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PROCESS SAFETY EDUCATION AND TRAINING ACADEMIC EDUCATION AS A FOUNDATION FOR OTHER PROCESS SAFETY INITIATIVES ON EDUCATION.

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Abstract

Commitment to process safety is fundamental to the process industry. Governance, promotion and participation in academic and related educational programs are an expression of the industry's commitment and stakeholder reach. Process safety education and training is a very broad topic. Industry-academic collaboration is essential when developing high level education and training on process safety. This article looks at the development of educational and training programmes for Master students, for students in Master after Master programmes and for experienced industry workers.

Keywords: process safety, education, engineering, industry, university, collaboration.

1 INTRODUCTION

Within essenscia[1], Delta Process Academy (DPA) is a platform governing three initiatives in close collaboration with our important stakeholders. First, together with the Department of Chemical Engineering of the Katholieke Universiteit Leuven, it funds and coordinates an Advanced Master of Safety Engineering[2], elements of which are part of the regular Master programme in Chemical Engineering. Secondly, two intensive process safety programmes have been developed. The first is aimed at experienced engineers, starting out in process safety and on managers of chemical companies. The next focusses on first and second year European master students within the framework of the ATHENS educational network. Additionally DPA has set up an experience exchange platform on process safety.

2 PROBLEM DEFINITION

The importance of process safety needs to be stressed on a continuous basis. Our concerns are based on the human and financial consequences of neglecting process safety. Education, training and sharing good practices on process safety are an essential cornerstone of a commitment to process safety and the prevention of incidents. They are also a cornerstone for another important element of process safety namely process safety knowledge and competence.

Process safety should be a concern of everybody in the company. The manager as well as the operator should be aware and understand the importance of process safety for their organisation. Process safety is one of the most important aspects for a company, and every function within the process industry should and needs to be involved with it (although often this is still not the case).

A major challenge is how to integrate process safety into the regular educational Master programmes (Level 1) versus the creation of additional Advanced Master programmes (Level 2). The latter is applicable when training experienced people from the industry; the former only applies to graduating students.

[1] essenscia, a multi-sector umbrella organization that represents the numerous sectors in the field of chemicals and the life sciences, Belgium

[2] See: University – Industry Collaboration: Safety Engineering Education at KU Leuven, Jan Degrève, 2013, Leuven.

Short generic or specific courses of one week duration can be categorized as an additional level (Level 3) and much specialised one or two day courses form the last level (Level 4). The final level is training only focusing on sharing experience (Level 5).

Of course there are levels in between and content overlaps between the levels. The higher levels are characterized by increased participation from industry and consultants as content or subject-matter providers.

3 ACADEMIC EDUCATION

The Master of Safety Engineering meets an existing need and growing demand for process safety experts coming from industry. To this end, the programme offers a university level education that gives the participants a broad overview and a scientifically based understanding of professional expertise in the many and different domains of process safety. Attention is paid to the development and acquisition of competences that are of importance to process safety: from the identification, analysis and evaluation of hazards and risks associated with products and processes, to the implementation of safety systems in an industrial context where people-related, organisational and management aspects also need to be considered.

A note of some historical significance: KU Leuven and the Faculty of Engineering Science have a long-standing tradition when it comes to offering an educational safety programme: the first initiative was taken in 1975, making it one of the very first academic safety technology programmes in Europe. Since then, the programme has of course undergone several changes, the last one in 2010.

The Master of Safety Engineering is very multidisciplinary in character. The very heterogeneous group of lecturers really does attest to this fact: about 15 are professors in academia (with members from Science, Engineering & Technology, Biomedical Sciences and from Humanities) whereas another 15 lecturers or guest professors come from industry or government institutions. Much care was taken in selecting the non-academic people because they need to have the ability to transfer their professional expertise and knowledge about best practices while not losing sight of the scientific basis underpinning process safety engineering.

The total number of students varies somewhat yearly, but has been somewhere between 20 and 35 for the past 5 years. Most incoming students are recent graduates, but approximately 30% register as part-time students and these are mostly working professionals. International students these days also make up about 30% of the student population. Their electronic application is reviewed by the programme director and a final decision for or against admission is made on the basis of their academic curriculum including grades obtained, English language proficiency and a personally written letter of motivation. Experts at the International Admissions and Mobility Office do a first pre-review of the candidates and supply background information, which is really helpful to make a final decision. Due to the heterogeneous student population (mixture of full-timers and part-timers) it is not easy to determine or interpret the average time-to-graduation. For full-time students it is around 1.3 years on average. The reason for this (longer than expected) duration is that some students find a job during their first year of study and then complete the programme on a part-time basis. Also, some students never return back to finish the programme after finding a job, which explains the drop-out of about 15-20%. Of the recent graduates more than 90% reported that they found a job within 6 months after graduation. Of these, 62% said that the degree Master of Safety Engineering was absolutely necessary to get that particular job, while 15% said it was valuable. Since the admitted students already have an initial Master's degree, considerably many job opportunities are already available to them. However, next to these opportunities, the Master of Safety Engineering degree opens up extra job possibilities in a field with much less competition from other diplomas. This explains why almost none of our graduates has a problem finding a suitable job. Also, when the alumni were asked about their general satisfaction with the study programme, 92% responded positively. Asked about whether or not they would choose the study programme again, 85% responded in a positive way.

Having spent five years organising the Advanced Master of Safety Engineering (Level 2), we have learned that the goals have been partially achieved. Based on participant evaluations and academic attendance, we can conclude that the course is achieving its goals. From our analysis of the mix of students we can conclude that participants are mainly international Master students aiming for an Advanced Master of Safety Engineering. Participation of students coming from the industry, preferably with five years of industrial experience, is rather low due to the study workload, time commitment and some of the course content. Students are a blend of national, European and International origins.

As a result of a dialogue and analysis between the University, the KU Leuven, the industry, essenscia and industry participants, three additional developments, all associated with the Advanced Master, have been developed or implemented. One initiative includes two short programmes on process safety (Advanced Master Class on Process Safety and Athens Course, Level 3) and the practically oriented parts of the Advanced Master of Safety Engineering, namely Safety in Unit Operations and Competence in Operations, aimed at a larger and mixed public made up of regular students and participants from the industry. The latter course consists of ten modular seminars, the former are one week intensive courses. Due to the modular nature of the courses, they are considered as a Level 3 element of a Level 2 course.

An additional initiative provides a platform to share experience on process safety, organising 4 to 5 workshops a year. Delta Process Academy governs all the initiatives. This article elaborates on the two initiatives, namely the Advanced Master Class on Process Safety and a part of the Advanced Master of Safety Engineering, namely Competence in Operations, representing 3 ETCS (European Credit Transfer and Accumulation System)[3] in the Advanced Master of Safety Engineering (60 ECTS in total).

4 ADVANCED MASTER CLASS ON PROCESS SAFETY

Delta Process Academy aims, with this 5-day ‘Advanced Master Class on Process Safety’, to provide professionals with a process safety course offering the essentials and pointing out the pitfalls of process safety. By attending this course, the participants develop a high level of awareness on process safety. Particularly for intermediary management positions in the process industry acquiring this awareness is an essential competence towards a successful further career. However, it is also an essential competence for attendees pursuing a specialist’s career in process safety.

The lectures are taught by academics and specialists from the industry, whereby each one of them is asked for a particular expertise or discipline.

Originally, the main purpose of the Advanced Master Class on Process Safety was an introduction to the Master after Master in Safety Engineering focussing on participants from the industry. In the meantime the Advanced Master Class on Process Safety has become a leading course in awareness and where the most important topics in relation to process safety are tackled. During the last three editions, 140 participants were granted the certificate of the one-week course[4].

Table 1 gives a content overview of the Advanced Master Class on Process Safety.

[3] http://ec.europa.eu/education/ects/ects_en.htm

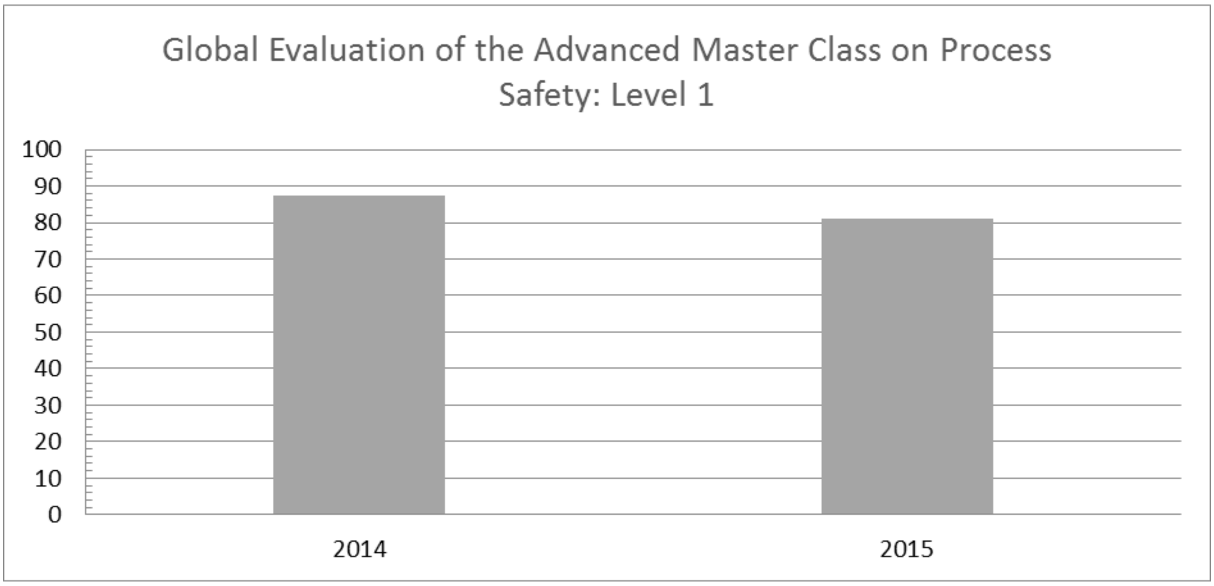
4 The course was initially a four day course, but is now extended to a five day course.

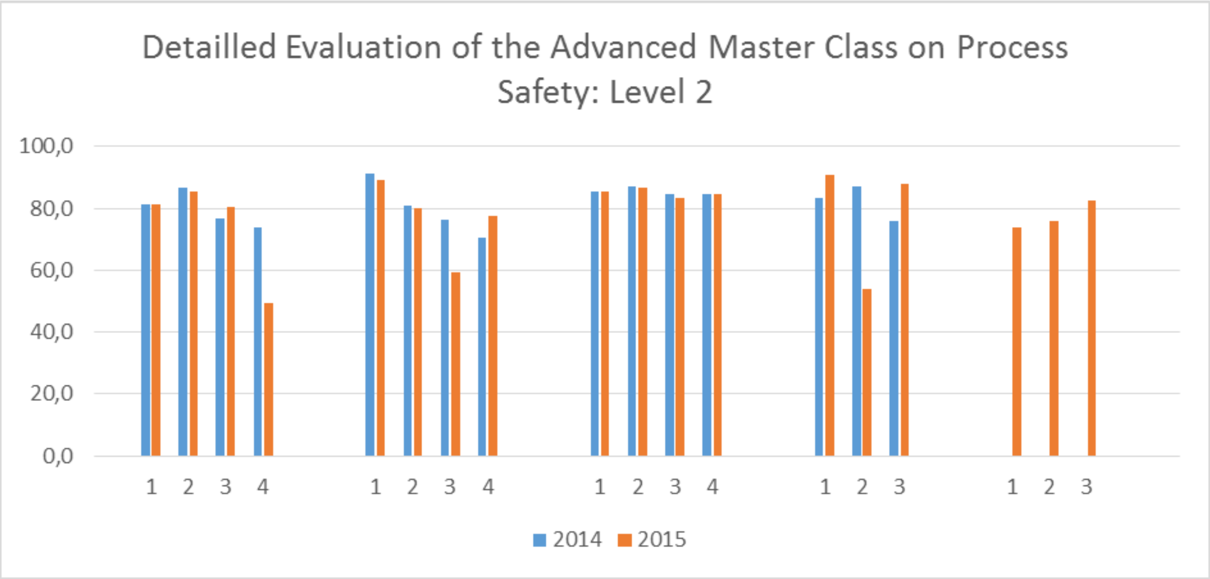
Table 1: Overview of the Advanced Master Class

Day 1: Introduction to process safety **Welcome speech** ***Still a need?*** **Introduction to process safety: Incidents & Legislation that define process safety** ***Are things improving?*** **Process Safety Management Systems** ***An integrated safety management system*** **Product Safety** ***Do we understand the intrinsic hazards?*** **Organizational and Human Factors** ***A practical point of view***
Day 2: Qualitative and quantitative risk analysis **Hazard & Operability Study** ***Use and pitfalls of HAZOP*** **Layers of protection analysis** ***Use and pitfalls of LOPA*** **PHA / sub selection / API 752 – Temporary Housing** ***A risk based approach.*** **Global overview of QRA** ***Towards a dynamic instrument in safety reporting?***
Day 3: Explosion safety **(Gas) Explosion Characteristics** ***Essential elements in risk assessment*** **Dust Explosion Characteristics and Ignition Sources** ***Essential for prevention*** **Vapour Cloud Explosion and Explosion Modelling** ***The number one cause?*** **Explosion Prevention and Protection – Atex directives** ***What is emphasized by the legislation?***
Day 4: Competence in operation & safety in unit operations **Introduction to process safety engineering** ***Safety engineering the corner stone of intrinsic safety*** **Managing reactive chemistry hazards** ***A scenario based approach.*** **Safety Integrity Level** ***A reliable device on a known risk.***
Day 5: Mechanical Integrity the first layer of protection **Corrosion** ***An important threat.*** **Mechanical integrity** ***A standard based approach.*** **Measuring, monitoring and inspection** ***A solution for everything?***

An important aspect related to the course is the evaluation of the teachers and of the content by the participants. For evaluating the course we use the two levels of the four levels of Kirkpatrick Evaluation Model. The first level, ‘reaction’, measures satisfaction by asking what the trainee feels about the training (instructors, material presented, venue, etc). The second level, ‘learning’, emphasises learner performance and identifies whether the trainee gained and retained new facts, knowledge and techniques. This was not measured by a real performance test but by an evaluation form, as for the first level test. The third and the fourth levels in Kirkpatrick’s model, ‘behaviour’ and ‘results’ were not evaluated. To increase the level of quality each year the two weakest courses – teachers are replaced.

Figure 1 illustrates the overall trainee satisfaction while Figure 2 gives an overview of the day to day evaluations results of Level 2 in Kirkpatrick’s Model.





This five-day course starts with an ‘Introduction to process safety’ on day 1 with lectures presenting ‘Incidents that’s define process safety’, ‘Integrated process safety management systems’ and ‘Organizational and human factors’. Intrinsic hazards of chemicals in relation to process safety are also presented during the last lecture of day one.

Day two is a day focussing on risk analysis. Starting with the identification of the scenarios by the HAZOP[5] technique and discussing the pitfalls, the powerful LOPA[6] assessment technique is explained.

After the semi-quantitative technique, during the following session PHA[7] is explained along with facility siting and temporary housing. The day ends by developing the scenarios within a full QRA[8]. During the first two seminars the couple HAZOP and LOPA are highlighted stressing the fact that the quality of the HAZOP will determine your risk assessment and process safety management and that effective and independent layers of protection are indispensable for your risk reduction and process safety management.

On the third day there is a focus on explosion safety. Vapour, gas and dust explosions are discussed thoroughly as well as protective systems. Related regulations are also highlighted. The day ends with the explanation and in depth discussing of the BLEVE[9] phenomena. Those seminars are taught by two in depth specialist that gained experience both in the academic world as in the industrial applications.

The purely engineering topics are presented during day four starting with the cornerstone of process safety namely process safety engineering. Different engineering designs are explained by means of typical installations. Day four ends with a purely chemical topic namely how we can manage reactive chemistry hazards, one of the main concerns in R & D.

Day five is the day where the focus lies on mechanical integrity, starting with the elaboration of the first layer of protection, namely the mechanical envelope, the day continues with mechanical degradation mechanisms. The last seminar deals with in depth discussion concerning the measurements techniques. Part of the seminar deals with compliance issues towards government inspections bodies regarding the mechanical envelope witch is a major concern of our industry.

The strong points of this Advanced Master Class on Process Safety are:

- The teachers are a mix of academic personnel or experts in their field or teachers that has a management function in the process industry
- Half of the classes are taught by professionals that have more than 20 years of experience
- The Advanced Master Class on Process Safety was given a score of more than 80% by the participants which is very encouraging for the organisation and for the teacher’s
- All the teachers are (chemical) engineers or have a PhD. in chemistry

The weak points:

- Time constraints
- Difference in baseline knowledge of the participants
- Teaching skills of high level experts
- Differentiation within the process industry

A similar initiative is aimed at Master students of Chemical Engineering within Europe. This short course on process safety is part of the ATHENS (Advanced Technology Higher Education Network/SOCRATES)[10] Network, composed of fourteen European technological universities or institutions. The Network’s main goal is to facilitate the exchange of students, professors and researchers between the major European technological universities and to collaborate on European technological development and training programmes.

Solving one of the main weakest points of the Advanced Master Class on Process Safety, namely time constrains, is difficult to solve within the existing timeframe. Developing additional modular course treating several aspects of process safety more in depth will be a solution. A factor that also should be considered is the connection of the theory with the application of process safety standards in practice. Therefor in the future it is important to on the one hand maintain and improve the academic education on process safety on the other hand starting up modular practical course within the industry. In the next years the open source training within the industry related to process safety will be developed.

[5] Hazard and Operability Study
[6] Layer of Protection Analysis
[7] Process Hazard Analysis
[8] Quantitative Risk Analysis
[9] Boiling Liquid Expanding Vapor Explosion
[10] See: http://www.athensprogramme.com/

The main challenge regarding the workshops encompasses maintaining the existing level of quality together with the voluntary exchange of experience and lessons learned.

As stated above, process safety should be embraced by everybody in an organization. So the development of courses related to the target audience, deserve also attention.

A similar initiative is aimed at Master students of Chemical Engineering within Europe. This short course on process safety is part of the ATHENS (Advanced Technology Higher Education Network/SOCRATES)[11] Network, composed of fourteen European technological universities or institutions. The Network's main goal is to facilitate the exchange of students, professors and researchers between the major European technological universities and to collaborate on European technological development and training programmes.

5 COMPETENCE IN UNIT OPERATIONS: CAPITA SELECTA IN PROCESS SAFETY

Competence in Unit Operations forms part of the Advanced Master of Safety Engineering, Process Safety option. This class involves 40 hours active teaching, covering a wide variety of topics and teaching skills in operations related to process safety on a (petro) chemical site.

There are more than ten lectures taught by industry experts and high level consultants. Here, we elaborate on the content of certain lectures. Like process safety itself, the lectures are a mixture of engineering related topics and more human and organisational oriented topics. Below, we explain why this seminar is programmed and provide a brief introduction to the content.

These classes reflect two aspects of industry-academic collaboration. Firstly, the blend of academic and industry professors and secondly, the blend of Master students and industry workers.

5.1 Standards

The importance of the use of standards needs to be stressed continuously. In (process) safety, risk analysis seems to be the key to all problems. Legislation around risk analysis is increasing, too. This seminar stresses the importance of applying standards, including internal and external standards.

Due to the increasing importance risk analysis, both in terms of legislation and in the industry, the use and the importance of standards cannot be overstated. By nature, technical standards are the result of continuous risk analysis over time. In other words, standards are the codification of experience. Therefore, ignoring standards or failing to develop internal standards, will put more stress on risk analysis and increases the chance of not addressing and managing all the risks.

This lecture presents an insight in standards for the process industry and their application throughout the whole lifecycle of a plant (design, construction, operation and maintenance of (petro) chemical plants). Standards are documented agreements containing technical specifications or other precise criteria to be used as rules, guidelines, definitions or characteristics and to ensure that materials, products, processes and services are fit for their purpose. The difference between performance standards and prescriptive standards is explained as well as engineering standards. Insight is provided into the organisational committees that are relevant for the process industry.

5.2 Intrinsic safety

This lecture looks at the testing of new products and their associated dangers.

Various tests are involved, from the development phase through to large scale production. The importance of testing is also illustrated by some incident analysis. The lecture elaborates on process safety testing in three phases. First on lab scale where differential scanning calorimetry is applied; the shock sensitivity and the reaction calorimetric are tested. Then, on pilot plant scale, more safety testing is necessary. The thermal stability is tested again under different circumstances. Also, there's an explanation of shock sensitivity, burning behaviour, acceleration rate calorimetric and adiabatic calorimetric. All tests are carried out before the products are approved for use in real production sites. These tests include: flammability characteristics: flash point, auto ignition temperature for liquids (AIT),

[11] See: http://www.athensprogramme.com/

minimum ignition temperature for dust clouds (MIT) and the layer ignition temperature for a 5 mm layer (LIT). For conductivity characteristics: the electrical volume resistivity (EVR) and the liquid conductivity are tested. For dust explosion characteristics: the minimum ignition energy (MIE) and the max pressure and the max pressure rate for dust explosion (Pmax, dP/dt -> KSt) are tested. At this stage, a 'What-if' analysis is required before the products can be used in production plants. To conclude, the Handbook and Software "Bretherick's, Reactive Chemical Hazards Database" is a good reference to search and find the required safety information for many products.

5.3 Mechanical Design

This lecture mainly concentrates on the mechanical design of pressure equipment. When designing pressure vessels, it is not only important to calculate the detailed dimensions of the sub parts, but also to incorporate the failure modes, method of stress analysis and selection of material in relation to its environmental behaviour. As pressure vessels are generally subjected to high pressures and temperatures, the main goal during the design phase is to avoid loss of containment.

Design considerations also include standardization of nozzles and heads in extension to shell and tube heat exchangers. An economical design will always address characteristics such as ease of fabrication, ease of welding, wall thickness, etc. Nozzles, supports and attachments that are points of high stress are also standardized to avoid rupture or buckling.

For the these reasons, pressure equipment has to comply with basic safety requirements pertaining to design, manufacturing and testing, which is governed in Europe by the Pressure Equipment Directive (PED) which dictates administrative workflow based on a risk assessment.

ASME[12] code is the most common code which provides formulas to calculate different parameters like maximum allowable stress, wall thickness calculation of a cylinder under pressure, etc. Simplified ASME evaluation approach includes material specifications classified into material groups.

5.4 Corrosion and Inspection

This lecture addresses two important aspects of Mechanical integrity, namely generic corrosion phenomena and the inspection of the latter. The lecture stresses that degradation mechanisms in the process industry leading to corrosion should be studied and well accounted for to avoid disruption to normal plant operation. Since it is hard to predict corrosion rates, literature data and iso-corrosion diagrams are used to estimate the rate of corrosion on a theoretical basis. Most of the corrosion phenomena are well-known and, usually, can be avoided with proper material selection and by avoiding typical environmental conditions. Typical wet corrosion phenomena are discussed: Crevice corrosion, Corrosion under insulation, Microbial influenced corrosion etc. Inspection of corrosion or other undesired parameters can be done by a technique known as Non Destructive Testing (NDT). The second part of this lecture discusses various non-invasive techniques, such as flaw detection, leak detection and stress measurement. New trends that have emerged in NDT and provide more knowledge about degradation mechanism are presented. One of those techniques is Acoustic Emission Testing (AT), which provides more information regarding actual conditions and is accepted in the process industry as it is easy to use for large installations and requires only a few hours to test. At the end of this lecture, corrosion monitoring is explained.

5.5 Functional safety

This seminar explains that functional safety is about reducing risk using instrumentation with a very high integrity and reliability that, normally, will never need to be used, e.g. emergency shutdown system. The cause of system failure can be a random, systematic or common cause. Random failure is spontaneous failure of a hardware component at any time. The solution to this type of failure is IEC 61508 (Functional Safety)[13] approach: fail safe design and detection methods and a hardware reliability study. Systematic failure is a hidden fault in design or implementation. The solution to this type of failure is the IEC 61508 approach: procedures and verifications. Common cause failure affects all channels of a redundant system, often related to environment (flooding, temperature, people, routing). A system is functionally safe if random, systematic and common cause failures do not lead to injury or death, spills in the environment, economic loss. The IEC 61508 is the umbrella of the

[12] ASME code: American Society of Mechanical Engineers.

[13] International Electro technical Commission.

standards for different domains, IEC 61511 (Functional safety - Safety instrumented systems for the process industry sector) for the process industry. During this lecture, a practical approach translates the lifecycle concept of the IEC 61511. Step 1 is the method of Hazards identification and risk assessment, Step 2 is the allocation of Safety Functions to Protection Layers, Step 3 is about the Safety Requirements Specification, Step 4 describes the design and engineering of the circuit.

5.6 Functional safety and human error

This seminar is programmed after participants have learned about the reliability of safety instrumented functions. This seminar deals with the interaction between safety instrumented systems and human error. Safety instrumented systems are automatic (up to 99%); putting process installation in a safe state and shutting off the hazard sources. This seminar deals with concepts that can minimize human error in safety instrumented systems. In summary, human error in safety instrumented systems can be greatly minimized and controlled by taking the following decisive steps: Second checker (4-eyes principle); Limits to settings in SPLC[14]; Recovery steps (Use feedback signals); Interlocks.; Signal comparison (voting system); Tagging and labelling; Use of key locks (with operational discipline to use it).

5.7 Human factors and organisation

In Process Safety, humans have an influence on every layer of protection. Most incidents involve some sort of human error. That is why we have to improve the reliability of operators, people responsible for maintenance and all other people involved with the process. During the lecture, human failure classifications are defined because each type of error needs a specific preventive approach. Very often, the prevention of human errors is not the main priority of the process industry, for three reasons. Firstly a misled belief exists in the process industry that human errors are inevitable. Secondly, the illusion still exists that human interaction is no longer necessary, due to system automation. Thirdly, it is easy to attribute the cause of an incident to one error, the human error, instead of acknowledging that a poor safety management system is the real cause. Managing human failures requires a high degree of corporate honesty. A human reliability assessment and implementation programme will greatly improve human performance.

This theoretical lecture is followed by another lecture presenting more than 10 high potential incidents within the petrochemical industry. Real-life problem analyses highlighting the weaknesses in the operational management system. This lecture states that human error is not a root cause but a symptom that managerial defence barriers failed. Operating discipline is key in the organization. We have to embrace this principle. Following rules and procedures is what it means to be professional; ignoring rules and procedures is not a professional attitude. Improving rules and procedures are part of incident investigations and risk analysis. This analysis also shows that accountability for each important operation is key.

5.8 Turnaround and contractor management

As we know, contractors play an important role in our industry and in process safety. That's why contractor management requires a high degree of organisational attention. This lecture stresses the importance of a good turnaround (TAR) and the unique nature of related project management. Turnaround is a blanket term that encompasses more specific terms such as I&T's (Inspection & Testing), debottlenecking projects, revamps and catalyst regeneration projects. Turnarounds are expensive, both in terms of lost production when the process unit is offline for a period of time and in terms of direct costs related to the labour, tools, heavy equipment and materials used to perform the project. Key elements, tips and tricks of a TAR and working with contractors are clearly stated and illustrated.

5.9 Key performance indicators

In this lecture, the following questions are raised: "How healthy is our Process Safety Management System?", "Do we manage process safety well or not?", "Are we well organized?" An answer to this question can be provides by KPI's (Key Performance Indicators). The lecture explains the standard dealing with PI on process safety, namely the API RP[15] 754 and highlights the differences with other

[14] Safety Programmable Logic Controller

[15] American Petroleum Institute Recognized Practice

guidelines on indicators like the CEFIC[16] guidelines. The lecture emphasises the many advantages of process safety indicators and the possible negative side effects. The lecture highlights that goal setting for process safety needs to be more self-critical and less self-congratulatory[17]; it also looks at the difference between the internal and external use of those indicators.

5.10 Emergency management

Despite all efforts made by industry, an emergency event can occur. Next to a strong organisational aspect, emergency management also involves an engineering aspect of the utmost importance. This lecture emphasises the organization, coordination, and management of available resources in order to respond to an event and bring the emergency under control, as well as addressing some important engineering aspects. The goal of this coordinated response is to protect co-workers, the public, the installations and the environment by minimizing the impact of the event. An emergency response plan (ERP) must provide the resources and information needed to evaluate the human and environmental health impacts of the event, assess and reduce human exposures to contaminants and develop science-based strategies for remediation. Emergency Response should be an integral part of all the activities throughout the life cycle of a site, even during the design and demolition phase. During the planning and construction phases, Emergency Response should be well established. Also, the lecture elaborates on the engineering aspects of ER and stresses that hazard identification should extend to natural disasters, extreme weather conditions terrorism and cyber-attacks and all such undesirable and unimaginable cases which can and might happen in the future. Modelling the effects of loss of containments can be viable in order to make an ERP operational and in order to schedule resources. A bund fire is explained more in detail during the lecture.

6 GOVERNANCE AND THE FUTURE

The Governance of Delta Process Academy, the initiative of the multi-sector umbrella organisation that represents the numerous sectors in the field of chemicals and the life sciences, is a key element in the whole education and training programme. The Governance Board consists of a number of plant managers from major chemical companies as well as top experts in the field of process safety. The primary function is to challenge the initiatives taken by the academy and to translate the industry’s needs in the field of generic education, training programmes and experience exchange platforms. Secondly, together with other companies, they fund and review the financial aspects of the academy.

7 CONCLUSION

When looking at further implementation and development, we need to compare our initiatives with the structure and organisation of a major hazard company and with certain essential parts of a process safety management system. By making this comparison we can see that we organize initiatives for almost everyone in a major hazard organisation except for the larger workforce and for contractors. As we know, workforce involvement and knowledge of process safety are essential for a high level of process safety throughout the organisation, especially when it comes to the operational part of process safety and the early warning signals. For that reason, suitable training programmes need to be developed for operators in order to maintain and increase a high level of process safety within the organisation. It is of utmost importance that those programmes are hands-on and of high direct benefit to the participants. In due course, programmes must also be developed for third party contractors.

After three years of organizing the Advanced Master Class on Process safety we can be satisfied with the number of participants and their evaluation on two levels according to the Kirkpatrick’s Evaluation Model. Inherent on this type of course are the selection and the content due to time constraints and the nature of the process industry. For the process industry in general, represented by essenscia, Delta Process Academy plays an important role in the first pillar of a process safety management system namely ‘Commitment to process safety’ and ‘Process safety knowledge and competence’.

When considering academic education and especially the Advanced Master of Safety Engineering, two major improvements are needed. First, the Master needs to be modular so that industry participants can pick out modules of particular interest. They should be able to opt for the modules that

[16] The European Chemical Industry Council

[17] Adapted from: Lisa D. Ordonez (2009). Goals Gone Wild: The Systematic Side Effects of Over-Prescribing Goal Setting. Working Paper, 09-083. Harvard.

best suit their personal development path within the organisation. Also, this will mean a better fit when combining learning, work and daily tasks as part of a life-long learning approach. Secondly, this modular approach would allow other universities to participate in the Master programme by developing a module when it fits within their specific area of competence.

There is a very good understanding and synergy with industrial partners, but collaboration with industry could be strengthened and intensified, especially with regard to exploring the possibilities for starting common research projects related to process safety.

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