required preparedness until 2016 within the framework of Seveso II.

When it comes to PSM practice, there have been a few confusing issues. One of the problems is lack of qualified labour for PSM, which is a multidisciplinary working area, in industry, government and consulting firms. Unfortunately PSM courses are not properly included in engineering programs in our country and training for the engineers in the field is not common. PSM education/training has become a necessity with the new regulations which came into force. Implementation of the laws without any postponement will make this necessity more apparent. For this reason, all process engineering related programs must include separate PSM courses instead of offering the subject being as a subtopic of OHS courses. PSM area is likely to be an important source of employment in the near future.

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