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EMERGENCY PREPAREDNESS AND RESPONSE IN METALLURGICAL PROCESSES

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The main aim of the presented paper is to feature the operational model of the emergency preparedness and response. It is based on the risk analysis and allows for fulfillment of the requirements of ISO 9001, ISO 14001 and ISO 45001 norms. The model in question represents the base of the real aims' unification within the range of proceeding in case of the metallurgical processes' failures.

Key words: metallurgy, production, emergency preparedness, emergency response, risk analysis

INTRODUCTION

In connection with globalization, economic development and implementation of "Industry 4.0" proactive creation of the occupational safety in metallurgical processes should be integrated not only with the proceeding automation but also with quality assurance and environmental influence minimization [1-3]. The newest ISO 45001 standard, which describes the guidelines for occupational health and safety management system [4], can be a foundation for such an integrated approach. Ten chapters of the standard are due to, promoted by ISO, new conception of High Level Structure [5]. Its aim is to provide the univocal requirements and definitions for different management systems, especially for the most often implemented ones: quality [6], environmental [7] and the occupational safety [4], which in fundamental range regulate the way of acting resulting in fulfillment of the requirements and expectations of the external clients, interested parties as well as the workers. Those requirements can be understood as a frames for consistent manner of objectives achievement.

For achieving the further steps of the integration, the methodology of the integration reflecting the models, methods and tools is of major strategic importance for the real integration of the systems [8,9]. The used model should include the unique procedures and processes directed at succeed on operational integration.

The integration on the operational level is especially relevant in the situations when there is no possibility to assure the compatibility of the realized process with the planned occupational safety, environmental and quality requirements. In the time of emergency, due to the different internal or external factors resulting from natural disasters or technological accidents, regular conditions of work are changed in the special ones. It is accompanied with the release of the pollutants into the environment and/or causes damage to employees' health. Emergency, in the integrated meaning, can be understood as the unexpected incident causing the break of the process' continuity and resulting in the pollutions of the environment and occupational accidents as well as loss of property [10-12].

Possessing the emergency preparedness and response model one can simultaneously fulfill formal requirements of the standards and minimize the risk of the emergency defined.

METHODOLOGY

The methodology of the conducted research includes preparation of the model of emergency preparedness and response in the integrated occupational, environmental and quality range.

It is based on the analysis of the requirements of new ISO 45001 standard and assessment of practical possibilities of integration of the occupational safety management system with the other management systems. According to them when deviation arises organization is ready to remove or reduce their influences (Operation - 8). Particularly in compliance with Emergency preparedness and response (8,6) point organization should identify emergency situations, prevent them and be prepared to respond them. Organization prevents and reduces the undesirable effects (Improvement - 10), especially – what is required by Incident, nonconformity and corrective action point (10,2) – controls and corrects the incident, deals with the consequences, reviews the risk and changes the system to minimize it. As the effect of identification of threats, assessment of the losses and risk acceptability evaluation organization makes a decision on how to undertake the risk. Therefore, the risk management must be perceived as the main part of the model. Even though organization is forced by the norms' requirements to use the risk management in the systemic actions, non of standards requires the formalized risk management and indicates the concrete risk assessment methods [4,6,7]. That is why the starting point for application of the emer-

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gency response is implementation of the developed method of risk assessment of the calculation character. The guidelines for risk assessment, which can be used as an element of emergency response, have been described in the following scientific papers [13-15] as the subject of the author's study.

Emergency preparedness and response has been prepared as a tool for process' safety assurance in the quality, environmental and occupational safety context, especially for every metallurgical process.

RESULTS IN METALLURGICAL PROCESS

The model includes the organizational and technological solutions used by the organization both to prevent and to react to the effects of occupational threats, quality incompatibilities and environmental influences, which have already occurred in the dangerous situations. Emergency response should be implemented when emergency preparedness, aimed at stopping the accident by monitoring of the identified operational criteria, is insufficient and the emergency happens, see Figure 1.

The base for procedure of emergency preparedness and response is risk assessment. It indicates tools and methods for processes' control and supervision. It enables to point the solutions appropriate for the process and describes human and intangible resources as well as documentation specific for the concrete emergency.

When, during realization of the process and assurance of the supervised conditions, the compatibility of the operational criteria with the requirements is not guaranteed, the conditions of dangerous situation occur. When the effects of the meaningful threats became the real ones, the response to the effects of the threats based on the quality, environmental and occupational health and safety criteria are needed.

After-emergency response acts also as the re-active monitoring including the analysis of organizational and technical factors creating such process' conditions as can cause the accident. The results of the analysis are crucial for identification of possibilities of process' improvement and assessment of the risk connected with them.

The emergency preparedness is dedicated towards minimization of the risk concerning the probability of the emergency. The emergency response is targeted at minimizing the risk connected with the threats resulting in the occurrence of the influences on the environment as well as the occupational diseases and the accidents at the workplace. It remains both as the actions undertaken immediately after the emergency and as the preventive ones. In the case of the reactive character it is included in the improvement phase. Than it has a significant impact on limitation of the emergency risk by minimizing both: probability of occurrence and significance of effects.

Emergency preparedness should be interpreted as the reduction of the probability of the emergency and its effects occurrence ($O_{S2} < O_1$) and the minimization of the risk of the emergency ($R_{S1} < R_1$). In contrast, assurance of the supervised conditions during the emergency situation should be understood as the limitation of the effects of the emergency, in the meaning of effects significance ($S_{S2} < S_{S1}$) and minimization of the risk of the occurred emergency ($R_{S2} < R_1$).

The influences of the emergency, being embodied in the organization despite the emergency preparedness and the actions undertaken for the sake of the emergency are the subject of the analysis being in the same time the inputs for the improvement process. The new improved solutions of the emergency actions are directed at the limitation of both: emergency influence significance ($S_{S3} < S_{S2}$) and emergency influence occurrence ($O_{S3} < O_{S1}$) and finally – minimizing the risk of the potential emergency ($R_{S3} < R_{S1}$, $R_{S3} < R_{S2}$).

It should be underlined that the above-mentioned actions shouldn't be treated as the one time activities but as the continuous and repeatable ones. Propositions of the preparedness and response actions in the chosen metallurgical processes have been shown in the Table 1.

CONCLUSIONS

Harmonizing the management systems according to the HLS can be considered only a starting point for the

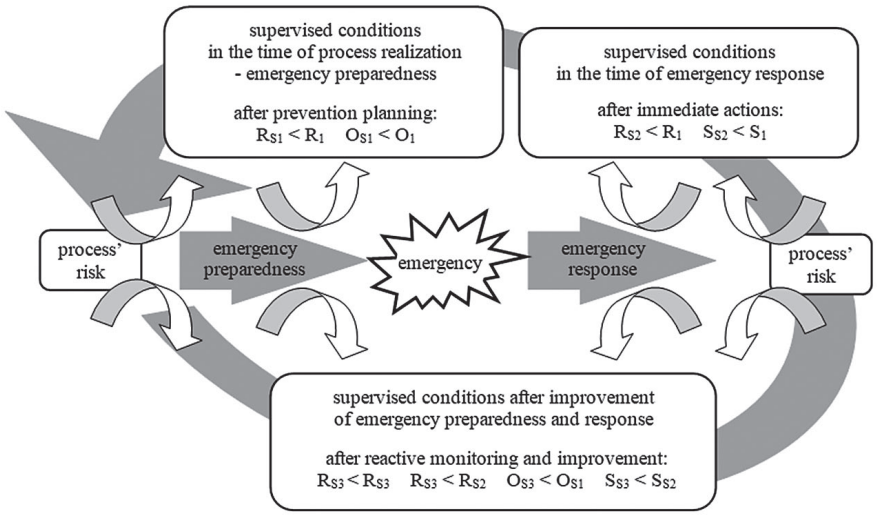

Figure 1 Model of the emergency preparedness and response including scheme of risk minimization.

Table 1 **Summary of the exemplary preventive and response actions.**

Preventive/response instructions	Aim of the instruction	Chosen preventive/response emergency actions
Emergency preparedness		
Using the machines and installations	Characterisation of the safety manner of using the installation in the normal operation	Technological instruction of the continuous casting machine
Monitoring the machines and installations	Identification of the situations connected with obsolescence of the installation and its corrosion	Condition based maintenance of the engines of pulling rollers of the continuous casting machine
Threats' analysis and risk assessment	Regular assessment of the risk of the emergency situations	Identification of potential emergencies, their risk assessment for all of the CSC devices, preparation of the emergencies response plans
Trainings for employees and subcontractors	Identification of the training needs, provision of training and verification of their effects	Trainings concerning the continuous casting process, particularly machine design and operations as well as their connection with cast defect-free products
Operational control	Maintenance of the operational criterions in the supervised conditions	Control of : particulate matter, sulphur dioxide, nitrogen dioxide, carbon monoxide
Emergency response		
Actions after process' discontinuity	Determining ways to restore machine / installation to normal operation	Repairing the ladle crane according to the prepared emergency response plan
Environmental emergency actions	Laying down rules of conduct with environmental influences of the emergency	Reduction of uncontrolled particulate matter emission, with cooperation with environmental emergency plan
Occupational accident actions	Laying down rules of conduct at the time of occupationally dangerous emergencies	Risk reduction, first medical treatment, call of emergency services, with cooperation with designed procedures

integration of the implemented systems. In practice "Operational control" requirement points the duty to plan and realize the operational actions minimizing the risks, which are different in various systems.

Dependently on the operational criteria organizations face a dilemma how to fulfill the integrated requirements on the operational level. Therefore research directed at searching the manners of the effective integration in the range of operational control are necessary.

In the metallurgical industry, in the conditions of the more and more demanding requirements in regard to the quality, environmental and occupational safety, modeling the authorial solutions – to fit around the individual needs of every organization – used in the integration of the management systems seems to be increasingly difficult. The proposed model may be an option of such a solution. It provides the conditions of "the supervised risk" in the emergency situations. Emergency preparedness reflects the preventive actions. After-emergency immediate actions allow the reduction of the emergency influence. Reactive monitoring enables the organization to limit emergency influence both significance and occurrence. Emergency preparedness and response can be, consequently, applied as a the tool for minimizing the risk of both: occurred and potential emergency.

Implementation of the model in the metallurgical processes, including continuous steel casting, can be treated as the own manner of fulfillment of the requirements of "Industry 4.0".

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