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ANALYSIS OF FACTORS INFLUENCING PROFESSIONAL SELECTION OF RESCUERS

BY

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National Institute for Research and Development in Mine Safety and Protection to Explosion – INSEMEX Petroşani

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Abstract: The large variety of efforts in the activity of rescue involves very difficult strains in terms of nature or intensity, but however limited they might be in the work process, they affect the whole body. The predominance of body functions engaged in a type of professional activity imparts the characteristics of work capacity. Thus, in the work capacity of underground personnel, whose activity requires predominantly physical effort, the locomotor apparatus and the kinesthetic analyzer have a leading role, and the visual and optical analyzers only have secondary role.

In the professional activity of rescuers, physical and neuro-psychic strains intertwine and combine in an infinite number of variants. The paper will present an analysis of factors that determine the working capacity of rescuers (respectively physiological factors, psychological factors, labor and socio-economic factors), because only objective knowledge of individual factors and professional demands and the compliance between them can lead to avoiding negative consequences on the individual, social relations and occupational safety.

Keywords: intervention and rescue personnel; work capacity; physical effort; physiological factors; psychological factors.

1. Introduction

In view of the high variability of individual skills in terms of job performance, work capacity should be understood as the total of individual capabilities to perform a maximum amount of work.

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Typically, only part of the work capacity, materialized in production achieved during work process, is spent in the professional activity.

Total work capacity also includes an important backup that is only used in extreme cases. Work capacity can be defined as the performance that man can achieve with maximum possibilities. Performance is the activity performed in the time unit and it can be physical or intellectual.

Knowing the variation limits in performance and the possibilities for assessing them represent one of the most important issues in rescue activity.

Knowledge of work capacity represents one of the main factors for organizing the activity of rescuers and by knowing the factors that determine work capacity, appropriate measures can be taken to prevent the body from overstressing by adapting the body to conditions specific to emergencies, during training.

2. Physiological Factors that Influence Work Capacity

• Health

For a healthy man, functional capacity of the body and systems involved in the work activity remain at a high level under the influence of daily performance.

Acute diseases, causing transient disturbances, may affect the work capacity to its complete annihilation; instead, chronic diseases, may, in some cases, cause a lower functional level and consequently reduced work capacity.

If we refer to characteristics required to successfully perform rescue activities, evaluated by practitioners themselves, then, according to the results of a study carried out at NRDI INSEMEX Petroşani, the situation is shown in Table 1, which presents the positions of each quality, as prioritized by research subjects (grouped in three training sessions). The questionnaire stated that 1 is the most important quality and 10 is the least important quality.

Table 1
Rank of the Qualities for Rescuers

Training session \ Characteristic	High qualification	Experience	Health	Emotional balance	Capacity to overcome dangers	Occupational interests	Social cooperation	Responsibility	Openness to tasks	Courage
A1	9	6	1	4	7	10	8	2	3	5
A2	9	7	1	3	6	8	10	2	4	5
A3	9	7	2	6	4	8	10	1	4	3

Therefore, analysis of data presented in Table 1 shows that health is considered to be the most important attribute for rescuers, followed by responsibility (having the rank of 1-2 depending on the training series).

• Type of food

When an individual performs work that requires higher energy consumption, it is absolutely necessary to equivalently increase the food ration value. Differentiated influence of nutritional principles on health and on body performance under special work conditions, such as those in which rescuers often carry out their work (high temperature, high humidity, strong air currents) was demonstrated. When measuring work capacity, in addition to physical development of the individual, also the functional structure of its body intervenes.

• Exercise and training

Following the application of the Fleishman Job Analysis Survey (FJAS) for the work analysis of intervention and rescue activities in toxic / flammable / explosive environments, it was found that the required level for the 9 physical skills that were evaluated was high, as shown in Fig. 1, meaning that their medium-high development is important for work performance. The recruitment and selection process must consider, among other things, the assessment of development level for these skills.

In the set of evaluated skills, besides physical skills, psychomotor skills (respectively reaction time) also require the highest degree of development for successfully carrying out the intervention and rescue activity in toxic/ flammable/explosive environments. Thus, the two skill classes achieved an average of 5.4 and 5.6 on a scale of seven stages of development.

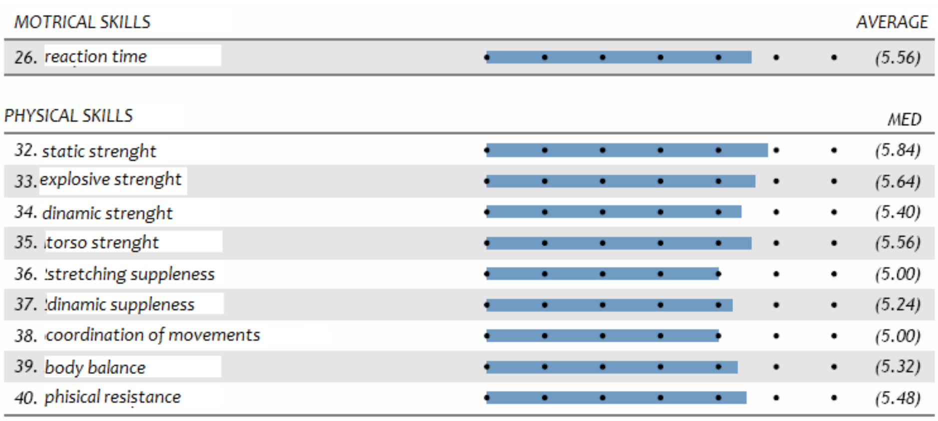

Fig. 1 – Level of physical skills assessed using FJAS.

Exercise and training represent factors of maintenance and enhancement of physical skills and work capacity, repetition of certain work and systematic exercise causing adaptation changes in the body. Only increased effort strains can strengthen work capacity at a high level and make it a habit for the body.

Training for professional activities predominantly based on physical effort includes an increase in muscle strength, better neuro-muscular coordination, which reduces energy consumption; a more effective cardiovascular activity, which provides a better supply of oxygen; a more efficient thermolysis, pulmonary ventilation allowing adequate respiration. The final result of muscle training varies by type of work performed, degree of repetition, speed, duration and intensity of activity performing apparatus.

Training also contributes to improved static and dynamic activity, progressively eliminating interference of muscles less interested in performing a specific motor act. It also contributes to better relaxation of antagonist muscles. When training is performed at a moderate activity level, it can be interrupted for several days (7-10 days), with no decreased of work capacity. On the contrary, when training refers to an activity accompanied by heavy muscular effort, its disruption over 4-6 days is followed by a decrease in performance.

Duration of stable, high level work capacity is dependent on the type of work and worker's psychological state. This can be longer for moderate intensity work and shorter for work accompanied by a high tension of organic systems. Whatever type of work is, sooner or later, the period of decreased work capacity appears reflected in lower productivity, caused by the occurrence of fatigue. This state should not be considered the result of depletion of functional potential, but primarily as a consequence of nervous control disorders, of various physiological processes caused by work and work environment.

Knowledge of work capacity in different periods of life has health, economic and social importance. In social and economic terms, two issues are of particular importance:

a) knowledge of the human body burden potential in young ages;

b) knowledge of work capacity at advanced ages.

Research on physical development showed that some parameters (vital capacity, chest perimeter) reach maximum development at the age of 18. By that age the heart volume keeps increasing, heart weight recording the largest increase between 17 and 18 years old. Because of these discrepancies in the development of the circulatory system and of other systems, it is understood that by the age of 20 years, heart and overall human body has a hard time adapting to considerable strains.

A well known fact is that maximum development of work capacity is reached at the age of 25 to 30 years, and men labour economics increases with age.

Consequently, it can be concluded that exercise and training improve performance in effort for cardiovascular system and increases maximum aerobic power ($V\ O_{2\ max}$) for a given level of effort, leading to increased oxygen extraction at muscular level, increased volume of systolic ejection and to reduced blood pressure and heart rate.

So, the well trained rescuer has a more significant cardiovascular reserve when he is exposed to heat.

3. Psychological Factors

Work skills are personality qualities which determine successful implementation of certain forms of activity. They include a highly developed sense of observation, the ability to accurately assess proportions of objects, to visually establish correlations of dimensions, especially for certain professions.

Success in fulfilling any activity depends on interfusion of general and special skills. Psychological characteristics, such as sense of observation, memory or intelligence are applicable in a broad framework of activities. In addition to these general skills, special skills are also required, such as managerial skills, pedagogical tact, etc. especially for those in leadership positions. Individual skills make sense only when related to actual types of activity. They depend on the nature of activities, the socio-economic importance and requirements for such activity.

Technical progress has imposed and developed new skills and previous ones have taken on new content. Labour specialization and division leads to specialization of human skills. An increased work capacity can be provided by systematically cultivating people skills.

Cognitive skills refer either to intelligence, as general cognitive ability or to specific cognitive skills such as memory, attention or concentration. For the professional activity of rescuers, cognitive skills that have the most important role for successful interventions are shown in Fig. 2.

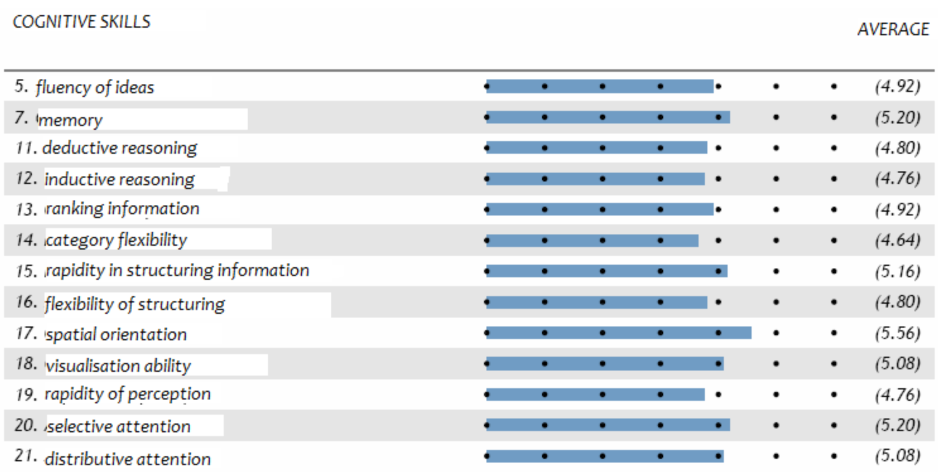

Fig. 2 – Level of cognitive skills assessed using FJAS.

Following the application of the Fleishman Job Analysis Survey (FJAS) for the work analysis of intervention and rescue activities in toxic/flammable/

explosive environments, it was found that the required level for the 13 cognitive skills that were evaluated was high, as shown in Fig. 2, meaning that their medium-high development is important for work performance. The recruitment and selection process must consider, among other things, the assessment of development level for these skills.

Interest or motivations are most often - especially in the current economic situation of our country - a powerful stimulant to acquire new knowledge or new skills. Interest intensity manifests in the persistence of human in a range of activities.

Psychology has shown that interest facients are very varied in relation to social and economic aspects of work management: promotion opportunities, secure job and opportunity to perform useful work, to perfect profession, to surpass oneself, to face risk and be well paid.

Order of motivation factors preference denotes a very high professional level, but often the essential motivation is high remuneration followed by social consciousness motivations.

The results of a study carried out within NRDI INSEMEX Petrosani revealed that the motivating factors in the rescue activity, for subjects of the study, are as shown in Table 2.

Table 2
Motivating Factors in Rescue

No.	Importance, [%] / Motivating factors	Very	Important	Medium	Low	No importance at all
1	**Material rewards**	62.96	25.93	–	3.7	3.7
2	**High prestige**	18.52	59.26	11.11	3.7	3.7
3	**Ensuring work safety**	29.63	37.09	–	18.57	11.11
4	Eliminating damage, helping injured	29.63	25.93	–	29.63	3.7
5	Preferment	14.81	3.7	25.53	18.52	33.33
6	Risk enjoyment	14.81	14.81	11.11	25.92	18.52
7	Enjoyment to achieve great deeds	7.41	14.82	22.28	18.52	18.52
8	Need to be seen	3.7	11.11	22.22	29.63	29.63
9	Need for competition	14.81	3.7	22.22	33.33	25.92

The presence in humans of strong convictions, well-defined conceptions of life represents the fundamental condition to overcome difficulties related to the act of will. Man, having clear principles of conduct and conviction of their correctness, can quickly decide on how to properly act, not hesitating to carry out the actions they have to perform. That is why cultural and professional training, commitment to profession and financial perspective, become stimuli in the act of will, thus promoting working capacity.

4. Work Environment and Social Economic Factors

Work is the main factor of human body's strain. Appropriate work management, avoiding idle hours and stray movements, using appropriate tools and less strenuous work positions as well as judicious use of pauses, maintain work capacity at high levels.

Work conditions, expressed as the ratio of actual working hours and breaks, represents a parameter to characterize industrial work. For hard work, such a rescue activities, this ratio is known and can reach 1:1 or higher, and for light activities the ratio is 11:1. Exaggerations of these parameters imply either a deficiency of work management or an exaggerated strain on the body caused by work and microclimate condition in the area.

Maintaining and increasing the body's functional possibilities are also conditioned by breaks during work. Alternating effort and rest should be regarded as a criterion of maintaining and promoting work capacity. A proper break after a cycle of activities has great efficiency in restoring work capacity. For cyclic activities, strengthening acquired functional changes occurs only if the new work cycle is performed prior to the collapse caused by previous activity. If repeating a cycle occurs when the impression left after previous effort is cleared completely, than work capacity isn't strengthened, contrarily it weakens.

Besides breaks during work (which are integrated into productive activity and represent opportunities to pause for workers, when functional capacity of the body is restored), work activity can often be interrupted by unwanted breaks, independent of worker. These breaks can be caused by shortfalls in work management, emergence of unexpected events or failure of machinery or equipment used during work.

Most often, they are not an occasion for rest, on the contrary, interrupting the chain of labour conditioned reflexes they appear as foreign pathogens accompanied by inadequate overreacting, disturbing the achieved dynamic stereotype, negatively influencing work capacity.

Work environment conditions have a particularly important influence on work capacity. Unfavourable microclimate conditions, inadequate lighting, intense noise and vibrations, elevated levels of toxic and explosive substances, dusts as well as permanent hazards of work environment threatening the safety of rescuers in action, represent limiting factors for work capacity.

The presence of these pollutants in the working environment, wearing protective breathing equipment as well as stress cause overloading of physiological functions leading to a competition of functional adaptation requests during labour thus diminishing work capacity.

An important aspect of professional selection is finding risk and protection factors associated with developing and maintaining emotional and behavioral problems. In this respect, in the selection process a particular role is played by personality assessment, both in terms of main personality traits that influence many types of behaviors as well as particular aspects, such as cognitive and behavioral coping with potentially stressful situations. There are coping strategies that are associated more frequently with both psychopathological and emotional distress.

The results attained by applying Strategic approach to coping scale - SACS and CERQ - Cognitive Emotion Regulation Questionnaire instruments on a total of 38, respectively 70 individuals indicate that intervention and rescue personnel trained within NRDI INSEMEX uses both adaptive strategies and strategies whose use is associated with emotional problems and even psychopathology. On one hand being aware that they use a strategy or another (with benefits and drawbacks involved) and, on the other hand psychological training interventions and personal development can help individuals learn the use of adaptive strategies to the detriment of those associated with emotional distress.

Socio-cultural conditions: professional and cultural levels have a decisive action on labour productivity, maintenance and facilitation of work capacity. By carrying out work in an organized manner, at well-established intervals of time, outside office hours people boast potential energy and an important leisure time. The way one uses this time has decisive influence on work capacity. A study carried out by Vaida and Pafnate shows that the level of professional training and use of free time outside working hours have a considerable influence on work capacity.

Potential work capacity is conditioned by work capacity reserves and some psychological moments, among which the volitional factor and availability to work have a leading role. These factors depend on the overall tone of the body, complexly determined by the central nervous, neuro-vegetative and hormonal systems as well as by social conscience of the individual. Availability to work varies based on fullness in terms of physical and intellectual forces; pathologies usually are accompanied by a decrease in availability to work.

The feeling of psychological-physical fullness largely depends on a number of external factors to which adds inner life relationships. Thus, professional, moral or material success can increase the availability of work capacity. Individual sensitivity to such influences varies from person to person and it is difficult to assess.

The study of professional pathology is of highest importance in assessing working conditions. Knowledge of professional pathology provides a solid foundation in establishing effective measures of prevention and worker recruitment, especially for mine rescuers whose activities are conducted under extremely heavy conditions and require great physical and mental effort.

5. Conclusions

Knowledge of work capacity is one of the basic factors for organizing the activity of rescuers and, by knowing the factors that determine work capacity, appropriate measures can be taken to prevent the body from overstressing by adapting the body to conditions specific to emergencies during training.

Health, as a factor that determines work capacity, is appraised by practitioners themselves as the most important attribute for a rescuer, followed by responsibility.

The physical effort performed by rescuers is intense because of the special and difficult conditions in which their work takes place. Exercise and training are factors for maintaining and enhancing physical skills, such as static strength, explosive strength, coordination of movements, etc., skills that require a high degree of development for the successfully performing intervention and rescue activities in toxic/flammable/explosive environments. Exercise and training improve performance in effort for the cardiovascular system and enhance the maximum aerobic power (V O_2 max) for a given effort level, resulting in increased oxygen extraction at muscular level, increased volume of systolic ejection and in reduced heart rate and blood pressure. Therefore the well trained rescuer has a more significant cardiovascular reserve when exposed to heat.

The success of any activity depends on the combination of general and special skills. For the professional activity of rescuers, cognitive skills that play the most important role for successful interventions are fluency of ideas, memory, deductive and inductive reasoning, ranking information, flexibility of structuring, speed of information structuring, structural flexibility, spatial orientation, visualization, rapidity of perception selective and distributive attention.

While working with the insulating device, there are a number of factors that make work stressful. Basically, those who work under the protection of insulating apparatus, besides carrying respiratory protection devices, are also subjected to great difficulty, in terms of securing their own safety, rescuing human lives, working under difficult microclimate conditions (high heat and humidity), toxic environment, smoke, urgent and highly skilled works (sealing damaged areas, work in water, transport of materials or injured people through low profile workings, etc.). Intervention and rescue personnel trained within INCD INSEMEX use both adaptive strategies and strategies whose use is associated with emotional problems and even psychopathology. On one hand, awareness of using one strategy or another and, on the other hand, psychological training and personal development can help individuals learn the use of adaptive strategies to the detriment of those associated with emotional distress.

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ANALIZA FACTORILOR CE INFLUENȚEAZĂ SELECȚIA PROFESIONALĂ A SALVATORILOR

(Rezumat)

Variația mare a eforturilor în activitatea de salvare comportă solicitări foarte dificile ca natură sau intensitate, însă oricât de limitate ar fi acestea în procesul de muncă, ele se repercutează asupra întregului organism. Predominanța funcțiilor

organismului angajat într-un gen de activitate profesională imprimă caracteristicile capacităţii de muncă. Astfel, în capacitatea de muncă a personalului din subteran, a cărui activitate necesită un efort fizic predominant, un rol principal îl au aparatul locomotor şi analizorul kinestezic şi numai în mod secundar - analizorul vizual şi cel optic.

În activitatea profesională a salvatorilor, solicitările fizice şi neuro-psihice se întrepătrund şi se combină într-un număr infinit de variante. Lucrarea va prezenta o analiză a factorilor care determină capacitatea de muncă a salvatorilor (respectiv factori fiziologici, factori psihologici, factori ai mediului de muncă şi social-economici), deoarece numai cunoaşterea obiectivă a factorilor individuali şi a solicitărilor profesionale şi realizarea unui acord între aceştia poate conduce la evitarea unor consecințe negative asupra individului, relațiilor sociale şi securităţii muncii.

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QUALITATIVE ANALYSIS OF EVACUATION IN EMERGENCY SITUATIONS (II)

BY

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Abstract: Fire safety regulations in Romania are currently based on prescriptive regulations, which have to be respected by the decision-makers in the design, execution and operation of buildings. This paper deals with ensuring the best conditions for evacuating users form a burning building. It is therefore proposed to analyze the adopted technical solutions, using performance indicators, as a complementary measure of compliance with prescriptive regulations.

In the present social context, the decision makers focus on ensuring the minimum fire safety measures provided by the current prescriptive regulations, in order to obtain the fire safety authorization. However, there are situations in which the compliance with the norms in force is not sufficient and a qualitative analysis of the adopted technical solutions is necessary.

On the basis of a simulation in a specialized software and some proposed performance indicators, the analysis of a space that complies with prescriptive rules is performed. Subsequently, proposals are made to optimize the chosen solutions.

Keywords: evacuation; egress time; prescriptive regulations; KPIs (key performance indicators); simulation; mathematical model.

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1. Introduction

As a complementary measure for the technical aspects specified in chapter 3.4 of the fire safety scenario, in order to establish the efficiency of the adopted solution, it is necessary to make a performance based evaluation.

The evacuation process can be analyzed by overlapping mathematical modeling the pedestrian movement during egress with heat, smoke and toxic gases propagation. This is done on the basis of proposed fire scenarios (what materials burn and in what quantity) and the evolution of the factors that can endanger the life of the users (temperature, visibility, concentration of dangerous gases, etc.).

Below there is a simple model and analysis of the constructive solution regarding evacuation.

2. Case Study - Analysis of the Egress Process by Mathematical Modeling and Performance Indicators for a Space that Complies with Prescriptive Regulations

The model to be analyzed is a bar/club on the ground floor, second degree of fire resistance (level of fire stability) with the dimensions 16 m × 13.5 m (the evacuation time is 53 seconds – 21 meters, according to the Fire Safety Buildings Regulations, P118-99). Evacuation for the 200 users is made through a door with the dimensions of 1.6 m × 2.1 m – 3 evacuation streams (2.85 streams, from calculations). Under these conditions the prescriptive regulations of P118-99 are met.

The travel speed is considered to be 1.2 m/s.

Fire scenario: due to the violation of fire protection measures in using pyrotechnics in closed space, the phonic insulation on one of the pillars near the scene took fire. The simulated fire has HRRPUA = 500 kW/m^2 (heat release rate per unit area).

Since the space is not partitioned, it is assumed that the moment the egress begins coincides with the fire start time (detection time, alarm time, recognition time and response time = 0) – users begin evacuation as soon as they notice the fire – the ideal situation.

Simulations were made in the Pathfinder and PyroSim – FDS (Thunderhead Engineering Consultants Inc), verified software, and their mathematical code accepted by the international community.

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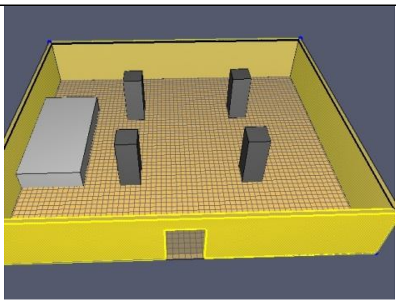
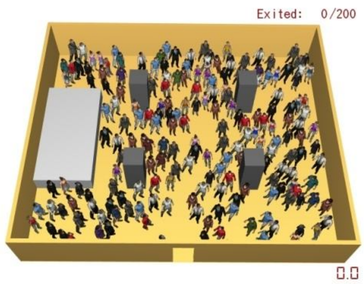
<tr><td></td><td>
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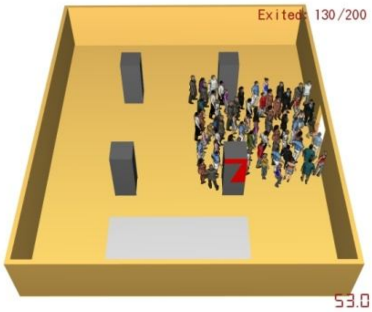
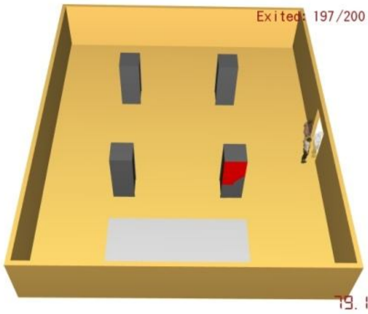
<tr><td>
</td><td>
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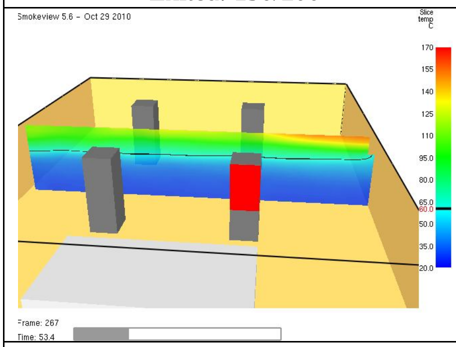
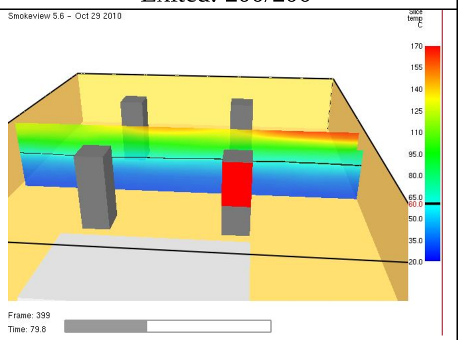
<tr><td>
</td><td>
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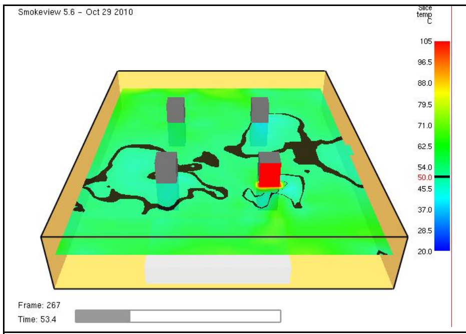
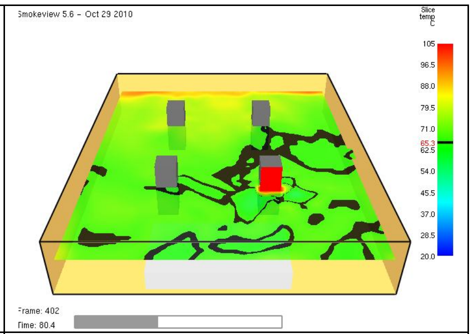
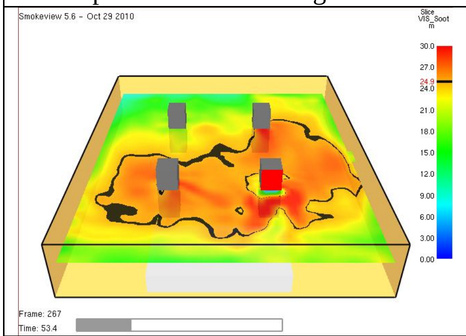
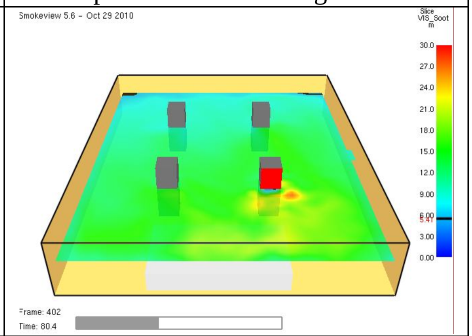
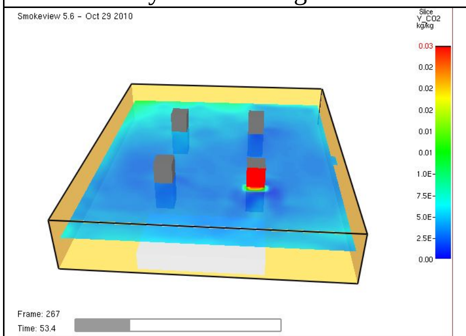
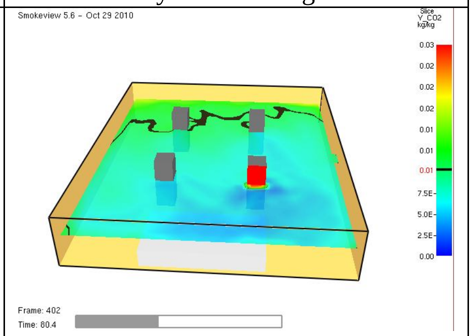
	
time: 53” Temperature at 1.7 m height = 50ºC	time: 80” Temperature at 1.7 m height = 65ºC
	
time: 53” Visibility at 1.7 m height = 25 m	time: 80” Visibility at 1.7 m height = 5 m
	
time: 53” CO_2 concentration	time: 80” CO_2 concentration

Proposed performance indicators:

Conditions to be observed to ensure a safe evacuation:

$$\text{ASET} > \text{RSET}, \tag{1}$$

where: RSET – required safety egress time – calculated time required between ignition to detection and the time at which the evacuation is completed; ASET – available safety egress time – calculated time available between ignition of a fire and the time at which tenability criteria are exceeded in a specific space in a building; ASET – min (T_{temp}, $T_{visibility}$, T_{CO2}); T_{temp} – the time interval between the moment of the fire ignition and the moment the temperature affects the users (maximum 50°C); $T_{visibility}$ – the time interval between the moment of the fire ignition and the moment the exit door is visible to the most disadvantaged user (the last one in the congestion zone). It is measured the distance from the most disadvantaged pedestrian and compared with the visibility (in meters); T_{CO2} – the time interval between the moment of the fire ignition and the moment the toxic gases concentration is hazardous for the occupants (*e.g.*: 0.03 kg CO2 / kg air have the following symptoms appear: mild intoxication, increased breathing frequency and pulse, nausea). Analysis can be performed for different dangerous gases.

$$N_{evac} = \text{min. } 1, \tag{2}$$

where: N_{evac} is the number of escape routes that meet the condition (1).

Indicators are not limiting.

Performance indicators analysis:

RSET = 80”

T_{temp} = 60”;

$T_{vizibility} = \infty$; The visibility at the exit door is very low at 145 ", but until then all users are evacuated;

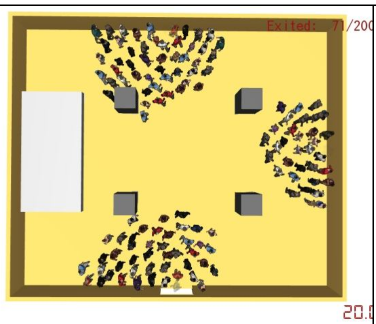
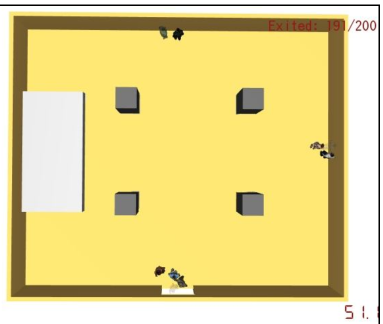
T_{CO2} = 200” (0.03 kg CO_2/kg air). Until this moment all users were evacuated.

$$ASET < RSET$$

N_{evac} = 0;

The analysis shows that the constructive solution must be modified or measures should be taken to prevent the temperature rise (e.g. hot gas and smoke exhaust systems, fire suppression systems).

If the 1.6 m × 2.1 m exit door (3 evacuation streams) is divided in 3 smaller doors (0.8 m × 2.1 m) – 1 evacuation stream for each one, the travel time drops down to 53 s. Thus, condition (1) is met.

	
time: 20” Exited: 71/200	time: 51” Exited: 191/200

3. Conclusions

It is possible to establish the time during which all users are evacuated and the time when the conditions are life-threatening. Thus, for some unfavorable fire scenarios, the fire safety engineer may adapt or modify the escape routes so the established performance indicators are met.

In each scenario, it is necessary to consider what materials can burn and how they are placed. These aspects influence how the fire spreads, and implicitly affects the performance indicators set for evacuation assessment.

Even though the prescriptive regulation are met in both situations, applying this method of analysis can determine the optimal constructive solution.

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ANALIZA CALITATIVĂ A EVACUĂRII ÎN SITUAȚII DE URGENȚĂ (II)

(Rezumat)

Reglementările pe domeniul securității la incendiu în România sunt în acest moment bazate pe norme prescriptive, pe care factorii decidenți în proiectarea, executarea şi exploatarea clădirilor sunt obligați să le respecte. Acest articol tratează asigurarea condițiilor de evacuare a utilizatorilor din construcții. Se propune astfel analizarea soluțiilor tehnice adoptatea, pe baza unor indicatori de performanță, ca şi măsură complementară a respectării normelor prescriptive.

În prezentul context social, factorii decidenți se focusează pe asigurarea măsurile minimale de securitate la incendiu prevăzute în actualele norme prescriptive, aceasta pentru obținerea autorizației de securitate la incendiu. Însă există situații în care respectarea normativelor în vigoare nu este suficientă, fiind necesară o analiză calitativă a soluțiilor tehnice adoptate.

Pe baza unei simulări într-un soft de specialitate şi a unor indicatori de performanță propuşi, se face analiza unui spațiu ce respectă normele prescriptive privind evacuarea. Ulterior se fac propuneri pentru optimizarea soluțiilor alese.

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IMPROVING OHS PERFORMANCE BY AN EFFECTIVE MANAGEMENT OF PSYCHOSOCIAL RISKS

BY

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Abstract: Employees’ exposure to psychosocial risks represents one of the most important characteristics of present world of work. European Foundation for the Improvement of Living and Working Conditions series of surveys showed about a quarter of European workers exposed to work stress. According to the EU Labour Force Survey on health and safety at work, approximately 28% of the persons with a work-related health problem experienced stress as the main health problem. This implies that stress was the second most frequently reported main work related health problem after musculoskeletal health problems. In this context, the awareness of all stakeholders involved in ensuring safety, health and wellbeing at work on psychosocial risk factors and their effects on both employees’ health and organisational productivity represents an important objective, subsuming to more extensive objectives of Europe 2020 Strategy.

Keywords: occupational health and safety; new and emerging risks; OHS management; psychosocial risks; wellbeing at work.

1. Introduction

Nowadays the strategic objective of the European Union laid down by the European Council is the development of a *competitive and dynamic*

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economy based on knowledge, which is able to support a continuous economic growth together with an increased number and quality of work places and to provide cohesion and social inclusion. One of the objectives subordinated to such strategic aim is the *"improvement of quality and work productivity"*. (European Commission, 2008)

The European Commission has set *ten dimensions of the "work quality" concept*, whose development is a condition for ensuring the above mentioned strategic aim and represents a multidimensional concept related to both work and market characteristics in general, namely:

1. Development of professional skills to meet the requirements of the present society;
2. Continuous study and development of competencies;
3. Gender equality;
4. Safety and health at work;
5. Flexibility and security;
6. Inclusion and access on the labour market;
7. Work organization and balance between professional and extraprofessional life;
8. Social dialogue and workers' involvement;
9. Diversity and lack of discrimination;
10. High performance at work.

Improving work quality and productivity represents an important requirement that ensures economic performance and productivity as one of the most important and most tackled aspects of the European Union policy in the area of social and employment issues (European Commission, 2004).

An adverse policy in the safety and health at work area can result in absenteeism, work accidents and occupational diseases and can develop into permanent work disability. Consequently, it can lead to unwanted effects on people and major negative impact on economy.

The economic costs of safety and health at work related issues stop the economic growth and affect business competitiveness in EU, representing a burden for the social security systems and public finance.

How work is organized at present together with safety and health at work, the way in which safety and health management is part of the whole organization management can play a major role in supporting such objective by providing the well-being at work that increases to a maximum the individuals' work capacity and prevents early retirement from the labour market. Moreover, it should be noticed the contribution that good health at work has on the general heath state. The work place is the environment allowing implementation of preventive measures and activities that promote occupational safety and health.

The continuously changing demands in the world of work and work places, as well as the rapid dynamic and stimulating pace create new psychosocial risks that can increase the level of occupational stress.

There is strong scientific evidence on workers' exposure to psychosocial risks as one of the most important characteristics of the work environment in relation to health. The series of surveys on working conditions in the European Union, carried out by the European Foundation for the Improvement of Living and Working Conditions, demonstrated that there is a trend of work environment psychosocial deterioration, mainly driven by the demands of increased workload, intense pace of work, high emotional demands, lack of autonomy, ethical conflicts, unbalanced work – extraprofessional life and lack of job security (Eurofound, 2012).

Even the European Parliament has highlighted the professional stress as a major obstacle to productivity in Europe and accused the psychosocial climate in organizations as an important determiner of productivity issues, quality and even accidents at work (European Parliament, 2011).

In such circumstances, appropriate strategy and policies are needed at national level, as well as competent decisions to adapt/complete legislation of safety and health at work, enabling enterprises/companies to implement measures that reduce/eliminate psychosocial occupational risks and protect their personnel against such action. The approach involves the integration of Professional Stress Management in the general Safety and Health at Work Management of the organization and requires the existence of a national policy and an appropriate legal framework.

In Romania the issues of actual management of psychosocial risks and occupational stress are not very well known and dealt with in the safety and health at work management at the enterprise level.

The Institutes in the area (such as I.N.C.D.P.M. „Alexandru Darabont", Institute of Public Health etc.), as well as a number of specialists have studied the issue of psychosocial risks as occupational risks and work stress as part of the objectives of research – development - innovation. Lack of regulation in the area, insufficient training of managers and employees in knowing, identifying and managing the psychosocial risks resulted in a scarce and defective control of such risks.

2. Objectives

The Ergonomics Laboratory of The National Research and Development Institute for Occupational Safety and Health "Alexandru Darabont" Bucharest developed the project "Study on development of safety and health requirements to prevent workers from exposure to psychosocial risks" within the first specific Objective: "Continuous improvement of safety and health at work level" in the SECTORIAL PLAN OF RESEARCH AND DEVELOPMENT of the Ministry of Labor, Family and Equal Opportunities 2009 - 2012 (which included five programs of which the fifth, had as its object the promotion of Safety and Health at Work).The main objective was to develop a premiere approach in Romania to the issues of workers' exposure to psychosocial risks, an approach that can be developed from different point of views meant to provide a useful instrument for employers, employees, specialists and safety and health at work representatives to identify, assess and control the psychosocial risks, considered a cause of work related stress, as well as a cause of possible negative effects at individual, organizational and social level.

3. Methods

The first phase of the work envisaged: identification of psychosocial risks to establish the necessary preventive measures to ensure the safety and health of workers.

The objective of the second phase was: developing safety and health requirements for the prevention of workers' exposure to psychosocial risks.

To achieve such objective two activities were planned:

- Developing health and safety requirements for the prevention of workers' exposure to psychosocial risks;
- Developing a guide on the identification, assessment and prevention of psychosocial risks.

4. Results and Discussions

In the first phase of the study, in relation to the requirements of safety and health at work to prevent workers' exposure to psychosocial risks there were developed and analyzed:

European and national legal provisions regulating the prevention/reduction of the psychosocial risks;

national provisions regulating the surveillance of the workers' physical and mental health

and elaborated:

safety and health requirements necessary to prevent workers' exposure to occupational psychosocial risks,proposals of legislative and non-legislative measures for early identification of the negative effects on the personnel health state and behaviour for the surveillance of the personnel's physical and mental health state.

Based on data from a comprehensive documentation and the results obtained within the research works carried out in this area, the *Guide on the identification, assessment and prevention of psychosocial risks* was elaborated (during the second phase) and it included:

1. Introduction.

2. Psychosocial Risk Factors. Psychical stress. Definitions. Concepts.

3. The legislative framework governing the prevention/reduction process of psychosocial risks.

4. Psychosocial risk factors – stressors.

5. The effects of stress on the state of personnel safety, health and wellbeing/comfort state.

6. System of indicators of psychosocial risk factors and the effects on human being.

7. Areas and occupational groups of higher risk of exposure to psychosocial factors.

8. Preventive measures to preserve the comfort, safety and health at work state by eliminating/reducing workers' exposure to occupational hazards of psychosocial nature.

9. Advice to employers. Tips for Employees.

ANNEXES:

Appendix 1A: *Results of the survey and experiments carried out in Romania using the Copenhagen Questionnaire, by a team of I.N.C.D.P.M. "Alexandru Darabont" researchers.*

Annex 1B: *Stress priority program. Management of psychosocial risk factors. Management Standards of Health and Safety Executive (UK)*
http://www.inpm.ro/files/publicatii/2013-02-ghid.pdf

Psychosocial risks were defined as *"aspects of work design, organization and management, of work social and environmental contexts that can lead to psychological, social or physical injuries"* (Risk Observatory Report, EU-OSHA, 2007), new, emerging risks derived from the present context of the world of work, changes occurred at the global social and economic level etc.

At the European and international level, actions on psychosocial and stress factors as risk factors for the comfort, safety and health of personnel engaged in various modern professional activities have been intensified. Such actions involve international, national and local bodies, specialists, managers, trade unions and interested staff.

Therefore, the authors of the guide mentioned that the activities included at national level as related to occupational factors of psychosocial nature included in the work stress factors should be integrated at different levels of action and oriented to:

- draw up legal framework that takes into consideration explicitly new and emerging risks, psychosocial risks, stress, harassment and violence at work, respectively;
- adapt the laws and regulations to the progress accumulated in the area and competencies of the coordination and control bodies;

- optimize training and information activities (at various levels) related to the existing psychosocial risks in various industries to the new techniques and technologies;
- design a collecting and transmitting system of statistical data on, for example, work areas, professional categories of high exposure to psychosocial risks, type of organization (public or private organizations, SMEs, big enterprises etc.);
- develop national, local meetings (scientific meetings, consultancy, exchange of information etc.) with the participation of all stakeholders involved in safety and health at work;
- a better use and application of accumulated knowledge from the both fundamental and applicative studies and researches in the area;
- develop training activities for specialists at various levels;
- draw up a national information platform on stress at work.

At organization level, we considered that it is necessary to characterize the situation by searching and finding the appropriate indicators for the actual analysed situation that can confirm the presence of psychosocial risks. If such risks have a cumulated origin, a prevention action is necessary to be initiated.

As for the directions of action, several aspects are envisaged: changes in work activity; work demands; conflicts of values and demands; relations and behaviors.

The actions of preventing the psychosocial risks need a complex, multidisciplinary and participative approach.

The main users of the work outcomes are: specialists working in research; specialists working in medical and psychological areas; certified teams for the analysis and assessment of the work conditions according to the legislation in the area; specialists managing risks at the organization level; employers and employees etc.

The estimated social and economic effects by applying the outcomes of the project it should be mentioned: increase in the comfort level (wellbeing) at work, provide safety and health at work; increase of professional life quality; maintain at a optimum level the staff capacities; adapt to changes in work structure and on the labour market; optimize the psychosocial climate at the workplace resulting in better economic performances; increase of the profit; increase in competitiveness on the internal and external markets.

The guide, as the main outcome of the project, represents the first tool totally elaborated in Romania on psychosocial risks, put at the disposal of the interested parties.

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ÎMBUNĂTĂŢIREA PERFORMANŢELOR DE SECURITATE ŞI SĂNĂTATE ÎN MUNCĂ PRIN MANAGEMENTUL EFICACE AL RISCURILOR PSIHOSOCIALE

(Rezumat)

Expunerea lucrătorilor la riscurile psihosociale reprezintă una din cele mai importante caracteristici ale mediului de muncă actual. O serie de sondaje ale Fundaţiei Europene pentru Îmbunătăţirea Condiţiilor de Viaţă şi de Muncă au arătat că aproximativ un sfert din lucrătorii europeni sunt expuşi la stress în muncă. În

conformitate cu datele EU Labour Force Survey privind securitatea şi sănătatea în muncă, aproximativ 28% din persoanele cu probleme de sănătate legate de muncă au acuzat stresul ca fiind principala problemă de sănătate. Aceasta înseamnă că stresul este a doua cea mai frecvent raportată problemă de sănătate, după problemele de sănătate legate de afecţiunile musculo-scheletice. În acest context, conştientizarea tuturor actorilor implicaţi în asigurarea securităţii, sănătăţii şi stării de bine în muncă cu privire la factorii de risc psihosociali şi efectele lor atât asupra sănătăţii lucrătorilor cât şi asupra productivităţii organizaţiei, reprezintă un obiectiv important, înscris în obiectivele mai largi ale Strategiei Europa 2020.

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MODELING THE DANGER OF INJURY WHEN FRAGMENTS OF MATERIAL RESULT FROM THE DETONATION OF EXPLOSIVE CHARGES

BY

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Abstract: The paper shows a summary of the results of research undertaken in the field of modelling the dangers of injury / destruction when fragments of material resulting from the detonation of explosive charges are jettisoned on workers and / or industrial objectives from the explosives testing center. So, American scientific practice from the moment is (FRMS type) developed to improve the performance of the specialized software from the security of explosives for civil use type IMESAFR (ex. Version 2.0) which was acquired in the NUCLEU project- PN 16 43 02 15/2016-2017, using different probability functions dedicated to this field type PDF (Probability Density Functions) in order to shape the graphic-analytical phenomenon when fragments of material resulting from the detonation of explosive charges are jettisoned.

Keywords: graphic-analytical modeling; virtual simulation; danger; Probability Density Function; explosive charge; fragment of material resulting.

1. Overview on the Mechanisms of Formation of Fragments of the Material Resulting from the Detonation of Explosive Charges

1.1. Detonation of Explosives

Detonation is a physical-chemical process, characterized by a high reaction speed and by the formation of large quantities of gases, at high

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temperatures, which leads to the generation of high forces of breaking and dislocation of rocks. To interpret the physical phenomenon of detonation, worldwide were expressed various theories, one of them being the hydrodynamic theory. It was accepted unanimously, considering the similarity of its mode of propagation by explosives with the propagation of the pressurized fluid. The detonation mechanism comprises three steps: **I.** The mechanical compression of each molecule of the explosive substance carried by a dynamic pulse; **II.** The thermal decomposition of each layer in the structure of the explosive, up to high temperatures, when given the rapidity of the chemical reaction, the dynamic compression process being carried out without heat exchange in the environment (adiabatic compression); **III.** The exo-thermal decomposition of the explosive due to the action of high temperatures.

1.2. The Formation of Craters

In Fig. 1 is presented schematically a crater produced by the detonation of an explosive (explosive charge [1]). Dimensions associated to a crater are the following: D_2 = the apparent diameter of the crater; D_1 = the actual diameter of the crater; h_1 = the actual depth of the crater; h = berm height.

Craters are formed when there is a detonation of explosive charges that is placed as follows: below ground level (closed space); on the ground (air-ground interface); suspended in the air. Regardless of the location of the explosive charge, the crater is the destructive effect of a blasting. When initiating the explosive charge, in his mass, there is a violent decomposition reaction, the detonation wave which results is propagated at a speed of 2000 – 8000 m/s. In the detonation wave front is developed a pressure that can reach 10^4 MPa and it is transmitted in the environment in the form of a shock wave, having the same direction of propagation as the detonation wave.

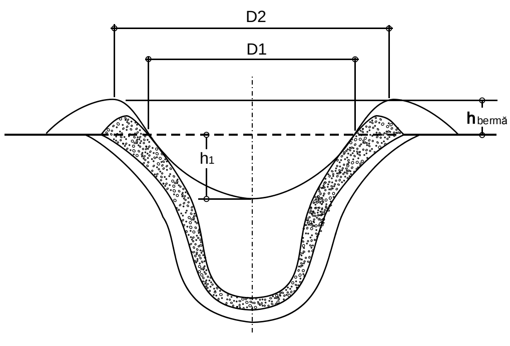

Fig. 1 – Defining the size of a crater.

[1] The explosive charge is the quantity of explosives prepared for detonation, in the view of displacement a volume of material (rack) for carrying out excavations.

The material resulting from an explosion type event considers three types of fragments: primary, secondary and scrap resulting from the crater formed. The primary fragments are coming from the body of the explosive detonated, and secondarily from the structure of the storage room (eg. roof, end walls, side and rear). Also, other residues that are generated in the impact crater formation are fragments from the ground or the foundation structure of the storage room. In the event of an explosion type event there may result a large number of individual fragments (of the order of thousands) that can be uniquely identified by its mass and speed of the main parameters (and implicitly by the kinetic energy). The model type QRA (Quantitative Risk Assessment) consecrated to quantitative risk assessment, provides opportunities for an analysis of the whole volume of fragments designed, based on a dynamic model of meshing of the mass, using the distribution pattern of recurrent Bin_n, (1) to provide a general overview of the 10 classes of results (Bin_i, i = 1, 10):

$$\mathrm{Bin}_n : \mathrm{DAM}_n = \mathrm{RM}_n + \left(\sum_{i=1}^{n-1} \mathrm{DM}_{[i,n]} \right) + \left(\sum_{i=2}^{n-1} \mathrm{B}_{11}\mathrm{DM}_{[i,n]} \right), \qquad (1)$$

where: DAM is the dynamic adjustment of the mass of the material fragment; n – the order of meshing of the fragment mass of material; RM – the residual material mass of fragment; DM – the fragment mass of material dispersion.

Thus, $\mathrm{Bin}_1/\mathrm{Bin}_{10}$ represents the fragments with the high/low mass and level significant/low of damage and/or destruction of the human component and/or structures.

Table 1 shows the results obtained for the ten classes ($\mathrm{Bin}_1,...,\mathrm{Bin}_{10}$) corresponding to level of damage/destruction (via kinetic energy) at the odds of maximum, medium and minimum, and average weight of each fragment designed depending on the type of material.

1.3. Description of the Primary Fragments

The primary fragments result from explosive destruction and its packaging after detonation, and their design mechanism by modelling is based on the number of fragments, by their mass and by the maximum range of throwing (Fig. 2).

The number of explosive products (N_w) is determined by the relation:

$$N_w = \frac{W_1}{\mathrm{NEW} \times \mathrm{QD}_1}, \qquad (2)$$

where: W_1 is the amount of explosives of the explosive product No.1; NEW – net explosive quantity of a single product (Table 2); QD_1 – distance depending on the amount of explosives.

Table 1

Class (Bin_{in} n=1,10)	Bin_1	Bin_2	Bin_3	Bin_4	Bin_5	Bin_6	Bin_7	Bin_8	Bin_9	Bin_{10}
Minimum kinetic energy (m-Kg)	100 K	30 K	10 K	3 K	1 K	300	100	30	10	3
Average kinetic energy (m-Kg)	173 K	54 K	17 K	5 K	1.7 K	547	173	54	17	5
The maximum kinetic energy (m-Kg)	≥300 K	100 K	30 K	10 K	3 K	1 K	300	100	30	10
The average weight of fragments of steel (Kg)	16.19352	6.75864	2.875824	1.206576	0.512568	0.214553	0.090266	0.038647	0.017191	0.006441
The average weight of concrete fragments (Kg)	34.20144	14.2884	6.07824	2.544696	1.079568	0.4536	0.190512	0.081648	0.036288	0.013608

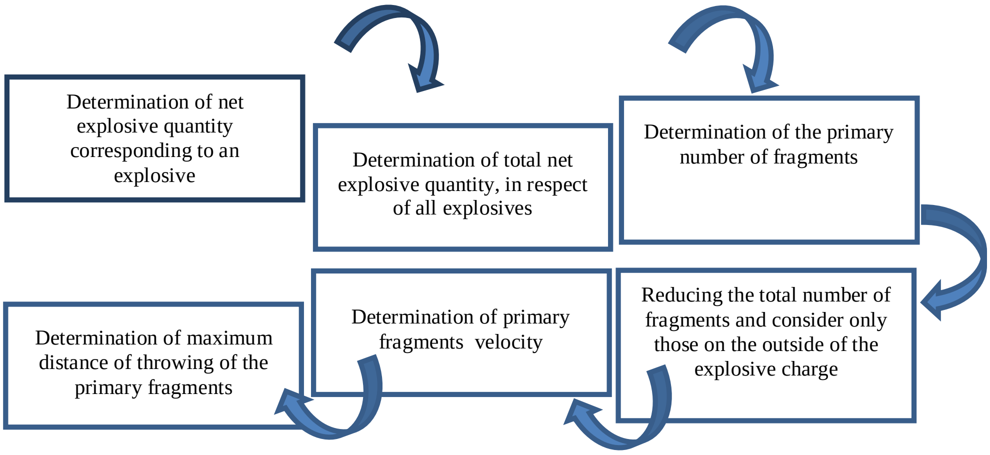

Fig. 2 – Process diagram for primary fragments projection.

Table 2

Explosive charges	NEW specific for a single type of explosive product (Kg)	Fragments derived from a single product Mass Bin_n, n=1÷10									
		1	2	3	4	5	6	7	8	9	10
Explosive charges with small fragments	0.4536	0	0	0	0	0	0	0	1	5	10
Explosive charges without primer fragments	0.4536	0	0	0	0	0	0	0	0	0	0
Metallic container with explosive charge	4.536	0	0	0	0	0	0	80	4.111	796	319
Explosive charge confined in the metal pipe	3.901	0	0	0	0	0	0	4	19	44	79

Further are displayed in tables the maximum range values of action/projection of the primary fragments (R_{max}), which is determined for each fragment, according to the average weight, of the suitable bin and the initial rate (Table 3).

Table 3

Explosive charges	V, [m/s]	R_s, [m]	R_M, [m]
Explosive charges with small fragments	1219,2	569,976	683,9712
Explosive charges without primer fragments	NA	NA	NA
Metallic container with explosive charge	1219,2	569,976	683,9712
Explosive charge confined in the metal pipe	1219,2	569,976	683,9712

The value $R_{\max}$ is set at the maximum value for the projection, whether for one explosive product (R_S) or for multiple products (R_M), depending on the amount of explosives considered, W_1. In case of W_1 lower than the net quantity of explosive from the explosive product it is used the value of R_S, and where W_1 is greater than this quantity, then it is used the value of R_M. Usually, the value of R_M is 20% higher than R_s, taking into consideration the known spraying debris.

In the event of an explosion type event, product within a potentially explosive structure type PES (for storing explosives for civil uses), results a very large amount of primary fragments whose number and the initial speed is determined according to the data of presented in Tables 2 and 3. Also, the components of the PES structure, remaining after the explosion, can block and remove the primary fragments resulting from this event. At the same time, it is necessary to determine the fraction of primary fragment blocked by structural components of PES (roof, front wall, rear wall and side walls).

Thus, to determine the number of primary fragments which may be blocked by various components of the structure of the PES, they must be divided depending on the angle of projection, namely: large angular throw fragments (hitting the roof) and lower angular throw fragments (the lower) (hitting the walls). The lower angular fragments are divided, at their turn, further in side impact fragments and horizontal fragments displaced in a direction nearly horizontal. Also, side impact fragments have an arched trajectory, to ES-type structure (the structure exposed to explosion), but it can be blocked, in the end, the wall of this structure, by artificial obstacles (Fig. 3).

The primary fragments are divided as follows, 25% of the total number of the fragments is considered to be high angle fragments, 7.5% of the total is considered to be fragments of the side impact, and 67.5% is considered to be horizontal fragments. Setting these values are based on interpretation of test data, including high-speed video analysis. The primary fragments are divided into fragments that can be blocked or contained by each structure type PES. The side impact fragments and the horizontal fragments are potentially blocked by the front wall, sidewalls and the components of the rear wall structure type PES, while high angle fragments are assumed to be potentially blocked by the roof component (Fig. 4).

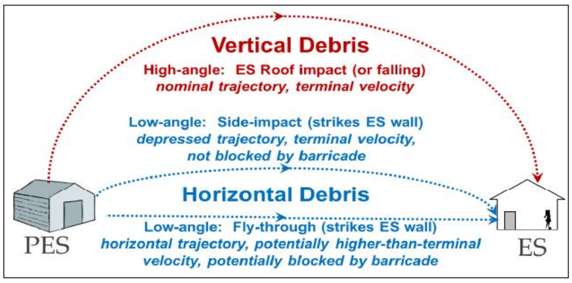

Fig. 3 – The design trajectories of primary fragments.

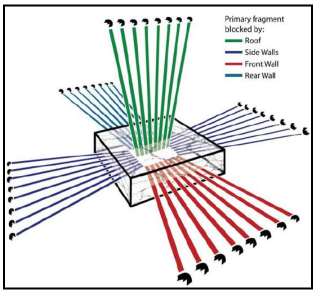

Fig. 4 – Blocking the primary fragments.

2. Density Estimation of the Material Fragments Projected

The configuration estimating of the path travelled by the material thrown away, can be done by using the methodologies results within various research conducted in this domain and requires well-grounded scientific knowledge on the main parameters evaluated, namely: the speed of impact and the mass of material fragment projected. It would be ideal for determining the position and speed of impact, specific to each fragment of discarded material, to use physical laws based on differential equations that characterize the wave phenomena, however, at the moment, there do not exist proven scientific results for a specific scenario related to an explosion type event.

The number of fragments and individual characteristics of mass and speed are dependent both on the type of material (*e.g.* steel or concrete), and the characteristics of explosives used to testing. Thus, the conceptual models can be developed for the production of trajectory calculations for the intervals of fragment of mass, launch angle and speed. However, Monte Carlo simulations are sensitive to present ranges assigned to each variable trajectory. Also, these models require running a series of simulations at the time of analysis, requiring extensive resources of time and the calculation result being one detailed and based only on assumptions.

Where, test results of explosives accident statistics, validated simulation data are available, then type models Fast-Running Models (FRMs) can be created for the analysis of hazards in a simplified manner, without using difficulty complex physical models based on the equation of state. So, American scientific practice from the moment (type FRMs), developed for specialized software in the field of explosives for civil uses security type

IMESAFR 2.0 which was acquired in the Program NUCLEU-Project PN 16 43 02 15/2016-2017, using different probability density functions dedicated to this field type PDF (Probability Density Functions) for graphic-analytical model of the phenomenon of projecting portions of the material, which result from such explosion events. This PDF is obtained by pre-processing, simulation and / or analysis of test data in a dedicated equation (closed form), after the pre-set density function can generate immediate results. Fig. 5 shows an example of simulation test data, by a number of data-points that have been translated into a closed-form equation. This PDF serves as a contour map, almost instantaneous forecasting projected portions of the material density. To represent different types of models based on the use of probability density functions, it can be designed with different levels of complexity. Thus, PDFs are composed of elements “down-range” type and azimuth (cross-range). “Down-range” component reproduces the shape of the origin of the blast outwards in any radial direction. This essential component distance determines the design portions of the material from the original location in which the explosive charge detonation occurs, and the range of their greater density. Cross range component determines the form of the tool when moving radially at a constant distance from the origin (azimuthal direction or cross-range). In the following, there will be detailed the two components of PDFs modelling practice often used in explosives security.

The most common PDFs are the uniform distributions in all directions from the origin (that is, no azimuthal variation). These distributions may be used effectively for modelling safety are evenly distributed or random in all directions around the site of an explosion such as both pieces of material resulting from the destruction of the roof that are thrown up and scattered, as well as fragments of wall structures of the various arcuate shape. The first example is a function of the type Gauss - normal of distribution (ex. a bell-shaped curve) used as component *"down-range"* without azimuthal variation, producing a distribution parameter type bi-variant Normal (BVN), characterized by the highest density at the origin which resembles a hill (Fig. 6).

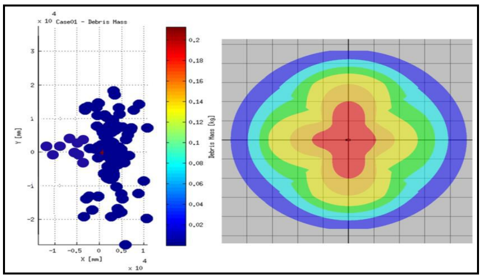

Fig. 5 – Representative test transposition date in PDF.

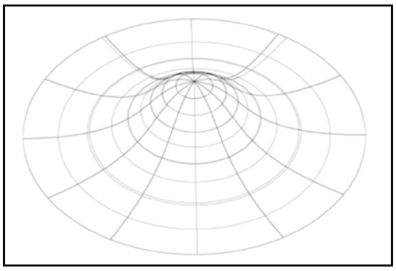

Fig. 6 – Distribution type Bi-Standard version (BVN).

The shape of PDF- for the distribution of BVN is given by the following equation:

$$P_i = \frac{1}{2\pi\sigma^2} \mathrm{e}^{\frac{-r^2}{2\sigma^2}}, \tag{3}$$

where: P_i is the probability of a single piece designed in a certain area; σ – the standard deviation of the distance *"down-range"*; r – the range from the origin to the point of interest

2.1. The ISURF Model

Probability density function BVN is useful for substantiating the basic scenarios, in which case is available a limited number of data and information, the danger of projecting fragments of material is assumed to be higher in the vicinity of the blast origin for the production location, as a result of the detonation of the charging material. However, there may be situations under which, a lot of the fragments are thrown out of origin. This aspect is especially true for primary fragments, the residues from the explosive charge and secondary arising from pieces of wall. When the model *"BVN down-range"* is used in these types of scenarios, the problem of the PDF is related to resolving over-prediction of throwing fragments near origin, in small amounts at intervals. Research conducted by the Institute of Explosives Manufacturers (IME) to develop specialized computer infrastructure for the security of explosives (IMESAFR), Research APT has developed a new function *"down-range"* to improve the model *"BVN down-range"*, resulting in a toroidal PDF with azimuthal variation (Fig. 7).

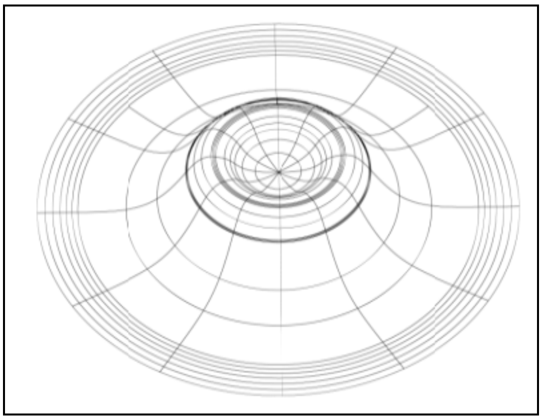

Fig. 7 – PDF toroidal without azimuthal variation, type ISURF.

Comparative analysis of the two established models for substantiating the scenarios of projecting the fragments of material resulting after the detonation of explosive charges, respectively: *Curve "BVN down-range"* and *Curve "PDF toroidal down-range"*, points out that the areas occupied by the two curves are identical, and declaring the approximate representation of the same amount of total mass of the projected fragments. It is also found that the model of the curve BVN is type conservative at certain intervals, compared with the curve PDF toroidal (Fig. 7). The new component of the model PDF *"down-range"* is referred to as slope (Range) and it is given by initial ascending function of the new model – ISURF, (Fig. 8). The complex shape of the model ISURF is provided by the three parameters mentioned, respectively a, b and c, which may have different values depending on: size of fragments thrown away of the resulting material type after detonation by explosive charge and type of structures used \ in the scenario of the explosion (*i.e.* the wall or roof).

The presentation chart of the model highlights the following elements of structure:

- parameter *a* is the ratio of the horizontal coordinate of the maximum likelihood (X_{peak}) and the maximum horizontal distance of throw (or "full-throw") the density of fragments (X_{MT}), it is used to determine the maximum range;
- parameter *b* the relation between probability density at origin (Y_0) and the maximum probability density (Y_{peak}) is used to determine the maximum magnitude;
- parameter *c* is used for controlling the shape of curves which are joining the set points and represents the percentage of probability generated by the surface under the curve, which is bounded by the horizontal distance from the origin to the maximum value of the curve, determining the percentage of the area under the curve.

Knowing the percentage by calculating the area under the curve will result in the determination of both the inner face of the slope and the slope of the outer surface.

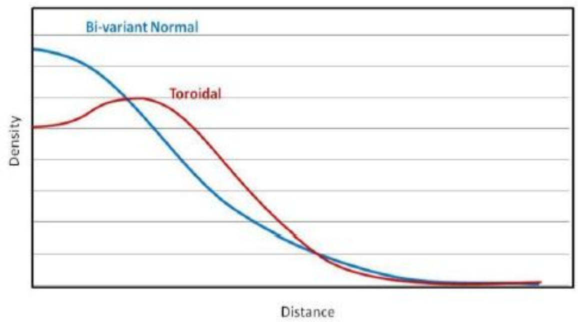

Fig.7 – Graph of curves *BVN down-range* and
PDF toroidal down-range.

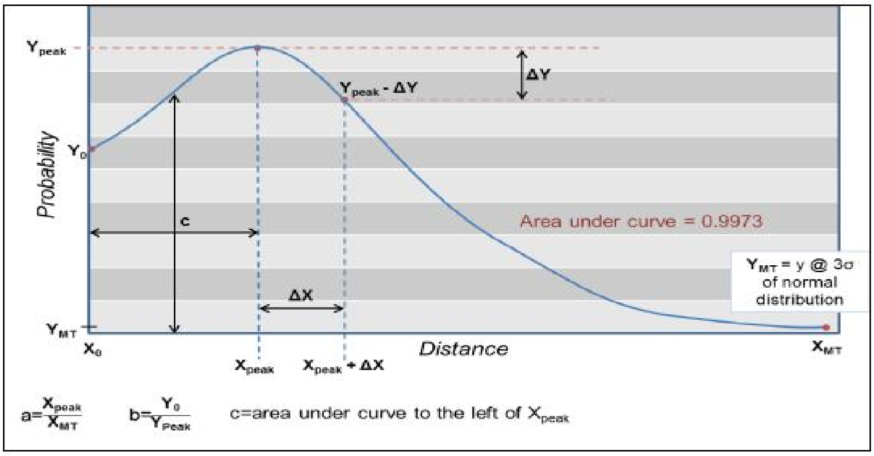

Fig. 8 – graphics details of the model *ISURF down-range*.

2.2. The ISURFGAD Model

This model is characterized by a zero change in azimuth (they produce the same results in all directions), being used for modelling uniform of the directional hazard, both for fragments by the roof, the circular crater effect at warehouses of explosives and for scenarios of explosion where fragments are thrown in random directions. Because, in the case of centrally located loads in rectangular buildings, it has been observed that the density of the thrown material is strongly affected by the azimuth (debris of material tend to “move along the normal” and not in the “corners”) generating an effect type Cloverleaf (PDF with azimuth zero – transversely range) shown in Figs. 8 and 9 presents a new type of PDF (ISURFGAD) based on a model range transverse that take this type of effect into account.

PDF derivation type ISURFGAD is performed independently for functions *"down-range"* and the transverse radius. The function is represented for one dial of 90^0, probability density of the portions of the material characterized by independent parameters, respective interval of the range (r) and the throwing angle (θ), thus:

$$\mathrm{PDF} = f(r) * g(\theta), \tag{4}$$

in which: $f(r) = f_1 = A^{'} + B^{'}r + C^{'}r^2 + D^{'}r^3$, out of range $[0,R_{P+}]$; $f(r) = f_2 = k_1\exp[k_2 \times (r - R_{P+}]$, out of range $[R_{P+},R_{\max}]$; $g(\theta) = [1/(2\pi R_c\sigma_\theta)]\exp[-0.5(\theta/\sigma_\theta)^2]$,
where: R_{p+} is the peak value of probability density; $R_{\max}$ – the maximum radius of the throwing portions of the material; R_C – the centroid radius.

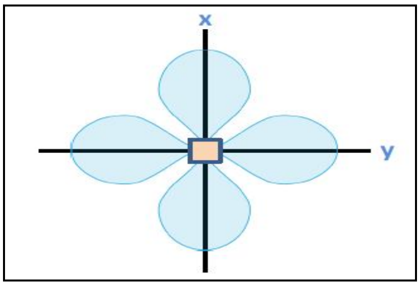

Fig. 9 – The model Cloverleaf of the dispersion of the fragments of material.

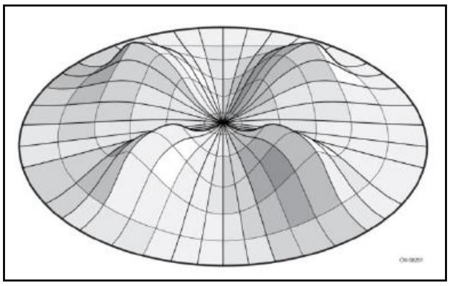

Fig. 10 – New PDF-type ISURFGAD.

3. Human Vulnerability Assessment under the Action of Portions of the Material Resulting from the Detonation of Explosive Charges

In previous sections were presented technical aspects of modelling portions of the material resulting from the detonation of explosive charges from structures type PES (for the storage of explosive materials) which can destroy structures exposed to explosion type events ES (for specific activities), with serious effects on the health and integrity of staff, and the population in surrounding areas. For modelling the degree of damage to the human component using probability equation (of the impact between the human body and thrown fragment) configured based on Poisson probability distribution (5), respective:

$$P_{\text{impact}} = 1 - c^{-EN^*}, \tag{5}$$

where: E it is the human exposure (0.278 m^2); N^* – is the number of fragments which may damage the integrity of the human component.

For solving the equation of probability, the model provides the estimation possibility of fatality areas with major and minor injuries based on the kinetic energy of the fragments projected, respectively:

$$P_{f(d)} = \text{Value of fatality} \times P_{\text{impact}}. \tag{6}$$

The lethality value is obtained from the curve shown in Fig. 11, highlighting the likelihood of fatality for an event $P_{f|e}$ compared with the kinetic energy of the fragments projected. Finally, the model calculates the overall probability of fatality caused by projected fragments, $P_{f(d)}$, by summing the projecting path, corresponding to the angular projection, of the large fragments and to the displacement of small angular, and the total probability of death is obtained by using the additive rule applied in the case of events which are not mutually exclusive, respectively:

$$P_{f(d)} = P_{f(d)\text{unghi redus}} + (1 - P_{f(d)\text{unghi redus}}) \times P_{f(d)\text{unghi mare}}, \tag{7}$$

where: $P_{f(d)}$ is the probability of death of a person due to the impact with a projected fragment.

Completely analogous is determined the likelihood of major damage/ minor injuries $P_{\max(d)}/P_{\min(d)}$.

To substantiate the danger of the mechanism of thrown fragments is using a pattern type SCIFM (Simplified Cose-In Fatality Mechanism) all scenarios specific to this phenomenon (Fig. 12).

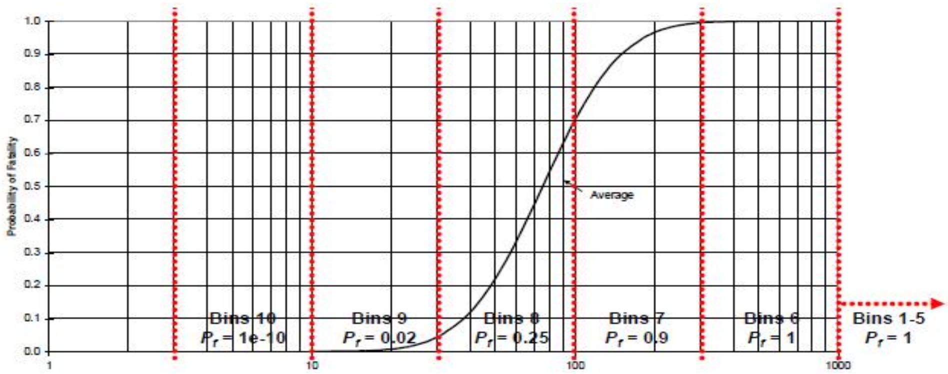

Fig. 11 – The probability of exposure of the human component by kinetic energy.

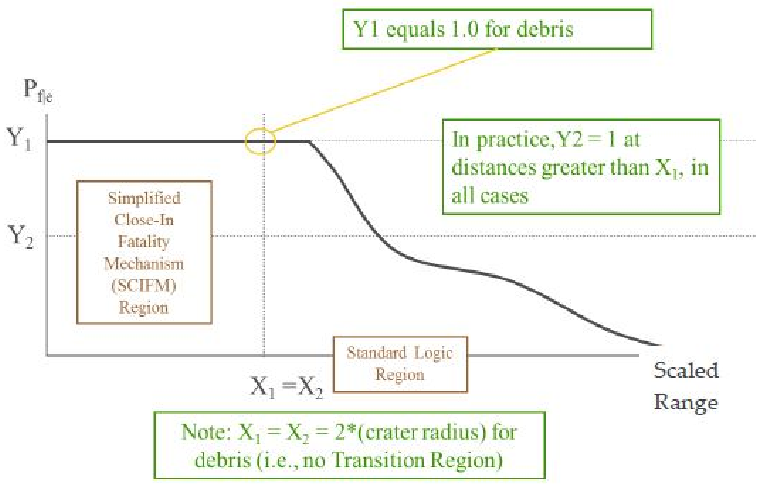

Fig. 12 – The Model SCIFM for fragments projected.

4. Examples of Application of the Presented Models

An example of surface PDF with the following characteristics: a = = 0.330, b = 0.038, c = 50%, d = 10%, maximum range extender = 579 m and σ = 20º, and it is presented in Fig. 13.

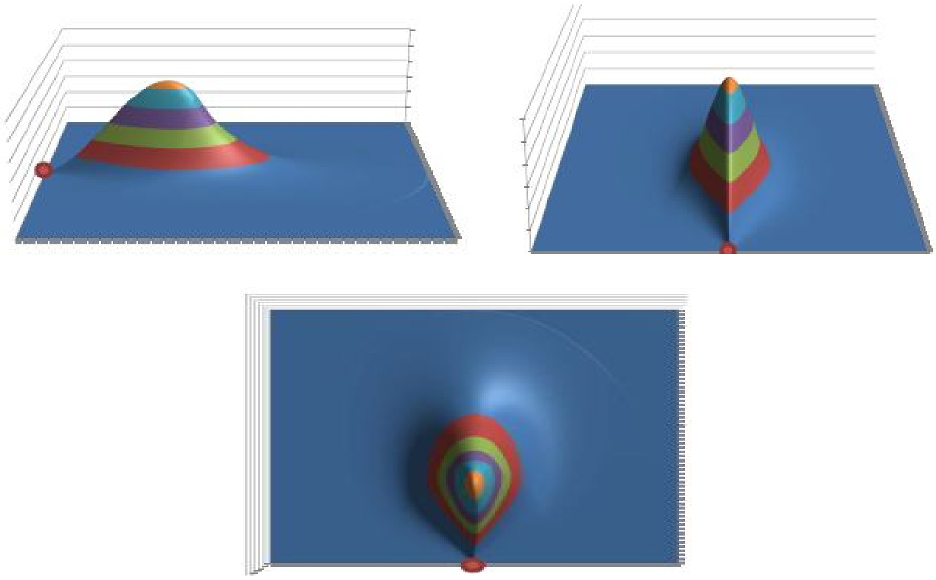

Fig.13 – PDF surface - ISURFGAD PDF.

The results obtained after modelling the risk of injury from projected fragments of the material resulting from an explosion type event, can be highlighted graphic-analytical, both through the associated diagrams of the contour maps of the destructive capacity, specific to the thrown fragments (kinetic energy of impact from fragments of the material), shown in Fig. 14, and on the histograms of probability values of damage on the human component that define the following areas of interest, respectively: the area of fatality (the degree of mortality), area of major injuries (the extent of damage irreversible) and area of minor injuries (the extent of damage reversible), shown in Fig. 15.

The results shown in Figs. 14 and 15 are needed to establish the areas of interest, in the case of an explosion type event as a result of detonation of explosive charges, resulting in the following planning areas: **area of high mortality**, defined as the area in which it accrues the death of approx. 50% of the exposed population; **the area of irreversible injuries,** defined as the area in which the exposed population is suffering serious harm to somatic level and lung, serious illness, first and second degree burns. Light buildings, suffer major damage becoming unusable. Heavy structures may undergo minor damage; **attention area,** defined as the distance that the effects of the accident can be felt and can cause a mild illness, of short duration, or superficial burns easily curable. When explosion accidents occur, light buildings existing in the area of attention, may suffer minor damage.

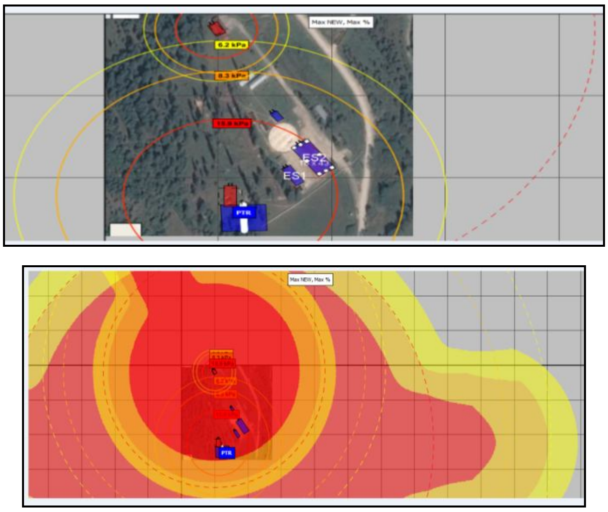

Fig.14 – contour map for a deposit of explosives with a capacity of 1,220 kg ETNT.

Histograms of the fatality curves

Histograms of the curves of major damage

Histograms of the curves of minor injuries

Fig. 15 – Histograms of areas of damage on the human component and structures.

5. Conclusions

Estimating the route configuration of the fragments of material projected can be achieved using model type Fast-Running Models (FRMs), created for hazard analysis in a simplified manner, using different functions for probability dedicated to this area (ex. model type ISURFGAD with the azimuthal variation), for graphic-analytical modelling of the phenomenon of projected pieces of material resulting from explosion type events.

The model of projecting the resulting material after an explosion considers three types of fragments: primary, secondary and scrap resulting from the area of the crater formed. Thus, primary fragments come from the detonated explosives body, and the secondary ones are coming from the structure of the storage room (ex. roof, front, side and rear walls). Also, the other debris of impact which are generated in the area of crater, are fragments coming from the ground or from the foundation structure of the storage room.

This paper has presented the technical aspects of material fragments modelling resulting from the detonation of explosive charges coming from potentially explosive structures, type PES (for the storage of explosive materials) which can destroy the structures exposed to explosion type, ES (for specific activities), with the serious effects on health and integrity of the working staff, and the population from surrounding areas.

The final results of modelling the risk of injury from projection of the material resulting from an explosion event, may be highlighted graphic-analytical, through the associated diagrams of the contour map and histograms of probability values of damage of the human component (death, major injuries and minor injuries).

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MODELAREA PERICOLULUI DE ACCIDENTARE LA PROIECTAREA FRAGMENTELOR DE MATERIAL REZULTAT ÎN URMA DETONĂRII ÎNCĂRCĂTURILOR DE EXPLOZIV

(Rezumat)

Lucrarea evidențiază o sinteză a rezultatelor cercetărilor întreprinse în domeniul modelării pericolelor de accidentare/distrugere la proiectarea fragmentelor de material rezultate în urma detonării încărcăturilor de exploziv, asupra lucrătorilor şi/sau obiectivelor industriale/civile de pe amplasamentul unui poligon de testare materii explozive. Astfel, practica ştiințifică americană de la momentul actual, dezvoltată pentru software-ul specializat din domeniul securității explozivilor de uz civil tip IMESAFR 2.0 care a fost achiziționat în cadrul Programului NUCLEU-Proiect PN 16 43 02 15/2016-2017, utilizează diferite funcții densitate de probabilitate consacrate acestui domeniu pentru a modela grafo-analitic fenomenul proiectării fragmentelor de material, care sunt rezultate din evenimente de tip explozie.

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INCREASING THE HEALTH AND SAFETY AT WORK BY EVALUATING THE POTENTIAL EXPLOSIVE ATMOSPHERE

BY

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Abstract: The explosivity of a gas mixture can be determined by estimating the lower explosion limit of the mixture of by applying Le Chatelier's principle and then comparing the result with the overall percentage of flammable substances in the mixture. If the total percentage of flammable substances in the mixture is higher than the calculated lower limit of the mixture, the mixture is considered explosive.

The lower explosive limit of a combustible gas mixture can be estimated using the derivation of the Le Chatelier's principle. The derivation uses only the flammable components of the mixture with the adjusted mole fractions corresponding to the relative percentage.

For this work was carried out the estimation of the degree of explosiveness of the atmosphere inside a fuel reservoir, based on the concentrations determined in samples taken from the inside. The flammable gases traced in the samples were methane, ethane, ethene, propane, propylene, acetylene, Iso-Butane and n-butane.

Keywords: safety; explosivity; explosive atmospheres.

1. Introduction

Explosions are the most frequent accidental events that occur during the storage, transport and preparation of solid and gaseous fuels due to factory defects, faults in pressurized recipients, fuel leakage, etc. (Razuş *et al.*, 2000).

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Explosion risk assessment is a process of assessing (estimating) the risk that occurs in the circumstances of an explosion hazard in order to give a qualitative and quantitative dimension of this element.

The purpose of the explosion risk assessment is humanitarian (to prevent human damage) and economic (to prevent economic losses, in the case of material and human damage). In order to assess the risk of explosion, it is necessary to know the explosive characteristics of air mixtures - flammable substances (Khitrin, 1962; Lewis & von Elbe,1987).

Flammable substances, which give exothermic reactions in contact with air and a source of initiation, are not present in the chemical and petrochemical industry today. Most hydrocarbons are extremely volatile under relatively normal operating conditions. To prevent explosions at work, a profound knowledge of their explosive properties is required.

The explosion limits of an oxidant combustible gas mixture delimit the concentration range (at constant temperature and pressure) in which an initial burst can propagate autonomously in the amount of explosive mixture (Lewis & von Elbe,1987).

In the field of low fuel mixtures (lean mixtures), the lower explosion limit (LEL) is defined as the lowest fuel concentration at which the explosion may occur and can propagate autonomously across the fuel-oxidant mixture volume, even after the ignition source has ceased action (Lewis & von Elbe,1987; van Tiggelen *et al*.,1968).

In the field of fuel excess mixtures (rich mixtures), the upper explosion limit (UEL) is defined as the highest fuel concentration at which the explosion still exists and can propagate autonomously throughout the fuel-oxidant mixture, even after the ignition source has ceased action (Lewis & von Elbe,1987; Zabetakis, 1965).

Between the two explosion limits, combustion triggered around the ignition source (electric spark, heated body) is progressively transmitted from one layer of gas to another as a combustion wave. Outside of the field delineated by LEL and UEL, combustion can still occur, especially if the source of ignition is a high energy spark or a large flame. Under these conditions, however, the combustion wave extinguishes after consuming a limited amount of mixture, propagating for a short distance (Lewis & von Elbe,1987; van Tiggelen *et al*.,1968).

Exact data on explosion limits and flash point are two important issues to ensure explosion protection. These are required for the safe use of flammable gases and vapors and combustible liquids in the industry.

Explosive limits for pure hydrocarbons, lower explosion limit and upper explosion limit are appropriate in the literature but in industrial applications, there are a wide variety of conditions including different temperatures and pressures, varied oxygen content, etc., and the explosions limits are hard to find and sometimes unavailable. Moreover, hydrocarbon mixtures are also encountered with different volumetric fractions and different components (Coward, 1950).

For a mixture of flammable gases, the lower explosion limit can be estimated by derivation of the Le Chatelier principle. The derivation uses only the flammable components of the mixture with corresponds to the molar fractions adjusted to the relative percentage as follows:

$$\%\text{LEL mix} = \frac{1}{\sum_i \left(\frac{x_{i\ \text{inflam}}}{\%\text{LIE}_i} \right)} \times 100,$$

where: % LEL mix is the lower explosion limit (LEL) of the mixture; $x_{i\ \text{inflam}}$ – the corresponding molar fraction of the fuel; LEL_i – Lower Explosion Limit (LEL) of the individual constituent.

Le Chatelier's principle specifies that if a system in a chemical balance exerts an external action, the balance moves in the sense of diminishing or canceling the exerted action.

The factors that influence the shift of the chemical balance are:

– variation in the concentration of the reactants or of the reaction products in the equilibrium mixture; the increase in the reactant concentration shifts the chemical balance towards the reaction products, while the increase in the concentration of the reaction products displaces the chemical balance in the direction of the initial products;

– temperature variation according to the exothermic or endothermic character of the two reactions (direct reaction and reverse reaction); the temperature increase will shift the chemical balance in the direction of favoring the endothermic reaction, and the decrease in temperature will shift the chemical balance in favor of the exothermic reaction;

– variation of pressure in the case of gas-containing equilibrium and in which the variation in the number of moles of gas occurs; the pressure increase will shift the chemical balance in the direction of less gas, and the pressure drop moves the chemical balance in the direction of more gas mills.

The explosiveness of a gas mixture can be determined by estimating the lower explosion limit of the mixture by applying the principle of Le Chatelier's and then comparing the result obtained with the total percentage of flammable substances in the mixture. If the total percentage of flammable substances in the mixture is higher than the lower limit calculated for the mixture then the mixture is considered explosive.

2. Materials and methods

In order to estimate the degree of explosiveness of the gas mixture inside the fuel reservoir, instrumental measurements were performed and 5 samples of air were taken, which were then analyzed in the laboratory by the gas-chromatographic method.

On-site instrumental measurements were made using the ExTEC HS 680 multi-instrument and the DRAGER X-am 7000 portable device (Figure 1), both for use in potentially explosive environments.

Portable device EX-TEC HS 680

Portable device DRAGER X-am 7000

Fig. 1 – Portable devices used for direct measurements.

In the laboratory the samples were analyzed by gas chromatography (Fig. 2), the flammable gases being methane, ethane, ether, propane, propene, acetylene, iso-butane and N-butane.

Fig. 2 - Clarus 500 Gas-chromatograph

3. Results and Discussions

The estimation of the explosivness degree of the atmosphere inside the tank was made solely based on the concentrations determined in the samples taken from the interior of the fuel reservoir.

Following the instrumental measurements over the entire surface of the inside of the fuel reservoir, it was not revealed the presence of toxic, asphyxiating or explosive gases.

Following gas chromatographic analysis, the following results were obtained:

Table 1
Results for Sample 1 - Taken from the N-E Side of the Tank

Flammable substance	Concentration $[\%]_{vol.}$	LEL [%]	x_{inflam}
Methane	0.0288	5	0.15
Ethane	0.0305	3	0.16
Propane	0.1100	2.1	0.57
Iso-Butane	0.010088	1.8	0.05
N-Butane	0.041334	1.6	0.22

LEL mix sample 1 = 1.92 %; Total percentage of flammable substances in the mixture = 0.19 %

Table 2
Results for Sample 2 - Taken from the Middle Area of the Reservoir in the North

Flammable substance	Concentration, $[\%]_{vol.}$	LEL [%]	x_{inflam}
Ethane	0.001859	3	0.039
Propane	0.003318	2,1	0.070
Iso-Butane	0.000713	1,8	0.015
N-Butane	0.002852	1,6	0.875

LEL mix sample 2 = 1.66 %; Total percentage of flammable substances in the mixture = 0.047 %.

Table 3
Results for Sample 3 - Taken from the Middle Area of the Reservoir in the South

Flammable substance	Concentration $[\%]_{vol.}$	LEL [%]	x_{inflam}
Methane	0.006492	5	0.202
Ethane	0.013664	3	0.425
Propane	0.009037	2,1	0.281
Iso-Butane	0.002170	1,8	0.067
N-Butane	0.007220	1,6	0.224

LEL mix sample 3 = 2.02%; Total percentage of flammable substances in the mixture = 0.032%.

Table 4

Results for Sample 4 - Taken from the SV Area of the Reservoir

Flammable substance	Concentration $[\%]_{vol.}$	LEL [%]	x_{inflam}
Methane	0.012498	5	0.350
Ethane	0.008461	3	0.237
Propane	0.014714	2.1	0.413
Iso-Butane	0.002613	1.8	0.073
N-Butane	0.009872	1.6	0.277

LEL mix sample 4 = 1.78%; Total percentage of flammable substances in the mixture = 0.035%.

Table 5

Results for Sample 5 - Taken from the NV Area of the Reservoir

Flammable substance	Concentration $[\%]_{vol.}$	LEL [%]	x_{inflam}
Methane	0.005656	5	0.202
Ethane	0.006809	3	0.244
Propane	0.010397	2.1	0.372
Iso-Butane	0.002247	1.8	0.080
N-Butane	0.008483	1.6	0.304

LEL mix sample 5 = 1.87%; Total percentage of flammable substances in the mixture = 0.027%.

4. Conclusions

Explosions are the most frequent accidental events that occur during the storage, transport and preparation of solid and gaseous fuels due to factory defects, faults in pressurized recipients, fuel leakage, etc.

The purpose of the explosion risk assessment is humanitarian (to prevent human damage) and economic (to prevent economic losses, in the case of material and human damage). In order to assess the risk of explosion, it is necessary to know the explosive characteristics of air mixtures - flammable substances.

The explosiveness of a gas mixture can be determined by estimating the lower explosion limit of the mixture by applying the principle of Le Chatelier's and then comparing the result obtained with the total percentage of flammable substances in the mixture. If the total percentage of flammable substances in the mixture is higher than the lower limit calculated for the mixture then the mixture is considered explosive.

In the present paper the estimation of the degree of explosiveness of the atmosphere inside the tank was made exclusively based on the concentrations determined in the samples taken from the interior of the fuel reservoir.

As a result of instrumental measurements on the entire surface of the fuel tank interior, the presence of toxic, asphyxiant or explosive gases was not highlighted.

For all 5 samples analyzed by the gas-chromatographic method, the percentage of flammable substances observed had values well below the lower explosion limit of the gas mixture, as follows:

• for sample no. 1 LEL mix = 1.92% and total percentage of flammable substances in the mixture = 0.19%;

• for sample no. 2 LEL mix = 1.66% and the total percentage of flammable substances in the mixture = 0,047%;

• for sample no. 3 LEL mix = 2.02% and the total percentage of flammable substances in the mixture = 0.032%;

• for sample no. 4 LEL mix = 1.78% and total percentage of flammable substances in the mixture = 0,035%;

• for sample no. 5 LEL mix = 1.87% and the total percentage of flammable substances in the mixture = 0.027%.

In view of all these considerations, the analyzed mixtures, taken from inside the oil fuel reservoir, are not considered explosive.

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CREŞTEREA GRADULUI DE SECURITATE AL LUCRĂTORILOR PRIN EVALUAREA ATMOSFEREI POTENȚIAL EXPLOZIVE

(Rezumat)

Explozivitatea unui amestec de gaze se poate determina prin estimarea limitei inferioare de explozie a amestecului aplicând principiul lui Le Chatelier's şi apoi

compararea rezultatului obşinut cu procentul total de substanțe inflamabile din amestec. Dacă procentul total de substanțe inflamabile din amestec este mai mare decât limita inferioară calculată pentru amestec, atunci amestecul se consideră exploziv.

Limita inferioară de explozie a unui amestec de gaze inflamabile poate fi estimată cu ajutorul derivării principiului lui Le Chatelier. Derivarea foloseşte doar componenții inflamabili ai mixturii cu fracțiile molare corespunzătoare ajustate la procentajul relativ.

Pentru aceasta lucrare s-a realizat estimarea gradului de explozivitate al atmosferei din interiorul unui rezervor de păcură, pe baza concentrațiilor determinate în eşantioanele prelevate din interiorul acestuia. Gazele inflamabile urmărite în probele prelevate au fost: metan, etan, etenă, propan, propenă, acetilenă, Iso-Butan şi N-Butan.

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IMPROVING SECURITY AND HEALTH THROUGH PROPER IMPLEMENTATION OF THE INSPECTION AND MAINTENANCE PROGRAMME OF ELECTRIC POWER EX EQUIPMENT DESIGNED IN FLAMEPROOF ENCLOSURE "d" AND INCREASED SAFETY "e" TYPE OF PROTECTION

BY

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Abstract: Inspection is an action that comprises the examination of electrical equipment to be performed without dismantling or with partial removal, where applicable, supplemented by means such as measurements to reach a certain conclusion regarding the state of the equipment in question.

Maintenance is a combination of all actions taken in order to maintain or restore an object given that it is able to meet the relevant specifications and requirements to perform its set functions.

The paper presents the most important aspects to be taken into account when carrying out inspection and maintenance of electrical equipment used in explosive atmosphere with type of protection flameproof enclosure "d" and increased safety "e" to ensure functionality and the type of protection equipment for safe operation.

Keywords: inspection; maintenance; security and occupational health; electrical equipment used in explosive atmospheres.

1. Introduction

Use of electricity for the operation of facilities, equipment, electrical machinery in a potentially explosive atmosphere is of increasingly more interest

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for the design, erection and the correct selection of the proper type of protection required to ensure safe operation, their approach requiring particular attention in view of the many technical, economic and operational safety and health aspects.

Modern technology tends to fully use materials, labor and safety and health at work, in order to obtain maximum efficiency in production at the desired outcome. This trend which is controlled by designers, is very delicate in itself, because production efficiency can be obtained only from the economy obtained from the manufacturer. Efficiency on site at the end user is based on the safe operation at low power consumption and zero events as regards the health and safety at work, taking into account the investment made for the purchase of equipment used in explosive atmospheres. There is a wide field of action for the reconciliation of the three types of efficiency categories in order to achieve optimal results.

Electrical systems in hazardous areas have certain features specifically designed for operating in such atmospheres. For security reasons it is essential that in these areas, for the entire lifetime of the plant facility, to be preserved the integrity of these special features.

The main requirements are well established in this direction by the standards, but many technical - administrative issues which require that the operators of installations, appliances, electrical machines operating in potentially explosive environments to be authorized in conformity with Articles 7 of NEx 01 – 06 and to carry out an inspection and maintenance plan in accordance with SR -EN 60079-17, remain unresolved.

Maintenance means a combination of all actions carried out in order to maintain or restore an object while it is able to meet the requirements of the relevant specification and perform its functions.

Inspection is an action which comprises a detailed examination of an object, be carried out either without dismantling or with partially dismantling, as appropriate, supplemented by such means as measurements, to reach a certain conclusion on the state of the object in question.

In order to carry out a correct inspection and maintenance of electrical installations in optimal conditions the following updated documents must be available:

a) classification of hazardous areas;

b) the gas group and temperature class classification of the equipment;

c) sufficient records to allow explosion-proof equipment to be maintained in accordance with the types of protection (list and location of equipment, spare parts, technical information);

d) the cable runs for underground cables.

Inspection and maintenance of electrical installations must be carried out only by experienced personnel whose training included instruction on the various types of protection and practical ways to install, all relevant rules and regulations, and general principles for the classification of hazardous areas.

The main factors which are likelly to cause the alteration of equipment are:

– susceptibility to corrosion;
– exposure to chemicals and solvents;
– the possibility of accumulation of dust and dirt;
– the possibility of water ingress;
– exposure to excessive ambient temperatures;
– risk of mechanical damage;
– exposure to abnormal vibration;
– staff training and experience;
– the possibility of unauthorized changes and adjustments;
– the possibility of improper maintenance, is not in accordance with the manufacturer's recommendations.

Inspections are classified in degrees and types of inspection. A certain type of inspection is carried out with a certain degree of inspection.

The types of inspection are: initial and periodical.

The grades of inspection are: visual, rigorous, detailed.

Visual inspection is the inspection that identifies without the use of auxiliary equipment and tools, those alterations of the equipment that can be identified visually.

In an electrical installation which operates in an explosive atmosphere, during the visual inspection apparatus is checked if it corresponds to the area classification, identification of the circuits is available, the enclosure, windows and the gaskets and/or sealing materials are suitable, there are no authorized visible modifications, screws, cable entries (direct and indirect) and the closing elements, if any, are of the correct type and are complete and tight, no apparent damage to the cable, the sealing columns, tubes, pipes and / or ducts is satisfactory, connections to ground, including any additional connections linking the equipotential to the earth is satisfactory (for example connections are tight and conductors are sectional sufficient, the apparatus is suitably protected from corrosion, weathering, vibration and other harmful factors, there is no abnormal accumulation of dust and dirt.

Rigorous inspection is the inspection that includes aspects covered by visual inspection and, in addition, identifies those defects, such as loose screws, which can be distinguished only by the use of access equipment (where required) and tools.

Detailed inspection is the inspection that includes the aspects covered by rigorous inspection and in addition identifies those defects that can be revealed only by opening the enclosure and / or when necessary using tools and test equipment.

All visual and rigorous inspections can be carried out with the equipment being energized. Detailed inspections generally requires the equipment to be de-energized.

Before the installation or equipment to join the service, it must be subjected to an initial inspection on a regular basis and then re-inspected to ensure that the installation is maintained in a satisfactory condition for further use in a hazardous area.

The initial inspection is the inspection provided for all devices, systems and electrical installations before commissioning, in order to verify the type of protection chosen and the conditions of installation to be appropriate. Initial inspection must be carried out with a detailed degree grade of inspection.

The results of the initial inspections must be recorded for all equipment.

A periodic visual inspection or rigorous inspection can show the need for a detailed inspection. It may not be easy to accurately predict a periodic inspection at an appropriate range.

The interval between inspections and the degree of the inspection should be determined taking into account a number of factors which exert an influence on the electrical apparatus, such as the type of equipment, the factors likely to cause damage to the equipment, the results of previous inspections carried out.

The time interval between inspections shall not exceed three years without requiring the consultation of an expert. However, if the equipment is supposed to be permanently supervised by experienced staff, the time intervals between inspections can be increased or inspections can be removed if this is explicitly allowed by the rules and relevant regulations.

The results of all periodical inspections must be recorded.

Inspection survey is applied to a certain fraction of installed equipment. These can be visual, rigorous and detailed. The size and composition of all the samples shall be determined depending on the purpose of the inspection.

Survey inspections should aim to finding defects of random nature (*e.g.* Loose connections), and should be used for monitoring the effects of environmental conditions, vibration, inherent design deficiencies, etc.

Survey results of inspections must also be recorded.

When an electrical apparatus is installed in areas where there may be an atmosphere caused by flammable gas, vapor or mist concentration and dangerous quantities protective measures have to be applied in order to reduce the likelihood of explosion due to the ignition by sparks, arcs or hot surfaces in normal operation or specified fault conditions.

The general condition of all appliances must be established periodically by the application of inspection specified and if necessary appropriate remedial measures shall be taken. Current actions taken to preserve the functionality status of fully installed equipment is called maintenance. It should be considered, in particular, maintaining the integrity of type of protection required for equipment.

Spare parts must comply with documentation for safety.

Electrical equipment located in a hazardous area can be adversely influenced by ambient conditions in which it is used. Some of the key elements to be considered are: corrosion, ambient temperature, ultraviolet radiation, water penetration, accumulation of dust or sand, mechanical effects and chemical aggression.

Corrosion of metals or the influence of chemicals (especially solvents) of the components of plastics or elastomers, can affect the type and degree of protection protections device.

If the enclosure or component is severely corroded, the affected part has to be treated by a suitable protective coating against corrosion, frequency and nature of such treatment being determined by the ambient conditions.

Screws, bolts and similar parts on which the type of protection, only to be replaced with similar parts in accordance with manufacturer's project.
Damaged gaskets must be replaced.

If maintenance is required for the purpose of removal from service of the equipment, exposed conductors must be fixed in a certified enclosure. Alternatively the cable can be adequately protected by isolation and separation of the ends of the cable conductors from all supply sources. If the equipment has to be permanently withdrawn from service, associated wiring must be removed or alternatively, properly fixed otherwise, in an enclosure.

Where screws or other fasteners or special tools have been provided, they must be available and should be used.

It has to checked that the electrical equipment has been designed to withstand the effects of ambient temperatures, of the highest and the lowest values that can be encountered in service.

Personnel in charge with the operation of these facilities operating in explosive atmospheres must be familiar with the requirements of all applicable standards, recommendations of all codes of practice, have access to all information necessary for the examination, if necessary, to use equipment and test procedures similar to those used by authorized bodies.

It is the responsibility of the user of the plant facility, to properly install, use and maintain the integrity of the equipment used in explosive atmospheres during its lifetime. Neglecting the following issues may cancel the type of protection and although this can’t be controlled by the manufacturer of the equipment, they are reported to the user as being crucial: to install the equipment correctly, taking into account the manufacturer's instructions to use equipment only in atmospheres for which it was certified, to operate the equipment only within the technical parameters with which it was designed, to limit the uncontrolled increase in temperature of the components of the equipement that may be heated excessively.

2. Conclusions

Explosion proof equipment, unlike ordinary industrial equipment, is designed having in mind two categories of technical features, which are incorporated:

1º One category of technical features, which are strictly related to the proper functioning of the equipment, from the technical point of view (for example, in the case of an electric motor, particular characteristics such as: torque, power, number of revolutions, etc., are of interest), the maintenance of which affects the way in which the equipment carries out its designed role in the technological installation in which it performs. Generally speaking, this category of technical features is well taken care of by the user of the equipment, although they are not directly related to the explosion protection provided by the equipment, but with the proper functioning of the equipment in the installation, from the technical / technological point of view.

The user reacts very quickly when one of these technical features is altered and takes immediate action to restore it to the innitial values, taking into account that the alteration of these features affects the proper functioning of the technological installation directly.

2º A second category of technical features, which are specific only in the case of explosion protected technical equipment, and which are related only to the explosion protection provided by the equipment. The alteration of these features (parameters) is not as obvious to the user, as in the previous case, since these parameters are not related to the proper functioning of the equipment from the technological point of view, but only from the explosion protection point of view.

That is the reason why, in many cases, the user leaves the maintenance of these parameters on a secondary level, and in some circumstances tries to restore them to a proper level when it is already too late.

Having in mind these conclusions, it is of paramount importance for the users of explosion protected technical equipment to subscribe to the importance of ensuring a proper maintenance, especially of these technical characteristics which are related to the explosion protection provided by the equipment.
This is achieved by having in mind the provisions underlined in the specific standards that deal with inspection and maintenance of Ex-proof equipment SR EN 60079-17 and SR EN 60079-14, as well as during the trainings organized on a regular basis by the National Authority in this field INSEMEX Petrosani, with the companies that operate with technical instalations in potentially explosive atmospheres.

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ÎMBUNĂTĂȚIREA NIVELULUI DE SECURITATE ŞI SĂNĂTATE ÎN MUNCĂ PRIN IMPLEMENTAREA CORECTĂ A PROGRAMELOR DE INSPECȚIE ŞI ÎNTREȚINERE A ECHIPAMENTELOR ELECTRICE DE PUTERE ÎN CONSTRUCȚIE EX CU TIP DE PROTECȚIE CAPSULARE ANTIDEFLAGRANTĂ „d” ŞI SECURITATE MARITĂ „e”

(Rezumat)

Inspecția reprezintă acțiunea care cuprinde examinarea minuțioasă a unui echipament electric efectuată fie fără demontare, fie cu demontare parțială, după caz, suplimentată cu mijloace cum ar fi măsurătorile, pentru a se ajunge la o concluzie sigură privind starea echipamentului în cauză. Întreținerea reprezintă o combinație a tuturor acțiunilor întreprinse în scopul de a menține sau a restabili un obiect în condițiile în care acesta este apt pentru a întruni cerințele specificațiilor relevante precum şi a îndeplini funcțiunile lui prevăzute.

Lucrarea prezintă cele mai importante aspecte care trebuie luate în calcul la efectuarea inspecțiilor şi întreținerii echipamentelor electrice utilizate în medii explozive cu tip de protecție capsulare antideflagranta „d” şi securitate marită „e” pentru a asigura funcționabilitatea tipului de protecție a echipamentelor si funcționarea în condiții de siguranță.

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TECHNICAL AND ORGANIZATIONAL MEASURES OF SAFETY WORK IN ELECTRICAL INSTALLATION FOR YOUNG ELECTRICIANS (II)

BY

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Abstract: The paper it's the result of the studies and researches based on the courses and programmes for qualification or/and improvement for persons from companies and from partnership between EON Romania and Technical College "Dimitrie Leonida", Iaşi , where the future electricians take contact with work conditions and the task of the work.

The need arises to achieve a set of technical and organizational measures of safety work specified of this work task and to revise the existing measures.

For young electricians who doesn't have practical or professional experience in this domain it's necessary to know this kind of technical and organizational measures of safety work in electrical installation.

The main of technical and organizational measures of safety work relate at how to work in electrical installation without removal under voltage, to execute maneuvers in electrical installation and how to react in emergency situation.

This set of technical and organizational measures of safety work appeared like a necessity because many companies standard are modified, Individual Equipment Protection are more performance and the working procedures are evaluated.

Keywords: safety work; electrical installation; electriciens.

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1. Introduction

The paper with the title “Technical and Organizational Measures of Safety Work in Electrical Installation For Young Electricians (II)” it’s the result of the studies and researches based on the courses and programmes for qualification or/and improvement for persons from companies and from partnership between EON Romania and Technical College “Dimitrie Leonida” Iaşi, where the future electricians take contact with work conditions and the task of the work.

In initialy phase of form at young electricians they must to know very well and corectly all the measures and rules specific of their duties, because any misbehaviour from this could go easily to the death.

2. Technical and Organizational Measures of Safety Work in Operating Electrical Installation, Whitout Removal under Voltage

(1.1)Execution of works whitout removal under voltage in operating electrical installation is allowed in situation where:

a) Work area it’s situated at a greater distance than limit deviation (distance of neighborhood) estabilished.

The measures of limit deviation (distance of neighborhood) are based on type of the nominal voltage of the installation who are under voltage and the type of installation. This must to be:

In case of lower voltage installation (including aerial power lines), that distance of neighborhood isn’t standard, but it’s strictly forbidden to directly touch pieces of her who are under voltage.

In case of installation or part of installation who have solid, liquid or gas electrical isolation covered with screen (metallic coatings), related to earth (cables, bus ducts, equipment with hexaflorura sulfur, etc.) or with insulating plates for electrical separation, distance of neighborhood isn’t standard, but the screens related to earth or electrical boards who are isolated could be touch directly in time of work and must to take additional technical measures as per (2).

b) Work area or part of that who are under the limit deviation (distance of neighborhood) regard of pieces of electrical installation under voltage it’s taken additional technical measures as per (2) from this technical and organizational measures of safety work.

c) limit deviation it’s limited between electrical installation where the voltage are removed and are made electrical separation, but aren’t related to earth and additional technical measure must to be taken:

– For work under limit deviation (distance of neighborhood) regard of the pieces of electrical installation who are under voltage must to take the following technical measures:

- to identify the installation (the place) where must to work;
- to verify visual the continuity of related to the earth at the metallic parts who ussualy doesn't must to be under voltage;
- to verify the the lack of electrical voltage, in case, at the metallic pieces of installation from the future work area (metal poles, metallic shelvings of distribution panels, doors of distribution boxes, supply line, etc.) by using the low-voltage detector;
- installing mobile electrically insulating materials, in case;
- the material delimitation of the work area, as appropriate, and the installation of security signs;
- taking measures to avoid non-electrical accidents;

d) The task it's made directly to electrical installation who is under voltage and it's taken technical measures as per (7) and (8) article from present instructions.

(1.2) The responsible of operating unit must to approve the list of tasks who are must to be made under voltage and the work form in base of:

- From an organizational point of view, the works in the electrical installations in operation must be executed in the base of:

- work permit (AL-ro, WP-eng.);
- internal technical instructions for labor protection (ITI-PM-ro, ITI-LP-eng.);
- Service duties (AS-ro, SD-eng.);
- the verbal provisions (DV-ro, VP-eng.);
- records (PV-ro, R-engl.).

(1.3) Works in electrical installation and equipment who are under voltage must to be execute only by electrician authorized for work under voltage.

(2) For works made at the distance more than limit deviation (distance of neighborhood) regard of the pieces of electrical installation who are under voltage must to take the following technical measures:

- to identify the installation (the place) where must to work;
- to verify visual the continuity of related to the earth at the metallic parts who ussualy doesn't must to be under voltage;
- the material delimitation of the work area, as appropriate, and the installation of security signs;
- taking measures to avoid non-electrical accidents.

(3) When it's work at the distance more than limit deviation (distance of neighborhood) at pieces of electrical installation under voltage, it's strictly forbidden:

a) to unmount permanent enclosures or to pass the limit;

b) to escalade the post air processing,on the support of voltage equipment and on the permanent enclosures.

(4) When it's work directly on the parts of electrical installation under voltage (by the service or maintenance staff), using the "in contact" method, this must to base like organization form ITI-PM (ITI-LP-eng.) or AS (SD-eng.), else who are using the "potential" method, must to have at the base like organizational form ITI-PM (ITI-LP-eng.) made in conformity with technological instructions specified to every task.

(5)-(5.1) To execute tasks under low voltage must to realize the next technical measures:

a) To identify the installation (the place) where must to work;

b) To verify visual the continuity of related to the earth at the metallic parts who ussualy doesn't must to be under voltage;

c) To verify the the lack of electrical voltage, in case, using the low-voltage detector;

d) Making the material delimitation of the work area, as appropriate, and the installation of security signs;

e) Taking measures to avoid non-electrical accidents;

f) To assure area behind and sides by the responsible and staff members isn't have unprotected parts who are under voltage and to estabilish a safe work area to make safe movements;

g) To use special devices and tools for work under voltage.

(5.2) To execute tasks under high voltage it's necessary the electricians must to have special authorization;

(5.3) Electricians must to have individual protection equipment (EIP-ro., IPE-eng.) at their work place, devices and protective aids specified in this technological measures;

(5.4) When it's use car mechanical scale, to avoid the danger when accidentally it's touch elements under voltage, electricians must to use electric insulating gloves, electric insulating shoes and safety helmet, when they go up and down on the scale and when they manipulate the scale.

(6)-(6.1) When it's work on electrical installation under voltage with potential, must to realize next technical measures:

a) To identify the installation (the place) where must to work;

b) Taking measures to avoid non-electrical accidents;

c) To use specially electric insulating devices and tools.

(6.2) To execute tasks under voltage with potential it's necessary the electricians must to have special authorization.

(6.3) In case when the tasks are made to a electric air line under high voltage, must to be out of order for function all automatic reanchoring installations, all the time when it's worked.

(6.4) When it's work on electric air line under high voltage and she is anchoring by protection, she wouldn't reconnect if isn't know the reasons for what she is anchoring and if that it's made from the area where it's worked.

(6.5) Electricians must to have individual protection equipment (EIP-ro., IPE-eng.) at their work place, devices and protective aids specified in this technological measures.

3. Surveillance of Electrical Installations

Control of electrical installation

(7) – (7.1) Control of electrical installation it's made by one or two electriciens.

(7.2)In the following situation control must be made by two electriciens:

a) electrical installation with higher risk area or specific risk;

b) underground electric installations where the access it's made from hatch;

c) outside electrical installations (electrical air line) in night time or lower visibility (blizzard, storm, fog, torrential rains).

(8) – (8.1) When electricians make control on electrical installation under high voltage who are located inside, the door must be closed and blocked from inside by the electricians do not allow other person access, but must be assure quick access outside. In the dark or night must be use the lamp or other light sources.

(9) – (9.1) In time when it's made the control it's forbidden:

a) To make other tasks;

b) removing permanent limitations of electrical installations;

c) climbing poles of the electrical line;

d) climbing on structure of electrical equipment.

(10) Electriciens who participate at rigging must to use individual protection means, in this way:

- To identify electrical installation, to verify the lack of voltage, link to earth and in short circuit, to be assured by the staff.
- Electriciens who made technical measures for lack of voltage in electrical installations (electrical separation, verify the lack of voltage, link to earth and in short circuit) must to use the follow individual protection equipments, guiding by the principle "at least twice electrical protection means in series on the same way of electrical current, possible to be crossed, in case of accidentally direct touch": helmet head protector with face protection visor, electrical insulating protective gloves,handle with arm protection sleeve for handling low voltage fuses type HPR (MPR-ro, High Power of Roof – eng.), thermo-resistant fabric costume, electrical insulating shoes or electrical insulating carpet, electrical insulating pole.
- In case of electrical equipments where the factory have their own instructions and individual protection means will be respect those.

(11)- (11.1) Maneuvres for engagement and disengagement for circuit breakers mount on trolley must to respect the follow conditions:

a) use of helmet head protector,electrical insulating protective gloves and electrical insulating shoes;

b) to use only the device made specially by the factory for this operation.

(11.2)It's strictly forbidden to manipulate the high voltage fuse who are under voltage.

4. Safety Work Measures at the Tasks in Case of Disturbances (Emergencies) in Electrical Installations

(12) The tasks made to prevent or to repair in case of disturbances (emergencies) must to be made by the operative electricians of this electrical installations, based on the Service duties(AS-ro, SD-eng.) in base of the work contract.

(13) When it's work at tasks to prevent or to repair in case of disturbances (emergencies) must to respect technical measures specify for this tasks according of this instructions.

(14) - (14.1) It's strictly forbidden to work at the crowning of overhead low voltage electrical lines from poles made by metal, wood, concrete without removal of under voltage.

(14.2.1) When you up and down to height the electricians must to be assured permanently by fall from height in function by the type of support who use to climb (pole, stairs, scaffold, shelves, transformer, etc.) and the characteristics of them, the work place (console, ruler, isolator, etc.) and the tools existing.

(14.2.2)Against fall down from height when make movements to ascending and descending electricians must to be assured with a belt positioning compose with two cords (one with fix length - 2 meters and one with adjustable length).

(14.2.3) Where the electrical installation permit, electricians could:

a) to use a complex safety belt composed with a descending protection system who is coupled with a sliding slide stop;

b) To anchor from the ground, with help of a special pole, flexible anchoring support to a mechanical resistant situated at the high and to couple the sliding slide stop to that;

c) To ascend using the three points method (two hands and a foot or two feet and a hand) using for acces the bolts from metallic poles or the holes from concrete poles, supported stairs or hooks with rubber or rubber swabs;

d)To protect against fall down with a means for positioning (rope with fixed length or adjustable length) before made any movements who need to use hands in other scop until ascending-descending (to put a retractable block fall down or to move the flexible anchor or to execute tasks).

The midlle length of the positioning with or without adjusting device must to be choose or adjusted in the way in case of fall down do not be more than 0,5 meter.

e) To repeat operations from b), c) and d) until finish his ascending.

Second electrician who ascending to help must to use his own sliding slide stop who is fixed at the flexible anchor support.

It's forbidden to use the same anchor support by two or many electricians in the same time.

(14.2.4) In case it's used a simple stair or extensible stair based on the ground, electrician must to assure

firstly the stair against overthrow and sliding.

(14.2.5) In case of horizontal displacement at height to work when it's an anchor point mechanical fixed situated above of work place electrician must:

a) to anchor from these point a retractable sliding slide stop with a connection piece.

b) To couple the end of the stopper cable to the dorsal or front ring from his own complex belt.

c) After this operation when the electrician it's assured could move horizontally (on the console, ruler, etc.) on his work place (isolater, conductor clamp, etc.)

(14.2.6)) In case of horizontal displacement at height to work when it isn't an anchor point mechanical fixed situated above of work place electrician must to use one of the methods:

a) to be assured against fall down from a console located to a electric air line pole must to use a connection point between with a rope with fixed length or adjustable length coupled at the two lateral rings from complex belt;

b) Using two connection devices (ropes) with fixed length, or adjustable, coupled at one of lateral ring from positioning belt who electrician must to pass successive and alternate over (among) the spaces from console, ruler etc. in the same time he make the movement to work place.

For all three situation must to use those connection means who have adjustable length or fixed length smaller then 0,5 meter.

(14.2.7) When must to pass from stair to the pole console and back, including when the work it's made from the stair, electrician must to be assured against fall down.

(14.2.8) It's strictly forbidden to execute extension from the stairs supported by earth.

(14.2.9) Electrician who execute tasks from tow stair (stairs on wheels with manually actionary) must to be assured against fall down.

(14.2.10) The stairs with electricians at work doesn't be moved.

(14.3) Tasks who are made above to a console located to a low voltage electric air line who is under voltage, must to be execute from cart of the car or from car stair.

(14.4) When execute tasks under voltage at the canopy of low voltage electric air line poles, must to verify the lack of voltage with a voltage detector or with a measuring device. If it's detected voltage must to power off the voltage and to fixed the fault who put under voltage the console with taken all necessary measures of safety work specified of this type of task.

(15)In the follow cases the tasks must to be execute with power off the voltage:

a) Elements who are repaired it's located between electrical phase from low voltage line;

b) Coultn't respect the minimal neighborhood distances from the high voltage lines on the common poles;

c) Existing of others dangerous conditions for electricians who work.

(16) Work at canopy of overhead power lines located on wood poles or concrete poles who are visually damaged it's allowed to work only from the cart of the car, from car stair or from the stair.

In this case the poles must to be fixed with support devices or anchor devices.

(17) When it's work at the night time or in low visibility conditions, the place must to be lighting, on the road must to use road signs, reflective triangles and also flashing light on the cars.

(18) At outside electrical installation when it's heavy rain, blizzard, fog, low temperatures, it's allowed to work only in case of repair the disturbances (emergencies), but with the condition to be assured with safety equipments, devices and measures necessary for this situation. When it is athmospherical discharges it's not allowed to work.

(19) - (19.1) Connection of the mobile generator group at the low voltage electrical installation must to be realize after a separation of the electrical installation who must to be powered.

(19.2) For repair the failure at the generator group must to be made after the visual separation across the low voltage electrical installation who is connected and with primary engine stopped, blocked with a key.

5. Conclusion

For young electricians who doesn't have experience or practical training in this domain it' s more than necessary to learn and know technical and organizational measures of safety work in electrical installation. In this way the paper "Technical and Organizational Measures of Safety Work in Electrical Installation for Young Electricians (II)" is a necessity for future electricians to familiarize with the terms like: work permit (AL-ro, WP-eng.), internal technical instructions for labor protection(ITI-PM-ro, ITI-LP-eng.), service duties(AS-ro, SD-eng.), the verbal provisions(DV-ro, VP-eng.), records (PV-ro, M-engl.), limit deviation (distance of neighborhood), identification of installation, limitation of the work area, visual verification, to verify the lack of voltage, individual protection equipment, to take all measures to avoid electrical and nonelectrical accidents.

Also, young electricians must to know the way and the measures required to control electrical installations depend of risk area, emplacement, the time when it's execute the tasks and atmospheric conditions.

Maneuvres in electrical installation will be execute strictly in a certain order and must to respect all rules and specific measures of this type of work.

In case of work at height will be follow strictly technical and organizational measures of safety work in electrical installation for this kind of task, type of stairs used, handling instructions of the stairs, also how to use anchor devices and fastening ropes and to assure the electrician who work at the height.

This measures will be always reviewed and completed, depend of the appear of new risks, tehnological evolution of individual protection equipment and internal safety work rules from companies.

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MĂSURI TEHNICE ŞI ORGANIZATORICE DE SECURITATE ŞI SĂNATATE ÎN MUNCĂ LA LUCRĂRILE ÎN INSTALAŢIILE ELECTRICE PENTRU TINERI ELECTRICIENI (II)

(Rezumat)

Lucrarea este rezultatul studiilor şi cercetărilor realizate în baza cursurilor şi programelor de calificare sau/şi perfecţionare a personalului din companii şi a parteneriatului dintre EON România şi Colegiul Tehnic ”Dimitrie Leonida” Iaşi prin care viitorii electricieni iau contact cu condiţiile de muncă şi sarcina de muncă.

Apare necesitatea stringentă de a se realiza o serie de măsuri tehnice şi organizatorice SSM specifice şi de revizuire a celor existente.

Pentru tinerii electricieni care nu au o experienţă practică sau profesională în domeniu este necesar să cunoască măsurile tehnice şi organizatorice SSM de bază la executarea lucrărilor în instalaţiile electrice.

Principalele măsuri tehnice şi organizatorice SSM se referă la execuţia lucrărilor în instalaţiile electrice fără scoaterea de sub tensiune, executarea manevrelor în instalaţiile electrice şi a lucrărilor în cazul incidentelor (deranjamentelor).

Aceste măsuri tehnice şi organizatorice SSM au apărut ca o necesitate datorită modificării standardelor companiilor de profil, a evoluţiei EIP şi a procedurilor de lucru.