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INDUSTRIAL SAFETY IN METALLURGICAL COMPANY

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Steel mills, due to the used chemical substances of combustible, toxic and explosive properties as well as because of the many other threats to the environment, human and property – must ensure the industrial safety. Therefore, it should cover actions minimising the occurrence probability and limiting the importance of threats and their effects. In the study, one has presented the scheme of solutions within the range of safe realisation of the processes and loss prevention, concerning both: technical aspects of used technological and measurement control devices as well as the organisational aspects of processes realisation. For the chosen threats one has proposed actions for prevention, protection and limitation realised as technological and organisational layers of protection, which can be applied in the regular conditions as well as during dangerous event.

Key words: metallurgy, industrial safety, risk management, threats, emergencies

INTRODUCTION

The industrial safety in the metallurgy is aimed at ensuring process' safety in the context of preventing the loss within the scope of workers' health and environmental one, loss refraining from breaking the processes' continuity, and as a result – material loss of the enterprise. However, one should consider that the industrial safety refers not only to the dangerous situations but to the regular conditions [1-3].

It should create the system in which the technical, technological and organisational solutions are applied, which ensures safe realisation of the processes and prevents the loss (Figure 1).

The functional system comprised of machines, devices as well as human factor, thanks to which the technical objects can fulfil the functions they were designed. The role of the safety system is preventing occurrence of the dangerous events and other threats, as well as minimising their effects in order the functional aims could be realised.

The safety system can constitute an integral part of the functional system, or can be added from outside. For ensuring the process safety it is advised to apply safety layers of prevention, protection and limitation [4-6].

METHODOLOGY

The metallurgical industry, especially metal-forming industry, is marked by numerous threats. As a result, due to various external and internal factors the processes' continuity can be broken. It can result, the best in the material loss refraining from the production discontinuation, and the worst loss of health and life of workers and big scale environmental damages. Therefore, it is crucial for the metal-forming industry to use the devices, machines, installations and the ways of their exploitation in such a way to eliminate or minimise the risk connected with the threats' occurrence to ensure the safety of the realised processes [1,2,7].

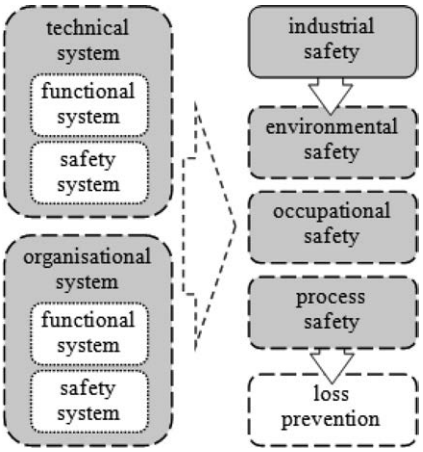

Figure 1 Scheme of industrial safety engineering

In order to ensure safety of the realised processes it is necessary to develop the systemic solutions scheme, covering the technical, technological and organisational aspects and fulfilling the legal and other formal requirements within this scope. The model in question should: be of the individual character refraining from the specific character of the realised processes, and cover the key-threats from the point of importance and probability of their potential results. It should be the effect of risk assessment connected with the processes' realisation, including the process' risk (Figure 2).

RESULTS

The steel mills, in most cases classified are, in accordance with the Seveso III Directive's guidelines as

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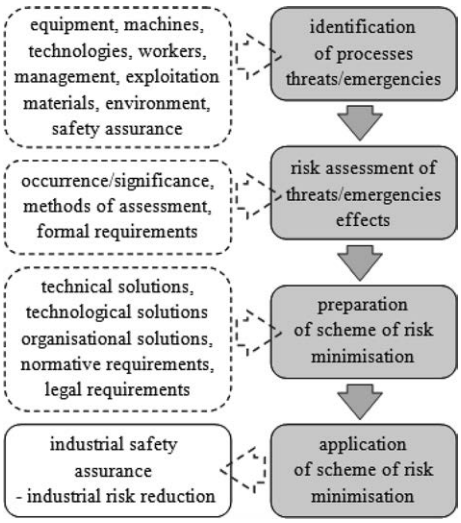

Figure 2 Steps of creation and application of industrial safety assurance scheme

the upper-tier establishments. It means that there are used hazardous substances – due to their combustive, toxic and explosive properties – in the amounts being able to cause serious failures. These substances are mainly: coke-oven gas, coal tar, benzol, and wash oil. Apart from the necessity of controlling the dangerous events (emergencies), the steel mills must undertake the actions connected with managing numerous threats for the human and environment – different than these ones stated in the Directive, and being present in the regular conditions. They cover the following ones: excessive noise levels, extreme environmental heat, production particulates and gases (Figure 3).

Prevention against dangerous events' and other threats' effects (layer of prevention) should be interpreted as the reduction of the probability of the emergency and threat effects occurrence ($O_2 < O_1$) and the minimisation of the risk ($R_2 < R_1$).

Protection (layer of protection) should be understood as the limitation of the effects of the emergency and other threat, in the meaning of both effects significance ($S_3 < S_1$) and occurrence ($O_3 < O_1$), and minimisation of the risk ($R_3 < R_1$).

In contrast, reduction layer must be understood as the limitation of the effects of the emergency and threat, in the meaning of effects significance ($S_4 < S_1$) and minimisation of the risk ($R_4 < R_1$).

All solutions of technical and organisational character – layers of protection, being applied in order to ensure the safety in the processes, must fulfil the legal and normative requirements. They are especially:

- legal essential requirements stated to the manufacturers concerning the safety of the products: Directive 2014/34/EU relating to equipment and protective systems intended for use in potentially explosive atmospheres, Directive 2006/42/EC on machinery, Directive 2014/68/EU relating to the making available on the market of pressure equipment, Directive 2014/30/EU relating to electromagnetic compatibility,
- legal minimum safety and health requirements for: protection of workers potentially at risk from explosive atmospheres – Directive 1999/92/EC, protection of workers from the risks related to chemical agents – Directive 98/24/EC, use of work equipment – Directive 2009/104/EC,
- normative functional requirements for safety elements: IEC 61508 – Functional safety of electrical/electronic/programmable electronic safety-related systems, IEC 61511 – Functional safety. Safety instrumented systems for the process industry sector,
- normative organisational requirements for management systems, including guidance for use: ISO 45001 – Occupational health and safety management system, ISO 14001 – Environmental management system, ISO 50001 – Energy management system, ISO 31000 – Risk management.

One has compared the layers of protection as well as the exemplary ways of security for the chosen threats of steel mills industry in table 1 [8,9], where: 1 – emer-

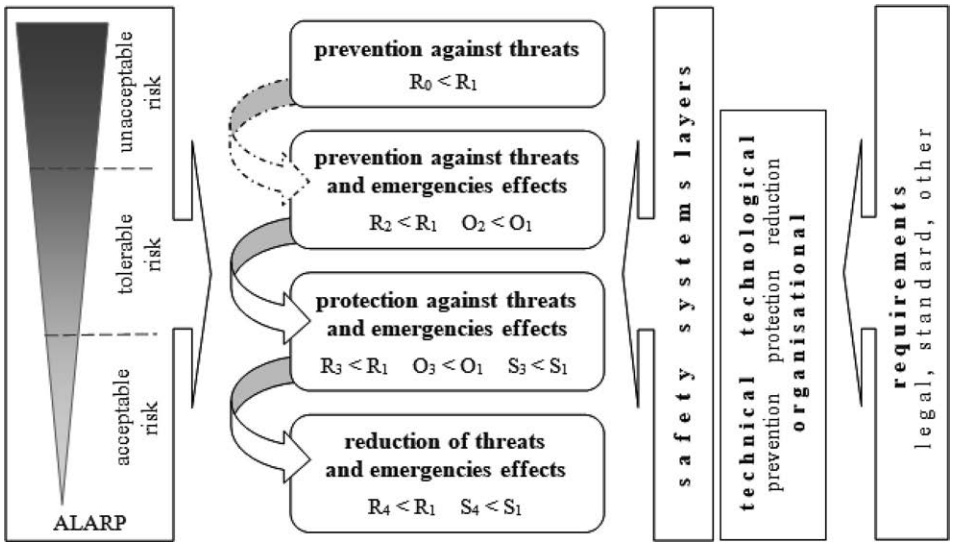

Figure 3 Model of the industrial safety assurance

Table 1 **Summary of the exemplary layers of protection for threats in the steel plant**

1	Layer of protection	Protection
	Technological layer of prevention, exploitative protection: - basic process control systems – BPCS - critical alarms and operators' interventions - safety instrumented systems – SIS Organisational layer of prevention, exploitative protection: - safety, occupational, energy and environmental management systems	- control and measurement devices - measurement points of technological parameters (pressure, temperature) - alarms and blockades at crossing the assumed work parameters - visualisation of the process' course in the control room - testing of functional safety system - technological and workplace instructions - operational and workshops procedures of safety management system
	Technological layer of protection, exploitative protection: - relief systems - leaking controlling system Organisational layer of protection, exploitative protection: - safety, occupational, energy and environmental management systems	- safety valves - concrete slabs limiting backwater and protecting the ground - operational and workshops procedures of safety management system
	Technological layer of limitation, exploitative protection: - limiting the dangerous event in the object - limiting the dangerous event in the nearby area Organisational layer of limitation, exploitative protection: - safety, occupational, energy and environmental management systems	- fire-brigade and medical services - means of communication and alarming - fire and evacuation lanes - fire extinguishers, fire hydrants - individual protection measures - internal operational-rescue plan - external operational-rescue plans - operational-training procedures of safety management system
2	Technological layer of prevention project protection	Modernisation of the jet set elements – increase of natural gas usage instead of coke – reduction of CO_2 emission
3	Technological layer of protection exploitative protection	Exchange of basket and filters of nozzles' installation – limitation of organised particulates emission
4	Technological layer of prevention project protection	Application of MFA (model-free adaptive) automatic measurement and control technology for heating value of fuel mix in all operational conditions – reduction of the energy usage
5	Technological layer of prevention project protection	Building the new gas boiler – limiting the air pollutants' emission

gency (explosion), 2 – CO_2 emission, 3 – particulates emission, 4 – energy consumption, 5 – NO_x emission.

CONCLUSIONS

Fundament ensuring the industrial safety in the steel mills is the identification of the threats of important character, especially these ones which may decide of occurring the hazardous event resulting in multi-loss. As the consequence, there must be risk assessment, covering the estimation of loss connected with occurring the effects of these threats as well as the probability of the occurrence and finally defining the risk's acceptability.

As a result of risk assessment it is necessary to take actions aiming at maintaining the risk on the lowest possible level. These actions should be written in the algorithm of proceeding of systemic character, both: for the threats leading to the dangerous events as well as the threats described with the lower risk's ratios. The algorithm should cover applying the layers of prevention, protection and limitation both: of the technological and organisational character.

The technological barriers can cover the exploitation barriers, as following: basic process control systems, critical alarms and operators' interventions, safety instrumented systems, relief systems and leaking control, measurements limiting the dangerous event's effects in the area of the object as well as outdoor of it and finally the project barriers preventing occurrence of the threat at the stage of project itself.

The organisational barriers represent the solutions being realised within the implemented systems of management of the process, environmental and occupational safety as well as the energy and they concern the systemic: prevention, readiness and ability of reacting to the dangerous events and accidents at work, monitoring, trainings, information, competences and motivation.

Applying these layers can be effective in ensuring safety aiming at minimising the risk connected both: with occurring the dangerous event as well as occurring the threats in the regular conditions of processes' realisation. It is of high importance to carefully chose particular solution which must be rational and legitimate, and the way of safety itself must fulfil the normative and legal requirements.

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