UDC 621
CODEN: MINSC5
In print: ISSN 1857 – 5293
On line: ISSN 1857 – 9191

MECHANICAL ENGINEERING SCIENTIFIC JOURNAL

МАШИНСКО ИНЖЕНЕРСТВО НАУЧНО СПИСАНИЕ

Special Issue – Специјално издание

BON TON in Safety and Health

БОН ТОН ВО БЕЗБЕДНОСТ И ЗДРАВЈЕ ПРИ РАБОТА

Volume 33
Number 3

Skopje, 2015

Mech. Eng. Sci. J.	Vol.	No.	p-p.	Skopje
	33	3	215–288	2015
Маш. инж. науч. спис.	Год.	Број	стр.	Скопје

MECHANICAL ENGINEERING – SCIENTIFIC JOURNAL
МАШИНСКО ИНЖЕНЕРСТВО – НАУЧНО СПИСАНИЕ

Published by
Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia
Издава
Машински факултет, Универзитет „Св. Кирил и Методиј” во Скопје, Република Македонија

Published twice yearly – Излегува два пати годишно

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UDC: "St. Kliment Ohridski" Library – Skopje	УДК: НУБ „Св.. Климент Охридски“ – Скопје
Copies: 300	Тираж: 300
Price:10 €	Цена: 620 денари

Address
Faculty of Mechanical Engineering
(Mechanical Engineering – Scientific Journal)
Editor in Chief
P.O.Box 464
MK-1001 Skopje, Republic of Macedonia

Адреса
Машински факултет
(Машинско инженерство – научно списание)
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МК-1001 Скопје, Република Македонија

Mech. Eng. Sci. J. is indexed/abstracted in INIS (International Nuclear Information System)
www.mf.ukim.edu.mk

MECHANICAL ENGINEERING – SCIENTIFIC JOURNAL
FACULTY OF MECHANICAL ENGINEERING, SKOPJE, REPUBLIC OF MACEDONIA

МАШИНСКО ИНЖЕНЕРСТВО – НАУЧНО СПИСАНИЕ
МАШИНСКИ ФАКУЛТЕТ, СКОПЈЕ, РЕПУБЛИКА МАКЕДОНИЈА

Mech. Eng. Sci. J.	Vol. **33**	No. 3	p-p. 215–288	Skopje 2015
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PREFACE

In the period from 29 to 31st of October 2015 in Ohrid, Macedonia, it was organized the first International Conference on Regional Cooperation "BON TON in safety and health" – by the University "Ss. Cyril and Methodius" in Skopje, Faculty of Mechanical Engineering, the Macedonian Occupational Safety and Health Association andAssociation for Safety at Work "28th of April" as the initiators and the Macedonian Association for lifts, "Ss. Kliment Ohridski" Bitola, International Slavic University – Sveti Nikole, PROGENS – Skopje, Association for Occupational Safety and health from Montenegro and the Institution of Occupational Safety and Health (IOSH) from UK.

The goal of this conference is determining the directions and focuses of the future researches and developments in occupational safety and health throughout exchange of theoretical and practical experiences. Throughout establishing of relation between the OSH institutions, there will be continuous collaboration between all OSH stakeholders in order to develop a culture of prevention in the field of safety and health at work.

The papers were in the area of legislation, inspection, audits and assessments of high-risk jobs, impact of chemical, biological and physical hazards, analysis of injury and occupational diseases, stress on the work place, rehabilitation of injured employees and their come back at the workplace, professional risk management, impact of the climate change, efficient electronic systems for record keeping, risks in construction industry, analytical and simulation methods for risk assessment, security systems in risk industries, costs and insurance systems for OSH, modern software for ergonomic design of the workplace etc. All papers are published in the conference proceedings on the web site of the conference: www.balkanoshconference.org

In the edition of the Mechanical Engineering Scientific Journal, are published just a few papers aside noticed as important topics in the field of occupational safety and health. We hope readers will find these articles useful and interesting in creating of their safety working places.

From the Organizational Committee

Prof. PhD. Jasmina Čaloska

ПРЕДГОВОР

Во периодот од 29 до 31 октомври 2015 година во Охрид, Република Македонија, се одржа Меѓународна Конференција за регионална соработка: **БОН ТОН во безбедност и здравје при работа** – во организација на Машинскиот факултет при Универзитетот "Св. Кирил и Методиј" во Скопје, Македонското здружение за заштита при работа, Здружението за безбедност при работа "28 Април", како иницијатори, и Македонското здружение за лифтови, Универзитетот "Св. Климент Охридски" од Битола, Меѓународен Славјански Универзитет, ПРОГЕНС од Скопје, Здружение за заштита при работа од Црна Гора и Институтот за безбедност и здравје при работа од Велика Британија.

Целта на конференцијата беше преку размена на теоретските и практични искуства да се утврдат насоките на идните истражувања и изградат ефективни практики во динамичниот систем на управување со ризици на работното место. Преку воспоставување на релации помеѓу соодветните институции, да се овозможи континуирана соработка помеѓу сите чинители со цел развивање на култура на превенција во областа на безбедност и здравје при работа.

Трудовите беа од областа на законодавството, инспекцискиот надзор, процени и ревизии на проценки на ризик на високоризични работни места, влијание на хемиските, биолошките и физички штетности, анализа на повреди и професионални заболувања, стрес на работното место, рехабилитација на повредените или заболени вработени и нивно враќање на работното место, управување со професионалниот ризик, влијание на климатските промени, ефикасни електронски системи за водење на евиденција, ризици во градежништвото, аналитички и симулациони методи за проценка на ризик, безбедносни системи во ризични дејности, трошоци и осигурување во системите за БЗР, современи софтвери за ергономски дизајн на работните места итн. Сите трудови се објавени во Зборникот на конференцијата објавен на web-страната на конференцијата: www.balkanoshconference.org

Во изданието на научното списание Машинско инженерство, се објавени само неколку издвоени забележани трудови на значајни теми од областа на безбедност и здравје при работа. Се надеваме дека читателите ќе ги препознаат овие трудови како корисни и интересни за креирање на нивните безбедни работни места.

Од Организацискиот одбор

Проф. д -р Јасмина Чалоска

Number of article: 493
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 221–225 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 005Ч331.45

Original scientific paper

INTEGRATION OF LEAN PRINCIPLES AND SAFETY MANAGEMENT SYSTEM

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A b s t r a c t: The development of fast growing competitive company in modern days is unthinkable without implementation of set of procedures regarding quality, safety, environmental impact, and efficiency. Especially in case of requirement for internationally recognized standards, managers often in order to increase the effectiveness in tangible results, are implementing philosophies and standards one at a time, instead of setting overall goals and implement integrated system that will cover the joint requirement. This paper presents the integration of Safety Management System (SMS) and Lean Manufacturing (LM), in terms of 5S and 6S principles. The presentation of the Lean principle and tools, along with its influence over different aspects of the company's performance form one side, and the SMS from the other is showing the field for integration of the implementation.

Key words: lean manufacturing;, safety management systems; 5s; 6s; workplace organization; environmental management

ИНТЕГРАЦИЈА НА „ЛИН"-ПРИНЦИПИ И СИСТЕМ ЗА УПРАВУВАЊЕ СО БЕЗБЕДНОСТ ПРИ РАБОТА

А п с т р а к т: Развојот на брзорастечките конкурентни,современи компании е незамислив без имплементација на сет процедури за квалитетот, безбедноста при работа, заштита на животната средина и ефикасноста. Особено кога станува збор за меѓународни стандарди, менаџерите со цел да ја зголемат ефективноста во поглед на опипливите резултати, имплементираат филозофии и стандарди една по една, наместо да постават повисоки цели и да имплементираат интегриран систем кој ќе ги задоволи заедничките потреби. Овој труд ја претставува интеграцијата на Системот за безбедност при работа (СБР) и „Лин" производството. Претставувањето на „Лин" принципите и алатките, заедно со неговото влијание врз различните перформанси на компанијата од една и СБР од друга страна, покажува простор за интеграција на имплементацијата.

Клучни зборови: „Лин"-производство; систем за безбедност при работа; 5S; 6S; организација на работно место; управување со заштитата на животната средина

INTRODUCTION

In the competitive business environment today, the concepts of Lean Manufaturing offer an opportunity to gain a competitive edge in production, services and all processes. In such company, a lean team set about changing its work area to cut out the sources of waste and improve productivity, following two concepts: to "lean out" the system and to "lean out" the safety.

Lean Manufacturing (LM) refers to a business concept wherein the goal is to minimize the amount of time and resources used in the manufacturing processes and other activities of an enterprise; its emphasis is on eliminating all forms of wastage. Health and safety hazards can actually be increased by LM because it mixes previously separated exposures and this has additive and cumulative effects. The intensification of work leads to higher plant productivity and to greater ergonomic and stress-related health effects for workers [1, 2, 3].

The 5S Process (Sort, Set in order, Sweep, Standardize, Sustain), or simply "5S", is one of the

most effective tools of LM because it is a basis for an effective Lean implementation. The 5S practice was initiated in the manufacturing sector in Japan and then extended to other industries and the services sector [1]. The 5S Process is a structured program to systematically achieve total organization, cleanliness, standardization and discipline in the workplace. A well-organized workplace leads to a safer, more efficient and more productive operation. It leads to boost the morale of the workers, promoting a sense of pride in their work and ownership of their responsibilities and increases an organization's profitability and competitiveness in the market place.

A key to workers' safety in LM operations is the development of informed, empowered and active workers with the knowledge, skills and opportunity to act in the workplace (5S) to eliminate or reduce hazards [1]. Shah and Ward [3] point out that those safety strategies are crucial for world-class competitiveness; companies that fail to utilize a strategic approach to company safety will be less successful over the long term.

Recently, 5S was expanded to 6S by the addition of "Safety". This paper discusses the 5S expansion to 6S as one of the most important tools and techniques of LM that focuses on effective workplace organization and standardized work procedures. The 6S process simplifies the work environment, reduces waste and non-value-adding activities, while improving quality, efficiency and safety. The aim of this study is to evaluate safety in LM approaches and Safety Management Systems (SMSs) and clarify the relationship between them.

This paper is organized in following six sections. Section 2 summarizes approaches to LM. In Section 3, workplace organization (5S and 6S) is introduced. The relationship between LM and Environmental Management Systems (EMSs) is discussed in Section 4. In Section 5, the SMSs are introduced and this section concludes with comparisons between SMS and LM. The final section (6) discusses and presents a conclusion of the paper.

LEAN MANUFACTURING

Lean Manufacturing is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer and internal variability [6]. It is a production philosophy that emphasizes the minimization of the amount of all resources used in various activities of the enterprise. It involves identifying and eliminating non-value-adding activities in design, production, supply chain management (SCM) and customer relationship management. Lean manufacturers employ teams of multi-skilled workers at all levels of the organization and use highly flexible and increasingly automated machines to produce volumes of products in potentially different variety.

More and more companies of all kinds and sizes have introduced lean manufacturing into their operations using processes such as 5-S, Kanban, Kaizen, Value Stream Mapping (VSM), Visual Control, Poka Yoke, TPM etc. While the primary goals may be to decrease waste, increase quality and reduce costs, the companies, their management and their employees also find benefits from improved safety. Considering the efficiency of the implementation of LM in manufacturing processes [3, 6, 7], the various aspects needed to sustain a successful LM implementation program should be analysed. As a result, the LM program may be viewed as a failure in the early stages of implementation [6]. The more successful the implementation is, the more rapid is the reduction rate of waste. Identifying waste begins with understanding the different forms of waste. In the Toyota production system seven forms of waste have been defined: over-production, waiting, transporting, over-processing, inventories, moving and defective parts.

Lean identifies wastes (over production, waiting/idle time, unnecessary transportation, non-value-added processing, unnecessary stock on hand/excess inventory, motion and efforts, defects/producing defective goods etc.) and applies tools and techniques (workplace organization, Kanban, Just-In-Time (JIT), Total Quality Management (TQM), minimizing total preventive maintenance, standardization of work, point-of-use-storage etc.) to optimize systems [3, 4]. These wastes are commonly referred to as non-valued-adding activities and for Lean practitioners these account for up to 95% of all costs in non-LM environments.

5S METHODOLOGY

5S (Sort, Set in order, Sweep, Standardize, Sustain) is a workplace organization tool that improves worker efficiency by organizing the contents of the work area and standardizing work pro-

cedures and it is a method of creating a self-sustaining culture that perpetuates an clean and efficient work place [1].

6S (5S + Safety) is a method used to create and maintain a clean, orderly and safe work environment. 6S is based on the five pillars of 5S in LM, plus a separate pillar for safety [5]. The first five of these elements were taken from the Toyota Management System (TMS) but the sixth 'S' was added to emphasize safety in the workplace [5]. Besides, 6S is often the first method companies implement in their Lean journey because it serves as the foundation of future continual improvement efforts [7]. This tool allows workers to be able to know and find tools easily, file the tasks conveniently and save time spent on looking for things.

The six lines of 6S work together to support improvement efforts in a company. They help reduce defects, reduce costs and increase productivity (Table 1). Also, 6S fosters a culture of continual improvement and employee engagement that is essential for successful implementation of Lean. 6S often makes it easier to implement other Lean methods such as one-piece flow and JIT production. The visual impact of a 6S makes the improvement it produces impossible to miss and this creates a real sense of achievement that can form the beginning of a more significant cultural transition [6].

Table 1

Six lines of 6S

No	Line	Definition
1	Sort/Get rid	Separate what is needed or not needed in the work area
2	Set in order/Organize	Organize what remains in the work area
3	Sweep/Clean and solve	Clean and inspect the work area
4	Safety/Respect workplace and employee	Create a safe place to work
5	Standardize/Make consistent	Standardize cleaning, inspection and safety practices
6	Sustain/Keep it up	Make 6S a company's philosophy

6S is a tool of LM whose value is easily understood with the concept of "a place for everything and everything is in its place". Also, another great quality of 6S is that it is doubly enabling for employees: it enables people to be free of aggravations that hinder their work and it is a positive way to involve people in improving their own work settings [5].

LEAN MANUFACTURING AND ENVIRONMENT

Lean is a process improvement methodology widely used in industry that focuses on identifying and eliminating wastes to improve productivity and reduce costs. Lean wastes include delays caused by transportation or waiting for the next production step, defective products, excess inventory and unnecessary movement or processing. If environmental wastes, such as wastes created during production, are considered, then Lean methodology can also be used to achieve environmental objectives [8].

An Environmental Management System (EMS) is a management framework for reducing environmental impacts and improving organizational activities relevant to environmental performance by helping to identify and to act through improvements [8]. EMSs provide organizations with a structured approach for managing environmental and regulatory responsibilities to improve overall environmental performance. An EMS helps an organization better integrate the full scope of environmental considerations and get better results, by establishing a continuous process of checking to ensure achievement of the environmental goals. The framework is based on a plan-do-check-act continual improvement approach that leads an organization through a regular cycle of planning, implementation, performance monitoring and review/improvement.

LEAN MANUFACTURING AND SAFETY MANAGEMENT SYSTEMS

A SMS (Safety Management System) reflects the organization's commitment to safety and it is an important ingredient in employees' perceptions about the importance of safety in their company [7, 9, 10]. The purpose of SMS is to help organizations tackle occupational safety and health challenges continuously and improve control on factors influencing health and safety. The Occupation Health and Safety Assessment Series (OHSAS) 18001 is intended to help organizations control occupational health and safety risks. It was developed in response to widespread demand for a rec-

ognized standard against which to be certified and assessed. LM is more efficient and productive than traditional manufacturing systems, it also concentrates health and safety hazards in small areas where large-scale engineering controls of hazards in spread-out assembly lines are frequently no longer possible. The concept of a safe working cycle that is similar to 5S, is one management tool in LM that can be used to solve difficulties in different aspects of the production systems and it is connected to achieving the safety workplace. A key factor for maximum productivity and optimal worker safety in LM operations is informed workers with the knowledge, skills and opportunity to act in the workplace to eliminate or reduce hazards.

Analysis of the research addressed to both safety and lean concepts yield very little information. Persons formally trained in the concepts of lean are respond that safety is an integral part of the 5S process and that to exclude safety concerns is inconsistent with lean concepts. The same can be said about persons formally trained in safety, their solutions to minimizing risk will appropriately address productivity concerns. Integration of both approaches can be optimal, aspect developed by ANSI Technical Report [13].

The analysed literature [9, 12] suggests 14 elements in SMS: Safety policy; Safety organization; Safety committee; Safety promotion; Safety training, In-house safety rules and regulations; Program for inspection of hazardous conditions; Job hazard analysis; Accident investigation; Process control program; Evaluation, selection and control of sub-contractor; Emergency preparedness; Health assurance program; and Personal protection program. These 14 elements define the processes that form the frame of a SMS. For SMS, there are four main elements: safety policy, safety risk management, safety assurance and safety promotion (Table 2) [9].

A hazard is any activity, situation or substance that can cause harm. Occupational hazards are divided into two broad categories: (1) health hazards and (2) safety hazards. Generally, health hazards cause occupational illnesses, such as noise-induced hearing loss and safety hazards cause physical harm, such as cuts, broken bones etc. According to different authors [10, 11, 12], the major factors in the creation of hazards in companies are: employees demotivation, lack of or unclearly defined working procedure and tasks, lack of control, lack of instructions or appropriate training, unsafe worker behaviour, low management commitment to safety, etc. All these factors can be defined in SMS and can be controlled in LM environments.

Table 2

Elements of a safety system [7, 9]

Elements	Functions
Safety Policy	Providing a fundamental approach to manage safety adopted within an organization Safety Risk Management with identifying the hazards, assessing, analysing and controlling the risk
Safety Assurance	Making sure that organizational products/services meet safety requirements
Safety Promotion	Combining safety culture, training and data sharing activities that support the implementation of an SMS in company

ANALYSING SIMILARITIES IN THE SMS AND LM IMPLEMENTATION PROCEDURES

In literature [9], there are pointed five lines of systematic safety in SMS: planning and documentation, managing and organizing, checking and assessing, analysis and evaluation, information and motivation. In the Table 3, there are compared the SMS approach with the LM approach, there are find the connections between noted pillars of SMS are common LM tools.

Table 3

A comparison between SMS and LM

5 Pillars of Systematic Safety in SMS	Lean Tools and methods
Planning and documentation	Plan (Deming Cycle)
Managing and organizing	Do (Deming Cycle) and 5S
Checking and assessing	Check (Deming Cycle) and 5S
Analysis and evaluation	Act (Deming Cycle) and 5S
Information and motivation	MIS (Management Information Systems) and tools of motivation

CONCLUSION

The LM in its philosophy is focusing on maximization of usage of all available resources (eliminating wastes) which increases the health and safety hazard, and vice-versa. The intensification

of work through LM leads to greater ergonomic and stress related adverse health effects, as well as increased safety hazards. On the other hand, the safety prevention is often including organizational aspects that are decreasing the productivity and efficiency.

To overcome these problems, through the integration of safety into the Lean Principles, companies can achieve health and safety protection through 6S and other methods, and still manage to increase their competitiveness in the market place and decrease the environmental impact.

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Number of article: 494
CODEN: MINSC5
Received: September 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 227–232(2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 614.878.027.1

Short communication

INTERACTIVE MODEL FOR INCREASING SAFETY AND ERGONOMICS IMPROVEMENT WHILE WORKING WITH HAZARDOUS CHEMICAL SUBSTANCES

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A b s t r a c t: In this paper is presented an interactive model for increasing safety and ergonomics improvement while working with hazardous chemical substances. The main purpose of the model is to reduce existing risks on the workplaces where hazardous chemicals are processed and to improve working conditions, leading to healthier, more efficient and more humane workplaces. The nature of the chemical substances is such that if all prescribed rules for proper handling are not respected and implemented, their presence at workplaces increases the existing risk. With use of the interactive model for increasing safety and ergonomics improvement while working with hazardous chemical substances, all critical points in the working systems are detected. Recommendations are also generated, giving clear and precise guidelines on how to overcome the shortcomings found. The model performs risk assessment through appropriately selected methods, depending on the nature of the current situation.

Key words: model; modules; risk assessment; hazardous chemicals; ergonomics

ИНТЕРАКТИВЕН МОДЕЛ ЗА ЗГОЛЕМУВАЊЕ НА БЕЗБЕДНОСТА И ПОДОБРУВАЊЕ НА ЕРГОНОМИЈАТА ПРИ РАБОТЕЊЕ СО ОПАСНИ ХЕМИСКИ СУПСТАНЦИ

А п с т р а к т: Во овој труд е претставен интерактивен модел за зголемување на безбедноста и подобрување на ергономијата при работење со опасни хемикалии. Целта на моделот е да се намалат постоечките ризици каде што се ракува со опасни хемиски супстанци, а воедно да се подобрат условите за работа, што води кон поздрави, поефикасни и похумани работни места. Природата на опасните хемиски супстанци е таква што нивното присуство при работењето го зголемува постоечкиот ризик, доколку не се почитуваат и спроведуваат сите пропишани правила за соодветно ракување. Со имплементација на интерактивниот модел за зголемување на безбедноста и подобрување на ергономијата при работење со опасни хемиски супстанци, се детектираат критичните точки во работните системи, а со предложените препораки кои се генерираат, се даваат јасни и прецизни насоки како истите да се надминат. Со моделот се врши и проценка на ризикот преку соодветно избрани методи, во зависност од природата на моменталната состојба.

Клучни зборови: модел; модули; проценка на ризик; опасни хемиски супстанци; ергономија

INTRODUCTION

Workers whose work activities involve handling dangerous chemicals must adhere strictly to the principles and procedures for safe operation. Due to the great risks and dangers that are constantly present while handling hazardous chemicals, many systems and instructions for safe operation are developed. Basic information about the safe handling of various substances is listed on the material safety data sheets (MSDS). It is a short list containing basic information about the proper and safe handling and storage, displayed on each chemical by its manufacturer. The list shows the basic information about the product, explosive and flammable hazards, reactivity, toxicity, preventive measures and first aid measures in case of an acci-

dent occurs. However, practice shows that these data are not sufficient to prevent the side effects, which can not only seriously harm the health of the worker, but the consequences can be much wider, such as collective accident and environmental pollution.

All employers and employees have an obligation to obey the laws related to the removal, reduction and prevention of risk in the workplace. When it comes to handling chemicals, in every country there are certain standards, legislation and regulations. Due to high risk of these jobs, the risk assessment must be carefully performed, and appropriate preventive measures must be proposed and implemented, reducing the illicit risk and protecting the health of the workers.

While working with hazardous chemicals, dangers and hazards are present not only where they are processed or manufactured, they are also present in all other places where the chemicals go through to eventually became or be incorporated in the final product [1]. They appear in their transport, their storage, as well as their distribution and recycling. This is why the model for increasing safety and ergonomics improvement while working with hazardous chemical substances covers all the aspects in order to detect and prevent the smallest existing risk.

The purpose of the model is to increase safety through communication with users to detect critical points in the working system which can be potential risks and also to give recommendations for overcoming the shortcomings.

The interactive model is a tool for preventing serious side effects, whose boundaries can range from individual accident, endangering collectively, to environmental or natural disaster. The information contained in the model are regulated from the international regulations for Safety and Health at Work (OSHA, CCOHS, EU OSHA, WHS / OS & H, WHMIS), but not regulated by statute in our country with regulations and standards and there are no legal obligations for their implementation. In the model are implemented all obligations which are governed by the "Law on Safety and health at work" within the Republic of Macedonia and all specific regulations concerning handling hazardous chemicals.

Important part of this model is the ergonomic aspect of the working environment, which has a significant impact on fatigue, injuries, precision and the possibility of error occurrence. Examples of some ergonomic principles are given on Figure 1.

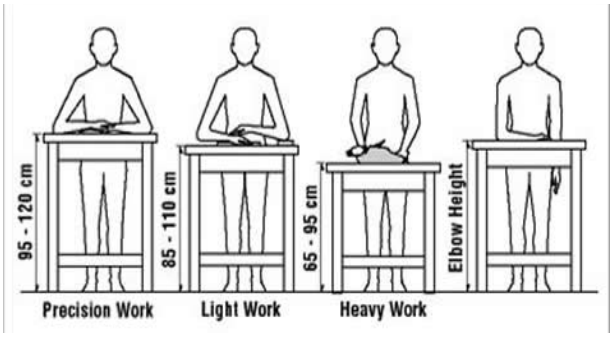

Fig. 1. Ergonomic working heights

The effects of exposure to hazardous substances can be instant or to reappear in the longer terms in form of eye irritation or chronic lung diseases. Some of the hazardous effects on health caused by chemical substances are:

- Skin burns or irritation due to contact with the corrosive fluid (Fig. 2);
- Dizziness or complete loss of consciousness inhalation of toxic fumes;
- Occurrence of acute symptoms, such as headache or nausea during inhalation;
- Poisoning by absorption of toxic substances through the skin;
- Asthma;
- Dermatitis;
- Cancer that appears after years of working with toxic substances;
- Genetic damage to offspring as a result of extensive work with mutagenic substances and so on [2].

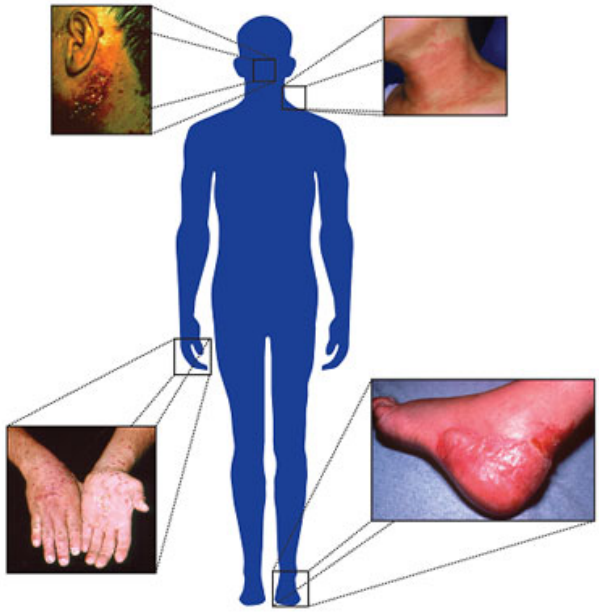

Fig. 2. Skin exposures and effects

Employers must adhere to strict rules of operation because all of the above mentioned hazardous effects may occur in workplaces where chemicals are involved. Workers also must daily comply with security measures.

Some chemical substances are considered as dangerous not only because of their molecular structure, but also for the form in which they are used [5]. For example, if aluminium is used in powder form, then it is an explosive substance when it spreads in the air and therefore it is necessary to take preventive measures [7]. In order to detect all critical points which may cause errors, individual or collective accidents it is essential to proceed with a detailed analysis of workplace and work activities, including the broader working environment.

The chemical industry and all industries that involve handling dangerous chemicals have high occupational risk, where individual error easily turns into collective accidents [6].

USED METHODOLOGY

A quantitative method is used for integrating the information into a model for practical application. Algorithmic links are made to the program modules, in order to get a tool that will lead to increase safety. The model can be used in all industries where hazardous chemical substances are being processed.

The created model uses the relational databases. While collecting data and creating databases, three classes objects come across: entities, attributes and relationships between entities. An entity is a set of real-world objects that have some common characteristics or properties. The properties of an entity are called attributes. Therefore, attributes describe the entity, while relationships are associations between entities [3].

Relational databases are based on the mathematical term “relationship”. n-ary relation on the set A is each subset of Cartesian product (A×A×A) (*n* times). The database is set of tables, and each table is a relation. For a precise description of the operations performed on the data in the relational database it is necessary to apply the appropriate mathematical apparatus, which are the algebraic relations. Using algebraic relations results a connection between the description of the data provided by the user and the description of the conceptual model on the data base. Any relation in the base has a name that distinguishes it from other relationships in the database and consists of rows and columns. Rows (syllables) in relation are subordinate n-tuples. Each column in relation represents a value of the attribute for a specific entity. For every relationship a key is defined and that is the minimum set of attributes which determines the relation [4].

Many existing semi - quantitative methods are used for quantifying the risk, depending on the current situation, available information and the type of risk that is estimated (KINNEY, PILZ, OHSAS, AUVA and BG, GUARDMASTER, FINE). The choice of appropriate method provides adequate implementation of the proposed measures leading to safe workplace environment, working with a small probability of occurrence of occupational diseases and injuries of employees.

Microsoft Access is used for creating models databases. Microsoft Access is one of the most competent tools for creating such and similar solutions.

STRUCTURE OF THE INTERACTIVE MODEL FOR INCREASING SAFETY AND ERGONOMICS IMPROVEMENT WHILE WORKING WITH HAZARDOUS CHEMICAL SUBSTANCES

Working with hazardous chemicals requires detailed organization of work systems where all aspects of operations must be precisely defined. In the model, the following hazardous chemicals are included: oxidizing, corrosive, toxic, flammable and combustible, explosives, compressed gases and reactive, also the conditions for handling them all. There symbols are given on Figure 3..

Fig. 3. Symbols for hazardous chemicals

For each group there are different rules for handling, storage, protective equipment, training, medical tests, first aid, dealing with accident etc.

Therefore, the model makes detailed analysis of all aspects of working with each group of chemicals, where considered:

1. The training which the worker must pass (different for each group of chemicals)
2. Medical tests that the employer must provide for the workers (different for each group of chemicals)
3. Microclimate conditions in working environments (different for each group of chemicals)
4. The ergonomics of the workspace organization
5. The ergonomics of working movements (repetitive movements work with one or two hands, working postures, etc.).
6. All ergonomic principles which reduce injuries, fatigue and diseases of workers (time to recover, loads and weights, loads of different muscle groups)
7. The method of handling (different for each group of chemicals)
8. Type of storage (different for each group of chemicals)
9. Working equipment (different for each group of chemicals)
10. Personal Protective Equipment (different for each group of chemicals)
11. The dangers and hazards (different for each group of chemicals)
12. Cleaning of chemical substances (different for each group of chemicals)
13. The disposal of waste (different for each group of chemicals)
14. Actions in case of accident (different for each group of chemicals)
15. First aid (different for each group of chemicals)
16. Legislation

For each of these items there are set of rules that must be respected and applied in daily work with dangerous chemicals. They are thoroughly explored from the world's international associations and organizations for occupational safety, such as OSHA, WHMIS, AICHE, NIOSH and others. Despite international standards and rules, a detailed examination is made on the obligations imposed by the Ministry of Labour in Macedonia. Some of them are: "Regulations on minimum requirements for safety and health of workers from the risks related to exposure to chemical substances" (Official Gazette, no.46 / 2010), " Regulations of personal protective equipment used by workers at work "(Official Gazette, br.116 / 07)," Regulations of safety signs and Health "(Official Gazette, No.127 / 07),"Regulations on minimum requirements for safety and health workspace "(Official Gazette, No.154 / 08)," Rulebook on minimum requirements for safety and health of employees who are potentially at risk from explosive atmospheres "(Official Gazette, no.74 / 2009) "Regulations on safety and health at work of employees from risks related to exposure to carcinogens, mutagens or substances toxic to reproduction" (Official Gazette, No.110 / 10), etc.

In order to avoid the risk of side effects which can be fatal for workers health and its surroundings there is specific way for properly operation for each group of hazardous chemicals. Therefore, the model, through its complex connections and large number of data, is composed of several modules, whose content exceeds more than 1000 different conditions.

The model consists of several different modules:

1. **Module for worker** (competence, education, gender, experience, age, medical tests, training etc.).
2. **Module for workplace**, depending on whether it comes to handling or storage of the chemical, shared on laboratory and warehouse. (Depending on the type of the workplace, the module checks whether all safety measures are taken. It analyzes the temperature, humidity, light, vibration, compatibility of materials, devices, tools, etc.)
3. **Module for ergonomics** (a detailed analysis of the organization of the working space is performed, which determines whether it is necessary to make corrections to improve the ergonomics. It also analyses loads, movements, fatigue, breaks and all other ergonomic factors that affect the welfare and health of the worker)
4. **Module for dangers and hazards** (assess whether workers are familiar with the dangers and hazards that may arise when handling chemicals)
5. **Module for Personal Protective Equipment** (analysing the proper use and maintenance of personal protective equipment in all different groups of hazardous chemicals)
6. **Legislation** (checks whether all the obligations are obeyed - placing signs, limiting

exposure, providing two exits where needed, setting faucets and showers etc.).

After the user's selection, in terms of used chemical, user fills data relating to the arrangements in the storage, way of handling, known hazards, safety at work, training, organization of workplace and environment etc. In order to get these results created databases are interconnected in the model. By using the information for chemical characteristics, the model can assess risk, thus it will check if the operation is carried out to the recommendations arising from the various chemicals. This means that for all chemical groups, the model makes verification whether the appropriate tools are being used, whether the employee has passed all necessary training, whether the chemical is stored in a proper way, what protective equipment is used, what activities are performed etc. The output of the model locate all critical points arising from users inputs and thereby it makes recommendations to reduce the risk of all influential factors in the employment system (training, storage, handling, protection, maintenance, ergonomics, etc.).

Despite the recommendations that the model will generate, simultaneously it will also determinate the level of risk, through the most appropriate method for a given situation depending on the probability of occurrence and consequences of the risk.

The choice of the appropriate method is made by experts in the field of risk assessment, so that substantially reduces subjectivity in the evaluation. The risk of jobs is determined by two aspects. **The first aspect relates to the health and safety at work**, depending on the chemical included in work. This includes training, storage, handling, safety equipment, microclimate conditions of the working environment (noise, vibration, drafts, lighting, temperature, etc.). **The second aspect relates to the ergonomics of the workplace and work tasks**. This means that assesses the ergonomics of the movements, body postures of the worker, duration and frequency of tasks, loads and weights, heights of work surfaces, work organization, equipment operation (machines and tools) etc.

For each identified shortage, the model generates a recommendation to overcome them. Through the application of the recommendations generated by the model, the risk will be reduced to an acceptable level, the jobs will be safer for operation, the ergonomics of tasks and jobs will be improved, and the productivity will increase. The model covers all measurable factors that affect the safety and good health of the worker, and any other factors that may affect the occurrence of error.

CONCLUSIONS

We are facing the larger use of chemicals in different sectors. Despite in the chemical industry where they are the final product, these materials are used in construction, mining, food industry, pharmaceuticals etc. The presented model can be implemented in all those industries working with chemicals that may not only seriously jeopardize the health of employees, but also causing ecological disaster.

The model covers all influential factors in the workplace and work environment, working activities and tasks, working assets, including the worker.

By using the model, the existing risks are reduced and recommendations for safe operation are simultaneously generated. With its implementation all critical points of error occurrence are eliminated.

Ergonomics is one of the most important factors affecting the fatigue and concentration of workers, which are most frequent causes for error occurrence.

With the implementation of the recommendations generated by the model, the jobs will be safer for the health of workers and the risks of error occurrence will be minimized.

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Number of article: 495
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 233–240 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 601.867.01-057.214:006.88

Original scientific paper

SAFETY RISKS DURING INSTALLATION, MAINTENANCE AND USE OF LIFTS

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A b s t r a c t: Vertical transportation is the safest transport compared to others; however, because of the enormous number of lift units, old lift stock especially in Europe, huge number of daily users, and significant number of employees in this sector, numerous serious harms and fatal accidents happen. The situation in Macedonia, although there aren't satisfactory statistics, is similar and perhaps even worse than that shown in the global averages. Nevertheless, there are few tools as standards, technical specifications, codes of practice, and other official documents, which integrated can improve the lift and escalator safety. The subject of this paper is to underline safety risks associated with installation, maintenance, modernization and use of lifts and possibilities and techniques of their reduction.

Key words: lift safety; standards; technical specifications; codes of practice; risk assessment; hazards

ОПАСНОСТИ ПРИ РАБОТА НА МОНТАЖА И СЕРВИСИРАЊЕ И ПРИ УПОТРЕБА НА ЛИФТОВИТЕ

А п с т р а к т: Покрај тоа што вертикалниот транспорт е убедливо најбезбеден споредено со другите видови транспорт, поради големиот број на лифтови во употреба, нивната висока просечна старост, посебно на територијата на Европа, енормниот број на корисници и големиот број на вработени во овој сектор, повредите се чести, а има и такви со сериозни и фатални последици. Покрај непостоењето на статистика, на Македонија, соодветствува светската статистика во оваа област, а во некои аспекти можеби состојбата е полоша. Од друга страна постојат повеќе алатки во вид на стандрадизациски документи чие користење може да помогне за зголемување на безбедноста на лифтовите. Предмет на овој труд е укажувањето на ризиците поврзани со работата на и околу лифтовите и нивното користење, како и можностите за нивни сведување на помало ниво или пак нивно елиминирање.

Клучни зборови: безбедност на лифтовите; безбедносни ризици; стандарди; проценка на ризик; опасности

LIFTS – CURRENT STATE OF THE ART

Abundance of Lifts

The present number of lifts that are in use worldwide is estimated at 12.000.000 with the rate of newly installed units of over 500.000 per annum. Less than half of these, or around 5.760.000 with an annual increase of a total of 124.000 units, account for Europe (The statistics of the number of lifts published by ELA for the period until 2014 inclusive was made based on incomplete data from 29 countries). The daily turnover of individual users, i.e., use of lifts – in the sense of individual trips (hereinafter referred to as "users") in Europe is estimated at about 1.000.000.000 and almost 4.000.000.000 worldwide. Hence, there is no doubt that the lift is one of the most frequently used transportation devices in the world.

It is only in EU that this economic branch employs around 152.000 people and since it is mainly based in the East, the total number of employees in this sector worldwide is multiply higher than that in Europe. The employees in this sector work in two main fields of activities: a) production and installation of new lifts and b) maintenance and modernization of existing lifts. Even 60% of the employees in this field are directly involved in field activities as are installation, servicing and modernization of lift equipment. In Macedonia, the number of employees in this economic branch is around 300.

Although vertical transport by lifts is far the safest in respect to any other transportation means, due to the large number of lifts in use, their average obsoleteness, particularly in Europe, the large daily number of users and the large number of employees in this sector who are at an increased risk at most of their working places due to the nature of their work, injuries happen frequently, sometimes with serious and fatal consequences. In the Republic of Macedonia, records on injuries on and near lifts (during work on lifts and their use) are not kept in any institution. There is no precise inventory even in respect to the number of lifts. The unofficial figure ranges between 8.000 and 10.000. Several statistic analyses of injuries at work and during use of lifts in the USA and EU could therefore be of an asistance and could serve in developing strategies for improvement of safety of lifts in our country and beyond.

Safety of lifts: USA and Europe

The latest study carried out by the Engineer Research and Development Centre in the USA and published in 2013 provides a detailed analysis of injuries and particularly fatalities during works on lifts and their use. In this study, data from the research and statistics carried out by the Centre were used. On the other hand, the Centre used, with a limited access, the data base of the U.S. Bureau of Labor Statistics referring to fatalities that happened in lifts and in their vicinity during work in the period 1992–2009 in which 263 fatalities on lifts and 8 fatalities on escalators are recorded. Data from the Consumer Product Safety Commission referring to injuries of passangers that happened during and beyond the working time in the period 1997–2010, were also used. According to the study, around 28 fatalities and 17.000 heavier injuries happen in the USA annually during work on or in the vicinity of lifts, or their use during and beyond the working time. Table 1 shows that 50% of the fatalities account for accidents during work on lifts or in their vicinity, around 20% account for users of lifts during working time and around 30% account for general users, i.e., users of lifts beyond the working time.

Table 1

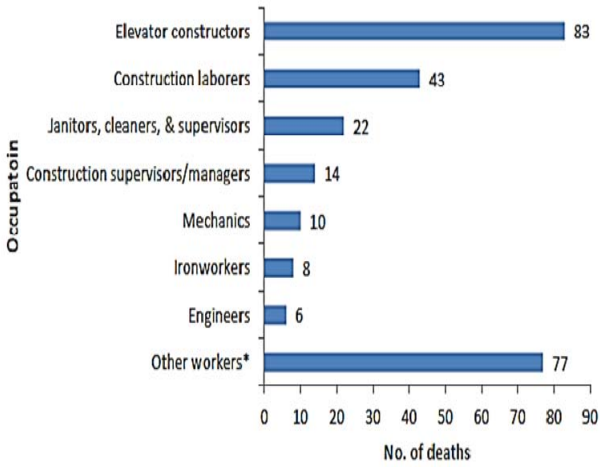
Average annual number of fatalities 1992–2010[a)]

	Lifts	Escalators	Total
Working on or beside a lift	15[b)]	0,4[b)]	15
Users during work	5[c)]	0,2[c)]	5
Users beyond work	5[c)]	2[c)]	7
Total	25	3	28[d)]

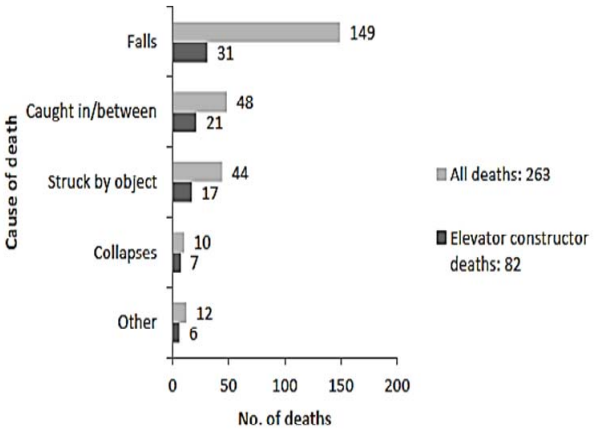
b). Data on fatal accidents according to CFOI (Census of Fatal Occupational Injuries) Research File 1992-2009 in conditions of limited access to data from the reports of the U.S. Bureau of Labor Statistics.
c). Additional data on fatal accidents obtained from CPSC – Consumer Product Safety Commission for the period 1997-2010.
d) Number 28 has been obtained by taking into account the real values of the addends, not their rounded off values.

Graph 1 shows that almost one third of the considered fatalities account for lift installers and repairers. Other professions present in fatal accidents related to lifts can be seen on the same graph. The most frequent reasons for the fatal outcome of the accidents suffered by professionals dealing with installation and repair of lifts as well as other professionals are given in Graph 2. Graph 3 shows the statistics of fatalities according to performed activities.

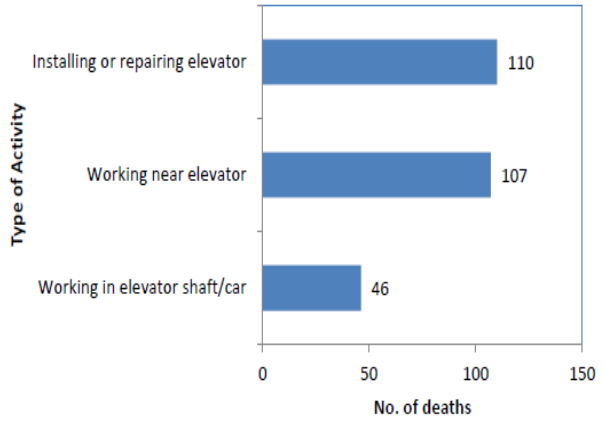
Graph 3 shows the statistics of fatalities according to performed activities.



Graph 1. Fatalities in the period 1992–2009 according to profession



Graph 2. Reasons for injuries with a fatal outcome



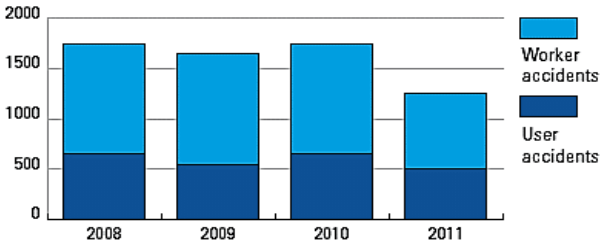
Graph 3. Fatalities according to activities performed at the critical moment

Installation and repair of lifts: The analysis of this statistics shows that almost ¾ of these 110 fatalities happened during installation or repair of lifts and involve lift installers and repairers. The remaining fatalities involve specialized technicians, engineers, construction supervisors, cleaners and other technicians. More than 1/3 of the fatalities happened due to falling into lift shafts affecting lift installers and repairers. Most of these installers and repairers were neither registered nor trained for such work. Almost 1/3 of these workers were trapped between (between two cabins in the same shaft, between a cabin and a counterweight, a cabin or a counterweight and the wall of the shaft), while 1/5 were smashed while working in the lift shaft, most frequently by a down sliding cabin during work in the shaft pit.

Work in the vicinity of a lift: Almost all of the 107 registered fatalities refer to construction workers and none lift installer or repairer. 49 of these fatal accidents (45 of these related to a fall in the lift shaft) happened due to unprotected openings of the lift shaft or due to their inappropriate fencing.

Work in the lift shaft or lift cabin: 46 fatalities belonging to this category happened during activities such as taking keys that have fallen into the lift shaft, cleaning of the interior of the lift shaft, repair of a stuck lift, falling of a cabin or a platform into the shaft pit [7].

On the other hand, the European national associations as is the leading European Lift Association ELA do not have the best statistics of those killed and injured in lifts. ELA has engaged an independent agency to collect information from national associations in the so called “black box” where data on accidents are stored without information on lift producers and repairers to encourage companies to provide such data by guaranteeing their anonymity. These data are necessary for getting a complete insight into the accidents related to lifts without which one cannot make a successful analysis and finally, successful improvement of safety. ELA, as well as some national associations as are the German VDMA and VdTÜV (VDMA - Verband Deutscher Maschinen und Anlagenbau and VdTÜV – Verband der TÜV), have some statistics on accidents and injuries (presented below), although incomplete as they allege. These refer to the total number of accidents with slight and heavy injuries as well as fatalities (Graph 4) according to which the most threatened are lift installers and repairers.



Graph 4. Incomplete data on number of injuries related to users and injuries that happened at working place in the period 2008–2009 in the EU countries

The reasons for these are given in two tables presented in the subsequent text (Tables 2, 3). The reasons for the accidents are classified according to the SNEL (Safety Norm for Existing Lifts is a frequently used abbreviation for the MKC EN 81-80:2008 standard.list of risks). According to this list, the most frequent reasons for accidents are inadequate devices for hanging/lifting of the

equipment in the machine room and the shaft, the unsafe access to the machine room and the lift shaft pit, absence of protective fence at delevelings in the machine room, etc.

Table 2

Main reasons for injuries at working place

Unsafe access to the machine room;
Inappropriate equipment for lifting and hanging of load;
Unsatisfying protection against electro-shock;
Unsafe access to the lift shaft pit;
Non-existence of protective fence at different levels – delevelings in the machine room;
Sliding floor in the machine room;
Sharp edges/objects;
Sliding, stumbling and falling;
Lack of appropriate tools.

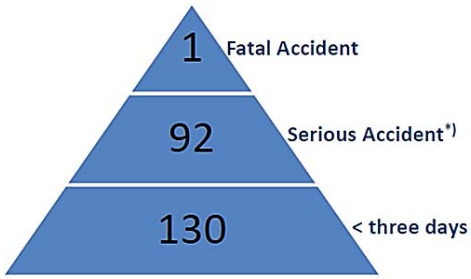
Table 3

Main reasons for injuries of users

Accuracy at stop points/inappropriate leveling;
Hindrances between the cabin and the door or the wall of the lift shaft;
Lack of protective devices on automatic doors;
Lack of cabin doors;
Problems with the lock on the lift shaft door;
Uncontrolled motion of the cabin;
Non-existence of a device for forced braking or speed regulator for electric lifts.

According to ELA, the ratio between accidents with fatal consequences and total heavy injuries ranges from 1/92 in the case of workers on lifts to 1/32 in the case of users (Pyramid 1 and 2).

Pyramid 1. Lift users – Number of heavy and slight injuries in respect to a single fatality case.



Pyramid 2. Injuries at work – Number of heavy and slight injuries in respect to a single fatality case.

Situation in Macedonia

In Macedonia, there have continuously been recorded injuries and, unfortunately, fatalities. Within only a year, there were 3 accidents with 4 heavy injuries and a fatality. The last accidents happened to lift installers, repairers and their superiors. Injuries happen each year. Fortunately, those that have happened lately have been of a slighter nature. As is the case in world frames, the fact that the workers directly involved in installing and servicing of lifts are the most endangered in this sector has also been confirmed in Macedonia. If the reasons for injuries and fatalities are considered, namely falling (collapse) of lift equipment and fall of employees into lift shafts, there is again agreement with the first stated reasons for accidents in the world (the most common reasons for fatalities are: fall into the shaft, smashing by or between the equipment, blow inflicted by equipment or tool, collapse of equipment and other reasons). On the other hand, fortunately, after the same period of four years, there hasn't been any more serious injury of users of lifts, or at least, none has been recorded. However, if the number of lifts in Macedonia and the number of accidents in this period are taken into account, the probability of occurrence of an accident and hence heavier injuries and injuries with a fatal outcome is greater than that in the EU.

POSSIBILITIES FOR IMPROVEMENT OF SAFETY OF LIFTS

Today, the expectations of the society in which we live in respect to safety are considerably high and the objective is to prevent accidents. This is also the motto of the European associations in this sector (Safety is No Accident). In addition to

the obligation referring to complete implementation and observation of the existing legal regulations by professional firms and lift owners, improvement of the safety of employees that are directly involved in installation, modernization and maintenance of lifts and those that work in the surrounding of the lifts can be achieved by integrated or parallel use and implementation of a number of standards, technical specifications, codes of practice and official manuals for safe work that are specially developed for this purpose. These tools may be simultaneously and independently used by:

1. State authorities during elaboration of the legislation in this field and its effectuation;

2. Specialized firms for: development, production, design, sale, installation, modernization and repair of lifts; and,

3. Owners of lifts.

All this, also anticipates an increased safety of everyday users.

Management of Safety Risks Pertaining to Lifts in Use defined in MKC EN ISO 14798:2013

MKC EN 81-80:2008 Standard – Safety Rules for Construction and Installation of Lifts - Existing Lifts – Part 80: Rules for Improvement of Safety of Existing Passenger Lifts and Lifts for Transport of Goods is a very powerful tool that is available. This standard was passed taking into account that, in Europe, almost half of over 5,5 million lifts are older than 20 years and are therefore less safe than the newly installed ones. The standard, first of all, refers to improvements and adjustments from technical aspects for the purpose of achievement of a technical level that will be approximately the same, in the safety sense, with that of the equipment manufactured in compliance with the latest standards. These adjustments have a positive effect as to the increase of safety of users, repairers and installers, people moving and working around the shaft or the machine room and of any other authorized person that has access to a lift and its vicinity. There have been defined 74 critical points referring to lifts, i.e., possible improvements that suggest phase by phase solution in compliance with the risk group. For the purpose of definition of the risk groups and the corresponding safety level, this standard refers to MKC EN ISO 14987: 2013 where three risk groups are defined as high, moderate and low. The latter contains description of principles and established procedures for consistent and systematic method of assessment of the risk pertaining to lifts, whereat safety is achieved through an iterative process. All this is conceptualized in 8 steps as follows: definition of reasons for making risk assessment, establishment of a risk assessment team, definition of the subject of risk assessment and the factors affecting it, identification of scenarios (dangerous situations, reasons as well as causes and effects), risk assessment, risk evaluation, response as to whether the risk has sufficiently been mitigated and definition of protective measures, i.e., reduction or possible elimination of the risk.

Depending on the expectations of a society in respect to safety, the established criteria for assessment (ethical), i.e., what is an acceptable risk and what is an unacceptable risk, as well as the economic power of that society, one can define which risks, with which priority and in which time frame will be reduced or eliminated. In any case, the risks in the highest priority group are the first to be treated and then the other risks (it is possible that some risk pertaining to heavy injuries be treated with a lower priority than another risk of slighter injuries which is in the first priority group due to its greater frequency of occurrence). The MKC EN 81-80:2008 standard therefore prescribes a procedure for identification of *dangers and dangerous situations* by means of check lists given in the annex to the standards that already contain the stated 74 dangerous situations. Through evaluation of the risks obtained by means of the risk assessment method given in the MKC EN ISO 14987: 2013 standard, one can define the so called risk profile, i.e., to which priority risk group a dangerous situation belongs. According to the recommendations given in the standard, this risk assessment should be made for each lift taken separately in order to define the risk group (high, moderate or low) of existing dangers and dangerous situations and start with gradual reduction or elimination of the risks. The main intention is to use MKC EN 81-80:2008 as the basis and guide in preparation of a national Rulebook that treats lifts in use (EU has no competence over the equipment in use, but it is the subject of national legislations), but also as useful documents and tools for the owners of lifts, maintenance firms and inspection bodies. Most of the EU countries have already implemented these in their legislations, while their application in France, Austria, Germany, Spain and Belgium has been the strictest and has already shown very good results. For example, in France, a programme for improvement of safety has been established and included in the local regulations by the support of the Government and the corresponding ministry. It is anticipated to last 15 years and be carried out in

three phases, each lasting five years. By detailed analysis of the conditions of existing older lifts, 31 risks have been selected from the standard. The elimination or reduction of 9 risks out of the selected 31 risks is anticipated to be carried out in the first phase (most of them refer to the safety of users), 6 and 2 risks are anticipated to be reduced or eliminated in the second and the third phase, respectively. The diagrams presented in the subsequent text (Diagram 3 and Diagram 4) show that injuries and fatalities were drastically reduced in the period up to 2012, while the same trend was kept until 2014. In France, there haven't been any injuries of users of lifts with fatal consequences already for 5 years. A considerable reduction is also noticed regarding the injuries at work.

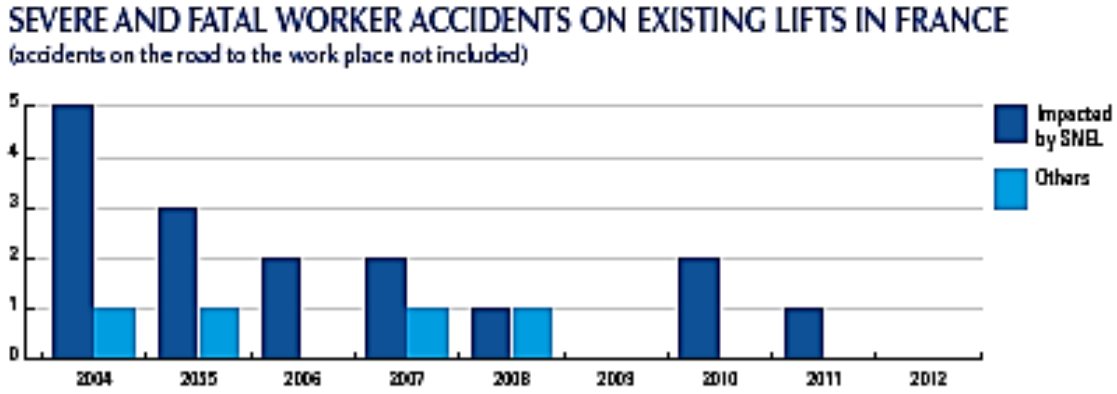


Diagram 3.. Injuries of repairers with heavy and fatal consequences on existing lifts in the period 2004-2012

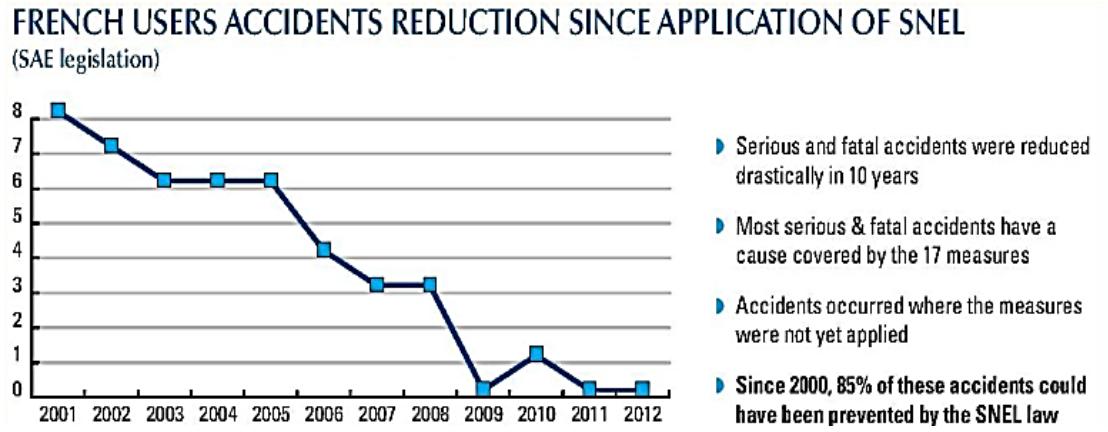


Diagram 4. Reduction of injuries of users after application of SNEL (EN 81-80)

Preparation of Procedures and Instructions for Maintenance of Lifts According to MKC EN 13015+A1:2009 and Use of Other Standardized Documents

High quality maintenance of lifts is the key moment for the total safety of lifts. To achieve a high quality level, MKC EN 13015+A1:2009 Maintenance of Lifts and Escalators – Rulebook for Maintenance Instructions is available. This standard lays down the minimal requirements and defines the rules for creation of instructions for maintenance, but does not define the obligations of owners and firms dealing with maintenance of lifts (in Macedonia, these obligations are defined in the Rulebook for Use of Passenger Lifts and Conveyors (Official Gazette no. 123/09). The standard refers only to establishment of maintenance procedures and is not intended for procedures for mantling/dismantling and making considerable changes involving replacement of the driving machine, the cabin or the controlling device as well as replacement of all safety components. It is also intended for preparation of instructions and maintenance procedures for legal entities that sell lifts on the market. Still, maintenance is a dynamic process that has to be carried out continuously throughout the entire serviceability life of the lift. It is there-

fore very important to apply the principles defined in МКС EN 13015+A1:2009 on existing lifts for the purpose of identification of dangers and taking actions for their reduction or elimination in order that they could satisfy the essential safety requirements defined in the European directives for lifts and machines that are transposed into our legislation. Prior to definition of the rules for preparation of the instructions, in the stated obligations of the maintenance firm, it is particularly emphasized that maintenance should be carried out by competent persons, qualified as to knowledge and practical experience and equipped with the necessary instructions, with support provided by the firm, for the purpose of safe performance of the tasks. If the conditions of work are not otherwise defined at national level, the company itself should have at least implemented and certified quality system ISO 9001 by application of the principles of this specialized standard for maintenance of lifts. For example, the German association VDMA, through its group of lifts and escalators, has issued a recommendation for increasing of safety of lifts in Germany, whereat two of the several main points refer to performance of risk assessment for each older lift by following the critical points in МКС EN 81-80:2008 and maintenance only by competent, trained lift repairers that work based on МКС EN 13015+A1:2009.

The main point of the standard is the procedure of preparation of maintenance instructions in which, in addition to the general statements, the elements that should be taken into account in their preparation are also defined along with all information that they should contain referring to the lift owner and the maintenance company. Further on, the standard calls for obligatory, previously performed risk assessment for each task anticipated in the maintenance instructions by use of a method complying with МКС EN ISO 14987:2013. It defines the obligations of the owner referring to rescue from a cabin in the case of lift defects, marking with additional labels, marks, pictogrammes or warnings if this arises from the risk assessment made by the maintenance firm and refers to its procedures transfused into instructions of work. It further defines the contents of the maintenance book and finally insists on use of the official language/languages of the country/the region in the preparation of the instructions, the maintenance book and the warnings. In the preparation of instructions and procedures for specific activities, the British Codes of Practice BS 7255:2012 Codes of Practice for Safe Working on Lifts could be of a great assistance. They refer to the safety aspects of all activities related to lifts (installation, regular maintenance replacement of important parts of lifts, replacement of safety devices, reconstruction and modernization as well as dismantling). This standard also includes activities in assessment of compliance and technical inspection of lifts and takes into account the risk pertaining to all persons that are authorized to access the lift equipment (controllers, inspectors). Further on, it includes the obligations of the owners of lifts, maintenance firms and all workers involved in the mentioned activities.

CONCLUSION

Considering the fact that a large number of lifts in our country are older than 20 years and their safety is low compared with the new generation of lifts, the competent state institutions have still not adopted a programme for improvement of the safety of older lifts in use, there are no criteria referring to quality of firms dealing with installation and servicing and there are no criteria regarding competence of workers involved in installation and servicing of lifts, the risk of occurrence of an accident is much greater than that in most European countries, which is unfortunately already evident. The developed standards and standardization documents are already yielding positive results where applied, which is sufficiently indicative for their application in our country, starting with system solutions of competent state authorities to solutions referring to firms in this sector and all of us that are involved in this sector in any other way. The final objective must be the motto of the European Association of Lift Industry – Safety is No Accident.

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Number of article: 496
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 241–245 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 005.52:005.334]:061.62

Original scientific paper

RISK ANALYSIS OF WORKING POSITIONS AT LABORATORIES

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A b s t r a c t: Because of the nature of the laboratory working activities, the employees engaged at laboratory working positions are exposed to various dangers and harms. As a result, the potential risk for occupational injuries and diseases is always present. The basic and key element for identifying the risk is recognizing the sources of dangers and harms which can affect the health of the laboratory employees. Risk identification is the basis for preparing a safe laboratory work strategy, which generally means implementing primary and specific rules for ensuring safe and healthy working environment for the employees. This paper presents the results of the conducted risk assessment of working positions at 15 (fifteen) laboratories in Republic of Macedonia. The laboratories included in the study are processing laboratories, chemical industry laboratories, mining industry laboratories, metallurgy laboratories, medical laboratories, food industry laboratories and researching laboratories. The risk assessment of the working positions is conducted according to the BG (Berufsgenossenschaften) method using the Nohl-Thiemeckeova risk matrix. The analysis result shows that more than ¾ of the laboratory working positions are with increased risk level.

Key words: risk; working position; harms; laboratories

АНАЛИЗА НА РИЗИЦИТЕ НА РАБОТНИТЕ МЕСТА ВО ЛАБОРАТОРИИТЕ

А п с т р а к т: Работните места во лабораториите, според самата природа на активностите што се извршуваат во лабораториите, претставуваат работни места на кои вработените се изложени на разни опасности и штетности. Како резултат на тоа потенцијалниот ризик за настанување на разни повреди и добивање на болести при работа е секогаш присутен. Појдовен и клучен елемент во идентификација на ризиците е препознавање на изворите на опасности, штетности и напори кои предизвикуваат повреди и болести на вработените во лабораторија. Идентификацијата на изворите на опасности претставува основа за изготвување на стратегија за безбедна работа во лабораторијата, што всушност значи примена на основни и посебни правила со кои се обезбедува здрава и безбедна средина за вработените. Во рамките на овој труд прикажани се резултатите од направените проценки на ризик на работните места во 15 (петнаесет) лаборатории во Р. Македонија кои се процесни лаборатории, лаборатории од хемиската индустрија, рудници (подземна, површинска експлоатација), металургија, медицински лаборатории, лаборатории од прехрамбената индустрија, истражувачки лаборатории. Проценката на ризик на работните места е направена со примена на BG (Berufsgenossenschaften) методата и Nohl-Thiemeckeova матрица за ризик. Добиените резултати од направената анализа покажуваат дека повеќе од ¾ од работните места во лабораториите се со зголемено ниво на ризик.

Клучни зборови: ризик; работни места; штетни фактори; лаборатории

INTRODUCTION

Every company, including laboratories as entities or as part of the company, is facing the challenges for providing healthy and safe working environment for the employees. Further, the health of the employees is linked with the increased working productivity and with the increased company profit. Laboratories are covering a wide range of economic sectors, such as: industry, trade, energy manufacturing, environmental protection and other.

The working conditions at the laboratory often produce a risky working environment.

The laboratory employees' safe and health is extremely important for meeting the basic working principles:

– the employees must deliver accurate and objective testing results according to the international standards and
– the employees must not put in danger their own safety and the safety of their colleagues.

The occupational safety and health at the laboratory is permanently under the influence of the following factors:

1) the type of the analysis that are performed at the laboratory
2) the impact from the client for the quality and the deadline for obtaining the testing results and
3) the impact from the employer.

For this reasons the occupational risks and the corect risk management are often ignored.

This is a serious problem and for these reasons most of the laboratories are preparing guidelines with standard instructions for safe work at the laboratory.

The objective of the guidelines is to provide the employees with the necessary safety instructions for proper behavior while handling the samples and operating with the equipment.

The concept for safe work at the laboratory is based on reliable safety procedures for ensuring safety from the existing sources of danger and harms.

The equipment and the chemicals used for testing the samples are often sources for danger and the activities at the laboratory are often stressful for the employees so they can provoke accidents and injuries.

Basic rule for every laboratory is to provide working space, equipment and possibilities for performing the analysis with optimal capacity, quality and safety.

The risk assessment of laboratory working positions conducted by the occupational safety and health experts at Tehnolab includes working positions from processing laboratories, chemical industry laboratories, mining industry laboratories, metallurgy laboratories, medical laboratories, food industry laboratories and researching laboratories

USED METHODOLOGY

Injuries and diseases are not occurring by themselves, they are always caused by some reason (some thing or somebody) and they should not happen if there are no existing sources of danger and harm.

Existing danger at the laboratory is a condition which can threaten and violate the health of the employee.

Occupational harms are harmful factors existing in the working environment with specific characteristics that can cause bad effects to the health of the employees.

The occupational risk is a possibility for occurring injuries, diseases or health problems as a result of the existing dangers and harms. In order to remove or decrease the risk on time it should be correctly identified.

In the laboratory the risk is present during all of the laboratory phases:

– prior to the analytical phase (sampling and admission of the samples);
– analytical phase (proper and safe sample testing) and
– post analytical phase (delivering results), as well as safely disposal of the analyzed sample and produced waste.

Different types of testing performed at the laboratory are causing different dangers during sampling. The most common are: working on heights, mechanical impact, working with sharp objects, exposition to biological harms (infective reagents), electrical current dangers, exposition to atmospheric effects and radiation.

During the analytical phase the most common dangers are: inhaling of chemicals and harmful gases, burns, biological harms (allergens and infective reagents), bacteria, viruses, radiation, dangers caused by containers with high pressure (explosion, fire or mechanical impact), physical harms (noise, illumination, microclimatic conditions and working with monitors), incorrect body position and physical and physiological efforts

For each identified and registered danger and harm the risk assessment is made by:

– analysis of the expected probability for occurring an injury or health condition (disease),
– weight analysis of the possible effects to the health of the employees caused by the working position type and characteristics of the working environment.

The risk assessment is conducted using the BG (Berufsgenossenschaften) method and Nohl-Thiemeckeova risk matrix (5 times 5) which predicts 5 possibilities for occurring of the disease or injury and 5 groups of possible diseases and injury types.

According to the BG method, the risk range (P) is defined as product of work position weight

and the possibility (B) for occurring the relevant harmful effect.

$$\text{Risk } (P) = \text{Weight } (T) \times \text{Possibility } (B)$$

The weight of the harmful effect for the employees' health can be in the range from light injury to lethal injury, and the occupational disease can be in the range from light injury (not affecting the health) to disease with terminal health effect which can limit the life activities (lethal disease).

The expected possibility of occurring an injury or disease can be in the range from "unlikely to happen" to "happens without doubt".

Regarding the urgent and priority measures, the risk level is defined as following:

– Low risk, no additional safety measures should be planed or implemented, the current condition should be maintained.
– Increased risk, safety measures should be planned and implemented in the period of one or two years.
– Medium high risk, safety measures should be planned and implemented in the next 6 months.
– High risk, safety measures should be planned and implemented in the next month,
– Especially high risk, the working process should be stopped and safety measures should be implemented immediately.

RESULTS AND DISCUSSION

The risk assessment study is conducted for working positions at 15 laboratories with different scope of analysis. During the study 35 working positions with 128 employees were analyzed. Some of them are:

– manager of the laboratory
– engineer in charge of quality
– engineer in charge of the laboratory
– engineer for laboratory testing
– engineer for biotechnology
– laboratory technician
– chemical technician
– technician for sample preparation
– medical laboratory technician
– shift analyst and
– independent laboratory technician.

According to the conducted risk assessment of the working positions in the laboratories, the most common dangers and harms are analyzed.

The results are given in Table 1. The results from Table 1 are shown on Figure 1.

Table 1

Most common dangers and hazards at laboratory working positions

No.	Type of danger/harm	Percentage of occurrence at the analyzed working positions (%)
1.	Incorrect body position: long term sitting or standing	100,00
2.	Exposition to direct contact with electrical current or high voltage equipment	100,00
3.	Responsibility	95,24
4.	Inhaling dust and harmful gases	80,95
5.	Working with monitors	76,19
6.	Exposition to direct contact with hazardous chemicals and reagents	76,19
7.	Using of equipment which can cause explosion or fire	71,43
8.	Physiological load: stress	52,38
9.	Noise	52,38
10.	Sliding or stumbling	52,38
11.	Mechanical injury from sharp	42,86
12.	Working with high pressured containers	42,86
13.	Visually sensor loads	33,33
14.	Working in shifts, night work	28,57
15.	Exposition to rotating and moving parts	28,57
16.	Biological harms: exposition to infective reagents	19,05
17.	Manual transport of load	14,29
18.	Violence at work, medical workers	9,52
19.	Exposition to direct contact with hot surfaces	9,52

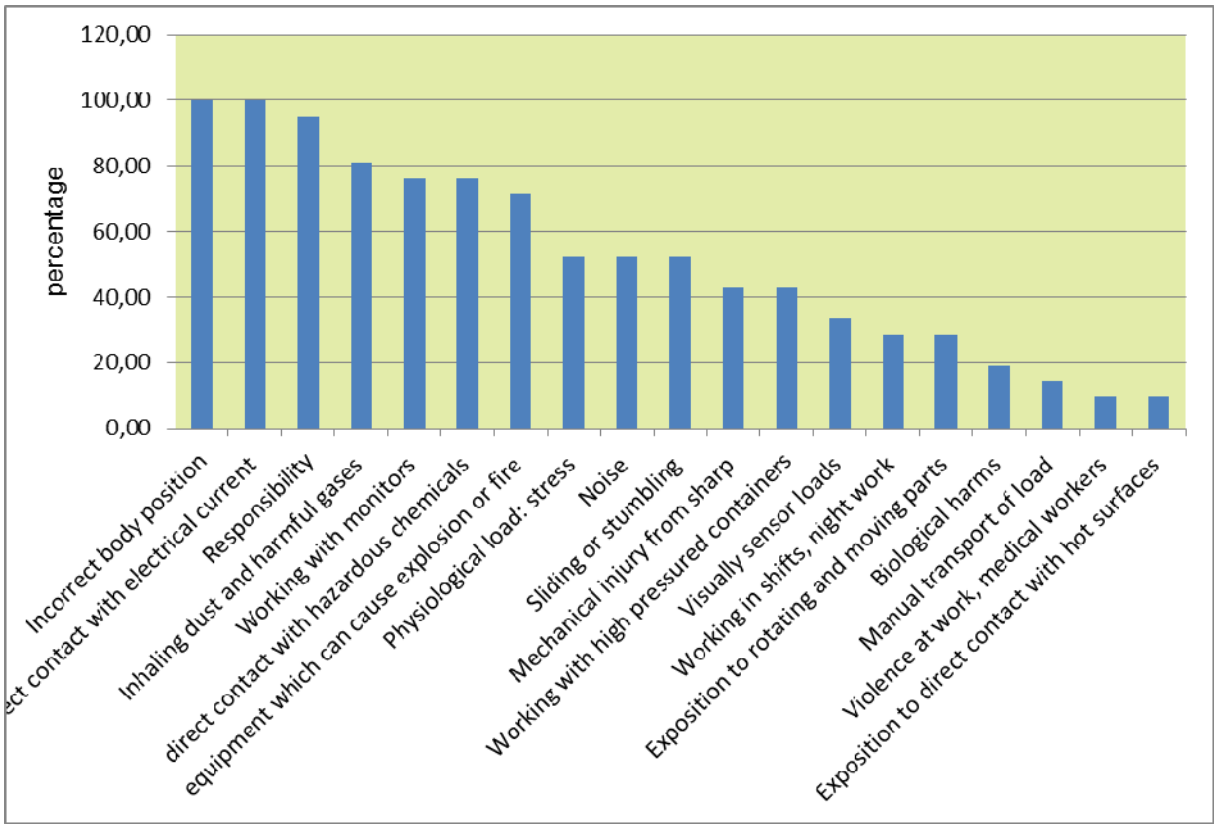

Fig. 1. Percentage of occurrence at the analyzed working positions

According to the identified dangers and harms the risk level of the working positions at the laboratories is analyzed. The results are shown in Table 2. The results from Table 2 are presented in Figure2.

Table 2

Analysis of the working positions at the laboratories according to the assessed risk

Assessed risk level	Percentage from the analyzed working positions (%)
Low risk	23,81
Increased risk	76,19

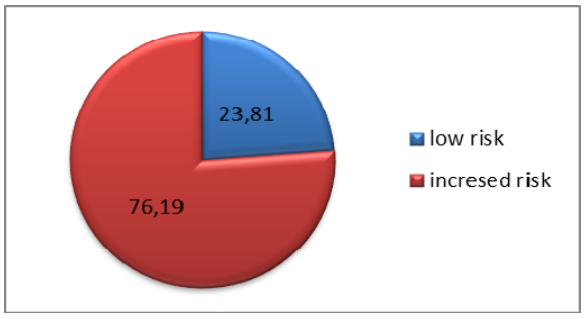

Fig. 2. Percentage from the analyzed working positions

The results from the analysis are showing that pore than ¾ of the laboratory working positions are with increased risk level. Therefore, every laboratory should implement a relevant safe work strategy for providing safe working environment and safe working equipment.

The implementation of the strategy is based on implementing primary and specific safety rules for providing safe and healthy working conditions which will not affect the health of the employees.

By following the primary safety rules, the risk is completely removed or decreased to acceptable level. Primary safety rules are including:

– Safety rules prior to the testing (introducing the basic company rules, interim rules and guidelines, sources of dangers and harms, prescribed safety measures and rules for allowed movement)

– Rules for sampling, labeling, transport and sample admission

– Rules for the laboratory working space (securing the working space from unauthorized entrance, proper working conditions, easy access to the working surfaces, proper conditions for cleaning and maintenance)

– Training of the employees (the laboratory safety is relied to active participation from all of

the employees because mistakes and bad working technique can endanger the best planned safe procedures in the laboratory)

– Using of personal protection equipment is mandatory

– Proper chemical handling and storage (safety data sheets should be placed on a visible surface and should be easy accessed in the laboratory where they are used)

– The safe work signs should be complied.

When risk cannot be removed or decreased to acceptable level the specific safety measures should be implemented (measures for testing in dangerous atmospheres, on height and other).

CONCLUSIONS

For decreasing the risk level at the laboratory the standard safety instructions and procedures should be followed during the phases of the laboratory analysis beginning with the phase for sampling and preparation of samples, post analytical phase and the phase for safe disposing of analysed samples and produced waste.

The laboratory employees must always report for the possible occupational safety risks by preparing guidelines, placing safety signs, training the employees for proper operation with the equipment, devices and chemicals, verification of the implemented safety procedures and relevant training for the occurred risks.

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Number of article: 497
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 247–251 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 331.458:004.774

Original scientific paper

E-RECORDS SYSTEM FOR OCCUPATIONAL SAFETY AND HEALTH

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A b s t r a c t: The recommendations, directives and ILO conventions, to implement the system for safety and health at work in the organization it suggests a complex, a complicated process. The process should not be considered as a separate activity, it has to follow, to be compatible and easily enforceable in all other activities of the activity of organizations. As one part of this complex process is a proper record keeping in the field of safety and health at work. New and advanced information and technologies allow fast, precise and easy application electronic records management system. This paper presents an electronic system for keeping records of OSH. The system is based on advanced Web technology that provides fast, easy, accurate preview and transfer the data. Embedded criteria, and scalability of the system, adjustable make application for keeping electronic records in all spheres of private and public sector, as well as all types of micro, small, medium and large enterprises.

Key words: e-records system; occupational safety and health; preventive measures

Е-ЕВИДЕНЦИЈА ВО СИТЕМИТЕ ЗА БЕЗБЕДНО РАБОТЕЊЕ

А п с т р а к т: Препораките, директивите и конвенциите на МОТ, за спроведување на системот за безбедност и здравје при работа во организациите, укажува на сложен, комплексен процес. Процесот не треба да се одвојува како посебна активност, тој, треба да ги следи, да биде компатибилен и лесно спроведлив со сите другите активности од дејноста на организациите. Како еден дел, од тој комплексен процес е и правилното водење на евиденција од областа на безбедност и здравје при работа. Новите и напредни информатички технологии овозможуваат брз, прецизен и лесно апликативен електронски систем за евиденција. Во овој труд се презентира електронски систем за водење евиденција од областа на БЗР. Системот е базиран врз напредна Web технологија, овозможува брз, лесен, прецизен преглед, и трансфер на податоците. Вградените критериуми, и скалабилноста на системот, го прават прилагодлив и апликативен за водење електронска евиденција во сите дејности од приватниот и јавниот сектор, како и за сите типови на микро, мали, средни и големи претпријатија.

Клучни зборови: системи за електронска евиденцијач безбедност и здравјеч превентивни мерки

INTRODUCTION

The electronic record keeping for Safety and Health at Work provides continuous monitoring and display of the actual situation regarding the implementation of measures for safe operation and directions for improvement. It contains a range of additional data used for the analysis of the situation in the field, both within the company and beyond the national and regional level. The current practice in the Republic of Macedonia shows that the record in the area of OSH is still marginalized, inappropriate and left to the conscience of the professionals or poorly trained persons from among the staff in the companies. Although it is a legal obligation for employers with high fines, the recording of the documentation is approached unsystematic. The purpose of making such a system

for electronic records is facilitating and unifying the records in the field of safety and health at work, following strict legislation and national standards in the area, which will respond appropriately to the needs of each company. The scalability of the system allows the selection of the most adequate records according to the specificities and needs of the business of the companies. The electronic record summarizes accurate and precise data on the employer, vocational training and training of employees for safe operation, periodically testing of the financial resources, physical, chemical and biological hazards, as well as microclimate conditions in the working environment of the organization. Included are data on accidents at work, too, occupational diseases and work-related deaths at work. Deadlines and results of mandatory preventive medical examinations of employees are also implemented in the electronic records. The system allows keeping a record of sanitary checks, debit employees with personal protective equipment, records control of fire extinguishers, and a database of technical reports, findings and opinions. This paper is the result of personal research, gained experience as an expert for safety, and a direct participant in designing and implementing systems for safety and health in organizations. Implementation of systems for electronic records and data processing in the field of health and safety at work in companies will contribute to the efficiency and productivity at work by continuously monitoring and improving the system for safe operation. It is worth noting that good record keeping is a long-term benefit for the companies.

BENEFITS OF ELECTRONIC RECORD KEEPING

Archiving and presenting the results of the monitoring of security systems at work, it is necessary to be led in a standardized way. In accordance with national legislation on record keeping in the field of safety and health at work, and the idea of unifying electronic record-keeping system –is made (is created) – **bzrevidencija.mk**. This system of electronic records is WEB-based, while users have access to data from anywhere at any time. All reviews the data, users can extract in PDF-format and to print. The user has authorized access to view the imported data, but not access to input or correct them.

Possibilities of the electronic records:

- Advanced WEB technologies.
- System of Scalability.
- Fast and accurate set of information.
- Rapid (quick, fast) exchange of information.
- Monthly inspections and notifications.
- Database technical documents and reports, findings, opinions, terms, descriptions, lists of evidence.
- Outsourcing of records.

Benefits of using the system for electronic records:

- Authorized access to data.
- 24/7 access to data from any location and any time.
- Multilanguage.
- Possibility of email and SMS notifications to every supervisor or employee.
- 24/7 technical support, maintenance and updating of the latest legislative changes.
- SSL protection connection (https).
- Protection against loss of data backup every 24 hours.
- Increased visibility of records.
- Increasing the efficiency and productivity of security professionals at work.
- Opportunities for statistical analysis and research.
- Reduce stress from the inspection services.
- Fulfilling the legal obligations.

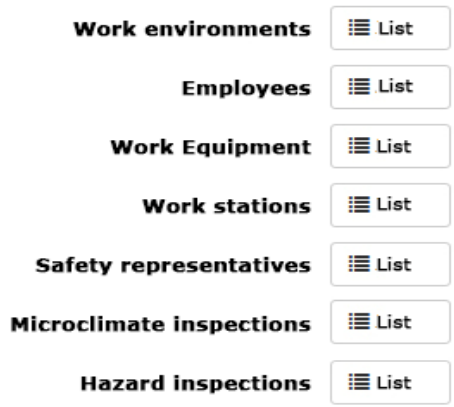

Fig. 1. Evidence for environments and employees

Last name 46 First name 46	31.08.2013	12.10.2015	-14
Last name 25 First name 25	11.07.2014	15.10.2015	-11
Last name 98 First name 98	11.02.2013	15.10.2015	-11
Last name 35 First name 35	11.01.2013	28.10.2015	2
Last name 86 First name 86	22.04.2013	31.10.2015	5
Last name 96 First name 96	08.04.2013	03.11.2015	8
Last name 68 First name 68	11.08.2013	03.11.2015	8
Last name 24 First name 24	27.07.2013	05.11.2015	10
Last name 60 First name 60	13.10.2014	08.11.2015	13
Last name 29 First name 29	05.11.2013	11.11.2015	16
Last name 80 First name 80	25.01.2013	23.11.2015	28
Last name 62 First name 62	13.05.2013	01.12.2015	36
Last name 52 First name 52	03.08.2013	19.12.2015	54
Last name 77 First name 77	19.09.2013	20.12.2015	55
Last name 101 First name 101	17.08.2013	23.12.2015	58
Last name 9 First name 9	09.06.2013	26.12.2015	61
Last name 10 First name 10	13.06.2013	27.12.2015	62
Last name 104 First name 104	11.07.2013	29.12.2015	64
Last name 100 First name 100	24.01.2013	20.01.2016	86
Last name 31 First name 31	31.10.2014	21.01.2016	87
Last name 22 First name 22	16.02.2013	25.01.2016	91
Last name 118 First name 118	15.09.2013	26.01.2016	92

Fig. 2. Generates list of deadlines for all systematic types of records maintained in the four levels of distress

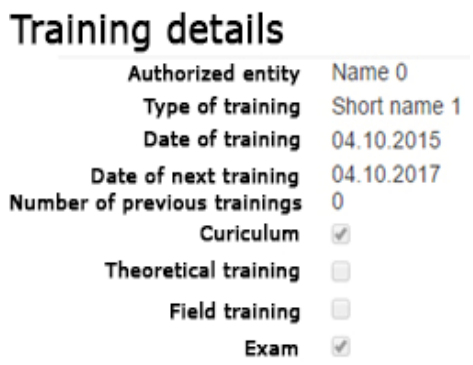

Fig. 3. Evidence of training and vocational training for work for employees

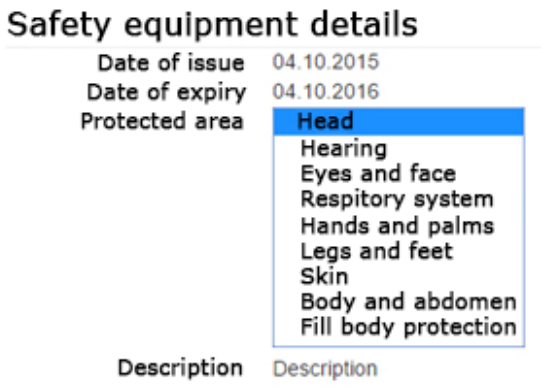

Fig. 4. Evidence of personal protective equipment

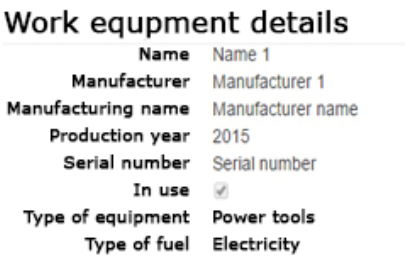

Fig. 5. Evidence for work equipment

Fig. 6. Evidence for conducted examinations of the physical, chemical and biological hazards and microclimate

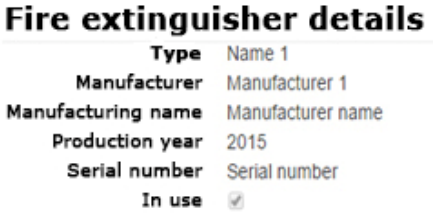

Fig. 7. Evidence for non-automatic equipment of fire extinguishers

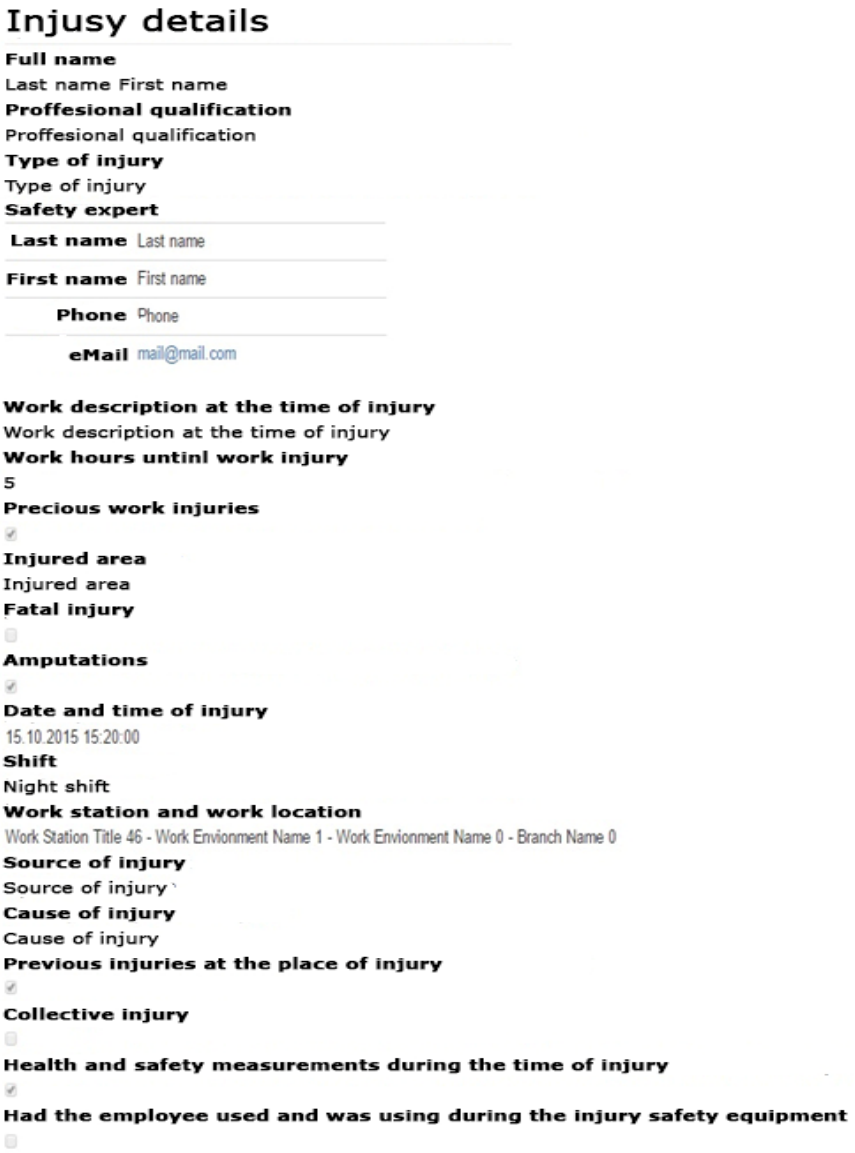

Fig. 8. Evidence of diseases, diseases related to workplace, occupational injuries and cases of deaths at work

CONCLUSION

The system for keeping records in electronic form, allows precise entry and data processing, effective search and adaptability according to the activity of the companies. It shows the real situation regarding the implemented measures for safe operation and directions for improvement. In this way increases the efficiency and productivity of personnel in charge of implementing the system for safe and healthy work in the company, but also reduce the dangers and hazards in the workplace and working environment, reducing the cost of implementing the measures for safe and healthy work, reduce / eliminate the risk of occupational disease, rioted health, accidents or death. By using this system, availability and insight of inspection services, companies gain improved public image. Production companies can assess the economic impact of accidents – lost production time, damage of machinery or raw materials and increased premiums paid to the insurance fund as compensation for workers. As a final and desirable result of workplace monitoring and implementing systems for safety and health at work in a uniform and clear manner, improving employee relations – with the Management, and jobs (workplaces) without accidents that raise morale and increase productivity.

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Number of article: 498
CODEN: MINSC5
Received: September 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 253–259 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 331.108.62:364.634

Original scientific paper

MOBBING AT THE WORKPLACE

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A b s t r a c t: Over the last decades, mobbing at the workplace and its impact on the workers' health and their productivity is recognized as a global public health problem. Mobbing is defined as a repeated and over time, offensive behavior through vindictive, cruel or malicious attempts to humiliate, terrorize or undermine an individual or groups of employees. Typical workplace mobbing actions include social isolation, intrusion into privacy, verbal attacks or intimidation as well as organizational measures such as deprivation of competencies or allocation of low-order work tasks. This behavior takes place on a frequent basis (at least once a week) and over a long period of time (at least 6 months). Mobbing is highly destructive, leading to psychological and psychosomatic disorders, decreased work productivity, job loss, as well as to suicide in extreme cases. At the same time, mobbing has negative impact on the victim family, his/her company, and on the whole society. The activities focused on prevention of the mobbing at the workplace (organizational preventive strategies) are more effective then the corrective solutions.

Key words: harassment; psychological disorders; psychosomatic disorders; workplace

МОБИНГ НА РАБОТНОТО МЕСТО

А п с т р а к т: Последниве децении мобингот на работното место се препознава како глобален јавноздравствен проблем кој што значајно влијае на здравствената состојба на работниците и нивната продуктивност. Мобингот се дефинира како специфично однесување на работното место при кое една личност или група луѓе психички малтретира и понижува друга личност со цел да ги загрози нејзиниот углед, чест, човечко достоинство и интегритет. Ваквото однесување често се повторува (барем еднаш неделно) во тек на подолг временски период (барем шест месеци). Типични активности со кои се спроведува мобингот на работното место се: социјална изолација на жртвата, вербална агресија кон неа, минимизирање на резултатите од нејзината работа и др. Како резултат на мобингот кај жртвата со тек на времето се јавуваат бројни психички и психосоматски нарушувања, може да дојде до напуштање на работното место, а во екстремни случаи и до самоубиство. Во исто време, последици од мобингот се јавуваат и кај семејството на жртвата, компанијата во која што работи, како и општеството во целина. Активностите насочени кон превенција, односно организационите превентивни стратегии, се многу поефикасни од корективните решенија на мобингот на работнот место.

Клучни зборови: психолошко малтретирање; психолошки нарушувања; психосоматски нарушувања; работно место

INTRODUCTION

Within the last decades, mobbing has emerged as an important factor influencing both the working performance and general health status of the population [1]. There is a general consensus in that the terms mobbing, bullying and harassment can be used synonymously, although geographical preferences mean that one or the other term is used more frequently in certain regions [2]. According to the World Health Organization (WHO) or the International Labor Office (ILO), mobbing is defined as "repeated and over time, offensive behavior through vindictive, cruel or malicious attempts to humiliate or undermine an individual or groups of employees" [3]. Typical workplace mobbing actions include social isolation (e.g. exclusion from meetings), intrusion into privacy, verbal attacks or intimidation as well as organizational measures

such as deprivation of competencies or allocation of low-order work tasks [4]. To fulfill all the criteria used by Leymann to identify mobbing, this behavior needs to take place on a frequent basis (at least once a week) and over a long period of time (at least 6 months) [5]. It should be noted that bullying crosses all socio-demographic borders and can be observed in all categories of age, gender, ethnicity, academic achievement, and professional environment [6], although it seems to be especially common in the health sector [7]. Its general prevalence is estimated at between 2% and 15%, but a recent study indicated that it is even higher in adolescents, of whom 20–35% reported involvement in mobbing as a victim, a perpetrator or both [8]. A special survey from 2004, initiated by the European Commission, revealed that 10.2% of women and 7.3% of men had been victims of workplace mobbing in the previous 12 months [9]. Tonini et al. discovered that women in the age group of 34 to 45 are especially likely to be the subjects of harassment, a phenomenon which can be explained by the increased level of family commitment in this age range, leading to a rise in stress [1]. The sequel of mobbing are extensive and include social phobia, depression [10, 11], suicidality [12], posttraumatic stress disorder, as well as substance abuse [1, 13].

DEFINITION OF WORKPLACE MOBBING

Davenport et al. describes "mobbing" as a form of organizational pathology in which coworkers essentially "ganged up" and engaged in an ongoing rituals of humiliation, exclusion, unjustified accusations, emotional abuse and general harassment in their malicious attempt to force a targeted worker out of the workplace [14]. It usually begins with one person who decides that he or she is threatened by a colleague and thus begins a desperate campaign that spreads through the workplace like a disease, infecting person after person with the desire to eliminate a target. People resort to mobbing to cover up their own weaknesses and deficiencies [15]. The term "bullying" describes attack by a single individual; it does not capture the particular grievousness of "mobbing" that refers to a group attack on a worker [16]. College and university campuses are common grounds for this non-violent, polite, sophisticated kind of academic workplace mobbing culture. If professors aim to put a colleague down, a clever and effective strategy is to wear the target down emotionally by shunning, gossip, ridicule, bureaucratic hassles and withholding of deserved rewards [17]. Women faculty members who are outspoken about ethical and unjust matters are usually the targets being mobbed. Their competence and professional success are perceived as threats by the bullies [18].

MANIFESTATION AND RECOGNITION OF MOBBING BEHAVIOR

Mobbing targets may find that they are subjected to a series of bullying and mobbing activities as listed in Table 1. Leymann identified and summarized these bullying activities into five categories depending on the effects to the target [5]. Targets have legal protection when experiencing some of the behaviors associated with categories 3 and 5. But majority of behaviors in categories 1, 2 and 4 are considered an organization's prerogative [3].

Table 1

Bullying and mobbing activities

I – Attacks on target's self expression
Target is constantly criticized. Subjected to nit-picking and trivial fault finding
Intimidation, humiliation and threats behind closed doors.
Given silent treatment. Bully refuses to communicate, avoids eye contact (indicator of abusive relationship), instructions received only via email, memos or yellow stickers.
II – Attacks on target's social relations
Target is subjected to excessive monitoring, snooping.
Conspiracy (other staff coerced into fabricating allegations. Complaints are often trivial and bizarre, bear striking similarity suggesting common origin).
Target is overruled, ignored sidelined, marginalized, and ostracized.
Isolated and excluded from what is happening.
Subtle threats to other staff that are on good terms with target.
Use of target's friends to be bearers of bad tidings or as informants.

III – Attacks on target's reputation

False allegations and pathological lies against target.

Defamatory remarks are directed at target's character rather than on environmental factors. Stigmatization of target's reputation within the department, institution and other institutional network.

Target is subjected to unjustified disciplinary action based on trivial or false charges.

Truths are distorted to justify wrongdoing of the bullies and to project the blame onto the target.

Resistance to independent, outside review of sanctions imposed on target.

Outraged response to any appeals for outside help the target may take.

IV – Attacks on target's professional life

Target's explanations of achievements are ridiculed, overruled, dismissed or ignored.

Starved of resources while others receive more than they need.

Work plagiarized, stolen and copied. Bully then presents their target's work to the superior as their own.

Either overloaded with work or have their work taken away or replaced with inappropriate menial jobs.

Request for leave have unacceptable and unnecessary conditions attached. Previous approval may be overturned. Annual leave, emergency leave and sick leave are denied.

Do not have clear job description. Bully deliberately makes the person's role unclear. Invited to informal meetings that turn out to be disciplinary hearings.

Promotion blocked and sabotaged. Target may be degraded and demoted to a lower position instead.

Subjected to unwarranted and unjustified verbal or written warnings.

Under frequent threats of verbal or written dismissal based on fabricated charges or flimsy excuses often using trivial incidents from the past.

Coerced into reluctant resignation, enforced redundancy, early retirement or ill health retirement.

Denial of target's rights to earn a livelihood (prevention of his/her getting another job) even after target has left the institution.

V – Attacks on physical and mental health of target

Target is belittled, degraded, demeaned, ridiculed, patronised.

Undermined, threatened, shouted and humiliated especially in front of others.

Harassed with intimidating memos notes or emails with no verbal communication.

Encouraged to feel guilty and to believe they are at fault.

Mental health trap.

FACTORS CONTRIBUTING TO MOBBING ACTIVITIES

Organizational dynamics particularly its culture and leadership, values and beliefs may foster and reinforce workplace mobbing. Management may participate in or actually initiate the mobbing or may know that a lower level manager is harassing employees but will not intervene. The most common trait of mobbing is that targets are highly achieving or superior in some arena (teaching, research, etc), blowing the whistle or having knowledge about a serious breach of ethics or wrongdoing by a powerful person in the workplace [19]. People, who are good at their jobs, are popular with colleagues or students, who speak out against unethical behavior and are intolerant of hypocrisy, are often targets of bullying. Those with integrity to withstand the efforts of the bully to create a group of "yes men or women" risk being victimized. It is often the person who is potentially an organization's best asset who becomes the target of bullying. Many mobbing targets love their work; they derive purpose and pleasure from it. Because targets tend to be forgiving, it is difficult for them to accept that another human being could knowingly cause such cruelty. They suffer grave injustices often for years without recognizing the problem as bullying [20]. There is considerable consensus that workplace bullies are selfish, inadequate, insecure and totally insensitive. They can be evasive, manipulative, dishonest and convincing. They are unable to fulfill the duties and obligations of their position but have no hesitation in accepting salary [8]. Jealousy and envy (of talents, abilities, circumstances or possessions of others) are strong motivators of bullying. Bullying bosses frequently intimidate those who have the skills to do the job better than them. They diminish the confidence and integrity of others in order to deflect attention from

their own inadequacies [20]. Bully's inappropriate behaviors are dysfunctional means of dealing with their own problems of low self esteem and incompetence. Since childhood, bullies have learnt that they can avoid the unpleasant consequences of bad behavior through the instinctive response of denial, blame and feigning victim hood [21]. Over 90% of the cases reported to the UK National Workplace Bullying Advice Line involve a serial bully. One in 30 people is a serial bully with sociopathic traits [19]. Their behavior profile includes compulsive lying, a Jekyll and Hyde nature, superficial charm, considerable capacity to deceive, an arrested level of emotional development and a compulsive need to control [15]. Serial bully likes to play people off against each other. They gain gratification from manipulating and watching others destroy each other [21].

PHASES OF WORKPLACE MOBBING

Mobbing is the end result of a systematic eliminative process that hides behind a veil of lies and justification making it difficult to prove [22]. An important hallmark of mobbing is the length of time that the episode can go on and the psychological and physical wear and tear on the target [15]. Leymann and Gustafsson outlined 5 phases of a mobbing episode as listed in Table 2. A mobbing process follows a predictable, stereotypical course according to research findings [22]. Davenport et al. noted that once the phases begin, they develop their own momentum. Phase 3 represents a circuit breaker to the cycle. Unfortunately, when targets finally seek assistance, they are inevitably labeled as a "troublemaker or mentally ill" based on rumors and gossip. This legitimizes senior management's decision to eliminate the target from the workplace [23].

Table 2

Phases of mobbing

Phase 1 – Critical incident (Conflict phase) An organizational conflict that is not managed lingers on, and subsequently compounds into a mobbing process that escalates into a critical incident [16]. Target is accused of anything from making an insensitive remark to committing an unethical act. Whether real or perceived, these accusations gave justification to the mobbers to take administrative actions against the target.
Phase 2 – Mobbing and stigmatizing Phase 2 consists of aggressive acts and psychological assaults against the target with the intent to "get at a person" or punish him or her [24]. A bully's aggression often manifests itself in criticism, insulting comments, whispers and other insidious behavior. The effect of this behavior is humiliation, intimidation, instillation of terror and fear in the target [10]. By this time more people have been co-opted into the mobbing process [23].
Phase 3 – Personnel management Phase 3 is the period in which administration seriously enters into the mobbing, usually after having ignored or minimized it in the earlier phases [19,23]. Due to previous stigmatization it is easier for administration to misjudge, place the blame on the target and to do something to "get rid of the problem" that is the mobbed person [24]. This often results in serious violation of the individual's civil rights. Because of fundamental attribution errors, colleges and management tend to create explanations based on personal characteristics rather than on environmental factors [22].
Phase 4 – Incorrect diagnosis Phase 4 is the period in which administration allies with the mobbers in the construction of the target as "difficult", "under extreme stress", or "mentally ill" [19, 23]. Employees who express concerns about inappropriate, unethical or bullying behaviors are frequently described as having a negative attitude, being paranoid or engaging in whistle blowing [20]. If the target seeks contact with psychologist or psychiatrist, there is great risk that that he or she will be labeled with an incorrect diagnosis such as "paranoia', "adjustment disorder" or "character disorder". This judgment can destroy the person's chances of gaining anything from vocational or occupational rehabilitation [22].
Phase 5 – Expulsion Phase 5 is the expulsion phase in which the target is forced to leave the organization either by being dismissed or through constructive dismissal because working conditions are intolerable [19, 23]. The mobbing process sometimes continues so as to justify the actions taken by mobbers and to

concretely prove the organization's decision as the right decision. Targets may find that they are completely expelled from the labor market, unable to find another job [16].

CONSEQUENCES OF WORKPLACE MOBBING

Effects on targets and family

Damage done to a person through workplace mobbing is an injury, not an illness, and is a workplace safety and health issue – not an individual mental health issue [6]. Mobbing is highly destructive and in extreme cases it can result in suicides [20]. Targets' position and influence in the organization is destroyed [24]. Workplace has its own web of social connections; mobbing targets tend to become ostracized and isolated. Colleagues shy away from targets as if somehow there is guilt by association. Targets exhibit profound feelings of self doubts, shame, worthlessness, humiliation, unhappiness and desperation [10]. They become withdrawn and alienated from their colleagues, friends and sometimes their families [19]. Mobbing may be responsible for anxiety depression and somatization syndrome that comprises of non-specific complaints such as headaches, dyspepsia, exhaustion, insomnia and dermatological disorder. Target's obsessive preoccupation with the mobbing experience may have negative impact on communication, intimacy and sex, work, parenting and household management within the family. If the target is forced out of job the resulting loss of income causes financial stress and ensuing feelings of shame and humiliation of not being the provider he or she was [19]. Targets do not understand because they have no frame of reference, no language to describe what is happening. When their attempts to change the situation fail and they feel all avenues have been exhausted, they are pushed as far as committing suicide or even murder cum suicide [25]. Leymann and Gustafsson estimated that 15% of suicides in Sweden were directly attributed to workplace mobbing [22].

Effects on organization

Destructive effects on the organization include lack of commitment of staff, higher absenteeism, increased personnel turnover and loss of motivation, vision, enthusiasm, creativity, loyalty, job satisfaction and morale. When employees have to protect themselves in abusive workplace, they have little time or mental energy for productivity. Abuse makes them disillusioned, despondent, exhausted and burnt out [15, 20, 24]. Frequent leaves, insurance, workman's compensation claims coupled with legal fees often depletes organization's operational and legal funds. The organization's reputation, public relations and commitment from employees are all at stake [24]. For most companies blaming the target is easier than doing the work of educating and helping the targets and bystanders. Often it is far easier for a company to remove the targets as they are seen as the "problem" for 'rocking the boat" [26]. Until organization begins to examine what is really going on and until problems can be brought to the surface for open and honest discussion, bullying will continue to thrive and destroy individuals and entire workplace [20].

Bystanders and bullying

Sadly co-workers do not support the target. They are scared they may be the next victim, should they show any compassion. Research indicates that the longer the target endures the mobbing the more difficult it is for bystanders to remain neutral and they become implicated in the mobbing process [23]. For perpetrators to be able to bully they need secrecy, cooperation and silent witnesses of bystanders. Co-workers are easily conned into following a strong charismatic leader [27]. The various reasons why bystanders do not support the targets are listed in Table 3.

Table 3

Reasons why bystanders do not support target [11, 20]

1. Work colleagues have no understanding or experience of bullying, manipulation, psychological violence, etc.
2. Few have integrity and moral courage to stand up against the bully. They pretend nothing is happening then it won't happen to them (their turn will come eventually).
3. They lack critical thinking skills and analytic abilities, cannot see through facade or bully's mask of deceit.
4. Bullies poison the atmosphere and actively poison people's minds against the target,

to regard target a threat to organization, as having "mental health problem". They use implied threats of disciplinary action against anyone who is friendly to the target. They form alliance with colleagues with same behavior profile.

5. When there is conflict, most people want to be on winning side or on side they think will survive.

6. Some gain gratification (perverse feeling of satisfaction) in witnessing the sufferings of the target.

7. Bystanders see Dr Jekyll's side of the bully; target sees Mr. Hyde's side of the bully.

8. Bullying is subtle and behind closed doors. Comprises of hundreds of incidents which out of context and in isolation are trivial. Bystanders do not see the full picture.

9. Bystanders are hoodwinked by bully's ruses for abdicating responsibility and evading accountability example, "that's all in the past, let's focus on future", "forgive and forget, you've got to move on", "what's past no longer relevant, make fresh start".

10. Colleagues are with own share of problems, they are not going to risk losing their job for someone else.

Prevention and coping strategies

Health injuries caused by workplace mobbing are catastrophic and leave behind long term consequences. Effective counseling intervention must include all levels – the target, the family and the organization [19]. The best possible ways of preventing workplace mobbing is to ensure that workplaces are psychologically safe and healthy places to work in. All employees must be treated with respect and dignity, bullying is not to be tolerated [20]. Management must be able to recognize early signs of mobbing and resolve the conflict before it escalates. Procedures must focus on the situation, issue or behavior, not on the people [24]. Employees can be educated and committed to stop bullying. It has been found that when witnesses support the target, the negative emotional and physical effects of workplace trauma are reduced considerably [27]. Education about mobbing is itself a remedy and vital therapy for targets. Laws will be changed if enough of us speak out against this "silent epidemic" [26]. The need for anti-mobbing legislation is paramount and has long been recognized in European countries. The ultimate objective is for target to recover his or her working life and get back on track whether through administrative reform, publicity of the wrong, redress in courts, removal to new workplace or therapy [24]. Targets of mobbing can and do survive with their exceptional personal and professional integrity intact. These same qualities that make an individual vulnerable to mobbing can help the target to survive. View this challenge as an opportunity to use freed-up time and energy to focus on scholarly activities and/ or further professional development [28].

CONCLUSION

Workplace mobbing is an insidious, non-violent and sophisticated kind of psychological bullying that predominantly takes place in busy enterprises full of different types of workers [17]. Elimination process follows a stereotypical course whereby targets are humiliated, intimidated, terrorized, ostracized, wrongly accused and terminated. Workplace mobbing causes targets intolerable suffering and despair, humiliation and death [29]. The mobbing won't stop until colleagues and administrators say 'NO" to mobbing, and manage to prevent the consequences of inaction that are enormous for everyone related somehow to the actual work environment [18].

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Number of article: 499
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No. 3, pp. 261–267 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 546.16-32

Original scientific paper

HYDROFLUORIC ACID – A DANGEROUS MATERIAL OF EXTREME RISK

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A b s t r a c t: Hydrofluoric acid is of great industrial importance in the manufacture of electronic components. However, poor knowledge of the characteristics and dangers of hydrofluoric acid is the main reason for its high risk. Based on data from the database FACTS (Failure and Accidents Technical information System), high participation in lethal outcomes established in the logistics subsystem for use and distribution. Beside the proposal to reduce the risk, the paper contains a brief description of the basic mode of action of hydrofluoric acid on the human organism and successful medical protocols at accidents with dangerous mentioned material.

Key words: risk, accident probability, logistics systems

ФЛУОРОВОДОРОДНА КИСЕЛИНА – ОПАСНА МАТЕРИЈА ОД ЕКСТРЕМЕН РИЗИК

А п с т р а к т: Флуороводородната киселина е опасна хемиска супстанца со неспоредливо поголем ризик за фаталенисход при несреќи отколку сулфурната, азотната или хлороводордната киселина. Иако е примарно опасна супстанца од класата VIII со силнокорозивно дејство, нејзините исклучително токсични карактеристики не предизвикуваат класична клиничка слика. Таа е летална во мали количини со временски транслирирано и индиректно дејство. При несреќиво присуство на поголеми количества може да предизвика еколошка катастрофа

Клучни зборови: флуороводородна киселина, опасна материја, ризик

INTRODUCTION

The acids are one of the main categories of chemical substances. Basically, the name acid is based on oxygen and assumptions and that the oxygen is required element in united elements which have strong oxidizing properties. This format is inherited from the *X*VIII century by the famous French physicist Antoine-Laurent de Lavoisier. The traditional and inchoate heritage of the logic of the influence of acids it is also present today in the average connoisseur of chemistry. The action of the acid on contact surfaces is expected to be stormy and destroyable.

The Lavoisier systematization does not include acids of halogen elements: fluorine, chlorine, bromine, iodine and astate. Because of the great reactivity, halogens in elemental condition are not as atoms, but as two atoms molecules. Between the molecules, act weak Van der Vaalsov attractive forces, whose strength increases with the atomic number (fluorine according to astate). This is because the fluorine and chlorine at ambient temperature gases, from a liquid bromine and iodine and astate are in solid state.

Electronegativity (by Pauling) of halogen elements, is strongest in fluor (3.98). Chlorine also has high electronegativity (3.16) then it follows bromine (2.96), iodine (2.66) and astate (2.20). Due to its electronegativity expressed with salt and metal building. The best known is the cooking salt

a known acid of this group is hydrogen chloride HCl.

Hydrofluoric acid is classified as weak inorganic acid because it has a lower dissociation constants a (pK_a = +3.17) compared to the other hydrohalic acids having $pK_a < 0^{th}$.

Classified as corrosive hazardous substance belongs to VIII group, its toxicity is fatal and thereby indirectly influence, usually is on time delay in stages 8 h to 24 h. The small atomic weight and high of electronegativity parameters that determine the extreme risk of hydrofluoric acid.

BACKGROUND OF HYDROFLUORIC ACID

Hydrofluoric acid is aqueous hydrogen fluoride, the chemical designation is HF. The molar mass of HF is 20.01 g/mol, a density of 1 15 g/l, and the temperature of the boiling point between +19.5 °C, a vapor pressure is 783 mmHg. The temperature of melt is – 83.55 °C.

Hydrofluoric acid is primarily used in industry for oil and its derivatives in the manufacture of this semiconductor, plastic, pharmaceutical industry in synthetic cryolite (Na_3, AlF_6), which has an important application in the production of aluminum, the production of synthetic fluoropolymer – polytetrafluoroethylene Teflon, production of enriched uranium (enriched uranium fluoride UF_4) for the glass and ceramic industry minutes, for cleaning aluminum and etc.

Hydrofluoric dissolves glass and concrete, skin, bones and rubber. It is known as a non-flammable (no ignition of temperature), but the solution with a concentration greater than 65% reacted with metals can release hydrogen. In the classification of hazardous substances belonging to the class VIII, UN number 1052 (gas HF, UN number 1790 for water solution 60% HF and UN number 1796 for water solution 60% HF.

The main raw material for the production of fluorine hydrogen is mineral calcium fluoride e (CaF_2). The main deposits of this mineral are found in China, Mexico, South Africa and Russia. The Annual extraction of basic minerals worldwide yeah exceeds the amount of 5 million tons. The production process is based on the reaction of the basic mineral with sulfuric acid at a temperature of 265 °C. From this amount produces about 2 million tons of hydrogen fluoride per year, and in Europe from about 240 thousand tons. For comparison, the estimated volume of production of sulfuric acid and ammonia annually in 2010 was over 150 million tons.

THE MODE OF ACTION OF HF, CONSEQUENCES AND TREATMENT

The pathogenesis of damaged tissues occurring in the effect of fluorine hydrogen acid differs significantly from the activity of equimolar solutions of sulphuric, or nitric acid fluorine hydrogen. Aqueous solution of fluorine hydrogen acid is a weak high electronegativity of fluorine ions and because of this they cause incomparably smaller scale burns and degeneration of skin compared to other acids. In general, dermal burns to a large extent depend on the concentration of the solution.

Aqueous solutions of fluorine hydrogen acid to 20% may cause pain or erythema to 24 h. However, the clinical picture after 24 h sharply deteriorated since the symptoms of the effect of the weak solution of fluorine hydrogen acid occur delayed. The poor reaction is solution fluorine hydrogen acid commonly seen in repairers (washers/cleaners) on glass pottery performs duties without adequate protective equipment, primarily gloves. Dermal damage to the fingers and palm sharply deteriorate during the 24 h [1].

Contamination of the skin with a solution of fluorine hydrogen passable acid concentration of 20 to 50% is also not give distinctive marks as is the case in vitriol, hydrochloric or nitric acid minutes. In this case the standard clinical picture emerges after 8 h. Also, symptoms develop in time the patient upon admission can be given urgent medical assessment as often reason for poor clinical outcome.

In case of contamination with high concentrations of fluorine hydrogen passable acid over 50%, there is a standard clinical picture is given urgent medical assessment and implement the necessary procedures.

Reason for deferred action acid is found in high lipophilicity of fluoride ions from which penetrates deep into the tissue accumulate in cells, leading to the painful character in with progressive evolution.

Standard clinical occurs because of the ability of ions fluorine hydrogen acid intensively to bind ions of potassium, calcium and magnesium, thus causing the arrhythmia so, halt the operation of the heart and death. Contamination of only 2.5% of the surface of the skin so concentrated fluorine hydro-

gen acid can be fatal [2] According to toxical estimates is sufficient surface contamination of 160 cm^2 of the skin with a solution that has a concentration greater than 50% of fatal outcome.

Fig. 1. Clinical presentation of burns that occurred under the influence of a weak solution of fluorine hydrogen acid (within 20%), change the clinical picture of the damage fingers during 24 h

The process of penetration of the fluorine ions in the tissue cannot stop surface decontamination. Neutralization can be performed by giving a solution of salt, potassium, calcium and magnesium [3]. One of the positive outcomes clinically described and contains radical methods of infusion (intravenous and intra-arterials) with high concentrations of potassium, calcium and magnesium (Figure 2). Inhalation of HF gas can cause irritation of the respiratory tract, and the formation of the solution of HF in the lungs may cause edema. Also inevitable damage to the esophagus and stomach. Minimum lethal dose by inhalation is estimated at 50 to 250 ppm for 5 minutes.

Fig. 2. Clinical presentation of the burn, which was caused by the action of highly concentrated acid solution (70%), an intravenous and intra-arterial (brachial artery) infusion treatment with preparations of calcium and magnesium, for example in a positive clinical outcome, is prevented necrosis of tissues and completely motor is stored in the patient's arm (4)

COMPARATIVE RISK ALLOCATION AND REPRESENTATIVE ACCIDENT – RISK ALLOCATION

Based on a database of accidents FACTS (Failure and Accidents Technical information System), from 1980 until today registered 101 accidents caused by hydrogen fluoride acid, 454 accidents with sulfuric acid, 225 accidents with nitric acid and 436 accidents with hydrogen fluoride acid. Although the estimated production of sulfuric acid is almost 70 times higher than the production of hydrogen fluoride acid obvious disproportion is the number of accidents that is greater by 4.5

According to FACTS established to accidents with fatal outcomes including: hydrofluoric acid 24 of 101 for sulfuric 59 454 to 12 225 nitric and hydrochloric of 20 436. The results of these values result posteriori probability – risk of occurrence of fatal cases of accidents. The comparative analysis is shown in Table 1.

Table 1

Comparison of risk with fatal outcomes of accidents for some acids

Acid	HF	H_2SO_4	HNO_3	HCl
Number of accidents FACTS	101	454	225	436
Number of accidents with death	24	59	12	20
Likelihood of emergence of fatal	0, 2376	0, 1300	0, 0533	0, 0459

A discrete probability distribution of cases in logistical subsystems (random variable X) of the dangerous substance "hydrofluoric acid" is established based on the number of accidents by FACTS based subsystems of production and is marked with (X_1), storage (H_2), reloading to (X_3), transport (X_4) and guide/distribution respectively to (H_5), 37, 10, 8, 27 and 19 accidents.

$$X=\left\{\begin{array}{ccccc} P(X_1) & P(X_2) & P(X_3) & P(X_4) & P(X_5) \\ \frac{37}{101}=0,3663 & \frac{10}{101}=0,0990 & \frac{8}{101}=0,0792 & \frac{27}{101}=0,2673 & \frac{19}{101}=0,1881 \end{array}\right\}.$$

The discrete probability distribution of the effects (random variable (Y) for the hazardous substance "hydrofluoric acid" is established based on the number of cases no effects marked by (Y_1), with the damaged (Y_2) and the fatal respectively (Y_3): 39 38 and 24 accidents.

$$Y=\left\{\begin{array}{ccc} P(Y_1) & P(Y_2) & P(Y_3) \\ \frac{39}{101}=0.3861 & \frac{38}{101}=0.3762 & \frac{24}{101}=0.2376 \end{array}\right\}$$

The values of the specific product of the probability of dangerous goods "Hydrofluoric acid" The values of Table 3 mean the independence of the impact of the logistics system and the outcome of cases.

Table 3 shows specific values of probabilities product dangerous substance "Hydrofluoric Acid" obtained from samples FACTS base.

If between the probabilities are calculated in Tables 2 and 3 no statistically significant differences, the logistics subsystems have no significant impact. the hypothesis that there is no impact on the logistics subsystem on the qualitative outcome of cases N, P(A) = P(B) then standardized random variable.

$$t=\frac{p_a-p_b}{\sqrt{\frac{p_a(1-p_a)}{N}}}$$

Table 2

Products probability of dangerous goods "Hydrofluoric Acid"

$P(X_1)\cdot P(Y_1)$ = 0.141457	$P(X_1)\cdot P(Y_2)$= 0.137830	$P(X_1)\cdot P(Y_3)$= 0.087050
$P(X_2)\cdot P(Y_1)$ = 0.038232	$P(X_2)\cdot P(Y_2)$= 0.037251	$P(X_2)\cdot P(Y_3)$= 0.023527
$P(X_3)\cdot P(Y_1)$= 0.030585	$P(X_3)\cdot P(Y_2)$= 0.029801	$P(X_3)\cdot P(Y_3)$=0.018822
$P(X_4)\cdot P(Y_1)$= 0.103225	$P(X_4)\cdot P(Y_2)$= 0.100578	$P(X_4)\cdot P(Y_3)$=0.063523
$P(X_5)\cdot P(Y_1)$= 0.072640	$P(X_5)\cdot P(Y_2)$= 0.070777	$P(X_5)\cdot P(Y_3)$= 0.044701

Table 3

Likelihood of product dangerous substance "Hydrofluoric Acid"

	$Y1$	$Y2$	$Y3$			
$X1$	9	21	7	$P(X1Y1)$ = 0.0891	$P(X1Y2)$ = 0.2079	$P(X1Y3)$ = 0.0693
$X2$	6	3	1	$P(X2Y1)$ = 0.0594	$P(X2Y2)$ = 0.0297	$P(X2Y3)$ = 0.0099
$X3$	1	4	3	$P(X3Y1)$ = 0.009	$P(X3Y2)$ = 0.0396	$P(X3Y3)$ = 0.0297
$X4$	19	5	3	$P(X4Y1)$ = 0.1881	$P(X4Y2)$ = 0.0495	$P(X4Y3)$ = 0.0297
$X5$	4	5	10	$P(X5Y1)$ = 0.0396	$P(X5Y2)$ = 0.0495	$P(X5Y3)$ = 0.0990
Σ	39	38	24			

The results may come to test the hypothesis concerning the proportion of the primary set of the primary sample, in the present case the values of Tables 2 and 3 are statistically agree. If we accept

A normal distribution N (0.1) and verification of the hypothesis is carried out in accordance with the values of Table Normal distribution for a defined threshold of significance. In addition, testing the hypothesis still has specificity compared to the standard test. The difference (pa-pb) (difference between the values in Table 2 and 3) can be positive and negative. Simultaneously differences can be below the threshold of significance (coincidental) or above the threshold of significance (significant). Verification of statistical hypotheses about the impact of logistics subsystems of the outcome of the fatal events of the dangerous substance "Hydrofluoric acid" are given in Table 4.

Table 4

Impact of logistics subsystems of the outcome of the fatal events of the dangerous substance "Hydrofluoric Acid"

N_i	$p_{ai} = \frac{P(Y_3 X_i)}{P(X_i)}$	$q_{ai}=1-p_{ai}$	$\sqrt{\frac{p_{ai}q_{ai}}{N_i}}$	$p_{b3} = P(Y_3)$	$\Delta p_i=p_{ai}-p_{b3}$	$t_i = \frac{\Delta p_i \sqrt{N_i}}{\sqrt{p_{ai}q_{ai}}}$
37	0.189189	0.810811	0.064388	0.237624	–0.0484	–0.7522
10	0.100000	0.900000	0.094868	0.237624	–0.1376	**–1.4507**
8	0.375000	0.625000	0.171163	0.237624	+0.1374	**+0.8026**
27	0.111111	0.888889	0.060481	0.237624	–0.1265	**–2.0918**
19	0.526316	0.473684	0.114549	0.237624	+0.2887	**+2.5203**

Based on a sample of 37 accidents, logistics subsystem production has no effect on the outcome of the fatal consequences of the dangerous substance accidents "Hydrofluoric Acid" value

$t_1 = – 0.7522 – [\in 1.2816 + 1.2816]$.

Due to the small number of accidents $N_2 = 10$, logistic storage subsystem dangerous substance "Hydrofluoric Acid" no representative analysis.

Due to the small number of accident $N_3 = 8$, the logistics subsystem reloading the dangerous substance "Hydrofluoric Acid" no representative analysis.

Based on a sample of 27 accidents in transport logistics subsystem, the established value for $t_4 = +2.0918$ is greater than $t_{0.01} = –2.3264$ and less than $t_{0.05} = –1.6449$, with a threshold of significance **p = 0.95**, can significantly be held *extremely low risk* of the impact of transport subsystem logical outcome of the fatal accident and at events a dangerous substance "Hydrofluoric acid."

Based on a sample of 19 accidents in the logistics subsystem use/distribution, determined value $t^+_5 = 2.5203$ which is greater than $t_{0.99} = +2.3264$, with a threshold of significance of p = 0.99 can significantly be concluded *critical risk* of the impact of logistics subsystem use / distribution of fatal outcome of events in accidents with dangerous substance "Hydrofluoric acid." The received status of the dangerous substance "Hydrofluoric acid" is an unpleasant surprise. Compared with other inorganic acids (sulphuric, nitric and hydrochloric), results in unexpected higher risk of fatal outcome accidents. From the displayed analysis is obvious that the problems arising in use and distribution. The most likely reason is the poor training of end users and their ignorance of the specific dangers of "Hydrofluoric acid," as well as non-standard clinical condition that occurs when damage to this dangerous substance.

SELECTED REPRESENTATIVE ACCIDENT HYDROFLUORIC ACID

Based on the presented results, the obvious is extremely high risk of fatal cause of accident with Hydrofluoric acid. Regarding the risk of sulfuric acid is almost twice as totally unexpected, and in terms of nitrogen and Hydrofluoric acid increased by 4 to 5 times respectively.

As representative accident fluorine hydrogen acid selected but a crash which occurred on September 27, 2012 in the chemical factory "Gumi

National Industrial Complex" (Korean Silicone Valley), in the city of Gumi, South Korea and l, 200 kilometers south of Seoul.

Fig. 3. Image blast tanks and discharge of hydrogen fluoride gas into the atmosphere, Tires, South Korea means the September 27, 2012

About 8 tons of fluorine hydrogen acid of gaseous vaporized in the atmosphere so after the explosion of the tanker, killing five workers and 18 were hospitalized.

However, other consequences of the accident have occurred under the influence of moisture in the air that formed fluorine hydrogen acid. About 3000 people sought medical help for eye and throat and for problems breathing it, and about 300 people evacuated from their homes. Concentration of 1.3 mg/l which was established in the industrial channel through it is inflow in river Nankdong, causing an environmental disaster and pestilence of fish. Also, emergency veterinary assistance was treated in around 2800 cases of 30 surrounding farms. In the next 80 days the enterprise had to stop the work.

The concentration of fluorine hydrogen acid in the air and destroyed the yield plantations covering about 500 hectares. After this accident Tires city was declared a disaster area by the government of South Korea.

Fig. 4. Destroyed crops of peppers and rice fields after the accident with hydrogen fluoride, Tires, South Korea 2012

MEASURES OF PROTECTION

Working with hydrofluoric acid Gamma required level of personnel protective equipment (Figure 5). Means HF resistant (plastic, not glass) Viewfinder (EN166B) and helmet (EN397 / 467), mandatory lowered visor, a protective "cloak" compulsory underlined viewfinder from below (EN 166-345-B), HF resistant gloves (EN 374- 3), HF resistant jacket (EN 467), HF resistant protective trousers (EN 467) and HF resistant shoes (EN 345/369) [5].

Training course for care work process with hydrofluoric acid is required. The operators must be drilled and Experienced in working with equipment storage, transshipment and transport of hydrofluoric acid.

Using equipment is mandatory in workflows hydrofluoric acid, not only in unfortunate situations.

All containers manipulation and reload equipment must be dimensioned to 110% declared static loads and maximum load are not to exceed 85%.

Dynamic resistance vessels in falling must be certified. During handling must be used s special containers and pallets. And so on.

Fig. 5. Equipment Gamma level of protection

CONCLUSION

The small molecular weight of hydrofluoric acid allows deep penetration in the tissues of humans, animals and plants. The appearance of the first symptoms is delayed and occurs because of intense necrosis of the tissues, the absorption of the essential chemical elements for the functioning of cells: potassium, sodium and magnesium. Small amounts of acid contamination on contact and inhalation can cause fatal consequences.

The volume of production, storage, transshipment, transport and use is far lower than the quantity of ammonia, sulfuric acid, gasoline, diesel and other dangerous substances. Because of its "imperceptible" effect, hydrofluoric acid has a minor share of the market of dangerous substances presses of focus and accidents with hydrofluoric acid are normally classified as "rare events". The operators do not usually specialize in working with this dangerous substance and usually neglect the need for application of specific safety equipment for different types of acids.

The main source of risk is determined in the logistics subsystem use and/or distribution. It is characteristic that in his action subsystem using the smallest amounts. Because of this quantitative characteristic overlooked dangers are not investing in equipment and training workers. The main measure to reduce the risk is clear: either hiring specialized firms or investment in training its own staff and adequate equipment.

Because of the specificity of treatment without clear symptoms and medical history, and because of ignorance of the true nature of the threat, hydrofluoric acid is one of the riskiest hazardous substances.

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Number of article: 500
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 269–274 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 331.45:303.62(497.7

Original scientific paper

PRINCIPE OF INTEACTIVE CONSULTATION AS A KEY OF CREATING SAFETY CULTURE IN THE WORKING ENVIRONMENT

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A b s t r a c t: Creating safety culture, as creating culture as concept is probably one of the most difficult approaches in facilitation of the human behavior. Although it is legal obligation of the employer is to inform and consult employees directly or through their elected representatives and to allow them to participate in planning and taking measures for safety and health at work, practice shows that most of the communication is informal, lacking or partial. Hence, team of DPIU ProgenZ LLC has conducted detailed research through the direct participants in the working process in order to establish or improve ways to implement interactive communication in the working environment, between employees and employers, as step of creating safety culture. The research used a method – inquiry and the same survey involved 162 examinees from different companies and industries. The results are examples of good practice in order to prevent the occurrence of accidents at work (workplace injuries, illnesses related to work, occupational diseases), raising awareness of a culture of safe operation of all interested stakeholders, as well as stress prevention in the workplace which is an indirect cause of the injury occurrence thereof and high on the scale of OSH problems for which is needed appropriate solutions.

Key words: safety culture; OSH; sharing information; consultancy; interactive communication; stress; preventive measures

ПРИНЦИПОТ НА ИНТЕРАКТИВНА КОНСУЛТАЦИЈА КАКО КЛУЧ ЗА СОЗДАВАЊЕ НА БЕЗБЕДНОСНА КУЛТУРА ВО РАБОТНАТА СРЕДИНА

А п с т р а к т: Создавање безбедносна култура, како и создавање на култура како концепт е веројатно еден од најтешките пристапи во обликување на човечкото однесување. Иако е законска обврска на работодавачот да се информираат и консултираат вработените непосредно или преку избраните претставници и да им овозможат да учествуваат во планирањето и преземањето на мерки за безбедност и здравје при работа, практиката покажува дека поголем дел од комуникацијата е неформална, недостасува или е делумна. Оттука, екипата на DPIU ProgenZ ДОО спроведе детално истражување преку директни учесници во процесот на работа, со цел да се воспостават или да се подобрат начините за спроведување на интерактивната комуникација во работната средина помеѓу работниците и работодавците, како чекор за создавање на безбедносна култура. Истражувањето користеше метод – "истражување" и во истото истражување беа вклучени 162 испитаници од различни компании и индустрии. Резултатите се примери на добра пракса, со цел да се спречи појава на несреќи при работа (повреди на работното место, болестите поврзани со работата, професионални заболувања), подигање на свеста за културата на безбедно функционирање на сите заинтересирани страни, како и спречување на стрес во работното место кое е индиректна причина за настанувањето на повредата на истите и високо на скалата на проблемите со БЗР за кои е потребен соодветни решенија.

Клучни зборови: безбедносна култура; БЗР; размена на информации; консултации; интерактивна комуникација; стрес; превентивни мерки

INTRODUCTION

There is no employee who is not exposed to health and life hazards. None workplace is completely safe! Creating safety culture trough interactive communication is a first step of prevention and control of hazards in workplaces.

"The product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and

the style and proficiency of, an organization's health and safety management"

Occupational Safety and Health (OSH) is a constitutional category with the status of a fundamental right of every employee that enters into the group *"constitutionally guaranteed basic economic, social, cultural and humanitarian man rights"*. Occupational Safety and Health (OSH) is an interdisciplinary concept of providing wellbeing of the people *and psycho-physical integrity of the workers* involved in the work. But at the same time it is also protection of employers from unforeseen and uncontrollable economic and material losses arising from damages resulting from the non-application of the measures for OSH. As a secondary effect occurs and the protection of colleagues with whom we work, indirectly our families and the wider community.

There mustn't be compensation of OSH measurements with various improvisations. Given this responsibility, each individual is required to advocate for raising consumer awareness of the general public about the importance of the rights and obligations in relation to the issue of safe and healthy conditions at work.

Very often you can hear that there is worldwide lost 4% of GDP. But, actually it is more, because the indirect costs are difficult to calculate. It is spoken for millions of deaths at the workplaces, but at the same time, you give yourself a clarification that it happens to someone else, that is far from us, that we have experience, how many years we are doing this work ... Maybe the figures represent Statistics, but we must take in consideration, that behind this statistics, lie human tragedies.

One of the main causes of workplace injuries includes:

- Lack of society preventive culture;
- Inadequate or insufficient regulation, or the multitude of regulations, rules, standards and regulations;
- Inadequate system of OSH, insufficient training, communication, consultation, informing of all stakeholders, defective / insecure working means;
- Insufficient external and internal supervision of the implementation of OSH measurements;
- Cutting the time of performance and increasing of the liabilities, insufficient time for the performer to adapt new requirements and to consider the possible dangers;
- Stress, indifference, low level of awareness;
- Coincidence - force majeure…

Researches are showing that most accidents can be prevented. **Prevention** is the cornerstone in the approach for managing risks, which leads to work injuries. Prevention (from the Latin. Praevenire = Prevents) means planning and implementation of a set of measures to prevent any unwanted appearance, which can result as accidents, injury, illness, stress etc.. This section of OSH, means analyzing work processes to identify risks, planning measures, taking actions for their elimination or mitigation with the ultimate goal of reducing injuries and occupational diseases as well monitoring their effectiveness.

Basic principles of PREVENTION on which should be based OSH measures conducted by the employer: Avoiding risks; Assessing the risks that can't be avoided; Dealing with risks at the outset; Adjusting the technological process and the work to the individual, especially to the characteristics of the workplace and work environment; The choice of working and production methods and tools, personal protective equipment; Conducting measures required to maintain and strengthening the health; Replacing dangerous with less dangerous; Develop a complete security strategy covering technology, organization of work, working conditions, interpersonal relations and factors affecting the work environment; Giving priority to collective security measures against individual measures; Provide appropriate guidance, instructions, training, **consulting and informing employees**; Control of working conditions; Planning for emergencies; Recording, documenting and transmission of information on safety and health at work; Investigation of accidents at workplace.

With the Law on Safety and Health in the Republic of Macedonia are regulated OSH measures, obligations of the employer and the rights and obligations of employees in the field of OSH, as well as taking **preventive measures** and enforcement of modern safety technical, health, economic, legal, educational and organizational measures and tools aimed primarily against professional risks, the elimination of risk factors for accident**,** information, consultation, training of workers and their representatives and their participation in planning and taking measures for safety and health at work.

Legally the ultimate responsibility for preventive action is given by the employers, but their efforts are doomed to failure without the active participation and workers' contributions of their knowledge, experience and behavior. Of course this is also a task of the State Labor Inspectorate and other government institutions, services for oc-

cupational medicine, educational organizations and professional associations. We must put emphasis on individual responsibility.

Employees, at every level, have a responsibility to care for their own safety and health at the workplace, as well as others employees on whom they have the influence, through their operating activities, to act in a manner showing awareness of the risks, to collaborate with management in coordination of activities related to OSH, timely reporting foe defects and possible dangers. It is necessary to have open talk about safety within a climate of trust, to promote learning and respect for the knowledge and experience, to establish and develop culture of safe operation which involves establishment of a clear policy for safety in the company, effective safety organization, setting safety rules and regulations, laying down the procedures for safe operation, providing training, communication, consultation and information on safety for all employees, conducting constant surveillance and monitoring.

This would contribute to a reduction, especially of the number of small accidents and "near cases", sick leave, stress at work, and to improve motivation and productivity of employees and awareness of OSH issues. Stress in the workplace has been identified as a major cause for absenteeism (sick leave) and diseases related to work. Because of this, the campaign in the period 2014-2015, conducted by the European Agency safety and health at work is titled "Stress management to a healthy Work place". This campaign follows the implementation of the campaign "We are working together for risk prevention" in the period 2013-2014. The consultation with employees and their notification, should be one of the guiding principles of prevention and also effective management.

WHAT DOES IT MEAN INFORMATION AND CONSULTATION?

In accordance with the Directive on information and consultation (2002/14 / EC), informing and consultation mean the existence of a constant two-way communication between employer and its employees. This should be addressed to any significant developments that could affect those involved in the process. Consultation of workers creates a culture where relationships between employers and employees, are based on the principles of cooperation, trust, openness, transparency, integrity, mutual respect and joint problem solving. This also requires good planning, research, analysis, advice and feedback, but also to respect the opinion of everyone. Depending on your workplace, you may have to take in consideration cultural and linguistic differences.

As we already mentioned above, the consultation and information are legal obligation, governed by Articles 12, 13, 14, 25, 26, 27 of the Law on Safety and Health at Work of the Republic of Macedonia. In summary, employers should consult their employees about workplace issues that can impact on the welfare and productivity, to inform employees for planned activities and to hear and take into account their views while deciding what to do, and employees should be involved in assessment of risks in the workplace and in the development of OSH policies as in partnership with the employer.

The obligation for consultation and information is also given with the ILO Convention on Occupational Safety and Health, 1981 (No.155) and its accompanying Recommendation (No.164) with the Guide of ILO, Management OSH Systems, with the European Framework Directive on Safety and Health at Work (Directive 89/391 EEC).

Benefits of worker participation and two-way consultation and informing include:

- Lower accident rates, achieving a healthier and safer workplace;
- Economical solutions, reduced costs of sickness benefit, rehabilitation, social Insurance, commitments to injured workers and their families, material damages to assets work, training the new employee and time required for his adapting to work, fines and penalties, litigation, other expenses and similar in case of an accident;
- Happier, more productive, more motivated workforce, lower rates of absence, better cooperation / mutual confidence in solving problems, positive working and interpersonal relationships.
- Greater awareness of workplace risks and commitment, because workers who are actively involved in it, or their involvement in making decisions on health and safety at work, will lead to better understanding and will make decisions easier. A stronger commitment to implement the decisions or activities;
- Bigger control of workplace risks, better decisions on health and safety - which are based on the experience of employees.

This in practice means active participation of employees and managers, in identifying problems and finding solutions, including:

- Effective and open dialogue, which includes listening each other matters of common interest;
- Collaborative problem-solving and decision of solutions;
- Participation in the development of policies and practices for safety and health, in promotion and realization of the conditions for OSH;
- Presentation to the superiors, their own views and management measures, reduction or complete elimination of the stress factors (technological, motivational, educational and other measures).

The employer may consult with employees directly or through their elected representative/s. Consultation can take the form of:

- regular staff meetings and communication with employees;
- regularly update information on notification boards and screen, regular training
- regular written communications such as newsletters and internal publications, e-mail, intranet or Internet site.

The information and consultation can be through less formal systems, as face-to-face discussions, chats or periodic meetings on specific problems or formal system, actually there are effective agreements/consultations, involvement of an adequate number of workers' OSH representatives and other representatives of workers, as also safety committees.

For effective and efficient two-way information and consultation must be consider mechanisms for feedback on OSH issues, which should be documented. You can use the "suggestions box" or more formal open meetings with the management; meetings shall be proposed held at the request of employees and it could be led by them; OSH decisions can be made jointly between management and employees; practicing quarterly written and/or verbal feedback to all employees and others.

In order to get a view on who is the best/most appropriate way of applying legal frame for consultation and information in Republic of Macedonia, we made a selection of several legal entities that have different prior activity on working (textile manufacturing, utilities, banking services, mining and processing services, commercial services) and with different rank size, in which was conducted an inquiry, by submitting a written questionnaires to employees on different workplaces.

The written questionnaire is consist of eleven questions. The answers are given by the selection of possible answers, and by written amendment of their own suggestions and views. The inquiry was conducted over a period of three months, July - September 2015. The inquiry included 162 respondents, from which 55.6% were men and 44.4% were women. The average age of the respondents was 42.8 years, and the average length of service was 14.8 years.

2. DESCRIPTION OF THE RESULTS OF THE CONDUCTED INQUIRY:

1. At the question: "Do you think you need to be consulted, informed and involved in the preparation of instructions, procedures, OSH policies, in the choice of means and equipment for work, in the preparation of risk assessment at your workplace, during the planning of changes and before finally adopting measures etc.”?

- 93.8% from respondents answered "YES” and
- 6.2% of respondents answered “NO”.

2. Do they know that **"consultation and information is a legal obligation of the employer”?**

- 94.4% respondents answered “YES”, and
- 5.6% of respondents answered “NO”.

3. **"Do you think that by implementing the information and consultation"** of workers, encourage them in giving suggestions and ideas to improve OSH, in reporting hazards/ mischievousness and risks of the work environment and the workplace, meaning "Do "Communication and information" of workers contributes for their motivation to participate "actively" in providing better safety and health at Work”?

- 98.8% of respondents answered “YES” and
- 1.2% of respondents answered “NO”.

4. Do you think that **"Through consultation and information of workers they are educated to understand the general principles of prevention, their application and development of OSH measures”?**

- 98.8% respondents answered “YES” and
- 1.2% of respondents answered “NO”.

5. At the question **"Do you think that if it is implemented on time two- way consulting and information, it will have a positive impact on prevention of workplace injuries, illnesses related to work and occupational diseases, reducing stress in the workplace"?**

- 98.8% of respondents answered "YES", and
- 1.2% of respondents answered "NO".

6. At the question **"What do you mean by including worker in two-way process of consultation and information?"** the respondents are asked to give a brief explanation, which gives an overview of the answers:

- "Greater awareness, training of workers and thereby reducing occupational diseases, the prevention of stress, injuries",
- "Direct participation of workers in troubleshooting OSH, teamwork and timely information about current events",
- "Workers receiving information of risk at work and protection from it, and then they will tell for risks they meet at work and will propose how to protect from them",
- "Participation of employees in making decisions about purchasing PPE and other resources ",
- " Information about all developments and legal OSH provisions",
- "To be involved, not only on paper and to take in consideration and to implement the proposals by workers for improving conditions",
- "To be heard/accepted the opinion of the employee before making final decisions and not just be silent listener, in order to increase security",
- "To settle things without consequence to the worker",
- "Worker directly to be involved in the dialogue or information and to receive feedback on the adopted solutions"
- "Assistance in the establishment of rules to protect the company",
- "Frequent employee's meetings (at least annually), discussion of all matters and increased communicating of more people, not just ranting responsible person".

7. At the question: **"What do you think, which is the best way for your active participation in two-way process of "consultation and information" or how would addressed your suggestions or complaints to the superiors"?** It were offered more answers, with possibility to specify more of them and to supplement. In addition to each of the answers is given the received result.

	Respondents
A. Through personal participation	**44**
B. Through the elected OSH representative of the workers	**66**
C. Through trade union officials or workers	**19**
D. Through OSH expert	**46**
E. A board-level legal entity made up of representatives of workers and employers	**6**
F. Other (Specify): "Through gatherings of workers in departments with Other (Specify): "Through gatherings of expert for the OS "	

8. At the question: **"What do you think is the best way to be consulted on matters related to OSH"?** It were offered more answers, with the opportunity to state more of them and to supplement. To each of the answers is given obtained result.

	Respondents
A. Conducting surveys / questionnaires	**33**
B. Maintaining annual / semi-annual / quarterly / monthly / weekly / daily meetings (59 respondents did not declare for periodical meetings, 5 think it is good to held at year 6 of semiannual and quarterly, 17 monthly and 10 per week)	**105**
C. Box for suggestions and complaints	**24**
D. Other (specify):	**0**

9. At the question: "By your opinion which is the best way to be informed about OSH matters" are given the following results:

	Respondents
A. Direct communication with the responsible	**87**
B. Delivery of manuals, written instructions	**34**
C. Through internal magazine / newsletter / leaflets	**4**
D. Bulletin board or board set of information popular location	**21**
E. Posters / Schemes colors	**3**
F. Through direct mail / e-mail / intranet / internal web portals	**8**
G. Videos / Short thematic movies / Power Point presentations	**4**
H. Honors specialized / dedicated training	**11**
I. Other (Specify)	**0**

10. At the question: "Do you think that there is need to introduce a system of reward and sanction to promote and control of OSH system"? 74.17% of respondents answered "YES" and 25.9% of respondents answered "NO".

Your suggestions: "Sanction for not wearing PPE", "Awards for implementation of OSH measures and better execution of tasks".

11. "Have you ever taken an active part in making suggestions to overcome OSH problems, improve work and working conditions"? With "YES" answered 33.3% of respondents and with "NO" 66.7% of respondents.

If the answer is YES, specify Your experience:	"When selecting PPE" "As a representative union" Yes, but they were not accepted "
If the answer is NO, then what is the reason:	"Nobody asked for an opinion from me" "My inaction in this matter" "There was no need " "I am administrative worker" "No because the best way it is done by the adequate service " " I didn't have opportunity" " There are other responsible"

3. ANALYSIS OF THE OBTAINED RESULTS AND CONCLUSION

The results of the survey showed that most respondents consider to be consulted, informed and involved in the planning and adoption of OSH measures, know that their consultation and information provided by the employer is a legal obligation, that thus they are encouraged to take an active part in providing OSH proposals and solutions, and two-way consultation and information has a positive impact on prevention of workplace injuries, illnesses related to work and professional diseases, reducing stress at the workplace. Overall by directly "Involvement of employees" imply on their participation and information in the area of OSH and taking into account their suggestions for prevention and through elected of workers OSH representative. According to respondents the best way to be consulted in practice is by holding meetings for OSH, but to be informed directly by the responsible. According to the majority of respondents, the introduction of a system of reward and sanction is a good way to promote OSH.

Most respondents said that they didn't take an active part in giving suggestions for overcoming OSH problems, improve performance and working conditions, so we think that the implementation of two-way communication with employees and employers, consult them and information in the field of OSH, selected through the above ways will lead to changing the actual situation, and therefore the application of good practice in order the prevention of occurrence of accidents at work, raising awareness of culture safe operation of all interested stakeholders, as well as prevention of stress in the workplace which is an indirect cause of the occurrence thereof and high on the scale of OSH problems for which is necessary timely finding solutions. Starting from the personal responsibility each of us should ask itself what could be made to create a safe workplace conditions and to contribute, it can be proudly said that awareness and culture of safe operation is on high level.

Companies that offer an open door in the involvement of workers, in detection of problems and finding solutions by taking into account their ideas, likely they will be more successful in effectively managing health and safety.

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Number of article: 501
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 19, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 275–279 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 621.791.03:007.52]:331.45

Original scientific paper

ROBOTS FOR SAFETY AND HEALTH AT WORK

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A b s t r a c t: The technology of service robotics is at the same time a very attractive, challenging and imaginative discipline. Robotics as a science has task or better say noble objective – for instance, displace human beings from doing tedious/monotonous, dangers and for life threatening jobs. The main finding robotics is robots and humans cooperate closely in the work as servants or helpers in everyday life. Application of industrial robots in production processes of various industrial branches year after year is increased. In this paper special attention will be given to the security in the working environment in the work process. Industrial robots are well represented in the process of welding. There are several systems that have achieved this goal. This paper deals with the safety of workers, protection methods, types and principles of protective systems, and the advantages and disadvantages of security and protection of workers at work in the welding process of industrial robots. This paper presents and norms that determine the area of security and protection of workers and dangerous/unsafe work to be substituted with industrial robots.

Key words: robots; robots in working environment; robots for safety and health; at work

РОБОТИ ЗА БЕЗБЕДНОСТ И ЗДРАВЈЕ ПРИ РАБОТА

А п с т р а к т: Технологијата на роботизација во областа на услугата во исто време е многу атрактивна, предизвикувачка и имагинативна дисциплина. Роботика како наука има задача или подобро речено благородна цел – да го промени човечкиот живот при работата во монотони и опасни по живот работни места. Главниот заклучок е, во роботиката роботите и луѓето во работата тесно соработуваат, како службеници или помагачи во секојдневниот живот. Појавата на индустриски роботи во производствените процеси од различни индустриски гранки од година во година се зголемува. Индустриски роботи се доста застапени во процесот на заварување. Постојат неколку системи кои ја постигнале оваа цел. Во овој труд е наведено безбедноста на работниците, методи на заштита, типови и принципи на системи за заштита, како и предностите и недостатоците на сигурност и заштита на работниците при работа во процесот на заварување на индустриски роботи. Овој труд потенцира, нормите со кои се одредуваат местата на безбедноста и заштита на работниците при опасна / небезбедна работа да бидат заменети со индустриски роботи.

Клучни зборови: роботи; роботи во работната средина; роботи за безбедност и здравје; при работа

INTRODUCTION

Robotics is a relatively young technical branch, but already has a rich tradition. For example industrial robots sooner or later will change the performance of everyday tasks of workers in the industry automation and modernization of production processes. An industrial robot is defined by ISO as an automatically controlled, reprogramma-

ble, multipurpose manipulator programmable in three or more axes. The field of robotics may be more practically defined as the study, design and use of robot systems for manufacturing. Typical applications of robots include welding, painting, assembly, pick and place such as packaging, palletizing and SMT, product inspection, and testing; all accomplished with high endurance, speed, and precision.

However, today when robots are highly represented in all production processes, they cannot function without the interaction with humans

Particular attention should be given to the issue security of workers in the working environment during the welding process because they are the most common industrial robots in the process of welding.

USE OF INDUSTRIAL ROBOTS

According to the classification made by the UNECE and adopted (United Nations Economic Commission for Europe) and IFR (International Federation of Robotics) service robots are divided into two groups:

– industrial robots,

– service robot.

The numbers of application of the industrial robots in manufacturing process in the world has been taken from the statistical data of International Federation of Robotics (IFR), the data of the Economic Commission to the United Nations for Europe (UNECE) and the Organization for Economic Cooperation and Development (OECD); World Robotics Service Robotics 2014.

In Table 1–3 is given Industrial Robot Statistics**,** through the years. Following statistical analysis should be point to the use of industrial robots in manufacturing processes in the world and in the welding process.

Table 1

Use of industrial robots worldwide, 2008–2010

	Annual use of robots			Total use of robots		
Continent/year	2008	2009	2010	2008	2009	2010
Europe	34695	20483	30630	343329	343661	352031
America	17192	8992	17114	173977	172141	179785
Asia/Australia	60294	30117	69833	514914	501429	498933
Africa	454	196	256	1777	1973	2232
Total	112972	60018	118337	1035301	1020731	1035016

Table 2

Total use of industrial robots in welding worldwide

Welding	2005	2006	2007	2008	2009	2010
Arc	100975	114625	122748	129748	128728	134200
Spot	145407	156342	166829	166829	161918	164280
Laser	943	1316	1987	1987	2022	2186
Another	2236	2414	3458	3458	3616	3564
Soldering	2539	2387	2987	2987	2844	2509
Unrefined	1343	2069	1966	1966	1400	1931
Total	253445	279153	294641	306975	300528	308670

Table 2

Industrial Robot Statistics, 2014

Industrial robots per 10,000 manufacturing workers – 2014		
	Country	Robots/10,000
1	Japan	295
2	Singapore	169
3	South Korea	164
4	Germany	163
5	Sweden	126
6	Italy	124
7	Finland	98
8	Belgium	89
9	United States	86
10	Spain	84
	Industrial Robots by Sector	**Percent of all Robots Used**
1	Automotive	33.2
2	Unspecified	25,0
3	Electrical and Electronics	9.9
4	Chemical, Rubber, and Plastics	9.4
5	Other	9.2
6	Machinery	4.3
7	Metal Products	3.7
8	Communications	2.5
9	Food	1.5
10	Precision Optics	0.8
	Use of Robots	**Percent of Robot Jobs**
1	Handling of Materials and Processes	35.4
2	Welding and Soldering	28.9
3	Assembling and disassembling	13,0
4	Unspecified	8.6
5	Other	7.9
6	Dispensing and Painting	3.8
7	Cutting, milling, and other processing	2.5
8	Communications	2.5
9	Food	1.5
10	Precision Optics	0.8

At Figure 1. is presented estimated worldwide annual shipments of industrial robots. 2013: The highest number of industrial robots ever sold. In 2013, robot sales increased by 12% to 178,132 units, by far the highest level ever recorded for one year. Sales of industrial robots to the automotive, the chemical, and the rubber and plastics industries, as well as to the food industry continued to increase in 2013. The electrical/electronic industry also increased the number of robot installations in 2013 after the reduction of investments in 2012. China became the biggest robot market with a share of 20% of the total supply in 2013. About 70% of the total robot sales in 2013 were in Japan, China, the United States, Korea and Germany. Between 2008 and 2013 the average robot sales increase was at 9.5% per year (CAGR).

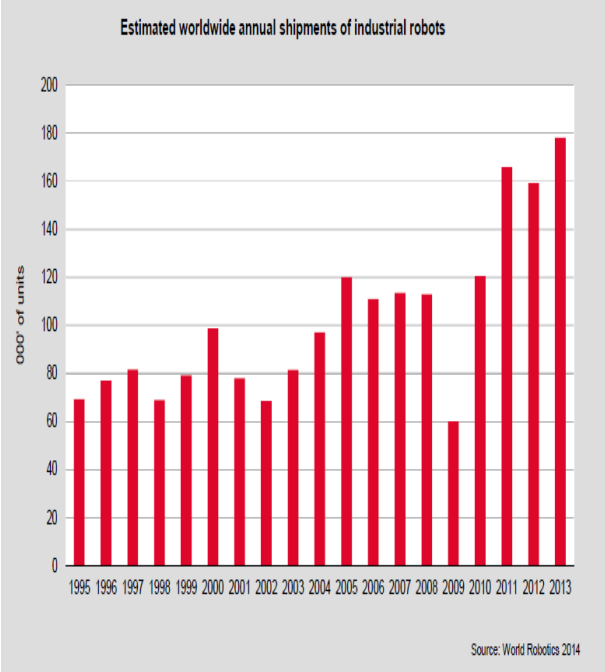

Fig. 1. Estimated worldwide annual shipments of industrial robots.

At Figure 2 is presented estimated worldwide annual supply of industrial robots, by industries, 2011–2013. Continueds increase of robot sales to the automotive industry. Since 2010, the automotive industry – the most important customer of industrial robots About 69,400 new robots, 4% more than in 2012, were installed in this industry in 2013, establishing again a new peak. The share of the total supply was about 39%. Between 2009 – when robot installations hit rock bottom – and 2012, robot sales to the automotive industry surged from 19,300 units to 66,500 units.

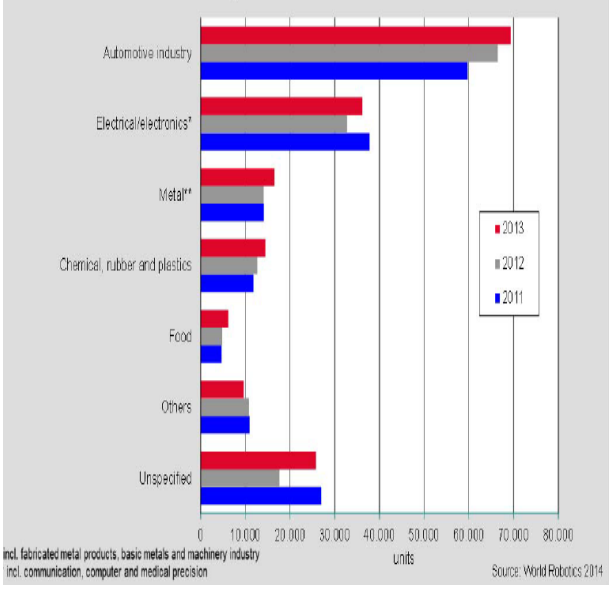

Fig. 2. Estimated worldwide annual supply of industrial robots, by industries, 2011–2013.

AREA OF SECURITY AND PROTECTION OF WORKERS

All welding and thermal cutting operations carried on in confined spaces must be adequately ventilated to prevent the accumulation of toxic materials, combustible gases, or possible oxygen deficiency. Monitoring instruments should be used to detect harmful atmospheres. Where it is impossible to provide adequate ventilation, air-supplied respirators or hose masks approved for this purpose must be used. In these situations, lookouts must be used on the outside of the confined space to ensure the safety of those working within. Requirements in this section describe standards established for arc and gas welding and cutting. A certified industrial hygienist should be consulted to understand the correct approach for your specific situation.

Fig. 3. Exhaust ventilation using welding Fume Extractor that is mounded on the wall.

DANGEROUS/UNSAFE WORK TO BE SUBSTITUTED WITH INDUSTRIAL ROBOTS

The increased use of robots in factories derives from a series of functional and technical considerations related to the development of innovative technologies, both hardware and software, applied to robots: the miniaturization of components, new materials, advanced sensorization systems, the strengthening of control softwares, and more. All together, these aspects contribute to the development of robots with increasingly higher performances in terms of speed, precision, reliability and ease of use.

Robot controller became more powerful and was ready to perform additional tasks like safety related operations. Based on this safe-move, robots were then presented. Software replaced hardware and allowed the robot to operate in a safer way with higher flexibility. At the same time the mechanics got better with a much higher degree of accuracy. New applications became possible like Remote-LaserWelding creating new possibilities for products.

Programming a robot is very simple. Even workers who must overcome a language barrier can learn to program a robot in two days, thanks to the simple interactive screen on the pendant.

Fig. 4. Simple interactive screen on the pendant.

It is not necessary to dedicate a robot to a single task such as making only one piece part. With the number of welding parts programs that can be stored in a robot control unit's memory, it is possible to go from one part to another part very quickly if the tooling nests are properly designed for quick change. Several different parts can be made in the same welding cell in a given day.

No robot can solve a welding quality problem all by itself. If the parts are not designed properly, the piece parts are not made properly, or the welding joints are not properly prepared or presented to the robot, there will be problems with quality.

Becoming a highly skilled welder takes years of experience, training and practice, whereas a robotic welding cell operator only has to load the part, press the appropriate buttons to activate the machine, and then unload the part. The training of a robot operator can literally take less than an hour.

Following the market trends of the desktop and laptop computers, the actual dollar cost of a robotic welding cell has dropped dramatically in the past 10 years. During the same period, software capabilities, programming ease, motion speed and accuracy have all been enhanced. The upshot of this is, that for a much lower cost, a robotic welding cell now offers far superior performance.

It is not true that a robot can weld any part that can be welded manually or semi automatically. Clamping requirements, access problems or specific positioning requirements may make the use of a robotic welding cell impossible or impractical.

Robots can be put on tracks or gantries, giving them the ability to weld parts that are 40 to 50 ft long and 8 or 10 ft wide.

Fig. 5. Welding systems can incorporate vision capabilities that provide for adjusting electrode position and welding parameters to permit quality automated welding even on parts with variations

CONCLUSIONS

During the welding process affects certain potential hazards such as, radiation, contamination of air, electric shock, compressed gases, collisions with other devices and man.

When designing a robotic welding system in each case should be taken certain preventive measures. Very important select the appropriate system of protection, it is the only way to achieve the correct effect. Most industrial robots used in automobile industry in the process of welding work.

Using protective measures, aimed to reducing the number of injuries when humans working. Although industrial robots introduced to primarily replace humans in work in difficult and dangerous jobs, their application of certain risks are arising which should special attention during application robot.

The development of new technologies usage of new materials in the industry and also in the automotive industry require a new production lines and it goes towards increasing the usage of industrial robots, so it can be expected a growing trend of application of robots in the welding process.

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Number of article: 502
CODEN: MINSC5
Received: November 1, 2015
Accepted: December 7, 2015

Mechanical Engineering – Scientific Journal, Vol. **33,** No.3, pp. 281–286 (2015)
In print: ISSN 1857–5293
On line: ISSN 1857–9191
UDC: 69:621.8]:331.454-047.44

Original scientific paper

RISK ANALISYS FOR OCCUPATIONAL INJURIES CAUSED BY MACHINERY USAGE IN BUILDING PROCESS

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A b s t r a c t: Construction industry with all if its specificities is the most vulnerable industry from the aspect of health and safety. Complex processes, diverse resources, temporary working teams, etc. makes building process highly risky. Construction machines as one of the essential resources demand special attention in the aspect site, work and health and safety planning. For the purpose of this research detailed analysis of construction machines usage and its impact on injuries occurrence is realized. In the analysis, data of 719 injuries are analysed of which 84 injuries occurred using construction machines. The riskiest machines are identified, causes of injury, ways in which injuries have occurred, the injured body parts as well as injury severity. Presented research is important for safety professionals and site managers in terms of the planning of preventive measures in the realization of construction works. Research has pointed the fact that most of the injuries occur due to improper realization of work operations and malfunction of the machines.

Key words: mechanization; building process; safety at work; injuries

АНАЛИЗА НА РИЗИКОТ ЗА ПРОФЕСИОНАЛНИ ПОВРЕДИ ПРЕДИЗВИКАНИ ОД УПОТРЕБАТА НА МАШИНИТЕ ВО ГРАДЕЖНИШТВОТО

А п с т р а к т: Градежната индустрија со сите свои специфичности претставува најранливата индустрија од аспект на безбедноста и здравјето. Комплексни процеси, различни ресурси, привремени работни тимови и слично, го прават градежниот процес да биде високо ризичен. Градежните машини претставуваат еден од основните ресурси кои бараат посебно внимание од аспект на работата, здравјето, безбедноста и планирањето. За потребите на ова истражување направена е детална анализа на употребата на градежните машини и нивното влијание на појавата на повреди при работа. Во анализата се вклучени податоци од 719 повреди од кои 84 се случени при употреба на градежни машини. Идентификувани се најризичните градежни машини, причините за повреда, начинот на кој што е настаната повредата, повредени делови од телото, како и сериозноста на повредата. Ова истражување е значајно за стручните лица и за менаџерите на градежните објекти во насока на планирањето на превентивни мерки во изведувањето на градежните работи. Резултатите од истражувањето покажуваат дека најголем број од повредите се случиле поради несоодветна реализација на работните операции и дефекти на машините.

Клучни зборови: механизација; градежен процес; безбедност при работа; повреди

INTRODUCTION

Every branch of industry generates specific risks of occupational safety that are arising from the work environment, the workplace and the necessary resources for the work operation. Increasing complexity of work processes requires more time and resources for organization of the same in a safe way. The building process has all the characteristics of a very complex process: each object that is being built is a specific, process requires a large number of participants and stakeholders, the problem of design and construction is present, a large number of different types of materials, tools and machinery is needed, the building process is exposed to weather conditions, the movement of

workers, materials and machinery is present in one or more buildings, education of the workforce is low, and so on. Despite being one of the most significant branches, construction industry features the highest injury rate. [1–6] Within the paper a part of research related to injuries resulting from the use of construction machinery is presented. Analysed violations have occurred at construction sites of Vojvodina in the Republic of Serbia for a period of 4 years.

METHODOLOGY AND CREATION OF A DATABASE

Research of risk of construction mechanization usage consisted of three stages. First, collection of injury reports in cooperation with Occupational health services of Autonomous Province of Vojvodina was done. After data collection, analysis of data was realized and database was formed. Finally, data analysis was made through analysis of machine type, cause of injury, way in which injury have occurred, severity, injured body part and role of injured worker in work process. The structure of the analysed injury reports is shown in the Table 1.

Table 1

The structure of the analysed injury reports

Area of construction sector		Number of analysed reports	
All areas – inside and outside the site		1158	100%
All areas – inside the site		990	85,49%
Building construction – inside the site	Total	736	63,56%
	Do not include key data	17	1,47%
	Included in the database	719	62,09%

The database consists of five groups of data as follows: data on an injured worker, data on the time of the injuries occurred, data on the type of work and work operations realized at the moment of injury, data on the source of injury, cause of injury and way that injury occurred and data relating to consequences of an injury (severity and injured body parts). Each of the data groups consists of a number of sub-groups that provide more accurate information about the parameters of the observed injuries. In order to determine what the direct source of injury is following parameters were identified based on the description of reported injuries: machinery that was source of the injury (Table 2), tools that were source of the injury, materials which were source of injuries and equipment that was source of the injury.

At the same time it has been analysed which resources were direct source of injury (machinery, tools, etc.) whether injury occurred during their improper use or if the injury was a consequence of the operation which was only associated to the observed resource, i.e. injury would not occurred if the resource was not used (for example, material takeover at the edge of the building during the use of tower crane). Determination of the cause of injury is very important for the risk identification and quantification process. If the cause of the injury is not specified, it is impossible to fully perceive all the factors of injury.

Observing the characteristics of any work, according to [7] process can be concluded that the causes of injury can be divided into two levels, indirect cause of the injury, presented in Table 3, and basic cause of the injury. The detailed classification was formed based on an injuries analysis according to literature [3–13] improved by using information available from the injury reports. Table 3 presents the 42 indirect causes of injuries that are defined on the basis of newly created database and injury reports. Indirect causes were divided into three groups according to whether they are associated with unsafe work and/or behaviour of workers, unsafe working conditions or unknown, which is the cause of the injury.

Many authors have carried out research on the possible ways in which injuries have occurred and formed different classifications [7–9]. Within the literature, numerous classifications of severity of injuries have been defined. [8, 14–16] Taking into consideration previous researches and the requirements of the valid legislation of the Republic of Serbia, the new division of injuries was created, encompassing six categories of injuries: small injuries (injuries which required first aid and/or hospital treatment and absence from work of up to 4 days), medium injuries (injuries which required hospital treatment and / or absence from work of between 4 and 13 days), large (injuries which required hospital treatment and/or absence from work of 14 days minimum), very large (injuries resulting in the total loss of ability to work), death (occurring instantly or later on as the consequence of an injury) and multiple death (an incident resulting in death of more than one worker). Classification of an injured body part was specified after the analysis of classifications adopted by international

institutions and certain authors who have analysed classifications particularly for the needs of construction processes, or whose classifications could easily be applied for that purpose. These classifications are presented in [10, 17, 18]. The adopted classification is shown in Table 4.

Table 2

Number and frequency of injuries by type of construction works and type of machine used in the moment of injury

Machine	Type of construction works						Total	
	Operating mechanization		Mechanization maintenance		Other type of construction works			
Concrete mixer truck	–	–	2	2.38%	4	4.76%	6	7.14%
Kipper truck	22	26.19%	2	2.38%	7	8.33%	31	36.90%
Dumper truck	1	1.19%	–	–	–	–	1	1.19%
Water tank truck	1	1.19%	–	–	–	–	1	1.19%
Truck Mounted Crane	–	–	–	–	1	1.19%	1	1.19%
Tracktor	1	1.19%	1	1.19%	–	–	2	2.38%
Wire rope hoist	–	–	–	–	1	1.19%	1	1.19%
Tower crane	2	2.38%	3	3.57%	13	15.48%	18	21.43%
Skip hoists	–	–	1	1.19%	–	–	1	1.19%
Truck concrete pump	–	–	–	–	1	1.19%	1	1.19%
Concrete pump	–	–	–	–	1	1.19%	1	1.19%
Forklift	1	1.19%	1	1.19%	–	–	2	2.38%
Excavator	6	7.14%	1	1.19%	1	1.19%	8	9.52%
Bulldozer	–	–	–	–	1	1.19%	1	1.19%
Loader	1	1.19%	–	–	1	1.19%	2	2.38%
Soil compactor – roller	1	1.19%	–	–	–	–	1	1.19%
Jumping jack	–	–	–	–	3	3.57%	3	3.57%
Small plate compactor	1	1.19%	–	–	–	–	1	1.19%
Concrete factory	–	–	–	–	1	1.19%	1	1.19%
Plastering machine	–	–	–	–	1	1.19%	1	1.19%
Total	37	44.05%	11	13.10%	36	42.86%	84	100.00%

DATA ANALYSIS AND DISCUSSION OF RESULTS

Building process cannot be performed without construction mechanization. These resources are so important today that their usage demands special attention from the point of management as well as occupational safety. In the research all resources (machines) which usage resulted with an injury are identified. Table 2 shows that Kipper truck and excavators are more risky than other machine for operators but on the other hand tower cranes are more risky for construction workers on site. These results are important for risk management and prevention planning and suggest that site planning has great impact in risk level when machinery is used.

As it can be seen from Table 3, most of the injuries 78.57% occurred because of an unsafe act of the employee. 38.10% of them resulted of improper realization of the work while 26.19% resulted from improper entry or exit from the machine. On the other hand 21.43% of injuries are responsibility of employer of which 17.86% occurred after malfunction of the machine.

Table 3

Number and frequency of injuries by indirect cause of the injury

Indirect cause	Num. of injuries	Indirect cause	Num. of injuries
Unsafe act (worker)		Unsafe conditions – procedures, rules (employer)	
alcohol		malfunction of tools	
poor housekeeping of workplace		use of defective or unsafe tools	
failure to wear PPE		malfunction of auxiliary equipment	
horseplay		use of defective or unsafe equipment	
incorrect movement, turning, blackouts		malfunction of machine	15 (17.86%)
improper realization of work operation	32 (38.10%)	unsafe access ramp	
improper use of tools and equipment		improper edge safety	
improper use of ladders		improper pit safety	
incorrect entry and exit from the machine	22 (26.19%)	improper safety of openings	
improper handling of machine	8 (9.52%)	improper safety of trench	
overturning of vehicle	4 (4.76%)	improper safety of working scaffolds	
improperly build material		improper safety of scaffolds	
		improper marking of hazardous places	
		improper ladder installation	
		improper storage of materials	1 (1.19%)
		cracking of built-in materials	
		inadequate PPE	
		poor housekeeping of corridors	
		poor housekeeping of access points	
		improper control of internal traffic	2 (2.38%)
		electrocution	
		improper design of internal traffic	
		excessive noise	
		exposure to radiation	
		insufficient ventilation	
		insufficient illumination	
		confined spaces	
		improperly stored explosive or hazardous materials	
		lack of fire protection	
		weather conditions	
Total	66 (78.57%)	Total	18 (21.43%)

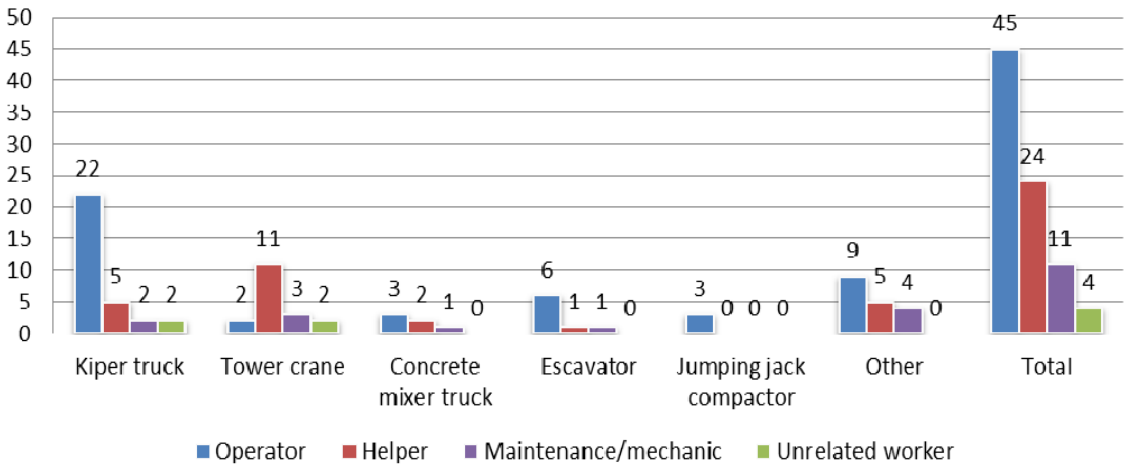

Fig. 1. Number of injuries by workers position in work process and type of machine

After analysis of construction works it was interesting to analyse which worker was injured; operator, helper, maintenance/mechanic worker or some worker unrelated to machine work operation. Results are presented in figure 1. It can be seen that operators are mostly injured workers for all machines except tower cranes which are the riskiest for helpers.

Analysing relation of injuries and type of construction works it is determined that operating mechanization, maintenance, loading and unloading and transfer of materials and other objects generate 83.33% of injuries when machines are used. (Table 4.)

Table 4

Number and frequency of injuries by type of construction works

Type of construction works							
Operating mechanization	Mechanization maintenance	Concreting	Finishing	Walking without handling, working or material transfer	Loading and unloading – manual	**Earthworks – manual**	**Transfer – anual**
37	11	6	2	2	11	4	11
44.05%	13.10%	7.14%	2.38%	2.38%	13.10%	7.76%	13.10%
84 (100%)							

In Table 5 results of injury severity, way that injury has occurred and body part that suffered injury is presented. Table 5 shows that "struck by machinery" is not the riskiest way for injury to happened. Hands-arms and foot-legs are mostly injures when machinery is used but body-torso and multiple injuries are at the top as well. For these injuries PPE is not effective but right preventive measures. High rate of medium and large injures implies that machinery usage is highly risky and demands detail and precise planning.

Table 5

Number and frequency of injuries by indirect cause of the injury

Way in which injury has occurred	Severity				Mechanization	
	Small	Medium	Large	Very large	Num. of. inj.	Frequency
Dropping of object	2		2		4	4.76%
Exposure to harmful substances		2			2	2.38%
Exposure to harmful environment	1		1		2	2.38%
Accidents occurred in traffic or transportation		4	1		5	5.95%
Fragments, parts of materials					–	–
Falls at same level		2	1		3	3.57%
Falls at level below	2	8	5		15	17.86%
Excessive physical strain and exhaustion of the organism		3	2		5	5.95%
Caught in, under or between	4	5	4		13	15.48%
Struck by machinery	3	1	4	1	9	10.71%
Struck by	10	6	3		19	22.62%
Struck against	2	4	1		7	8.33%
Body part					**Num. of. inj.**	**Frequency**
Head	3	1	3		7	8.33%
Face	1		3		4	4.76%
Eyes		2			2	2.38%
Respiratory system					–	–
Hands – arms	9	17	2		28	33.33%
Foot – legs	8	9	3		20	23.81%
Body – skin		1			1	1.19%
Body – torso	2	5	3	1	11	13.10%
Multiple injuries	1		10		11	13.10%
Total	**24**	**35**	**24**	**1**	**84**	**100.00%**

CONCLUSIONS

Research has shown that trucks and tower cranes are the most risky machines analysing non-fatal injuries. Analysing indirect causes it was concluded that training process should include intensive on-site work in order to prevent future mistakes. Operators are the most injured workers considering all types of machines except tower cranes. It is interesting that helpers of tower cranes who are mostly involved in hooking and unhooking as well as binding of materials and other objects are the most injured workers in tower crane work process. Analysis injuries severity has shown that severity levels are higher when machines are used. Hands-arms and foot-legs are most vulnerable body parts which is not different compering to the rest of construction works [19]. But, body-torso and multiple injuries are right behind by probability to be injured which suggests that some risks should be avoided instead threated with PPE. Analysing the ways in which injuries have occurred, it can be concluded that struck by an object, falls at level below and caught in, under or between are most probable ways for an injury to occur.

Acknowledgment: The work was done within the scientific research project TR36043 "Development and application of acomprehensive approach to the design of new and safety assessment of existing structures for seismic risk reduction in Serbia", supported by the Ministry for Education, Science and Technology, Republic of Serbia. This support is gratefully acknowledged.

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Mechanical Engineering – Scientific Journal, Vol. **33,** No. 3, p-p. 287–288 (2015)
CODEN: MINSC5
In print: ISSN 1857–5293
On line: ISSN 1875–9191

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