

PROCESS SAFETY IN METALLURGICAL PRODUCTION

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As a consequence of technological accidents regular conditions of metallurgical processes can change into operational discontinuity. For that reason the main aim of the paper is to present a concept of the risk based process safety assurance. It is directed at the arrangement of the supervised processes realization resulting in prevention and minimization of uncontrolled damages to employees' health and environmental pollution. The fundamentals of the described concept is risk management and systemic approach required by guidelines of: environmental and occupational management systems as well as Risk Based Process Safety (RBPS) management system. The exemplary actions of the risk based process safety assurance in metallurgical production are presented.

Key words: metallurgy, production, management system, process safety, risk analysis

INTRODUCTION

In metallurgical processes high temperatures in combination with chemical reactions create extreme conditions [1]. Due to the different reasons being a consequence of natural disasters or technological accidents those regular conditions of process realization can turn into emergency ones [2].

Emergency usually leads to break of the process' continuity causing health, environmental and financial losses not just in the organization. It shows the need of process safety assurance realized with application of process risk minimization approach, where risk should be understood as the combination of the probability of an event and its consequences [3,4].

In every organization the actions connected with risk management should be of the systemic character [5,6]. New generation of process safety assurance is Risk Based Process Safety management system dedicated to all processes involving manufacturing, using and handling dangerous substances or energy [7]. Basing on the process safety commitment, understanding threats and managing the risk as well as learning from experience RBPS management system is directed not only at process efficiency, but primarily on human and environmental safety [8] – Figure 1.

It is a real multidisciplinary tool for fulfilling occupational, environmental and quality operational aims by process continuity assurance. Fundamental elements of RBPS management system are both: risk assessment and design of improvement solutions for which risk should be also evaluated [7,8].

Organizations, which – dependently on kind, category and quantity of the used and stored dangerous substances

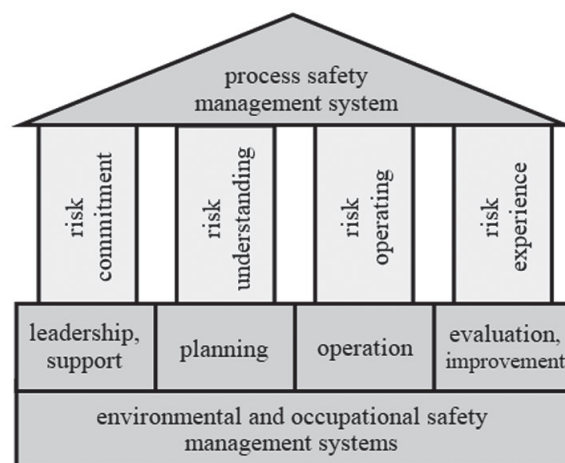


Figure 1 Scheme of dependences between process safety and both environmental and occupational management systems, based on risk management; developed on the basis of [7,9,10].

– create the possibility of accident are called lower-tier establishments or upper-tier establishments. Such establishments should function on the basis of the rules of prevention of the accidents and limitation of their consequences both for human health and environment [11].

Those requirements involves particularly preparation of the safety report including confirmation that [11]:

- safety policy and safety management system have been implemented,
- threats for accidents have been identified and possible accidents' scenarios have been prepared,
- measures needful for preventing the accidents and limitation of their consequences have been assured,
- safety and reliability rules have been taken into account in construction, operation and maintenance of every element of the establishment being in connection major accident threats,
- internal emergency plans have been prepared.

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Basing on the list of the safety reports, it can be said without a doubt, that as upper-tier establishments one can classify the companies with metallurgical production. Therefore research on the practical solutions of process safety assurance in metallurgical production are of the crucial meaning.

The reflection of safety assurance in metallurgical processes must be based on risk management connected with processes of melting and transporting metals. It should allow for supervising those actions which can discontinue the operability of the production and can be dangerous for employees and environment.

METHODOLOGY

The primary objective of the carried out studies was to develop an operational concept of the risk based process safety assurance.

The undertaken actions were directed at verification of possibilities of simultaneously environmental and occupational process safety assurance using risk as the decision factor, applying process continuity assurance and basing on pillars of RBPS.

The foundation of the research was analysis of the requirements of ISO 14001 and ISO 45001 standards as well as guidelines for Risk Based Process Safety (see Figure 1) [7,9,10].

In the normalized range the commitment to process safety, realized as defined authorities, roles, responsibilities, accountabilities, trainings and awareness as well as information and communication in environmental, occupational and continuity aims' achievement, has been underlined in *Support* point. Understanding threats and risks – by planning and development of actions on the basis of the environmental and occupational (also connected with the maintenance of equipment) risks – have found the reflection in *Planning* point. Operating risk – through assurance of the supervised conditions in: risky processes, changes in processes with acceptable risk and when accident occurs – has been described in *Operation* point. Learning from experience, including monitoring and auditing, is needed in *Evaluation* section. Undertaking the improvement actions to change the processes and the system to minimise the risk is required by *Improvement* point [9,10].

Basing both on the foundational blocks of the RBPS management system and requirements of environmental, occupational and process continuity management systems it can be conducted that organization – independently on the operational aims – always decides how to realize the processes and how to prevent the accidents after identification of threats, assessment of the significance and probability of losses and risk acceptability evaluation. Risk management, including risk assessment, is therefore the crucial element of process safety assurance.

Risk based process safety assurance model is dedicated for those establishments which, because of internal or external reasons, need to minimize the production risk, also to metallurgical plants.

RESULTS IN METALLURGICAL PRODUCTION

The proposed concept of the risk based process safety approach specifies guidelines for planning, operating, monitoring, reviewing and improvement of operational processes. It is targeted at risk reduction and assurance of process safety by protection against and recovery from the accidents.

The key assumptions of the described algorithm are consistent with normalized guidelines of environmental and occupational safety management systems. Risk management is of the crucial character. It is written into to continuous improvement cycle covering: risk knowledge, risk operating, risk experience, risk minimization as well as risk commitment – Figure 2.

To assure the process safety organization has to fulfill all of the requirements of the risk management concept. Every plant, nevertheless, itself decides which tools, methods and rules – both in technical and organizational meaning – should be used for effective planning, operation, evaluation and improvement as well as leadership and support.

The exemplary actions which can be entered in the stages of the risk based process safety assurance in metallurgical production are the following:

- identification of threats and their effects during emergency scenarios (*Hazard* and *Operability* Analysis HAZOP), quantitative risk assessment (QRA), definition of risk tolerability and estimation of how the safety layer protection reduces the accident risk (Layer of Protection Analysis, LOPA),
- establishing the operational criteria by pointing out the key features (Unit risk ratios URR and Priority numbers PRO, PRI), identification of the crucial technological parameters (Influence risk ratio IRR) and using influences matrix,
- statistical process control (SPC), using control charts and Process capability indices (Cp, Cpk) as well as condition based maintenance (CBM),
- assurance of required safety level (SIL) by Independent Protection Layers (IPL) for prevention (Basic Processes Control System BPCS, Alarms and Operator Interventions, Safety Instrumented System SIS) and mitigation of risk using active and passive physical protection (relief devices, dikes),
- implementation of emergency and community response plans, according to the national low requirements.

The other actions realized on different stages of the process safety assurance being with coherence with environmental and occupational safety principles can be as follows:

- planning, conducting and evaluation of trainings within the range of: awareness of safety standards, QRA, HAZOP and LOPA methodology, determination of SIL and applicability of IPLs,
- carrying out the internal and external audits, and risk based safety management overviews to monitor and improve safety effectiveness of processes, facilities and people,

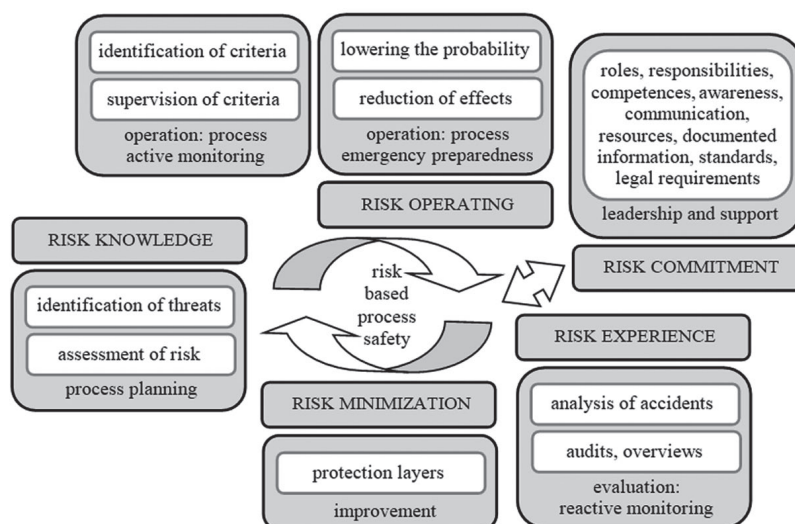


Figure 2 Concept of the process safety assurance based on process risk management.

- assurance of compatibility with ISO 9001, ISO 14001, ISO 45001 and another implemented standards by identification of the common points as well as development, implementation and improvement of unified operational documentation and procedures.

CONCLUSIONS

Plants, where metallurgical production using dangerous substances is realized, should – according to the European Union law – be prepared to prevent potential accidents and reduce their consequences.

A tool for maintaining compliance with those requirement can be the concept of risk based process safety assurance, proposed in the paper.

General assumptions of the concept are unified with environmental and occupational safety management systems requirements (ISO 45001, ISO 14001) and fulfill Risk Based Process Safety guidelines. The unified approach means that organization can manage the threats and their effects using for the purpose of safety assurance the same rules, methods, documents, employees or other resources of the company.

The unification is determined by operational risk identification and assessment. The risk knowledge is a starting point for risk based management. The results of process risk tolerability assessment should be a basis for process safety decision making including risk experience and using risk commitment.

Operational elements, which should find the application within the range of safety assurance based on the risk management, implemented in metallurgical plants are processes and documents connected with assurance of: compliance with environmental and occupational safety standards, roles, responsibilities, competences, awareness and communication, identification of threats and risk assessment, protection layers on emergency preparedness and response, and improvement stages, analysis of accidents, audits and overviews as well as all good practices and operating instructions.

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Note: The professional translator responsible for English language is Dominika Wnukowska, Katowice, Poland.