Increasing the resilience of economic agents by implementing the intervention and rescue activity

Cosmin Ilie, George Artur Găman, Daniel Pupăzan, Angelica Călămar, Andrei Gireadă

National Institute for Research and Development in Mine Safety and Protection to Explosion – INSEMEX Petroşani, Romania. Corresponding author: C. Ilie, cosmin.ilie@insemex.ro

Abstract. Emergency management is a complex task, involving precise coordination of numerous activities and people, as well as fast decision-making in environments where critical, vital information, might often be missing. Despite all technical and technological progress, most industries record accidents with human casualties and property damage. For this reason the presence of special intervention – rescue teams at economic units is critical, because they can ensure a quick and efficient response to confine/eliminate damages that generate toxic or chemically aggressive environments and rescue personnel caught by surprise by such events. Research conducted so far found that in case of an explosion/fire type event, its first phase management by the economic operator is difficult, because economic units do not dispose of a structure capable of providing a urgent and effective response to such situations. In this circumstance, this paper aims on one hand to highlight, with the help of a case study, the serious consequences that may occur if the response time is delayed, and on the other hand to establish a series of activities (theoretical/practical, endowment, intervention procedures, etc.) that must be covered by economic operators to increase resilience to emergencies in hazardous environments.
Key Words: intervention and rescue, toxic/explosive/flammable environments, crisis, resilience.

Introduction. Crises and conflicts were, are and will be realties that the world has faced, is facing and will face in the future. Hence, the necessity of their anticipation in order to prevent them, but also their understanding in order to act adequately in each case for their coherent and systematic management.

In this regard, a major role rests with the management of crisis situations, both as science and art. In fact, crisis management is the answer that the leadership of organizations, institutions and/or society as a whole must promptly provide when anticipating or even facing a crisis.

Resilience to emergency. Resilience can be described as the ability of a system, community or society exposed to risks, to resist, absorb, to host and to recover from the effects of a hazard in a timely and efficient manner, including through conservation and restoration of its basic essential structures.

Reducing disaster risk is a complex national and international issue, which requires public understanding (Boin & McConnell 2007), scientific knowledge, careful planning, early warning systems, disaster preparedness and effective response mechanisms.

Specific objectives include:

- ensuring a high level of protection against disasters by preventing or reducing their effects and by fostering a culture of prevention;
- preparedness and response optimization for economic agents in case of disaster;
- facilitating fast and effective emergency response to major disasters.

Higher level of employee's, material goods and environment protection (Cutter 2008), would minimize the adverse social, economic and environmental impact of disasters that could affect economic operators and most vulnerable people, thus contributing to more sustainable growth favorable for resilience.

The concepts of resilience must take into account the need to anticipate, plan and implement process of substitution in crisis, in order to act with handy resource materials (Duţu 2013), technical resources, human resources, for assuming continuity of basic functions and services until returning to nominal position.

Moreover, resilience management and reducing vulnerability are closely linked. It is necessary to unite efforts in progress and share risk assessment quota, to map

relevant resilience management approaches, to ensure that risk assessment is followed by development of resilience concepts across different security sectors.

Management of emergency situations caused by failures in toxic/flammable/explosive environments is achieved through preventive, operative intervention and rehabilitation measures, consisting of identifying, documenting and evaluating types of risk and their determinants (Twigg 2009), notifying stakeholders, warning, alarming, evacuation and accommodation of economic operator's employees, limitation, removal or counter-balancing negative effects resulted from risk factors manifestation.

Based on the above, intervention and rescue activities have a particularly important role when unwanted events occur within companies.

Personnel training, application of specific procedures in times of crisis and endowment of economic units with protective respiratory equipment can reduce response time in case of unwanted events.

Intervention and rescue in hazardous environments. Activity in special conditions created as a result of underground or surface damage, threatening staff or property and which, because of gases, vapors or toxic or asphyxiating dusts concentration exceeding, requires the use of respiratory protective equipment is ensured by rescue stations and trained/authorized personnel servicing such stations (Găman et al 2009).

Rescue stations will be serviced by the following staff:

- intervention and rescue personnel (operative rescuers);
- control and coordination personnel;
- rescue station equipment maintenance mechanics.

Direct performer of difficult and dangerous work of rescuing people and protecting industrial objective are the operative rescuers. Success of the rescue operation depends essentially on the course of their intervention, their courage and confidence in the insulation device that protects them (Găman et al 2012).

Rescuers tasks:

- exploring the affected area;
- first aid;
- resuscitate victims;
- giving oxygen;
- evacuating the wounded;
- measuring damage proportion;
- measuring gas content;
- mapping team finds;
- locating and extinguishing fires;
- isolating the burning area;
- pumping water;
- installation of interim supports;
- moving equipment.

Rescue teams are required to:

- work with the insulating device in hazardous environments;
- ensuring individual and collective security in action;
- work with teammates to achieve assigned tasks;
- execute operations under special conditions of visibility, temperature, workspace and communication.

Exploring the damaged area. Is an operation of great responsibility, because drawing up the plan for damage elimination and survivors searching depend on it (Pupăzan et al 2015a). Action in major damage conditions is difficult because it takes place in unknown, full of risks conditions. Rescue teams are threatened by numerous dangers, exploring the area is sometimes conducted under conditions of high temperature in a toxic environment. At this stage, rescuers have many and difficult tasks, because intervention at this stage is full of unknown elements. The unexpected can occur anytime, demanding

greater efforts, concentration, dedication, physical strength, courage and sometimes even self-sacrifice from rescuers.

Actual damage elimination phase. Is conducted based on a plan. In these situations the difficulty of labor is reflected by the volume and weight of equipment, materials or victims to be moved around, sometimes at great distances in narrow space, in conditions of low visibility and high temperatures. In addition, the rescuer is equipped with the insulating device that weighs 14-18 kg, lamp, sometimes a stretcher, sanitary bag, ropes, hoses, blankets, etc., which by their weight and volume increase demands on the body during movement.

Given the danger in the area and environmental conditions (Pupăzan et al 2012), at intervention in damaged are the rescuers are requested (Figure 1):

- self-control in stressful situations and full control of their behavior (to not remove the mouthpiece or face mask in the area, to not panic, to not leave formation, etc.);
- to cope with intense effort through a special adaptive capacity of the body to these requests;
- to be especially handy in performing operations, handling tools, equipment and machinery they work with.

Figure 1. Rescuer's intervention.

All these requirements can be met by:

- proper use of respiratory protective equipment, skill achieved with initial training and reinforced in time, within trainings they carry out at the rescue station;
- fitness training and proper handling of intervention equipment, tools and devices achieved in the production process;
- conducting effort under stress and strict compliance with intervention and execution of various operations procedures.

Rescuer's activity falls under the category of "hard work" in terms of effort, far exceeding the global average work consumption of workers from active working fronts. This hard work character is also given by the fact that the professional effort contains many static components and large amplitude oscillations of maximum efforts deployed. The longer their duration, the heavier work becomes.

Execution of rescue activities is occasional, not permanent (Pupazan et al 2015b), so changing daily habits from basic profession, brings an increase in neuro psychic effort by increasing intellectual strain. The more the situations arising in damage elimination process are furthest from usual work, the grater the neuro psychic effort will be.

In terms of team spirit and need for cooperation, they are more pronounced in rescue activities than under usual conditions, personal interrelations being closer because in case of failure of the insulating device one entrust hid live to others. Principle of rescue team indivisibility in action underlies on the same unforeseen.

Case study

The intervention of mine rescuers from the Central Mine Rescue Station Petrosani at the event occurred at SURDUC NEHOIASU adduction gallery belonging to HIDROCONSTRUCTIA SA, SIRIU BUZAU BRANCH. Surduc Nehoiasu adduction gallery is part of Surduc-Siriu hydro-energetic development project, powering Nehoiasu hydroelectric plant. From the construction point of view, the gallery is circular on the inside and the entire length is protected by a 30-35 cm thick concrete coating.

After the blasting operation performed on 01.11.2009 by the first working shift, a methane ignition occurred in the SURDUC- NEHOIASU adduction gallery that destroyed the ventilation column over a distance of approx. 2 km, surprised and injured five workers, one of which was in bad condition.

In normal working conditions the gallery was ventilated through a partially aspirant ventilation system. Failure led to destruction of the ventilation system, the working remaining unaired on a length of approx. 3100 meters.

Following the event the victims managed to save themselves and reported the failure. Because of the damage occurred in the gallery and high concentrations of gases, for entering the area the intervention of rescuers was required. Thus, expert rescuers from INCD INSEMEX Petrosani were alarmed and an operative team of rescuers was displaced, in order to investigate the damaged area and determine the causes of the event (Figure 2).

Figure 2. Searching the damage area.

Following searching activities it was found that there was no ventilation in the gallery, the ventilation column considerable was partially damaged on a great distance, the electrical power plant serving the mechanical equipment was destroyed and there were accumulations of over 2% methane on a distance of approximately 1800 meters.

The working didn't fall under the category of gassy mine because the measurements made during digging didn't show relative flow rates of methane and other explosive gases that would lead to framing the working under special conditions. All installations found in the gallery and also blasting operations were performed using low-quality equipment and explosives, and the electrical power plant serving the machinery wasn't Ex made.

Electricity supply for the installations in the gallery was cut off and the partially ventilation system was disconnected

The conclusion drawn by the search team was that entering the gallery wasn't possible without restoring the partially ventilation system because otherwise the rescuer's safety was endangered.

Because the economic operator didn't have a trained and authorized intervention and rescue operative team, able to intervene in the damaged area, help had to be

requested from mine rescuers within PETROSANI-SALVAMIN CENTRAL MINE RESCUE STATION in order to restore normal work conditions in the area.

Following this request, rescue team of nine rescuers was moved on the spot, in order to search the area and perform activities to remedy the damage. A briefing referring to the event was conducted, both dynamic and thermal effects identified by the first expertise team being presented.

Two teams of mine rescuers were organized, namely: a search team, made up of four mine rescuers who entered the gallery to conduct a thorough check in order to establish a contingency plan and a mine rescue team (Figure 3) consisting of 5 mine rescuers prepared to intervene in any moment.

Figure 3. Rescuer's intervention.

The search team, under the protection of closed circuit insulating devices based on compressed oxygen, entered the culvert gallery for preliminary inspection conducted step by step, analyzing in detail all elements on the movement route.

Dynamic effects were noted - the axial fan and ventilation duct metal column, partially torn and fallen on the gallery hearth, damaged wiring, CH_4 concentrations of 2-5% and support elements presenting thermal effects.

Rescuers were withdrawn to surface to inform headquarters and prepare a several phases intervention plan to restore ventilation in the culvert gallery. The following steps were concluded:

- restoration of partial ventilation column up to quota 1000 + 800 meters, where the axial fan was installed;
- total revision of the electrical installation;
- starting the forced draught centrifugal fans installed at surface and conducting a new control of the damaged area checking for gas concentrations evolution;

Rescuers intervention (Figure 4) continued with recovery of the partial ventilation column to the working face. Thus, rescue teams consisting of 8-9 mine rescuers, intervened performing the following main activities:

- installation of an VEP 1500 axial fan at elevation1800 meters of the ventilation column;
- restoring ventilation column over a distance of approx. 1200 meters, by repositioning tubes in the column and replacing the twisted, flattened, deformed ones that no longer met requirements;
- installation of two VEP 1500 fans in the column at elevation 2500 m, respectively at approx. 50 meters from the coal face.

All these actions were carried out under the protection of insulating breathing apparatus. The operations were conducted over a period of 20 days in continuous operation, requiring a great effort from rescue teams.

Figure 4. Rescuer's intervention.

This case study highlights several aspects:

- lack of rescue teams within the economic unit didn't allow for allowed fast intervention to evacuate people caught in the event;
- intervention of specialized teams was made with some delay (influenced by the great distance to the place of the event), they intervening only to refit the working place in question;
- first intervention team's search action was hampered due to lack of specialized personnel (belonging to the entity where the damage took place) to accompany the research team explaining technical details of entire galleries (arching, ventilation, electrical installation, sumps, etc.).

Conclusions. Lack of specialized teams within the economic agents for intervention in the event of breakdowns, accidents, disasters, etc., leads to incapacity of having a quick response to such events with adverse consequences for personnel and property.

In each economic agent, intervention and rescue activities are customized according to specific damage types and work carried out (staff management, endowment with rescue equipment, work and intervention procedures).

Implementation of intervention and rescue activities in the economic agents leads to:

- increasing the resilience of economic agents, by enhancing intervention abilities in safety conditions in case of emergencies, accidents, disasters;
- individual and collective work accident prevention, events that bring dramatic consequences and adverse consequences on the patrimony.

References

Boin A., McConnell A., 2007, Preparing for Critical Infrastructure Breakdowns: The Limits of Crisis Management and the Need for Resilience, Journal of Contingencies and Crisis Management Volume 15, Number 1.

Cutter S. L., 2008, A place based model for understanding community resilience to natural disasters, Global Environmental Change.

Duţu P., 2013, Crisis management and prevention of armed conflicts, UNAP Carol I Publishing House.

Găman G.A., Lupu C., Pupazan D., 2009, Proceduri şi regulamente ale formaţiilor de intervenţie şi explorare în medii toxice / explozive / inflamabile, Editura INSEMEX.

Găman G.A., Pupăzan D., Ilie C., 2012, Development and implementation of an expert system for the management of crisis events in mining industry, Environmental Engineering and Management Journal, Vol.11, No. 7.

Pupăzan D., Găman G.A., Ilie C., 2012, Information system for simulation and assessment of rescuers interventions in toxic, explosive and flammable environments, Environmental Engineering and Management Journal, Vol.11, No. 7.
Pupăzan D., Găman G.A., Călămar A., Ilie C., 2015a, National regulations regarding intervention and rescue in toxic/ flammable/ explosive environments, Balkanmine.
Pupăzan D., Călămar A., Găman G. A., 2015b, Importance of mine rescuers vocational guidance and selection process, Ecology, Economics, Education And Legislation, VOL III Book Series: International Multidisciplinary Scientific GeoConference-SGEM.
Twigg J., 2009, Characteristics of a Disaster - Resilient Community - A guidance note, Version 2.

Received: 24 September 2016. Accepted: 27October 2016. Published online: 30 October 2016.
Authors:
Cosmin Ilie, INCD INSEMEX Petroşani, G-ral Vasile Milea street, no. 32-34, Petrosani, Hunedoara, Romania, e-mail: cosmin.ilie@insemex.ro
George Artur Găman, INCD INSEMEX Petroşani, G-ral Vasile Milea street, no. 32-34, Petrosani, Hunedoara, Romania, e-mail: artur.gaman@insemex.ro
Daniel Pupăzan, INCD INSEMEX Petroşani, G-ral Vasile Milea street, no. 32-34, Petrosani, Hunedoara, Romania, e-mail: daniel.pupazan@insemex.ro
Angelica Călămar, INCD INSEMEX Petroşani, G-ral Vasile Milea street, no. 32-34, Petrosani, Hunedoara, Romania, e-mail: angela.calamar@insemex.ro
Andrei Gireadă, INCD INSEMEX Petroşani, G-ral Vasile Milea street, no. 32-34, Petrosani, Hunedoara, Romania, e-mail: andrei.gireada@insemex.ro

How to cite this article:
Ilie C., Găman G. A., Călămar A., Gireadă A., 2016 Increasing the resilience of economic agents by implementing the intervention and rescue activity. Ecoterra 13(3):26-32.