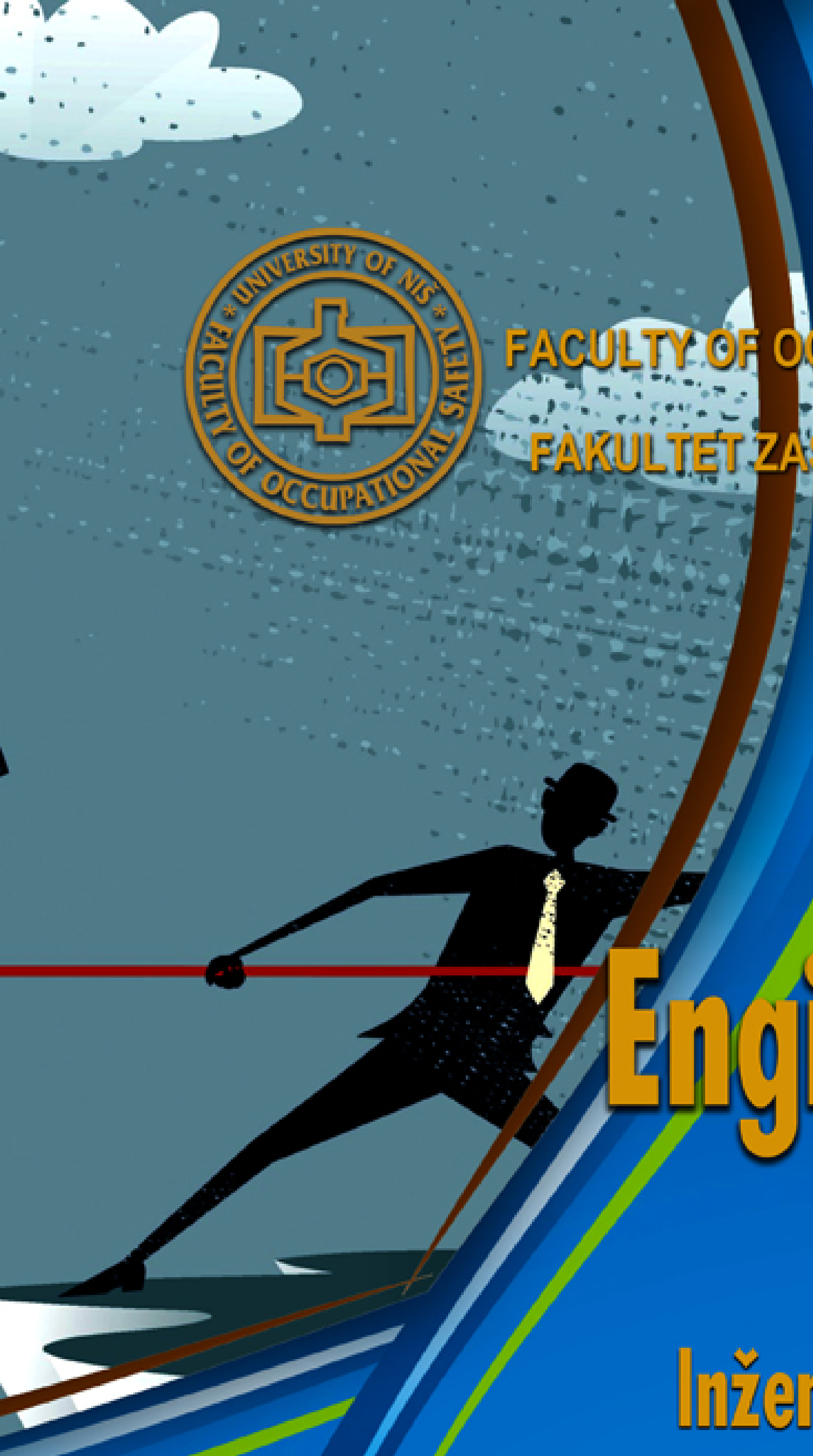

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From Editor's desk

Beautiful youth has always believed, and still believe, that it is easy to run the world.
Panzini

Extending the scope and increasing the reaserch quality through the involvement of staff and students of doctoral studies into research projects is one of the strategic goals of scientific research of the modern university. Recognizing the need and the importance of the development and promotion of young scientists, the editorial staff of the magazine has decided to support young authors with the aim of publishing and promoting the results of their research. Scientific interests and achievements of young researchers are here to hold readers' attention.

Divna mladost uvek je verovala, a i danas veruje, da je lako pokrenuti svet.
Panzini

Proširivanje obima i povećanje kvaliteta istraživanja kroz uključivanje saradnika i studenata na doktorskim studijama u istraživačke projekte, jedan je od strateških ciljeva naučnoistraživačke delatnosti savremenog univerziteta. Polazeći od potrebe i značaja razvoja i napredovanja naučnog podmlatka, uređivački kolegijum časopisa je odlučio da pruži podršku mladim autorima s ciljem objavljivanja i promovisanja rezultata njihovih istraživanja. Vašoj čitalačkoj pažnji prepuštamo njihove naučne interese i dostignuća.

On behalf of the editors
Dr Vesna Nikolić, Prof.

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ENGLISH LANGUAGE IN SAFETY ENGINEERING DISCOURSE

Abstract: *In a fast-changing world of safety, health and environment, professionals, students or anyone else in the field of occupational safety are often required to use English language in their professional and/or academic careers. Apart from technical excellence, engineers need good English language skills and knowledge of ESP (English for Specific Purposes) vocabulary terms in order to make professional improvement. Occupational health and safety (OHS) is an interdisciplinary field, which uses specialist terms and expressions from subject areas as diverse as engineering, medicine, law, psychology, etc. The aim of this paper is twofold. Firstly, to discuss briefly the relevant theory of English for Specific Purposes, and the significance of technical words and subject-specific terminology to OHS engineers. Secondly, to identify and provide a reference to some health and safety glossaries and terminology resources in English language that may assist health and safety experts who need to read and write professional literature in English.*

Key words: technical words, occupational health and safety, vocabulary terms, English for Specific Purposes.

INTRODUCTION

Development of science and technology demanded a language that would connect the international scientific community and enable the people of same vocations but different language background communicate and share their ideas. Engineering is often perceived as a hands-on, technical profession but there is an increasing demand for softer skills, especially the knowledge of English language.

In the introductory chapter to Technical Writing and Professional Communication for Nonnative Speakers of English, Huckin and Leslie state: ”Scientists and engineers may be technically brilliant and creative, but unless they can convince co-workers, clients, and supervisors of their worth, their technical skills will be unnoticed, unappreciated, and unused. In a word, if technical people cannot communicate to others what they are doing and why it is important, it is they and their excellent technical skills that will be superfluous”, [6].

Today all of the world's major scientific journals are published in English, which is the evidence that English is the “lingua franca” of science and technology. This fact sets the standards for a new approach in English language teaching and learning, a technique that would concentrate on English for the purposes specific to certain groups of people. If English language in different situations can be variously distributed, then tailoring English for Specific Purposes (ESP) also seems possible and justifiable. ESP is designed to meet specific needs of the learners and target groups may include doctors, judges, managers, engineers, etc. From this perspective, there is an emergence of various forms of specific English courses which concentrate on the employment related needs - technical English, medical English, business English, engineering English, English for tourism, English for aviation, etc.

The job of a Safety Engineer, or Occupational Health and Safety Engineer (OHS engineer), involves the variety of activities: assessing, mitigating and managing a wide range of hazards with the aim to minimize the risks of hazardous malfunctions; evaluating working conditions and inspecting working environment and equipment; identifying safety hazards and checking compliance to established occupational health and safety rules and requirements; responding to employee concerns of health and safety issues; developing educational, technical, and promotional materials and conducting risk management and safety training for employees [13]. Such interdisciplinary tasks require the knowledge of the state-of-the-art in the safety, which is conditioned by a good command of English. This implies both General English which is traditionally taught at schools, and Engineering English which falls within the category of ESP.

ENGLISH FOR SAFETY ENGINEERS - ENGLISH FOR SPECIFIC PURPOSES

Every branch of science and every profession have their own language for communication, and safety engineering is certainly not an exception. Safety engineering has extensive, unique and specific terminology. The primary goal of the ESP course is to teach professional communicative competence that is the ability to communicate in English according to the situation, purpose and specific roles of the the participans in dialogue. English for Specific Purposes has its place in linguistics, applied linguistics and various occupations, which makes it an interdisciplinary subject. Strevens [11] defines the absolute characteristics of ESP. According to him, ESP consists of English language teaching which is (i) designed to meet specified needs of the learner, (ii) related in content (i.e. in its themes and topics) to particular disciplines, occupations and activities, (ii) centred on the language appropriate to those activities in syntax, lexis, discourse, semantics, etc., and analysis of this discourse, and (iv) in contrast with General English.

ESP concentrates more on the context than on grammar and structures. ESP users are usually very motivated to learn what is closely related to their subject-matter fields. Vocabulary plays a key role in ESP, and it implies the vocabulary and technical words and phrases of a specialized discourse.

Non-native English speakers who are engaged in safety engineering do not have to attend ESP courses in order to perform their career activities globally. In order to improve their knowledge of subject specific vocabulary generally used by specialists in the field, they can take advantage of the available resources of EPS vocabulary word lists. The narrow focus of this paper is the terminology of occupational health and safety, and for this reason we should bear in mind that “environmental and occupational health is not a single topic, but rather a colourful, complex, and diversified range of interrelated subjects including all of the basic sciences, engineering, computer science, government, disease, injury identification, prevention, and control” [5].

LANGUAGE FORMS IN THE SAFETY ENGINEERING DISCOURSE

Safety engineers or occupational health and safety engineers and specialists who work in international companies worldwide are often required to read the specialized texts with up-to-date information which generally cover the wide range of technical topics, which means they need to rely on their knowledge of both general and specific English. Their assistance in translating the official documents (e.g. ISO standards) to their native languages is mandatory, since they best know the specialized vocabulary and terminology in a particular area.

In order to fully understand the demands of his or her job, OHS Engineer or specialist in an international environment needs to recognize and understand various language forms in the engineering discourse. One solution to overcome the difficulty of using English is to focus on language forms commonly found in scientific texts - compound nouns, passives, conditionals, anomalous finites (i.e. modal verbs), nominalization of verbs and adjectives, technical terms, and functional structures such as causal and reasoning verbs and impersonal language.

In many instances, it can be demanding and frustrating to those who seek the information in English, but lack decent language proficiency. There are certain language forms and structures that are considered to be imperative in safety engineering discourse and they involve:

- Language to describe warnings and health and safety requirements (e.g. modal verbs, imperative statements)
- The ability to read and comprehend manuals, guides and reports
- Verbs that would explain what safety engineers do (e.g. check, measure, monitor, assess, evaluate, etc.)
- Verbs that refer to what machines and devices do (e.g. break down, design, run, etc.)
- Abbreviations and acronyms (e.g. EPA - Environmental Protection Agency, OSHA - Occupational Safety and Health Administration, SOP - Standard Operating Procedure, LEL - Lower Explosive Limit, etc.)
- Expressing consequences/ cause and effect
- Giving presentations (e.g. presentation of a design or to explain an accident or failure)
- Words which have different general and technical meanings such as sub-technical vocabulary (e.g. run, power, work), etc.

Apart from the above mentioned, it is necessary to highlight the knowledge of specialist vocabulary and terminology which will be discussed in the remaining part of this paper.

VOCABULARY - TECHNICAL AND SUB-TEHNICAL VOCABULARY

Vocabulary knowledge is the single most important area of second language competence regarding academic achievement [8] and also professional achievement. A safety engineer needs to have a fundamental knowledge of other sciences and the vocabulary in the following areas - physics, chemistry, biology, physiology, statistic, statistics, mathematics, computer science, engineering mechanics, industrial processes, business, communication and psychology [14].

As it has already been stated by the main ESP theorists [3,7,10] the vocabulary in the ESP can be divided into three compartments:

- technical,
- sub-technical (semi-technical), and
- general vocabulary.

Each field of study has a corpus of terms needed to discuss the issues it deals with. General vocabulary of frequent use in a specific area comprises the most numerous group; it is formed by words from the general lexicon which do not lose their own meaning, but appear in technical context [12]. General English vocabulary is in most cases traditionally acquired at schools and universities and it consists of the most frequent words of everyday English.

Semi-technical or sub-technical vocabulary comprises the words that have one or more "general" English meanings, or have an extended meaning in specific fields [12]. This vocabulary is polysemic, which means it has two or more meanings, its original meaning and another one belonging to the specific context. Sub-technical vocabulary appears in many disciplines and it may include the words like design, function, isolation, relation, basis, report, presuppose, simulate, assess, etc. As we can see, these are common words with a specialized sense. Sometimes, semi-technical words give notable problems to second language learners, and it is usually difficult to recognize them [9]. By improving the knowledge of general English, one could fill the gap in sub-technical English because scientific English uses the same structures as any other kind of English but with a different distribution.

Technical words or technical vocabulary are closely associated to a specific subject knowledge, field or area of study which occur in specialist domains only with specialized terms [2,9]. The authors that discuss the issue of vocabulary in ESP agree that technical vocabulary is not problematic to non-native speakers or engineers in certain area, since they are already familiar with the terminology of the specific field. On the other hand, using technical vocabulary may be a daunting task since not even a native speaker can know all the words in his or her own language, and technical words are used only by the specialists in this field [9]. Technical vocabulary possesses a unanimous definition and words are monosemic, or used only in one specific domain for which they have been created. In the field of environmental and occupational safety engineering, we can ascribe specialized words related to equipment, environmental controls, new laws, loss prevention, safety management, insurance, environmental control, environmental engineering, occupational health, medicine, nursing, law, planning, etc. Safety terms are "tools" (concepts and ideas) used by safety engineers worldwide in applying their skills to make our technological world safer.

The list of technical terms can be developed by compiling dictionaries or glossaries. Glossary, also known as vocabulary, is a dictionary of the special terms in a particular field or job, with the definitions for these terms. The rapidly expanding field of environmental science has generated many new terms and multi-term words in this field. The question is: how much English vocabulary does an OHS engineer need to use English as a second language?

OCCUPATIONAL HEALTH & SAFETY TERMINOLOGY

The constant evolution of the legislation on health and safety at work at both the national and European level has generated a variety of subject-specific vocabulary. The majority of terms originate from Health and Safety Regulations, Acts, Guides, Statutes, European legislation such as EU Directives, important legal references at the national and European level, and most notably ISO standards. Normally, they are written in native languages, linguistically or conceptually correlated in two or more languages, but they need to be recognized in English since it is a main language of EU Directives.

Keeping in mind specific group of English language users, many illustrated glossaries and glossaries of terms have been designed. One of these is *OSHA Glossary* coined by Occupational Safety & Health Administration, The United States Department of Labor [15]. It contains definitions, photos, and graphic illustrations of equipment and tools. Similarly, Koren Herman's *Illustrated Dictionary of Environmental Health & Occupational Safety* [5] first published in 1996 cover 16,000 terms and it is a very comprehensive language tool with drawn illustrations that can be used to make the term more meaningful and understandable. Another example may be *The Dictionary of Terms used in the Safety Profession* [1] published by the American Society of Safety Engineers which is a concise, informative and valuable safety asset.

Glossary of Occupational Health & Safety Terms [4] developed by the Industrial Accident Prevention Association is designed for joint health and safety committee members, health and safety representatives, and others with workplace health and safety responsibilities, and it provides easy understandable definitions of common workplace health and safety terms. Internet may be a valuable resource and tool for lexical investigation. One of the thought-provoking presentations of safety terminology may be *The Environmental and Occupational Health & Safety terminology website* (EOHS) [16]. EOHS terminology website is an experimental service of the terminological project conducted by Advanced School of Modern Languages for Interpreters and Translators (SSLMIT), University of Bologna in Forlì. The corpus of terms is a systematic collection of law texts which serve as knowledge base. Besides showing all the termbase records, the multilingual glossary enhances identification of equivalences between the four legal systems (English, Italian, German and French).

The terms presented in the Table 1 are randomly chosen from the terminology website and show the variety of grammatical structures (nouns, adjectives, noun compounds, noun phrases). Sometimes, a term can be expressed by a single word, but more often it is a group of nouns or phrases since nominal compounds tend to behave as key elements in specialized or technical discourse.

Table 1. *Environmental and Occupational Health & Safety terminology grouped by domains*

Preventive measures	Active noise reduction hearing protector, Assigned protection factor, Biological monitoring, Breathing apparatus, Breathing hood, Ear muffs, Ear plugs, Emergency escape or first-aid sign, Environmental monitoring, Exposure action value, Eye protector, Fire precautions, Fire safety sign, Full body harness, Goggles, Health surveillance, Helmet, Illuminated sign, Industrial safety helmet, Lower exposure value, Mandatory sign, Medical examinations, Medical surveillance, Occupational exposure limit, Occupational footwear, Personal fall protection system, Personal hearing protector, Personal protective equipment, Prohibition sign, Protective footwear, Radiation protection, Respiratory protective equipment, Risk assessment, Risk phrase, Safety colour, Safety footwear, Safety sign, Self-contained breathing apparatus, Self-retracting lifeline, Signboard, Suspension belt, Warning sign, Workplace protection factor
Diseases/ accidents	Asbestos-related disease, Carpal tunnel syndrome, Employer's liability insurance, Hand-arm vibration syndrome, Health detriment, Incapacity for work, Industrial Injuries Disablement Benefit Scheme, Noise-induced hearing loss, Occupational disease, Personal injury, Work-related accident
Documents/certfification certification	Accident book, Asbestos Management Plan, CE marking, EC declaration of conformity, Health and safety file, Health and safety plan, Health and safety policy statement, Health record, Monitoring record, Pre-tender health and safety plan, Safety data sheet
Protective measures	Emergency exit, Emergency lighting, Emergency route, Encapsulation, Enclosure, Evacuation of employees, Fire-fighting, Fire-fighting equipment, First aid equipment, First aid room, Glove-bag technique, Incapacity benefit, Industrial injuries disablement benefit, Statutory sick pay
Work places and equipment	Accelerator, Confined space, Construction site, Controlled area, Designated area, Display screen, General lighting, Hearing protection zone, Machinery, Power tool, Rest facilities, Safety component, Supervised area, Work environment, Work equipment, Workplace, Workstation
Risk factors	Agent, Asbestos-containing material, Biological limit value, Carcinogenic, Cell culture, Chemical agent, Chemicals, Corrosive, Daily personal noise exposure, Danger zone, Dangerous for the environment, Dangerous preparations, Dangerous substances, Dust, Electric field, Electromagnetic field, Electromagnetic power density, Explosive atmosphere, Extremely flammable, Hand-arm vibration, Harmful, Hazard, Hazardous situation, Impulsive Noise, Inhalable dust, Intermediate frequency field, Ionizing radiation, Irritant, Major accident, Manual handling of loads, Mechanical vibration, Mist, Mutagen, Noise, Occupational exposure, Oxidizing, Passive smoking, Peak sound pressure, Physical agent, Pollutant, Public exposure, Radioactive contamination, Radiofrequency field, Radionuclide, Respirable dust, Risk, Sealed source, Sensitizing, Threshold limit value, Transmission line, Weekly personal noise exposure, Whole-body vibration, Work at height, Workplace bullying

According to EOHS database, English language terms are very readable, grouped into fields, or domains which represents the main are of interest within health and safety at work. The domains include:

- Diseases/accidents
- Documents/certification
- Preventive measures
- Professional figures and company committees
- Protective measures
- Risk factors
- Work organization

The vocabulary list comprises of up-to-date English terms which are accepted and recognized internationally and taken from standards and regulations.

As it can be noted from the list, some of occupational health and safety terms are general English words and sub-technical terms, and they occur in everyday speech, but in health and safety discourse they have different meaning.

In EOHS term website, terms are not only identified and compiled into term records; they are defined by providing the legal source of definition and cross-referenced so that the user can simply read the text to fully understand the meaning. The advantage of glossaries of this kind is that the users learn a new word in context as they learn complete phrases. From language learning theory, this is a good step towards developing fluency in English. Acquiring single new words and huge vocabulary without being able to put words together in a coherent sentence is commonly discouraged or disregarded [9].

The corpus of terms may be further expanded and revised, and newly defined terms could be added. It is just one of the examples of how to make profession-related terminology appealing to HS specialists who are not attending courses of English for Specific Purpose.

CONCLUSION

English language is used in the vast majority of international organizations and scientific publications in engineering field; therefore, most engineers whose native language is not English would experience difficulties in applying professional terminology if they lack a sound knowledge of specific terminology.

If they want to pursue their long-term competitive careers, they need to familiarize themselves with engineering contents in English language as well. Learning a specific genre of English with specific goals, such as English for Specific Purposes (ESP) where English is meant for vocational and occupational purposes, can be just one of the formal language acquisition techniques. The alternative, not so formal, but very practical tool for autonomous learning is reading technical literature in a foreign language. To safety experts who are non-native users of English, glossaries should be indispensable resource for acquiring vocabulary terms related to their professions. Luckily, there is plenty of literature available on the internet to suit their needs.

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BIOGRAPHY

Aleksandra Petković was born in Niš, Serbia, in 1981. She graduated from the Faculty of Philosophy, English Language Department in 2005, and received MA in English Language from the Faculty of Philology, University of Belgrade. Her research interests include English for Specific Purpose, applied linguistics, English in environmental sciences, etc. She is currently working as a research and development associate at the Faculty of Occupational Safety in Nis, University of Nis.

ENGLESKI JEZIK U OBLASTI BEZBEDNOSTI I ZDRAVLJA NA RADU

Aleksandra Petković

Apstrakt: *Svet bezbednosti, zdravlja i životne sredine se veoma brzo menja, te su stručnjaci, studenti i svi ostali iz oblasti zaštite na radu veoma često u obavezi da koriste engleski jezik u toku rada i/ili učenja. Osim tehničke izvrsnosti, inženjerima je potrebno dobro poznavanje engleskog jezika ali posebno poznavanje stručne terminologije i engleskog za posebne namene (engleski kao jezik struke) za stručno usavršavanje. Bezbednost i zdravlje na radu (BZNR) je interdisciplinarna oblast u kojoj se upotrebljavaju specijalistički termini i izrazi iz različitih oblasti, kao što su inženjerstvo, medicina, pravo, fizika, psihologija, itd.*

Cilj ovog rada je dvostruk. Prvi cilj je da u kratkim crtama predstavi relevantnu teoriju engleskog kao jezika struke i značaj stručnog vokabulara i terminologije specifične za inženjere iz oblasti BZNR. Drugi cilj rada je da pruži preporuku i posluži kao izvor referenci pojedinih rečnika i terminoloških glosara iz oblasti bezbednosti i zdravlja na engleskom jeziku koji mogu biti korisni stručnjacima od kojih se zahteva da čitaju i pišu na engleskom jeziku.

Ključne reči: stručna terminologija, bezbednost i zdravlje na radu, vokabular, engleski za posebne namene.

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MULTI-CRITERIA DECISION-MAKING FOR SELECTION OF RENEWABLE ENERGY SYSTEMS

Abstract: *Multi-criteria analysis involves defining each criterion using attributes, based on a suitable alternative for achieving objectives. The method used in multi-criteria analysis is Analytical Hierarchy Process. Analytical hierarchical process (AHP) is a tool in the analysis of decision making, created in order to assist decision-makers in solving complex decision problems involving large number of decision makers, large number of criteria and in multiple time periods. AHP method is used for selecting the best renewable energy systems. The aim is to, by using the method of AHP, demonstrate which of the analyzed renewable sources of energy is the most convenient to be used in a sustainable system.*

Key words: *energy, multi-criteria decision making, analytical hierarchy process.*

INTRODUCTION

Most countries around the world will face serious energy shortages in the near future. The high consumption and population growth in the world will force the inhabitants of many countries to deal with the critical problem of dwindling domestic fossil energy resources. For these reasons, today a very popular question is which of the existing renewable energy is best used to achieve a sustainable energy system. The answer to this question can be given by analyzing sustainable energy system using AHP method.

The method AHP is one of the methods for decision making. Decision making is a process that consists of a series of activities to be taken in order to select the best solutions (alternatives). Decision making is only the first step in achieving results, and most often the implementation of decisions is much more complex job.

The selection can be done in several ways, through:

- Techniques of decision making (using a set of procedures for key expert problem solving in the decision-making process, such as diagnostic techniques, linear programming, simulation techniques, etc.);
- Decision rules (defined as a predetermined guidelines or tests for judging);
- Decision making skills (defined as the ability of effective use of knowledge in problem solving).

Any decision that is the result of the analysis from the past and which is aimed at achieving a goal, assumes that the consequences will be known only in the future. Every decision is therefore the link between the past and the future (Figure 1).

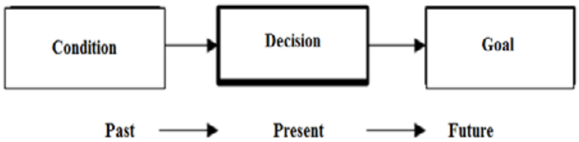

Figure 1. *Analysis of decision situation*

Phases of decision making

According to (*Čupić Suknović, 2010*), there are 11 phases of the decision process (Figure 2). These are:

Keeping records of the problem - at this stage are recorded problems for which the decision must be made.

Ranking problem - exists in situations when it is obvious that all the problems can not be solved at the same time.

Defining the problem - is one of the most important phases of decision making process. Through this phase it is necessary to provide all elements needed for the subsequent phase formation models.

Collection of facts - or create a database of relevant data for a defined problem.

Predicting the future - due to the fact that today's decision was made to be realized (with all the consequences) in a future environment.

The formation of the model - for the specific problem the interactions between variables, as well as the corresponding criteria of effectiveness solutions, are defined.

Problem solving (model) - determining the numerical or analytical ways of solving problems (models). Solving the problem (using appropriate methods and techniques) should be approached in this way to ensure getting the appropriate number of alternative solutions in order to make one of the basic assumptions of e decision-making.

Evaluation of results relates to the verification of agreement of the obtained results with the expected results of real systems.
Making decisions - no decision. The decision is made when we can accept the results from one of the alternatives, while in the opposite case a problem can not be resolved with this methodology, or should be returned to any of the previous stages, on certain corrections and additions. The mistakes can practically be made in all stages; however, the most common and most typical errors are in modeling phase.

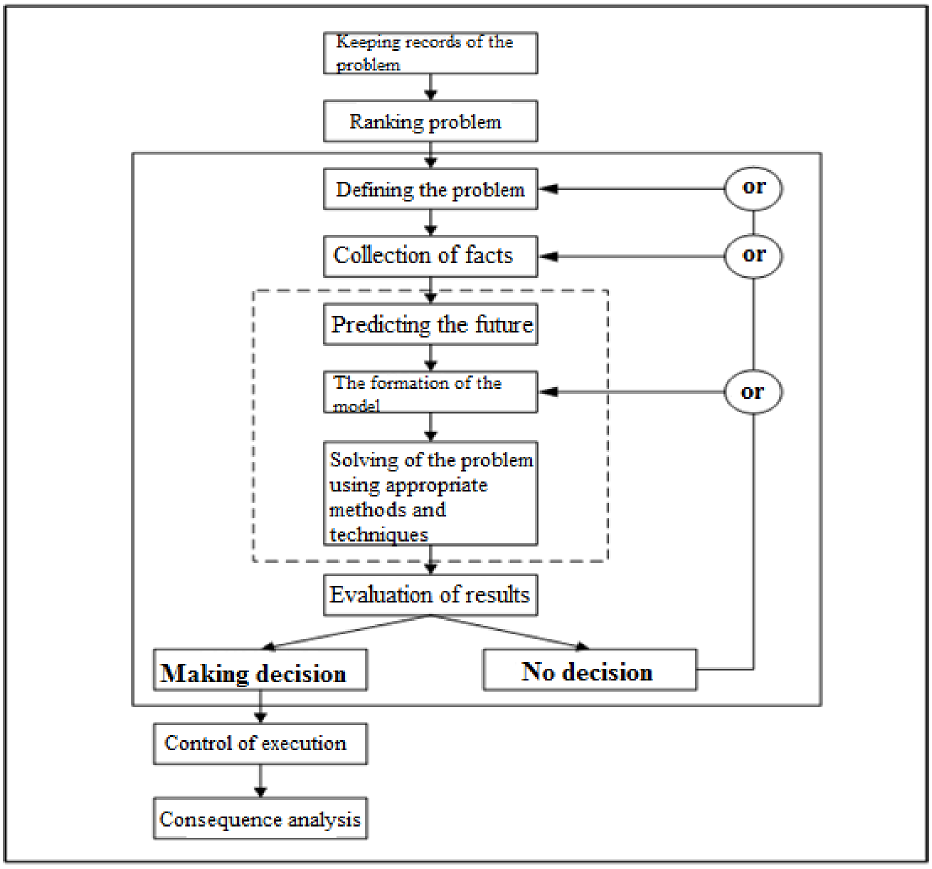

Figure 2. *Phases of decision making*

Control of execution - when the decision is made, special attention must be paid to control its execution.
Consequence analysis of the execution of the decision - is about concrete consequences on the real problem, when those consequences can be not only wrong but also unrecoverable. And then, of course, the analysis should be done bearing in mind that the same mistakes are not repeated in a similar situation.

Levels of decision making

Basic levels of decision making are:

- Individual decision making;
- Group decision making;
- Organizational decision making;
- Meta-organizational decision making.

Individual decision making. At this level, decisions are made by individuals. Different decision-makers in the same situations (decision problems) will behave differently, depending on their level of experience, education and achieved skills in decision making.
Group decision making - teamwork. In complex social environments individuals are, as a rule, members of various groups organized to satisfy different purposes.
Organizational decision making. It has been studied by a large number of highly renowned authors in the field of management.
Meta-organizational decision making. It represents a step forward in the possible applying of decision theory. At this level, we observe the totality of all organizations (of a country) as the enterprise system; of course, it varies from country to country.

Model of decision making

Characterizing decision making problem with an appropriate model is one of the first steps in the decision making process. Decision making is formalized with the set:
O={A,S,φ,Y,W,Π}
Where:
A - a set of alternatives,
S-set of possible environment states and their description,
φ - copying of decisions in the outcome,
Y - the outcome of the decision,
W - an indicator of the outcome of the decision,
Π - policy decisions choice.

Considering that the management aim can be realized in many ways, it is necessary to define a set of alternatives which achieve this. Method of forming a set of alternatives depends on the specific problem and, except general guidelines, there is no universal method with which this could be always well done. The quality of available alternatives affects the quality of decisions, although the choice of the alternative is specific and serious problem. When it comes to managing, a set of alternatives represents a set of management operations or a set of management strategies.
Criteria or decision rules allow comparison alternatives through indicators of decision outcome and selection of the best, or one of a satisfactory alternatives.

Multi-criteria decision making

Multi-criteria decision making means defining each criterion using attributes, based on which chooses a suitable alternative for achieving objectives. Each attribute should provide a means of assessment (evaluation) levels of one criteria (objective). As a rule, the greater the number of attributes should be characterized in any action (alternative) and they are selected based on a set of criteria defined by the decision maker.
During solving the problem of multi-criteria decision making, where appropriate, should undertake the following activities:

- Quantification of qualitative attributes;
- Normalization of attribute values;
- Linearization of attributes;
- Define the weight coefficients of criteria.

The quantification of the qualitative attributes

For translating qualitative attribute values in quantitative, the following scale is often used: regular, interval scale and scale relationships. The interval scale form is usually applied in decision theory:

Table 1. *Interval scale*

Qualitative assessment	*Bad*	*Good*	*Average*	*Very good*	*Excellent*	*Type of criteria*
Quantitative assessment	1	3	5	7	9	max
	9	7	5	3	1	min

In this way, the decision matrix is transformed into quantified decision matrix.

Normalization of attributes

"Equalization" of attribute values is done together with normalisation. The process of normalization includes: Calculation of norms for each j column of the matrix of decision making:

$$Norma_j = \sqrt{\sum_{i=1}^{m} x_{ij}^2}\,;\; j = 1,2,...,n$$

Where:
xij - value of the j attribute by the i alternative.

Calculating the normalized matrix elements of decision making. For attributes of type max:

$$n_{ij} = \frac{x_{ij}}{Norma_j}$$

For attributes of type min:

$$n_{ij} = 1 - \frac{x_{ij}}{Norma_j}$$

In this way, quantified decision matrix transforms into normalized decision matrix.

Linearization of attributes

The linearization is doing with the aim of reducing the value of the attribute at the interval (0,1) and translation of various units of measure in the unnamed number.

Defining the weight coefficients for the criteria

Realistic problems often have criteria of different level of significance, and it is necessary that the decision maker defines the factors of significance of criteria using appropriate weighting coefficients - weight (if their sum is equal to one it is the normalized weights). The decision maker subjectively defined weight coefficients.

Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is one of the most commonly used methods of multi-criteria analysis. The author of the idea and mathematical settings of AHP is Thomas Saaty.
The decision making process considers as a hierarchical process with multiple levels. At the top of the hierarchy is the **goal**, and the next level is composed of selected **criteria**. The lowest level consists of the possible **alternatives**, and at intermediate are under criteria.
The process of solving the problem of decision making is often extremely complex due to the presence of competing and conflicting objectives among the available criteria or alternatives.

Phases of the analytic hierarchy process

The process of applying the method has four phases:

1. Structuring the problem

Phase of structuring consists of decomposing the problem of decision making in a series of hierarchical levels, where each level represents a smaller number of manageable attributes. AHP is based on mutual comparison of elements in a given hierarchical level in relation to the elements at a higher level. If we observe the general case of hierarchy with three levels (goal - criteria - alternatives) (Figure 3), the criteria are compared in relation to the goal, in order to determine their mutual importance, and alternatives to each of the set criteria.

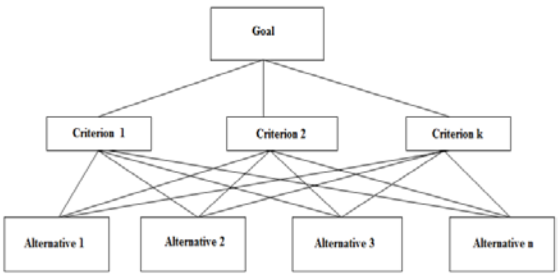

Figure 3. *Structuring the problem*

2. Data Collection

The second phase of the AHP method comprising:

- Data collection and (their) measurement;
- Assign a relative assessment in pairs with attributes of a hierarchical level, for given attributes of first and the higher hierarchical level;
- Repeat the process for all levels of the hierarchy.

To assign a weight scale is used Saati "nine-point" as shown in Table 2.

Table 2. *The scale of relative priorities*

Significance	Definition
1	Same significance
3	Weak significance
5	Strong significance
7	Demonstrated dominance
9	Absolute dominance
2,4,6,8	Intermediate value

Following this method of ranking, the decision maker will assign a weight for each pair separately, as a measure of how important is one attribute from another. Upon completion of this process will result in the appropriate matrix of pairwise comparisons corresponding to each level of the hierarchy:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

The characteristics of the matrix A:

$a_{ii} = 1$

$a_{ji} = 1/a_{ij}$ for $i,j = 1,..., n.$

$\det A \neq 0$

3. Evaluation of the relative weight

The third phase of the AHP method is to estimate the relative weight. Based on the matrix A with elements a_{ij} the priorities of criteria, sub-criteria and alternatives are determined.

For this purpose, we use:

- The method of arithmetic mean,
- A method of geometric mean and
- Method of difference.

The consistency of assessment

After determining the weight, their credibility should be established. This is done by determining the consistency of the matrix A. The matrix A, in case of consistent (consequent) assessment for which $a_{ij} = a_{ik} a_{kj}$, satisfies the equation:

$Aw = nw$, or:

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \dots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \dots & \frac{w_2}{w_n} \\ \dots & \dots & \dots & \dots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \dots & \frac{w_n}{w_n} \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix} = n \cdot \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix}$$

The problem of determining the weights can be solved as a problem of solving a matrix equation with matrix columns w solution for eigenvalues λ different from 0, ie.

$Aw = \lambda w$, or

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix} = \begin{bmatrix} \lambda_1 w_1 \\ \lambda_2 w_2 \\ \dots \\ \lambda_1 w_1 \end{bmatrix}$$

If the matrix A contains inconsistent assessments, the weight vector w can be obtained by solving the following equation:

$$(A - \lambda_{\max 1})w = 0 \;\; if \; \sum w_i = 1$$

where λ_{max} is the largest eigenvalue of the matrix A, or:

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(Aw)_i}{w_i}$$

Due to the properties of the matrix A is valid $\lambda_{\max} \geq n$, and the difference $\lambda_{\max} - n$, is used in measuring consistency of assessment, or to calculate the index of consistency:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

Based on this index we determine the index of inconsistency:

$$CR = \frac{CI}{RI}$$

where:
RI(Random Index)parameter which is given in Table 3.

Table 3. *Values of the index RI [4]*

n	1	2	3	4	5	6	7	8
RI	0	0	0,52	0,89	1,11	1,25	1,35	1,40

The value of CR $\leq$ 0.10 indicates that the estimates for a and j are consistent. Otherwise, the evaluation should be repeated.

4. Determination of the problem solutions

The last phase of the AHP method is finding the so-called composite normalized vector. Since the successive levels of the hierarchy are interconnected, single composite vector of unique normalized weight vectors for the entire hierarchy is determined by multiplying the weight vectors of all successive levels. Composite vector is used to find the relative priority of the entities at the lowest (hierarchical) level, which allows the achievement of the set goals of the overall problem.

Case Study: Selection of the best energy-efficient technology

During selection of the best sustainable energy system it was used AHP method for finding the most suitable types of renewable energy for sustainable planning of energy development. Sustainable systems are considered from four perspectives: technological, economic, ecological and sociological. These aspects represent the decision making criteria.
For each aspect are defined criteria, namely: Energy Production Capacity (EPC), Technological Maturity (TM), Reliability (R) and Safety (S) for the technological aspect, the Investment Costs (IC), Expense Management (EM), Lifetime (L), and Repayment Period (RP), for the economic aspect, the Impact on the Ecosystem (IE), CO2 emissions (E) for the environmental aspect and the Social Benefit (SB) and Social Acceptability (SA) for the social aspect.
The alternatives are different types of renewable energy: Solar Energy (SE), Wind Energy (EW), Hydropower (HE), Biomass (BM) and Geothermal Energy (GTE).
The hierarchical structure for selection of the system with a sustainable renewable energy sources is shown in Figure 4.

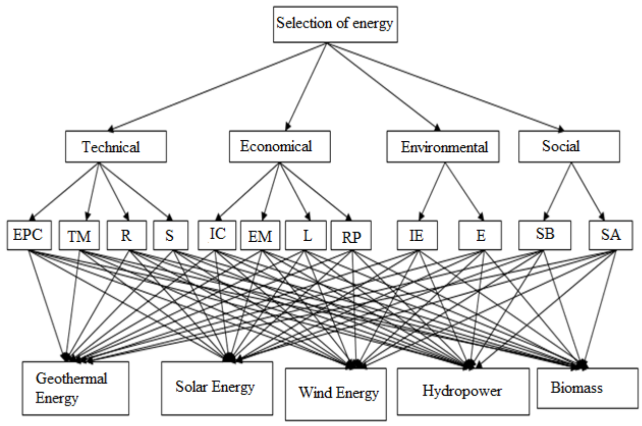

Figure 4. *Hierarchical structure of a sustainable system with sustainable renewable energy sources [1]*

Analyses are made after completion of Pairwise comparisons and determination of relative weight. The first phase of the analysis is to check the consistency of decisions. Consistency index (CI) for all matrix of comparison is appropriate (≤0.10). Index of consistency in this study varied between 0 and 0.1.
The second phase of the analysis is to calculate the relative weights of the main criteria and sub-criteria. The relative weights of the main criteria and sub-criteria are shown in Figure 5.

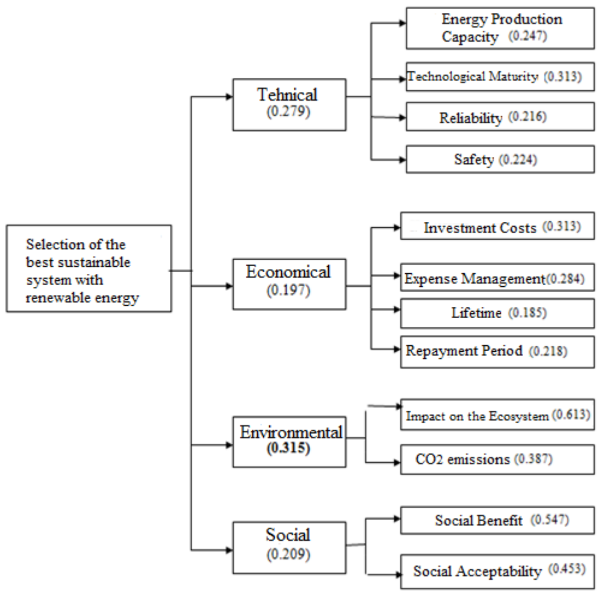

Figure 5. *The relative weight in relation to the main criteria and sub-criteria in a hierarchical structure.*

Based on the relative weights of the criteria we see that the most significant is environmental criteria, whereas economic criteria is the least significant. After this, the significance is determined by used alternatives. The importance of used alternative technology has been shown in Table 4.

Table 4. *Significance of used alternative technologies*

Technology	Relative Weight	Results
Geothermal Energy	0.184	3
Solar Energy	0.175	4
Wind Energy	0.298	1
Hydropower	0.145	5
Biomass	0.198	2

From the table it can be concluded that wind energy is a renewable energy source for sustainable system (RT=0.298), while hydropower has the lowest priority (RT=0.145).

CONCLUSION

Renewable energy sources and new technologies which use these sources are becoming increasingly important segment in all areas, especially in the energy sector. Using renewable energy has reduced consumption of nonrenewable energy resources. The use of these sources is very important from the aspect of environmental protection. The results show that the choice of type of renewable energy sources depends on the selected criteria and sub-criteria of decision making. However, regardless of the different approach to the problem, our case study showed that wind energy is the most cost effective renewable energy source.

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BIOGRAPHY

Milica Stojanovic was born in Leskovac, Serbia 1990. She graduated from Chemical- technological school in Leskovac, and in 2009 she enrolled undergraduate studies at the Faculty of Occupational Safety in Niš, where she obtained B.Sc. in Environmental Engineering. She finished master academic studies at the Faculty of Occupational Safety and obtained master's degree in Environmental Safety in 2014.

VIŠEKRITERIJUMSKO ODLUČIVANJE PRI IZBORU ENERGETSKI ODRŽIVIH SISTEMA

Milica Stojanović

Rezime:. *Višekriterijumska analiza podrazumeva definisanje svakog kriterijuma pomoću atributa, na osnovu kojih se bira odgovarajuća alternativa za realizaciju postavljenog cilja. Korišćena metoda višekriterijumske analize je Analitički hijerarhijski proces. Metoda analitičkog hijerahijskog procesa (AHP), predstavlja alat u analizi odlučivanja, kreiran sa ciljem pružanja pomoći donosiocima odluke u rešavanju kompleksnih problema odlučivanja u kojima učestvuje veći broj donosilaca odluka, veći broj kriterijuma i u višestrukim vremenskim periodima. AHP metoda je korišćena pri odlučivanju o izboru najbolje energetski održivog sistema. Cilj rada je da se pomoću metode AHP pokaže koji od analiziranih obnoljivih izvora energija je najpogodniji za upotrebu i postizanje održivog sistema.*

Ključne reči: energija, višekriterijumsko odlučivanje, analitički hijerarhijski proces.

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A TOOL FOR RISK ASSESSMENT

Abstract: *A lot of companies need to carry out a risk assessment, but most of them do not have the experience to determine the risk in a qualitative way. Therefore, these organizations use the tools for qualitative or qualitative - quantitative risk assessment. A useful tool for risk assessment is risk matrices (risk assessment scoring matrices/ risk ranking matrices).*

The aim of this paper is to present various risk matrices. Typical risk assessment matrices with different levels recommended by the American standards and other standards have also been presented in this paper.

Key words: reliability, severity, risk, matrix, probavility.

INTRODUCTION

Risk can be the subject of discussion if there are at least two outcomes of an event (occurrence) or in case if there is at least one outcome that is not desirable. The fact that there are more outcomes of an event causes indeterminedness while the fact that the outcome of an observed event may be different from the desired, creates the possibility of loss [12].

The term anticipated value at risk is used to link the probability and the loss. Value at risk is a widely used risk measure of the risk of loss (consequences of the risk occurrence). In practice, the term risk is often used to denote the value at risk [12].

Risk is a concept that denotes a potential negative impact on some of the characteristics of values that can arise from a future event, or in other words, risks are events or conditions that may occur, and their occurrence can have dangerous or negative effects. Risk is incurred by the exposure to the consequences of uncertainty.

Qualitatively, risk is proportional to the expected losses that can be induced by a certain accident and to the likelihood of an occurrence. Greater loss and greater likelihood result in an increased overall risk.

In engineering, the definition of risk is:

RISK = (Probability of Accident) x (Losses per Accident).

Risk management can be defined as a general management function with the aim to identify risks, assess risks and prepare the organization (company) how to best handle the effects (consequences) of the risks. [1]

The purpose of risk management is to enable organizations to realize their goals in the most direct, effective and efficient way. Risk management applies to all risks. The aim of risk management is to reduce the existing risks to the levels acceptable by the society.

Risk assessment is the first general step in risk management. Risk assessment is determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat. Quantitative risk assessment requires calculations of two components of risk R, magnitude of the potential loss L, and the probability p that the loss will occur.

RISK MATRICES

Risk ranking is based on a matrix whose axes are the ranks of consequences and probability. The combination of ranks of consequence and likelihood creates risk rank. Although many risk matrices have already been developed and implemented, the development of new risk assessment matrices is a special challenge.

Characteristics of Risk Matrices

Although risk matrices are easy to use, they can create liability issues and give a false sense of security.

An effective risk ranking matrix should have the following features [11]:

- Be simple to use and understand
- Not require extensive knowledge of the use of quantitative risk analysis
- Have clear orientation to applicability
- Have consistent likelihood ranges that cover the full spectrum of potential scenarios
- Have detailed descriptions of the consequences that relate to each consequences range
- Have clearly defined tolerable and intolerable risk level
- Show how a scenarios that are at an intolerable risk level can be mitigated to a tolerance level on the matrix
- Provide a clear guidance on what action is necessary in order to mitigate the scenarios with intolerable risk levels.

Typical risk assessment matrices

There are two ways to evaluate the matrices of consequences and likelihood: qualitative and quantitative. Therefore, there are two types of matrices: qualitative and quantitative- qualitative. The first type is used for qualitative assessment of likelihood and consequences, while the second type is used for quantitative assessment of likelihood and qualitative assessment of consequences.

Both matrices classify the consequences by using the following terms: death, major permanent disability, minor permanent disability, temporary disability.

In qualitative matrix, likelihood is represented through the following categories: frequent, likely (probable), accidental, unlikely, improbable.

Likelihood in quantitative-qualitative matrix is expressed quantitatively, as follows: 100-999/10000, 10-99/10000, 1.0-9.9/10000, 0.10-0.99/10000, 0.010-0.099/10000.

Typical risk assessment matrices are the following: the matrix derived from the U.S. Military Standard MIL-STD-882c which has 6 categories of likelihood and 4 categories of consequences; a 5x4 matrix derived from the U.S. Military Standard MIL-STD-882B; a 3x3 matrix with 3 levels of risk according to OHSAS standard, recommended by the European Agency for Occupational Safety and Health; a matrix according to Australian standard AS/NZS 4360: 2004.; a 5x5 matrix with 4 levels of risk: law, medium, increased, extreme; a 4x4 risk assessment matrix by NCPS (U.S. Department of Veterans Affairs National Center for Patient Safety); a 5x3 matrix designed according to the Regulation on Chemical Risk and Environment Pollution Assessment, Preparation. Measures and Remediation Measures (Official Gazette of RS No. 60/94, 63/94).

Qualitative matrix is presented in Table 1, whereas qualitative-quantitative matrix is presented in Table 2.

Table 1. *Qualitative matrix for risk assessment [3]*

Likelihood	**Consequences**			
	Death	Major permanent disability	Minor permanent disability	Temporary disability
Frequent	1	3	7	13
Likely	2	5	9	16
Accidental	4	6	11	18
Unlikely	8	10	14	19
Improbable	12	15	17	20

Table 2. *Quantitative- qualitative matrix for risk assessment [3]*

Likelihood	**Consequences**			
	Death	Major permanent disability	Minor permanent disability	Temporary disability
100-999/10000	1	3	7	13
10-99/10000	2	5	9	16
1.0-9.9/10000	4	6	11	18
0.10-0.99/10000	8	10	14	19
0.010-0.099/10000	12	15	17	20

Risk ranking: 1-5: unacceptable risk - must be reduced, 6-9: undesirable risk - all feasible measures must be applied, 10-17: acceptable risk, 18.20: acceptable risk

The simplest matrix is 2x2 matrix presented in the figure 1.

Probability		Consequences	
		Major	Minor
	High	**1**	**2**
	Low	**2**	**3**

Figure 1. *Risk assessment matrix [6]*

Probability: high - expected to occur in the following 12 months; low - is not expected to occur in the following 12 months

Risk:

1 - high risk; 2 - medium risk; 3 - low risk.

Typical risk assessment matrix recommended by The U.S. Department of Defense Standard Practice for System Safety (MIL–STD–882) is shown in figure 2.

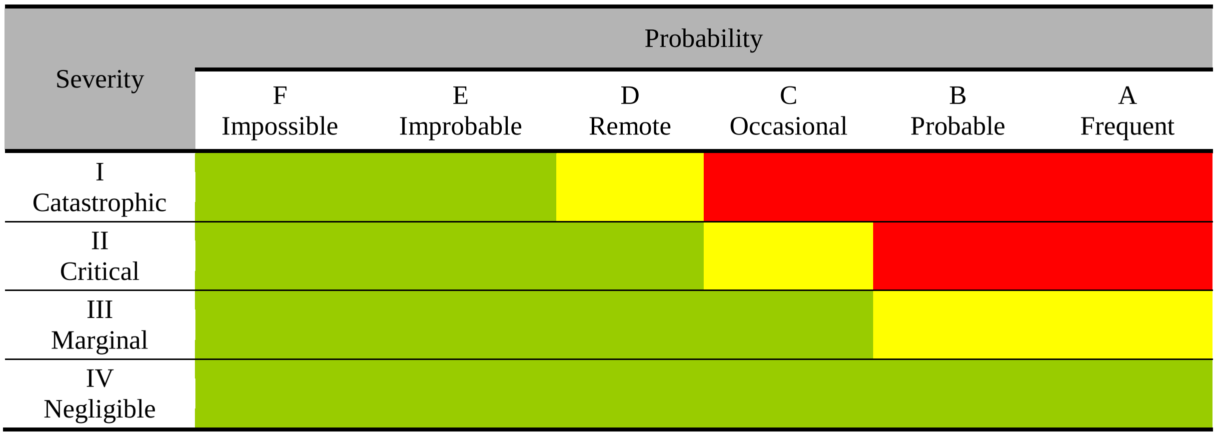

Figure 2. *Risk assessment matrix according to MIL-STD-882C[5]*

High risk
Medium risk
Small risk

Increased risk
Severe risk
Medium risk
Low risk

The U.S. Department of Defense uses 5x4 risk matrix (MIL-STD-882B) shown in Figure 3.

PROBABILITY	**SEVERITY**			
	I Catastrophic	II Critical	III Marginal	IV Negligible
A) Frequent	**1**	**3**	**7**	**13**
B) Probable	**2**	**5**	**9**	**16**
C) Occasional	**4**	**6**	**11**	**18**
D) Remote	**8**	**10**	**14**	**19**
E) Improbable	**12**	**15**	**17**	**20**

Figure 3. *Risk assessment matrix according to MIL STD 882B [2]*

Severity	**Category**	**Definition**
Catastrophic	I	Death or system loss
Critical	II	Severe injury, occupational illness, major system damage
Marginal	III	Minor injury, minor occupational illness, minor system damage
Negligible	IV	Less then minor injury, occupational illness, or systemm loss
Probability	**Level**	**Definition**
Frequent	A	Likely to occur frequently
Probable	B	Will occur several times in the life of an item
Occasional	C	Likely to occur sometime in the life of an item
Remote	D	Unlikely, but possible to occur
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced

Figure 4 shows the risk matrix according to the Australian standard AS/NZS 4360: 2004. A 5x5 risk matrix with 4 risk levels: extreme risk, high risk, medium risk and low risk, whereas

E – Extreme risk – detailed action plan required
H – High risk – needs senior management attention
M– Medium risk – specify management responsibility
L – Low risk – manage by routine procedures

Extreme and high risk demand more detailed plan to reduce risk to medium or law risk.

				Potential consequence				
			People	Injuries and diseases that do not require medical treatment	Minor injuries that require first-aid only	Severe injuries that require hospitalization or multiple medical treatment	Life-threatening injuries or multiple injuries that require hospitalization	Death or multiple injuries that pose threat to life
			Reputation	Internal control	Observation by internal controls to prevent escalation	Observing that require external executors or investigation	Intense public or political significance	Publicity
			Business process and systems	Minor errors within the systems or processes that require corrective action	Failure to procedures in the process	The requirements for one or more responsibilities are not met	Strategies are not in accordance with the national plan	Critical system failure, bad policy advisory
			Finance	1 % of budget	2.5 % of budget	> 5 % of budget	> 10 % of budget	> 25 % of budget
				Insignificant	Minor	Moderate	Major	Catastrophic
Probability	Historical			1	2	3	4	5
>1in 10	Is expected to occur in most circumstances	5	Almost certain	M	H	H	E	E
1 in 10 – 100	Will probably occur	4	Likely	M	M	H	H	E
1 in 100 – 1000	Might occur at some time in the future	3	Possible	L	M	M	H	E
1 in 1000 – 10000	Colg occur but doybtful	2	Unlikely	L	M	M	H	H
1 in 10000 - 100000	May occur but only in exceptional circumstances	1	Rare	L	L	M	H	H

Likelihood

Figure 4. *Risk assessment matrix according to Australian and New Zealand risk management standard AS/NZS 4360: 2004[23]*

Recommendations for OHSAS standard by the European Occupational Health and Safety Agency recommned a 3x3 matrix with 3 risk levels (low, medium and high), as shown in Figure 5.

Likelihood	Consequences		
	Slightly harmful	Harmful	Extremely harmful
Highly unlikely	**Low**	**Low**	**Medium**
Unlikely	**Low**	**Medium**	**High**
Likely	**Medium**	**High**	**High**

Figure 5. *Risk matrix [4]*

Likelihood:

Highly unlikely - will not occur during the whole professional career of an employee

Unlikely - may occur more than once during the whole professional career of an employee

Likely - could occur several times during the whole professional career of an employee

Consequences:

Slightly harmful - accidents and illnesses that do not cause long-term effects (minor injuries, eye irritation, headaches, etc.).

Harmful - accidents and illnesses caused by secondary, but no long-term consequences (fractures, second-degree burns on a limited body surface, allergies, etc.).

Extremely harmful - accidents and illnesses that cause serious and permanent consequences and/or death (amputations, complex fractures leading to disability, cancer, second and third-degree burns, burns over a large body area, etc.).

High risk is unacceptable	Low and medium risks are acceptable

4x4 Risk assessment matrix by NCPS (US Department of Veterans Affairs National Centre for Patient Safety) is shown on figure 6.

		Severity			
		Catastrophic	Major	Moderate	Minor
Probability	Frequent	**3**	**3**	**2**	**1**
	Occasional	**3**	**2**	**1**	**1**
	Uncommon	**3**	**2**	**1**	**1**
	Remote	**3**	**2**	**1**	**1**

Figure 6. *Risk assessment matrix [21]*

Probability: in order to rank probability, it is important to know how often a concrete event happens.

- Frequent – can occur several times in a year,
- Occasional – can occur several times in 1 or 2 years,
- Uncommon – can occur several times in 2 or 5 years,
- Remote – can occur once in 5 or 30 years.

Severity:

- Catastrophic – death or serious bodily injuries,
- Major – permanent loss of body functions,
- Moderate – minor bodily injuries

Risk:

1 - Low risk,
2 - Medium risk,
3 - High risk.

Figure 7 shows 8x6 risk matrix.

Likelihood		Consequences			
		Very serious	Serious	Moderate	Minor
Almost certain	> 50 %	**S**	**S**	**S**	**M**
Very likely	> 1/10	**S**	**S**	**S**	**L**
Rare but likely	> 1/100	**S**	**S**	**S**	**L**
Slightly	> 1/1000	**S**	**S**	**M**	**A**
Likely	> 1/10000	**S**	**M**	**L**	**A**
Almost unlikely	> 1/100000	**M**	**L**	**A**	**A**
Unlikely if not intentional	> 1/1000000	**L**	**A**	**A**	**A**
Unlikely	< 1/1000000	**A**	**A**	**A**	**A**

Figure 7. *Risk assessment matrix [17]*

Figure 8 shows 5x3 matrix according to Rules on the methodology for assessing the risk of chemical accidents and environmental pollution, preparatory measures and measures for the elimination of consequences ("Official Gazette of RS", no. 60/94 and 63/94)

Likelihood of accident	Consequences: Negligible	Minor	Serious	Major	Catastrophic
Low	**Negligible risk**	**Minor risk**	**Serious risk**	**Major risk**	**Catastrophic risk**
Medium	**Minor risk**	**Serious risk**	**Major risk**	**Catastrophic risk**	**Catastrophic risk**
High	**Serious risk**	**Major risk**	**Catastrophic risk**	**Catastrophic risk**	**Catastrophic risk**

Figure 8. *Risk assessment matrix [8]*

Risk assessment of consequences can be done on the basis of the indicators in the following table:

Indicators that determine the consequences	Consequences: Negligible	Minor	Serious	Major	Catastrophic
Number of dead	-	-	1-5	6-20	>20
Number of injured - intoxicated	-	1-10	11-50	51-200	>200
Dead wild animals	< 0,1t	0,1-1t	1-2t	2-10t	>10t
Dead domestic animals	< 0,5t	0,5-10t	10-50t	50-500t	>500t
Dead fish	< 0,5t	0,5-5t	5-20t	20-100t	>100t
Contaminated area	-	1-10ha	10-100ha	1-5km^2	>5km^2
Damage of shares	< 0,02 million dinars	0,002-0,2 million dinars	0,2-2 million dinars	2-10 million dinars	>10 million dinars

Advantages and disadvantages of risk assessment matrix

Risk assessment matrix has the following advantages:

1. It is a useful guide for engineering practice.
2. It is a standard tool for establishing the connection between consequences and probabilities in risk assessment of a given exposure to risk.
3. It disables the acceptance of unnaceptable risk and enables making operating decisions, improving the distribution of resources to mitigate the loss.

Limitations of the risk assessment matrix are:

1. The possibility of applying only identified hazards (not a tool for the identification of hazards).
2. Subjectivity.
3. The possibility of a comparative risk analysis only.

RISK ASSESSMENT METHODS

The EU Directive stipulates that each country can adapt a risk assessment methodology suitable to its legislation. Some EU member states have specific regulations on the manner and methodology for risk assessment.

Risk assessment matrices are used in various methods for risk assessment. Depending on the data and the matrix used, the methods can be: qualitative, quantitative and qualitative -quantitative.

Some of the typical methods for occupational risk assessment are: the AUVA method-the method of Austrian group of paper and pulp producers (Allgemeine Unfallversicherungsanstalt) and WKO method (Wirtschaftskammern Österreichs)-the Austrian Federal Economic Chamber; BG (Die genjerblichen Berufsgenossenschaften)- method of German professional associations; SME - Safety and Health method for Small and Medium sized Enterprises recommended by the EU. A special method defined by the Regulation on risk assessment is used in Croatia [7].

CONCLUSION

After defining a risk assessment matrix, diagrams of risk and the process and rules of transformation of a risk diagram into a risk matrix, and presentation of the matrix for risk assessment according to various standards (U.S. Military Standard MIL STD 882, Australian Standard AS / NZS 4360: 200, OHSAS standards and others) it can be concluded that it is best to choose matrices with fewer categories of likelihood and consequences, and smaller number of risk ranks. Accordingly, the most common types of matrices are 3x3, 4x4, 5x5, 5x4 and 6x4.

In the case of matrices with fewer categories of likelihood and consequences, it is easier to choose the level of consequences and likelihood that corresponds to the factual situation.

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BIOGRAPHY

Dejan Ristić was born in Zemun, Serbia, in 1975. He received the diploma in fire protection and master degree in safety at work from the University of Nis, Faculty of occupational safety in Nis.
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ALAT ZA PROCENU RIZIKA

Dejan Ristić

Apstrakt: *Mnoge organizacije imaju potrebu za procenom rizika, ali većina ne poseduje iskustvo i resurse da rizik kvantitativno odredi. Zbog toga, ove organizacije koriste alate za kvalitativnu ili kvalitativno-kvantitativnu procenu rizika. Koristan alat za procenu rizika su i matrice rizika (matrice za rangiranje rizika).*
Cilj rada je da se prikažu različiti tipovi matrica za procenu rizika. Tipične matrice za procenu rizika sa različitim nivoima koje proporučuju američki standardi, kao i drugi standardi, prikazane su u ovom radu.

Ključne reči: pouzdanost, ozbiljnost, rizik, matrice, verovatnoća.

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COMPARATIVE ANALYSIS OF METHODS FOR RISK ASSESSMENT - "KINNEY" AND "AUVA"

Abstract: *Individuals, entire economy and society are exposed to risks more than ever. The problem of occupational safety and health has been present from the moment of origin of labour and it has been dealt with in line with the overall development of society. For this reason, different methods and matrices for risk assessment have been developed. The subject of this study is to review the methods of risk assessment, as well as to apply these methods at the workplace where dangers and hazards occur. The aim of the study was to use KINNEY and AUVA methods for assessing risk for the workplace of Operating Engineer - Occupational Safety, Environmental Safety and Fire Protection, and to perform a comparative analysis of with the aim to state possible advantages or disadvantages of chosen methods.*

Key words: the risk assessment, methods of risk assessment, KINNEY method, AUVA method.

INTRODUCTION

The issue of safety and health at work has been present since the origin of work. It has emerged and has been dealt with in line with the overall development of society. It used to refer only to the consequences of risk because the knowledge about the risk was rather poor, while nowadays it is possible to prevent risk and reduce negative consequences.

Occupational safety and health involve working conditions in which certain measures and activities are taken to protect the life and health of employees and other people. The interest of society, all entities and each individual is to achieve highest level of safety and health at work and to avoid the consequences, such as injuries, occupational diseases and work-related diseases by reducing them to the lowest possible level; and finally, to develop conditions of work in which an employee would be satisfied while doing his job.

To realize this aim, it is necessary to carry a systematic approach for preventive actions and link all entities, holders of certain obligations on the national level and beyond. International institutions are responsible to carry out the established rules, measures and standards of working conditions as well as to comply with technological and social - economic development, to improve the safety and protect the health of employees, by adopting national regulations.

Many methods and types of matrices were developed for risk assessment. Four methods with different focus in risk assessment were developed (ISO/IEC27005) method of risk matrix with predefined values (ISO / IEC13335-3), and a method of measuring risk by ranking threats, method of assessing the impact probability and possible consequences and methods of distinction between acceptable and unacceptable risks. The case study was to check methods of risk assessment - Kinney and AUVA method - as well as to apply these methods for the chosen workplace in which dangers and hazards occur. The aim is to perform risk assessment, by applying all methods, for the workplace of Operating Engineer - Occupational Safety, Environmental Safety and Fire Protection Engineer, as well as to carry out comparative analysis of the given methods to show the possible advantages or disadvantages.

METHODS

In order to realize the primary aim, it is necessary to analyze the method that will be used in the risk assessment, to describe the workplace, then to perform risk assessment and finally to point to possible advantages or disadvantages that occur under the given methods.

The methods that will be used in risk assessment are the matrix methods - KINNEY method and AUVA method. Matrices can be used to assess the risks in the workplace, the ranking of the different risks of importance for assessing, the acceptability of risk for assessing residual risk and priority ranking [11]. The advantage of the matrix is that they can be understood by the staff in charge of occupational safety.

Risk assessment is possible if we know the nature of harms and dangers and the factors that define the intensity [5]. The data obtained by risk assessment are combined with data from other sources (such as data obtained by monitoring employees' health, matrix operations and exposure limit values, permissible levels of exposure and available statistical data).

The EU Directive suggests that each state can customize specific methodology for assessing risk according to their legislation. Some EU members have specific regulations on the way and methodology to risk assessment [12].

KINNEY METHOD

In Kinney method, the risk is seen as the emergence of dangers and hazards. Risk assessment is the product of three dimensions [1]:

- The probability of an accident or damage;
- The severity of consequences for an employee in case of dangers and hazards;
- Frequency of occurrence of dangers and hazards.

Criterion - probability (P) is ranked ranging from 0.1 - virtually impossible, to 10 - predictable (table 1).

Table 1. *Description of the criteria for assessing the probability*

Probability	Description of the criteria for assessing the probability
0,1	Virtually impossible
0,2	Practically impossible
0,5	Plausible, but unlikely
1	Improbable, but possible at boundary conditions
3	Unusual, but possible
6	Possible
10	Predictable

Criterion - consequences (C) (possible damage) is ranked ranging from 1 to 10 and that is considered catastrophic, highlighted in Table 2.

Table 2. *Description of the criteria for assessing the consequences*

Consequences (C)	Description of the criteria for assessing the consequences
1	Disease, injury which requires first aid and any other treatment
2	Medical treatment by a doctor
3	Serious - disability, serious violation with individual hospitalization and lost days
6	Very serious - individual accidents with lethal outcome
10	Catastrophic - with multiple lethal outcomes

The criterion - the frequency of occurrence of danger and harm (F) ranks of rarely - once a year, permanently - continuous 10 (table 3).

Table 3. *Description of the criteria for frequency*

Probability	Description of the criteria for frequency
1	Rare (yearly)
2	Monthly
3	Occasional (weekly)
6	Regular (daily)
10	Permanent

Evaluation of risk R is performed by the formula:

R = P x C x F

Table 4 gives a tabular presentation risk assessment.

Table 4. *Table of risk assessment*

Identified risk or harm	Evaluation of risk				Measures to control risk assessment
	P- probability	C- consequences	F- frequency	R- the risk level	

The level of risk (R) is ranking from acceptable, negligible levels RI, to extreme, impermissible, which requires interruption of work activities and the instantaneous preventive actions which is defined as the risk level RV (Table 5).

Table 5. *Description of risk classification*

Total rating	Level of risk	The classification of the level of risk	Description of the classification level of risk
0,1 – 20	R I	**Negligible risk**	No action is required.
21 – 70	R II	**Low risk**	There is no need for additional activities in the management of the operation. More cost-effective solution or improvement without additional investment should be considered. It is necessary to monitor the situation in order to obtain information on the implementation of prescribed activities.
71 – 200	R III	**Medium risk**	Efforts are needed to reduce the risk or cost of prevention. Costs must be carefully planned and limited to a certain level. It is necessary to define a deadline for the implementation of improvement. For those events which may have extremely dangerous consequences, it is necessary to further examine the probability of occurrence of such an event so as to define the required level of activity and to mitigate risks.
201–400	R IV	**High risk**	An activity cannot start unless the level of risk is reduced. Additional resources may be required in order to reduce risks. Considerable resources may be required, in order to reduce the risk. If the risk applies to all started activities, it is necessary to take urgent action to reduce the level of risk.
Over 400	R V	**Extreme risk**	The operation cannot be started nor continued until the risk is reduced. It s not possible to reduce the risk by additional investments, and therefore the ativity should stay idle.

AUVA METHOD

For the assessment of the risks in the workplace in the working environment, a modified AUVA method can be used.

Elements of the assessment and evaluation of risks to AUVA method are Probability of danger or harm and severity of possible consequences. Accordingly, the level of risk (LR) was defined as the product of the probability an unwanted event (RP) and rank as possible severity of the violation (RV):

LR = RP x RV

Probability of dangers or harms depends on employees' exposure to risks and hazards in the working environment (existing state of health and safety at work). Employees' exposures to dangers and hazards are ranked as follows (table 6):

Table 6. *Ranking of the dangers and harmfulness*

Exposure hazards and harmfulness during the working day (week, month, year) %	Qualitatively ranking of exposure dangers and harmfulness	Quantitative ranking of exposure dangers and harmfulness
< 20%	Very rarely	1
21% - 40%	periodically	2
41% - 60%	often	3
61% - 80%	The most of work hours	4
> 80%	Through all workday	5

The environmental condition or the current state of occupational health and safety has been determined by the following elements (table 7):

Table 7. *Elements for assessing the condition of the environment*

Nº	Elements for assessing the condition of the working environment	Document/ base	Compatibility with the requirements / satisfies	
			YES	NO
1.	Workspace and work surface			
2.	Tools and equipment for work			
3.	Protection from electric shock			
4.	Heating and ventilation			
5.	Microclimate			
6.	Light			
7.	Electromagnetic radiation			
8.	Noise and vibration			
9.	Atmospheric and climatic influences			
10.	Fire and explosion protection			
11.	Passage, access and evacuation routes			
12.	Raw materials, basic and additional material			
13.	Organizational of occupational safety and health			
14.	Personal protective equipment			
15.	Training for safe work			
16.	Information on safety and health at work			
17.	First aid			
18.	Protection of nonsmokers, the ban on alcohol and other addiction			
19.	The maintenance of premises			
20.	Condition of facilities for personal hygiene			
21.	The inspection about supervision			
22.	Injuries and occupational diseases			

On the basis of the level of compliance with the requirements of health and safety at work is determined by the rank condition of the working environment as follows (table 8):

Table 8. *The ranking of dangers and harmfulness*

occupational health and safety demands are fulfilled (OHS) in%	Qualitative ranking of condition in the working environment	Quantitative ranking of condition in the working environment
OHS>80%	Satisfying	1
60%< OHS ≤80%	Medium term necessary measures	2
40%< OHS ≤60%	Short term measures necessary	3
20%< OHS ≤40%	Currently necessary measures	4
OHS ≤ 20%	Measures for instant termination of work processes	5

Description of the workplace – Operating Engineer for occupational safety, environmental protection and fire safety

According to the systematization within a certain company, this person is responsible to:

1. Apply and implement legal regulations and internal acts in the field of occupational safety, the environmental protection and fire protection.
2. Control work equipment, devices and means of personal protective equipment and devices and systems with harmful radiation or hazardous emissions.
3. Follow and control the working conditions of the working environment and control the handling of hazardous materials.
4. Perform training for safe work and fire protection.
5. Perform professional duties.

Application of Kinney methods for the workplace Operating engineer for occupational safety, environmental protection and fire protection

In Table 9 presents the application of Kinney methods for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection.

Table 9. *Application of Kinney methods for the workplace operating engineer for occupational safety, the environmental protection and the fire protection*

Nº	Work activities	P- probability	C- consequences	F- frequency	Level of risk
1.	Working in the field and in the facility	0.1	3	1	**0.3**
2.	Using computer and other electrical devices	0.1	10	1	**1**
3.	Working in the open	0.1	1	1	**0.1**
4.	Working on a computer – using a monitor	0.1	2	2	**0.4**
5.	Using a computer and other administrative office duties	0.2	2	3	**1.2**
6.	Performing the work in OHS and fire protection, direct communication with employees and inspection and other state bodies, it is possible crisis situations.	0.1	2	2	**0.4**
7.	Performance of regular work activities	0.2	3	3	**1.8**

Based on the conducted workplace Operating engineer for occupational safety, the environmental protection and the fire protection, is workplace with an acceptable risk, given that the level of risk for all work activities does not exceed 20 chapters R <20.

Application of AUVA methods for the workplace Operating engineer for occupational safety, environmental protection and fire protection

Table 10 presents the existing condition of health and safety at work.

Table 10. *The existing condition of health and safety at work*

Nº	Elements for assessing the condition of the working environment	Document/ base	Compatibility with the requirements / satisfies YES	NO
1.	Workspace and work surface	Regulations on Safety Measures for Auxiliary Facilities, ("Official Gazette of SRS", No. 29/87) Inspection	●	▲
2.	Tools and equipment for work	Regulations on the procedure of inspection and test equipment for the operation and testing of working environment ("Official Gazette of RS" No.94 / 06 and 108/06) Instructions for inspection, testing and maintenance of assets. Records of the inspections and tests of work equipment	●▲	
3.	Protection from electric shock	Regulation on technical norms for low voltage electrical installations ("Official Gazette of SFRY", no. 53/88 and Official Gazette No. 28/95) Instructions for inspection, testing and maintenance of assets.	●	
4.	Heating and ventilation	Inspection	●	
5.	Microclimate	Report on the measurement / inspection	●	
6.	Light	Report on the measurement / inspection		●
7.	Electromagnetic radiation	Report on the measurement / inspection	●	
8.	Noise and vibration	Report on the measurement / inspection	●	
9.	Atmospheric and climatic influences	Inspection		▲
10.	Fire protection and explosion	Law on fire protection ("Official Gazette of SRS", No.37 / 88) Regulations for fire protection.	●▲	
11.	Passage, access and evacuation routes	Regulations on Safety Measures for Auxiliary Facilities, ("Official Gazette of SRS", no. 29/87) / Inspection		

12.	Raw materials, basic and additional material	Do not use hazardous materials, or Instructions for inspection, testing and maintenance of assets. Records of hazardous substances used in the course of work	●▲	
13.	Organizational of occupational safety and health	Collective agreement Regulations on safety and health at work.	●▲	
14.	Means and equipment for personal protection	The norm means and equipment for personal protection at work. Records of the inspections and tests of means and equipment for personal protection at work	●▲	
15.	Training for the safe operation	Law on Safety and Health at Work ("Official Gazette of RS", No.101 / 05) Regulations on safety and health at work. Records of employees trained for safe and healthy work	●▲	
16.	Information on safety and health at work	Law on safety and health at work ("Official Gazette of RS", No.101 / 05) Directive 92/58 / EEC on the minimum requirement for ensuring label for safety or health of workers at work		
17.	First aid	Regulations on safety and health at work. Ordinance on equipment and procedures for the provision of first aid and rescue service organization in case of an accident at work ("Official Gazette of the SFRY", No.21 / 71)		●▲
18.	Protection of nonsmokers, the ban on alcohol and other addiction	Smoking ban. Ban on the use alcohol and other psychoactive substances in companu's buildings and premises.	●▲	
19.	The maintenance work premises	Inspection	●	
20.	Condition of facilities for personal hygiene	Inspection	●	
21.	The inspection about of supervision	The inspection about supervision		
22.	Injuries and occupational diseases	Records of injuries, occupational illnesses and diseases related to work	●▲	

● RANK OF THE CONDITION OF THE WORKING ENVIRONMENT - OFFICE 1
▲ RANK OF THE CONDITION OF THE WORKING ENVIRONMENT - GROUNDS 2

Table 11. *Identification of dangers and threats on the workplace and working environment and possible consequences*

Nº	Work activities	Possible danger and harmfulness	Possible consequences
1.	Working in the field and in the facility	Slipping and tripping when moving on the ground and inside on buildings	The fracture of bone and soft tissue injuries
2.	Using a computer other electrical devices	Indirect contact	The burns, injuries caused by electric shock
3.	Working in the open	Low temperatures in winter (wind, rain, snow) High temperatures in summer	Colds, respiratory system diseases, sunstroke
4.	Working on a computer - monitor	Long term eyestrain	Malfunctions disorders and vision,
5.	Using a computer and office work	Long term sitting	Headache, a stiff neck, pain in the shoulders and back, disorders of the digestive system
6.	OHS and fire protection, direct communication with employees and inspection and other state bodies, it is possible crisis situations.	The psychological burden	Psychosomatic disorders
7.	Regular work activities	The responsibility for receiving and transferring information, the use of appropriate knowledge and skills	Psychosomatic disorders and diseases (high blood pressure and other diseases of the cardiovascular system and digestive system)

Table 12. *Ranking of risk*

Nº	Code of danger or harmfulness	Rank exposure	Rank of the working environment	Rank of probability	Severity rank of possible consequences	The measure of risk	Rank of risk	
							Five degrees scale	Three degrees scale
1.	10	1	2	1	3	3	I	A
2.	16	1	1	1	5	5	I	A
3.	27	1	2	1	1	1	I	A
4.	30	2	1	1	2	2	I	A
5.	31	3	1	2	2	4	I	A
6.	32	2	1	1	2	2	I	A
7.	33	3	1	2	3	6	II	A

On the basis of the recording process of the organization of work, applied measures of health and safety occupational, dangers and threats in the workplace and working environment, and risk ranking, it has been estimated that the workplace Operating Engineer for occupational safety, environmental protection and fire protection is a workplace with an increased risk.

Comparative analysis of the results of the risk assessment for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection with Kinney and AUVA methods

While conducting risk assessment for the workplace Operating engineer for occupational safety, the environmental protection and the fire protection used Kinney and AUVA methods. Both of methods use a five-degree scale ranking of risk. The analysis shows that rank of risk for all activities were given position 1 when it comes to KINNEY method. At AUVA method last, seventh activity has rank of risk 2.

CONCLUSION

There are several methods for risk assessment and health risk assessment. The methods are divided by areas for which they are intended. They differ by the matrices and the ranking scale they use, according to which they can be three degrees, five degrees and multi degrees. Matrices that are used can be 3x3, 4x4, 5x5, 4x6, 9x9 and others, which have been defined by certain standards. Accordingly, the methods can be more precise or less precise.

This paper investigates one workplace with KINNEY and AUVA methods. Using both methods to assess the workplace of an Operating Engineer for occupational safety, environmental protection and fire protection, it has been assessed as a workplace with acceptable risk. However, AUVA method besides taking into account possible dangers and harmful effects, possible consequences and exposures also considers the condition of the working environment, unlike KINNEY methods which is based only on probability, consequences and frequency. The results showed that the AUVA method is a bit more precise because it uses many factors for risk analysis unlike KINNEY methods. Therefore, AUVA method is more precise and reliable than KINNEY method.

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BIOGRAPHY

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UPOREDNA ANALIZA METODA ZA PROCENU RIZIKA „KINNY“ I „AUVA“

Milena Stanković, Vladana Stanković

Rezime: *Pojedinci, privredni subjekti i čitavo društvo, izloženi su rizicima više nego ikada. Problem bezbednosti i zdravlja na radu je prisutan od kada postoji rad, nastajao je i rešavao se u skladu sa celokupnim razvojem društva. Iz tog razloga, za procenu rizika razvijene su različite metode i matrice. Predmet rada je prikaz metoda za procenu rizika, kao i primena tih metoda za radno mesto u kome se javljaju povećane opasnosti i štetnosti. Cilj rada je da se kroz izabrane metodeza procenu rizika - Kinny i AUVA, za radno mesto - operativni inženjer za BZNR, ZŽS i ZOP, izvrši procena rizika, kao i da se izvrši uporedna analiza datih metoda kako bi se ukazalo na moguće prednosti ili nedostatke izabranih metoda.*

Ključne reči: procena rizika, metode za procenu rizika, Kinny metod, AUVA metod.

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OCCUPATIONAL SAFETY IN HAZARDOUS CONFINED SPACE

Abstract: *The paper presents the concept of hazardous confined space by identifying hazards in closed areas, with special emphasis on dangerous gases commonly found there, and occupational safety measures that involve: testing the air, cleaning and ventilation, separating enclosed spaces, personal protections, entry control, blocking mobile device and rescuing casualties. For only 8 years in America, there has been an average of 89 work-related deaths in confined spaces per year, and approximately 23 (25.5%) of those who died were persons attempting rescue. Asphyxiation by gases was the primary cause of death. The persons who were participating in rescue were in most cases co-workers, not or emergency medical service personnel. Since rescue operations in confined spaces are unique hazards, proper training of personnel and the availability of specialized equipment are required to protect persons attempting rescue from injury and death. Emergency medical service personnel should be familiar with all potential threats and rescue techniques in confined space. Analogously, the paper describes all the potential dangers and hazards of indoor space*

Key words: hazardous confined spaces, occupational safety.

INTRODUCTION

Confident spaces are present everywhere in the industry, and they are the places where accidents occur frequently. The term confident space is used to designate certain structures such as tanks, vessels, tanks, sewers, etc. Every space in which people work may be or may become confident space. The term actually describes the environment in which hazard can occur – it can be structural, process, mechanical, atmospheric, physical, chemical, biological and ergonomic hazard, and dangers from liquid or solid material. Many conditions that cause these hazards do not refer only for closed spaces, but they deteriorate by introducing a fenced area in a confined space. Indoor spaces are much more dangerous than normal confident space. Seemingly minor changes in conditions can instantly change the status of these jobs from harmless to life threatening. The work in confined spaces is related to construction, inspection, maintenance and modification.

In an enclosed space, ventilation is one of the most important methods for the control of air quality. In these areas there are potential sources of pollution. Therefore, the ventilation method is commonly used for dilution and the elimination of pollutants from indoor space. It can carry out fresh air from outside or recycled air that is purified in an appropriate manner.

Special measures to be taken, in addition to good ventilation, are a dual system of protection against electric shock and harmful gases and vapours, the existence of entry and exit, ensuring appropriate working conditions (light, ventilation, vibration, manipulation tools) and the existence of procedures for working in confined spaces.

Dangerous enclosed area is any room or space, usually of less volume in which the air is not changed naturally, nor through natural ventilation. Such areas usually appear under the earth, but they may be on the surface, and sometimes only partially open. According to some definitions, hazardous confined space can be any enclosed space in production facilities.

HAZARDS IN CONFINED SPACE - HAZARD IDENTIFICATION

Hazardous enclosed spaces may include: storage systems, railway and other systems that are used for different purposes, boilers, pipes of large diameter, channels, underground caves, wells, abandoned mines, various marine facilities and the like.

Hazardous enclosed spaces are those that are only partially open and in which gases and vapours, heavier than air, may accrue. They can be: deep pit, boilers, reactors with open passages, channels detected with a lid, manholes, elevators, etc.

Accidents in enclosed spaces differ from the accidents in everyday working environments. Seemingly minor error or omission in the preparation area, selection or maintenance of equipment or work activities can cause an accident. This is due to less tolerance for error in these situations than in activities that occur in normal workplaces. In our country and worldwide, every year there is serious damage to workers' health and increased number of deaths at the entrance to such premises. In this respect, it is most likely that the following group of workers will die - workers who work on the maintenance of installations such as assemblers, welders, workers who are working on divorce gas, water, worker who digs wells, etc. Also, in some cases, victims can be professions and technicians, rescuers and casualty workers, and sometimes insufficiently trained members of the fire service.

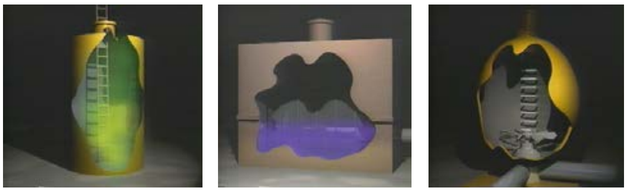

Figure 1. *Examples of confident space*

It is surprising that people are not very familiar with the causes of these accidents. This is confirmed by the black chronicle which gives examples of such accidents, usually according to unidentified toxic gases or deaths under mysterious circumstances.

It is rare to indicate the cause of death, and deaths are often caused by a lack of oxygen in the air, or air pollution by toxic gases. In order to define the problem of these accidents, it is necessary to have more expertise and experience in this field. Knowing the theory without practice is not enough which can be seen in the following example.

A laboratory worker in a metallurgy lab constantly complained that he felt bad. In doctor’s office he suddenly lost consciousness. Since the doctor did not diagnose any of the common diseases, the worker was sent to examination by a sanitary expert. They discovered that the worker was working with the liquids that evaporate very easily and quickly. The laboratory worker tried to put a few drops of this liquid on the glass under the microscope. He kept the fluid in 100 cm^3 bottle. The room in the lab was large enough (4x5x4). The room was constantly vented with a fan, so that the air in the room had been changed for several times. The sanitary inspector confirmed, taking into account the size of the laboratory and good ventilation system, that there could not be health-threatening concentrations of toxic fumes into the room even in case if the entire amount of the liquid from the bottle had been spilled. However, when after a few days of his regular work, the worker lost his consciousness again, the sanitary and occupational safety officers invited another laboratory physician to carry out the examination. They opened a bottle with toxic liquid and observed them with the sample microscope for two or three minutes. During this time, the technician unconsciously inhaled the vapour liquid from the bottle. Since the bottle was very close to his head, it became clear that he breathed in about 80% of these toxic fumes and only 20% of the room air. Air space was safe for all workers in that room, and there was an accident with the mentioned laboratory.

This example, in addition to the large number of poisoning not only in laboratories, can serve as a necessary caution to all similar works in the industry.

The most complicated and the most difficult aspect in dealing with confined spaces is to define risk. Determination of hazards includes hazardous and potentially hazardous conditions and they determine the level of risk and acceptability. The difficulty in determining the risk occurs because many dangerous conditions can produce acute or traumatic injuries, and it is difficult to identify and define them since they are constantly changing with the changing conditions. Oxygen is slightly heavier than air and it is therefore very important to reduce risks while working.

OXYGEN IN A CONFINED SPACE

Oxygen is the most prevalent element, colourless, odourless and tasteless; therefore, our senses can even remotely assess neither the presence nor the amount of the gas in very active element.

The property of oxygen is the fact that it constantly seeks "partners" with which to unite. Thus, for example, in conjunction with hydrogen it forms water, it generates carbon dioxide with the carbon, and with iron it creates iron oxide, and so on.

There are plenty of cases in which so-called silent oxidation runs constantly. Under certain circumstances, the oxidation process accelerates and the reaction becomes exothermic, which means that it produces heat to the environment. When heat with combustible materials reaches a combustion temperature, self-ignition and burning with flames occur. Any burning is, in fact, rapid oxidation and combustion is continuation of burning. Oxygen itself does not burn, and in some cases even enhances combustion explosion.

The air we breathe have about 21% oxygen. If the percentage of oxygen in breathing is reduced below 16%, one feels discomfort. Respiration is accelerated, and also pulse, while the buzzing in the ears occurs. When oxygen is decreased to concentration of 15-10%, the man is still conscious, but his reasoning is wrong and he becomes tired very easily. If the amount of oxygen in the air falls to 10% or lower, there is a sudden fatigue, weakening pulse and loss of consciousness (collapse). If he is quickly brought to fresh air and given necessary emergency assistance, he can still be saved.

In case of oxidizing in normal conditions, such as the open air, the oxidation material takes oxygen from the surrounding air and persons who come into contact with such material are not exposed to any danger. However, if the oxidation process happens in a confined space for longer period of time, percentage of oxygen content in the air is reduced, and the air loses oxygen and becomes enriched other gases and vapours.

Oxygen from the air, in some cases, is gradually consumed through chemical and biological reactions. Such slow oxidation reactions often appear in empty systems and boilers that are not used for some time.

The examples of chemical reactions may be the usual rust corrosion of the internal surfaces of the system, and similar vessels. In some cases, this reaction may absorb too much oxygen.

Since biological reactions are known, for example heating the straw, in some cases it may be enough to light a straw if is stored indoors. Similar biological reactions of slow oxidation can occur in abandoned wells in sewer pipes, waste water in the abandoned workshops, and the like. Sometimes they can contain organic matter that can cause greater absorption of oxygen from the air these spaces.

In practice, it is necessary to keep in mind that the lack or insufficient amount of oxygen in the indoor air is not noticed at first sight, even though the workers may have certain symptoms. For example, rapid breathing and heart rate acceleration. The workers usually do not pay much attention to it, they simply ignore the danger and don't; notice it until it is too late for their own rescue. The situation is more difficult if the path to the exit to fresh air is longer, and must be crossed, or if a worker has to climb the stairs or a ladder.

OTHER GASES IN A CONFINED SPACE

In chemical industry, there are hundreds of types of flammable and explosive gases. All of these gases and vapours are flammable and explosive in a wide range, scale mixture with air, i.e. within the boundaries between the so-called lower and upper limits. These values are determined experimentally in the laboratory and are expressed in percentages.

Out of all toxic gases, carbon dioxide, which is already in low concentrations and life-threatening, caused the most casualties. It is a gas that acts insidiously because no taste or smell, so if the air and with low gas contents of this long inhalation, leads to its accumulation in the lungs. Other gases in this group of toxic gases, for example, hydrogen sulfide, have a fragrance that reveals them, but, unfortunately, their smell quickly becomes dull, thereby increasing risk.

The third group of gas-noxious gases is characterized mainly, by the air enclosed space. It reduces the percentage of oxygen necessary to the health and lives of people. We have already mentioned carbon dioxide and other inert gases. After extinguishing the fire in small confined spaces, which are filled with carbon dioxide, there happens suffocation and unprotected workers due to lack of oxygen, or due to reduced percentage of required gas. Accidents with a tragic ending happen in cases with closed tanks, boilers and if there is nitrogen in the room. Deaths in hospitals are also evident, and also deaths that as consequence of the replacement of unmarked steel tanks which housed oxygen bottles filled with carbon dioxide.

There is another important division of dangerous gases that may endanger the safety and health of workers in indoor areas, including:

- flammable gases (flammable and exhaust gases from the engine);
- vapors of flammable liquids, solvents and thinners (gasoline, diesel, kerosene, acetone, tetrachlor and various hydrocarbons);
- gases that develop during the process of fermentation (fermentation gases from organic matter, such as methane, carbon dioxide, hydrogen, hydrogen sulfide and other in mixtures);
- gases and fumes from waste water (in the sewers and septic tanks);
- natural gases, lighting and the like;
- gases that occur after an explosion and fire (in the mines after an explosion and after extinguishing fires in enclosed spaces).

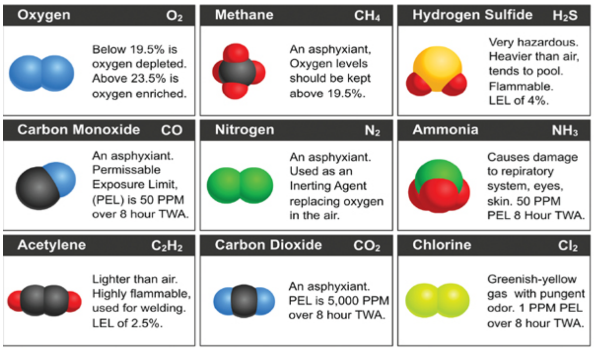

Figure 2. *Hazardous gases found in confident spaces*

From this distribution we can see that in every branch of economy there are specific hazards of certain gases and vapors. Knowing these substances, especially for occupational safety and health experts, is of great importance because it allows them to properly act and secure workers at their workplaces.

In all these groups dangers that threaten the health and lives of workers appear. The example may be a great number of deaths from the engine in the garage, especially in winter, which is one of the dangers in enclosed spaces.

Some gases are lighter than air, and climb higher where they get diluted, and therefore do not pose threat to healthy people. However there are a lot of industrial gases, which are heavier than air, such as, for example, the propane-butane, and a variety of other hydrocarbons. These gases accumulate in open pits and similar recesses, sometimes unnoticed "current" moat, canal or crawling short distances through the ground to the lowest points accumulated. The accumulated gases suppress oxygen, and may, according to all properties, cause death by asphyxiation poisoning, explosion and fire. This also explains the surprising amount of certain gases in the areas where they are not expected to be found.

In this respect, we may well serve an instructive example of the loss of propane-butane from railway tanks left on the track of a factory in the northwestern Bohemia. The mixture of these gases is about two and a half times heavier than air. The gases from the tanks are coming out and move deeper, over a mile-long trench to where the workers are melted asphalt on an open fire, there was suddenly so strong explosion from which several workers received serious burns and two others were killed. At first no one knew what caused this tragedy. After a detailed study of the site and its surroundings, it was a remote railway tanks with propane-butane. It was found that the tank was not properly sealed.

The inert or noble gases are constantly and increasingly being used in practice, especially for inert spaces that are at risk of explosion. For this purpose, the most commonly used are carbon dioxide and nitrogen, and in special cases, expensive argon and helium.

Carbon dioxide is used as a proven means for extinguishing a fire, cooling, to create a protective layer of air near the welding arc. This is true for argon. In terms of occupational safety, it is essential to mention that, carbon dioxide, when used in a confined space in whatever form, greatly reduces the percentage of oxygen in the air of the area, and the workers who would be there could stayed longer because of the lack of oxygen to suffocate.

During construction of the ship in an American shipyard, thirteen employees got choked. Similar cases are occurring with the use of nitrogen, helium and argon.

OCCUPATIONAL SAFETY IN CONFINED SPACE

Entry into hazardous confined spaces, especially the performance in such areas poses a major threat to the health and lives of people. Therefore, in many technically developed countries operating in such areas is subject to previous approval of the competent authority. It is necessary to first control working conditions by an occupational safety expert.

If there is danger for workers in confined space, it is necessary prior to their entry, to clean and ventilate this space. As a worker could enter into a hazardous confined space it is necessary to execute a sequence of procedures, some of which should be allocated as follows:

- Testing of the air;
- cleaning and ventilation;
- separation, breaking links with other technological devices;
- personal protective equipment for workers;
- entry control;
- blocking of mobile devices;
- rescue.

Each enclosed space in which percentage of oxygen in the air can be reduced and toxic, flammable or asphyxiating gases and vapors ma be found, must be tested prior to entry of workers in terms of air quality in the confined space. The workers, who did the work in this area must be qualified and practically trained to properly use various agents at work.

Each employee, before entering the hazardous confined space must be fully aware of the dangers posed to him. To measure and determine the air quality of enclosed areas, different appliances are used.

These devices, if possible, should not be brought into the premises in which it is assumed that the air is contaminated with various substances (polluted), it is recommended to take a sample of that air. As for the sample of air, it is always necessary to try to take the same outside special equipment or special engagement vessels, which the indoor air operations, and pulls out certain instruments exams. In any case, sampling of air, their testing and analyzing, sorting the results obtained and their use, it's all in the office of qualified industrial sanitary experts or chemists.

Measuring and testing the indoor air of enclosed spaces in terms of explosiveness, toxicity and oxygen content must be done before any entry into the area, and during workers occupancy in a confined space. These tests must be repeated at short intervals, as always there is the possibility of permanent changes in the composition of the air.

Cleaning and ventilation vary depending on:

- the type of material from which, for example, made tank;
- from the lysate, i.e. of the chemical changes that occurred on the inner surface of the material from which the tank is made;
- quantities of lime and other deposits within the vessels, tanks, boilers, etc .;
- the size and shape of tanks, boilers, etc .;
- the size, shape and position of the inlet and other openings which are located on the container;
- the position of the vessel which may arise due to the "corners" and "pockets" and other places unsuitable for cleaning.

The air in a confined space can be cleaned and ventilated, according to the following general guidelines:

- from the bottom to remove as much mud and sludge;
- method of cleaning customize the type of closed containers.

The most commonly used jet of water from a pipe or, in the absence of hoses, jets of water from the full bucket. In some cases, it is necessary prior to boiling the water to be heated and is thus left in the container to stand for 24 h or more. If the dish in your profile articulated, in this case it is necessary to pay special attention to various corners, pockets and other places suitable for a variety of deposition and the city also cleaned thoroughly. In some cases, the washing water containers with a variety of chemicals are added in order to neutralize the impurities.

Cleaning can be done by using steam of nitrogen and other inert gases, and also by air.

Figure 3. *A worker with personal protective equipment*

In some cases, there is no need to do the cleaning but the air must be clean at all times.

If you are in a confined space with air and flammable and explosive gases or vapors, it is necessary to take care about the potential accumulation of static electricity.

It is also necessary to take into account that after cleaning the pots or other enclosed spaces, there still may be danger to the health and life of workers in that area and that the remains of various deposition, often invisible but still in sufficient quantity (in the pores, seams etc. places) may pollute the air. Therefore, it is necessary to repeat the test after cleaning the air in a confined space as long as they do not provide completely satisfactory results after which the worker can freely enter an enclosed space and do his job.

Special cleaning area and taking special measures to protect workers out of the question in those cases where it is necessary material sealed container, for example, tanks, heat during work inside or outside, as it happens in welding, flame cutting and other similar operations. In such cases, the risk increases even more in that from the residual sediment release gases and grazing of aging. Therefore, before proceeding to such work, the vessel is filled with water or inert gas, carbon dioxide or nitrogen.

Any employee who enters a dangerous confined space shall be provided protective belt and matching rope whose one end is outside, i.e. the enclosure, securely mounted. When a worker enters a dangerous confined space, he should be followed by another worker who will look after him while he is in a confined space and be ready at any moment to him in case of an emergency treated, alone or together with other workers.

According to the type of potential hazards it is necessary to provide the appropriate personal protective devices, for example: breathing masks, protective suits against the effects of acid resistant, protective footwear, protective helmet, gloves and so on.

In practice, when working in hazardous confined space with a narrow inlet opening, it is necessary to use protective rope to tie to the back of an injured worker if he lost his consciousness, so that he could be easily placed in an upright position. Furthermore, for physiological reasons, it is recommended to use the buffer zone in such system, and in that way to pull out the worker, his chest near his stomach.

Proper lightning is a must while working in hazardous enclosed spaces. For this purpose, it is recommended to use a battery or a portable electric lamp with a muzzle and a long cable. With this type of lighting, powerful current and voltage transformer must be placed outside the enclosure.

There are flammable or explosive gases or vapours in hazardous confined space, and the lamps used in their construction are resistant to such gases and vapors. Tanks and equipment that are used must also be grounded.

Handheld devices and devices used in hazardous enclosed spaces shall be made of beryl bronze and in any case the first-class material. Footwear should not have metal nails.

Near the entrance to the hazardous confined space, threatened by flammable and explosive gases and vapours, there should be sufficient amount of pure cold water hose with spray attachment.

Traditional methods for managing these activities should be carried out in a confined space, and they allow entrance only to skilled persons. Within both systems, there are clear demands about authorities, responsibilities and conscientiousness among educated people and people who enter premises, as well as among the staff and management who happen to be there in case of emergency.

The document about entry permission is aimed to inform. If you include only the information relevant to a particular circumstance, it provides an entry permit only to certified persons. Permission to enter is most effective as a brief overview documenting the actions that have been performed, and points to the need for further precautions. Entry permission should be issued by a qualified person who also has the authority to withdraw a license if something changes. A person who is issued a permit should not depend on the supervisor hierarchy. The permit specifies the procedures to be followed and the conditions under which they enter and under which the operation can continue, as well as the records on the results of tests and other information. Signed permission is placed at the entrance or at the door or any other place the company ordered. It stays in that place until it is removed or replaced. Permission to enter in the minutes after the completion of the work.

Figure 4. *Symbol of hazard*

The system works best with permissions where the hazardous conditions are recognized from previous experiences, and control measures tried and proven to be effective. The system of permits allows the division of expert resources in an efficient manner. Limitations permits are located at the places of previously unrecognized hazard. If there is no qualified person, this danger may remain untreated.

All kinds of mobile tanks and similar devices can become a source of danger and in different ways. They can, for example, while in sleep mode, be moved to the city at the moment where one or more workers are present at the place, or can become a source of danger due to various repairs that require the use of electricity. For this reason, moving the vessel must be prescribed and blocked to prevent unwanted motions and movements. The method to securing blocking would be the next, and it should include the following.

Appendix written approval to enter into a hazardous confined space and the use of special forms that are provided for all moving parts are blocked. The main engine will include devices for mixing in large rotating drums or tanks for the boot device. They are fixed in such a way that the motor could not be activated until workers are present in the confined space. It is best to turn off the engine by a single key which is delivered to a particular worker who is doing his job in confined spaces. In this way, the worker will perform his tasks without fear of possible sudden movements. If you happen to be in the endangered area and if there are many workers who entered, each of them must have their own padlock placed on the main switch in the off position and reserve keys for them until the work continues.

After the main switch is turned off and locked in a fixed position, it is necessary to examine and determine whether this is the only switch that controls the initiation of slurry mixer, and etc.

As additional safety can be achieved by the blocking system with lock, and it separation device driver can be used, for example by removing the belts, the chains and the like.

Also, additional safety could be achieved by fixing portable device which prevents the initiation, and possibly by fixing a gravity device.

For each work in the hazardous confined space it is required that workers are provided with the appropriate personal protection equipment, depending on the nature and type of work environment. If, for example, before beginning of work the insufficient amount of oxygen is found in the air, in this case, we must necessarily rely on the fact that the lack of oxygen during work operations can be further reduced. Therefore, it is necessary to control the percentage of oxygen not only before the entrance into the dangerous area but also in the course of performing work, and in many cases it depends on the time spent in that area. It is also important to take into account the time necessary to get out the threatened area for fresh air.

Lack of oxygen in the workplace, as well as the presence of toxic and flammable gases, can cause loss of consciousness among the workers. Therefore, in each company an organized system of rescue workers and casualties may be established and organized. Rescue groups need to be practically well trained. In connection with the work of rescue groups, the following guide needs to be overlooked:

Figure 5. *Rescue from confined spaces*

In each entry, jeopardized workers in confined space

must be located next to the entrance of another worker who will constantly observe and take account the worker inside a confined space, and immediately help them if necessary.

Practical exercises for members of the rescue group for casualty rescues in confined spaces must be maintained regularly and within the deadlines.

All appropriate personal protective equipment, such as protective breathing masks, protective zones with associated rope, lamps, etc. must be ready and near the entrance to the confined space.

In case a worker is in a confined space is threatened, the worker who observes should not enter unless the emergency alert informed other workers. Those workers will be seen from the entrance and at any moment, they can come and join people in rescuing. Very often, tragic cases are repeated because they did not act properly, i.e. as described above.

If there have been more workers in confined space, it is necessary to keep a record of their number to be know how is inside at every moment.

In the event that an employee who is performing indoor surveillance loses consciousness, or is not able to go outside, a worker-observer should act in accordance with predetermined rescue mode, as follows:

- to immediately alert the surrounding workers, rescue group, party fire and health center;
- to slip inside the tube inlet for clean air, thereby providing increased ventilation and closed the endangered area;
- worker, which should indicate a vigilant eye, can not enter into hazardous areas without adequate means of personal protection and if not provided workers who will watch from the doorway;
- after the rescue worker enters, other workers outside buildings urgently need to prepare all the aids to pull the killed and fingering first aid;
- workers, observers must continuously through the inlet view monitor employee-rescuers, and in the case of invisibility must be with him regarding using agreed signals;
- If the injured worker is unconscious, it is necessary to immediately proceed with artificial respiration “mouth to mouth”, or using breathing apparatus. If there is a respirator at hand, in these cases the doctor does not have to always be near. When CPR must be renewed and during transport the injured health center or hospital, and artificial respiration was discontinued as soon as the victim for consciousness returned.

Proper application of the described method and experience prevents the loss of many human lives to which, otherwise, with entry and retention in the surveillance indoors, often.

CONCLUSION

Unavoidable obligation of work organization is to train these workers to identify the hazards to which they may be exposed in hazardous confined space, as well as in the maintenance of labour discipline. A lot of workers lost their lives for not following the basic instructions. They arbitrarily entered dangerous confined space, without informing their superiors and the associates.

There has been cases that workers who were dead could not be found for hours; sometime, in cases where the records about workers was bas, it took them days to find the bodies. General safety regulations, logically, can not cover all the possible cases for different types of works in a variety of hazards in confined spaces in various industries.

It is therefore the duty of occupational safety and health experts and sanitation engineers employed in industries, to stick to the applicable general rules of safety at work and make detailed regulations for plants and site safety. These regulations shall not, in any case, be less strict than the general ones.

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BIOGRAPHY

Ana Stojković was born in Nis, Serbia, in 1989. She graduated in the field of environmental protection, is currently a master student of the Faculty of Occupational Safety in Nis, Department of Occupational Safety. She passed the exam certification in the field of health and safety at work. Her interests include occupational safety, staff training on occupational safety and the critical control points in the manufacturing process. During previous researches she has written 15 papers in the field of occupational safety.

ZAŠTITA NA RADU U OPASNIM ZATVORENIM PROSTORIMA

Ana Stojković

Apstrakt: *U radu je prikazan pojam opasnog zatvorenog prostora, identifikacija opasnosti u zatvorenim prostorima, sa posebnim naglaskom na opasne gasove koji mogu da se nađu u njima, kao i mere zaštite na radu koje obuhvataju: ispitivanje vazduha, čišćenje i provetravanje, odvajanje zatvorenih prostora, lična zaštita radnika, kontrola ulaska, blokiranje pokretnih uređaja i spašavanje nastradalih radnika. Prema istraživanjima za samo 8 godina u Americi, bilo je u proseku 89 smrtnih slučajeva vezanih za rad u zatvorenim prostorima na godišnjem nivou, a oko 23 (25.5%) onih koji su nastradali su osobe koje su pokušavale da spase ugrožene radnika. Gušenje gasovima bio je primarni uzrok smrti nastradalih. Nastradale osobe koje su pokušale da spase radnike uglavnom nisu pripadnici adekvatnih spasilačkih službi, već su to kolege ugroženih radnika. Operacije spašavanja u zatvorenim prostorima moraju biti adekvatno sprovedene od strane stručnih i obučenih lica. To podrazumeva pravilnu obuku kadrova i dostupnost specijalizovane zaštitne opreme opreme. Osoblje hitne pomoći, spasilačkih službi i civilne zaštite mora biti upoznato sa svim potencijalnim opasnostima i tehnikama spašavanja iz opasnih zatvorenih prostora. Analogno tome, u radu su opisane sve potencijalne opasnosti zatvorenog prostora.*

Ključne reči: zatvoreni opasni prostor, zaštita na radu.

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MANAGING OILS AS HAZARDOUS INDUSTRIAL WASTE

Abstract: *The management of waste oils is one of several key issues in the field of environmental protection. One of the leading problems is how to manage and process hazardous waste, including liquid hazardous waste oils. Due to the increasing amount of this waste, it is reasonable to be concerned about how to manage waste oils without harmful effects on the environment. The obvious problem with waste oil management in Serbia is insufficient laws and regulations in this area, as well as the fact that waste oil has been illegally incinerated, spilled and disposed. The adoption of the Waste Oils Directive and the Law on Waste Management set the legal framework for the management of waste oils, thus opening the possibility for investment and business in this area.*

Key words: waste, waste oil, management, storage, treatment.

INTRODUCTION

From the standpoint of environmental protection, waste oils are one of the biggest problems due to their negative characteristics on basic environmental elements such as water, air, soil, climate, human health and other wildlife. Inadequately treated and stored waste oil may cause the greatest harmful impact.

In Serbia, the only practical way to manage waste is disposal at the local landfills which mostly do not satisfy even basic sanitary and technical conditions, and some of the existing landfills are virtually full. At the present moment, there are very few landfills that may be included in a sanitary landfill in Serbia. Integrated waste management system represents a series of actions and activities that includes:

- Prevention of waste generation,
- Reducing the amount of waste and its hazards,
- Waste treatment,
- Planning and control activities and processes of waste management,
- Transport of waste,
- The establishment, operation, closure and maintenance of waste treatment plants,
- Monitoring,
- Counseling and education regarding business activity and activities in waste management.

This system is based on the selection and implementation of effective technologies to achieve specific goals of waste management with the appropriate regulations. The main prerequisite for a successful implementation and operation of an integrated waste management system is specified hierarchical functioning of the activities within it.

Whether waste oil is characterized as hazardous waste and whether it is necessary to reduce the quantity at the source of generation are the subjects of the National Waste Management Strategy. This strategy is made according to the large number of goals of interest to all levels of management - from local government to the republican level. It is necessary to sort out the following:

- Protection and enhancement of the environment,
- Protection of human health,
- Achieving the principles of sustainable waste management,
- Changing attitudes towards environmental protection and waste, as one of its segments,
- Increase public awareness.

Waste and waste management

Waste is any material or object that is produced by a production process, service or other activities, items excluded from use, and waste materials generated in consumption which, from the standpoint of producers or consumers, are not for further use and must be discarded.

Inadequate waste management is one of the biggest problems in terms of environmental protection of the Republic of Serbia and exclusively the result of inadequate attitude of the society towards waste. The waste is divided in several ways: according ti its composition, the place of origin, toxicity, see Figure 1.

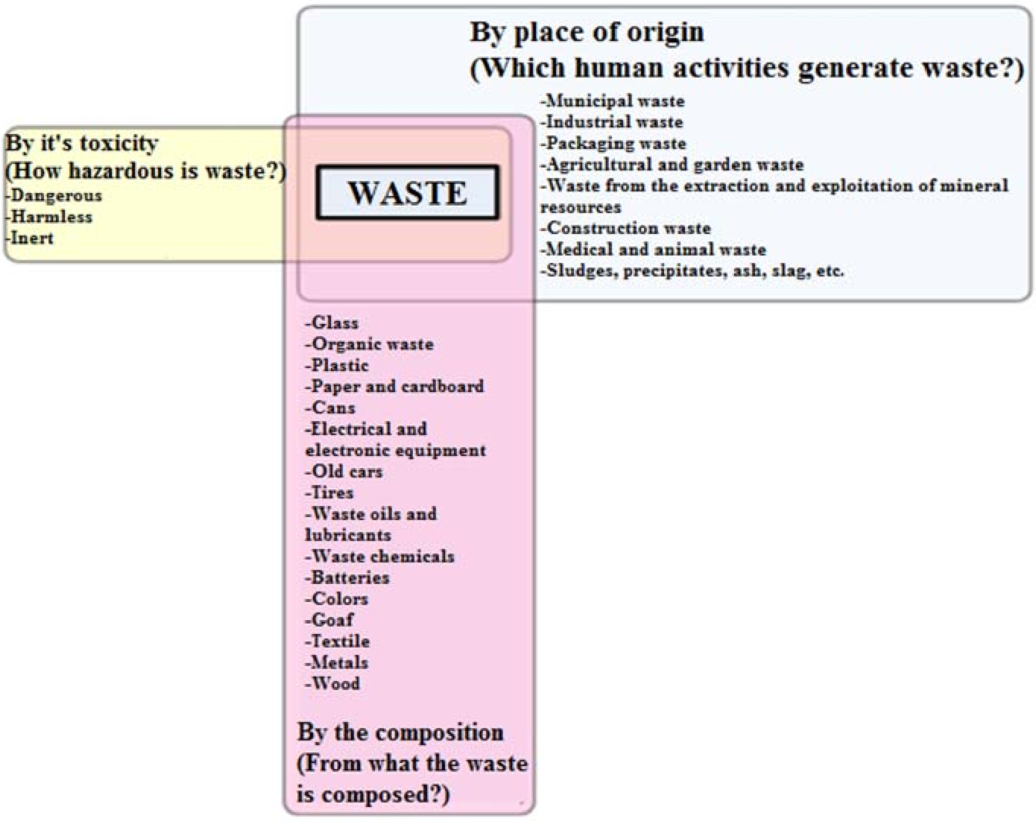


Figure 1. *Types of waste*

Management of waste oils

Mineral oils are petroleum products and their main function is to serve as a lubricant. After the expiry of the use value due to its characteristics waste oils are classified as hazardous waste. Extremely high possibility of recycling waste oils emphasizes the need for collecting large quantities to preserve the environment and regulate the consumption of natural resources.

Management of waste oils is a set of measures that include collection of waste oils for material use or use for energy purposes or otherwise for final disposal when they can not be used.

Management of waste oils must be conducted in a manner which does not endanger human health and the environment. Managing waste oils is strictly prohibited in following cases:

- discharge of waste oils into surface water, ground water and drainage systems;
- disposal and discharge of waste oils harmful to the soil and any uncontrolled discharge of residues from the processing of waste oils;
- the use and disposal of waste oils causing air pollution above prescribed limits of applicable regulations and which have a negative impact on human health and wildlife;
- collection of waste oils in tanks that are not regulated or equipped for reception of waste oils.

To perform the tasks of collection, storage and treatment of waste oils it is necessary to:

- have adequate space,
- proceed with waste materials in the prescribed manner,
- maintain proper documentation of the amount collected, stored or treated, as well as the final disposal of residues after treatment.

Lubricant waste oils are disposed in special containers for collection of waste lubricating oil which must be impermeable and closed and with the prescribed mark of key number of waste oil and should also have label categories of waste oil.

Figure 2. *A container for waste oil*

The possibility of utilization of mineral waste oils

Estimates of the quantities of waste mineral oils which are generated in the Republic of Serbia are incomplete, ranging annually about 106,000 tons of waste motor oils and 275,000 t monthly of organic-aqueous emulsion. It should be kept in mind that there are very few plants that treat waste oil in Serbia. However, the largest amount of waste oil from motor vehicles end up in landfill or in the sewer. A large part of the used oil is burned uncontrollably in home furnaces, used for protection and impregnation of wood, for lubrication of various molds, weed removal, dust.

Treatment (recycling) of waste oils creates the possibility for reuse, and depending on the method of treatment can have the following applications:

- Includes new products,
- Allows the reuse of waste oils,
- Allows the heat treatment process, ie. use waste oil for energy purposes,
- Waste oils are in appropriate technological procedures getting prepared for disposal or further processing or use.

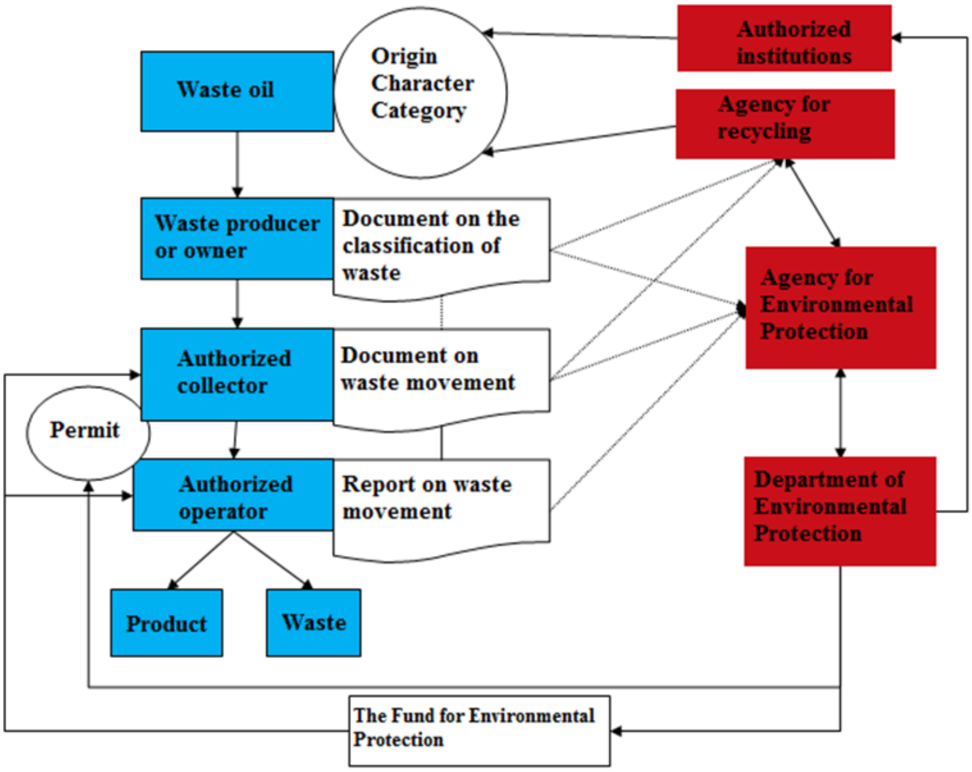


Figure 3. *Flow diagram of managing waste oils*

Currently the largest use of waste oil is as fuel due to its basic features that can physically burn. For this reason, the use of waste oil as fuel is fully comparable with other energy sources, especially heavy fuel oil and natural gas.

Of all the methods of waste oil recycling, refining requires the most rigorous conditions and relatively complex systems in order to obtain good quality oils.

The primary application of waste oil in the EU is for energy purposes. Table 1 shows the percentage share of regeneration of waste oils or use for energy purposes in the total amount collected of waste oil in some EU countries.

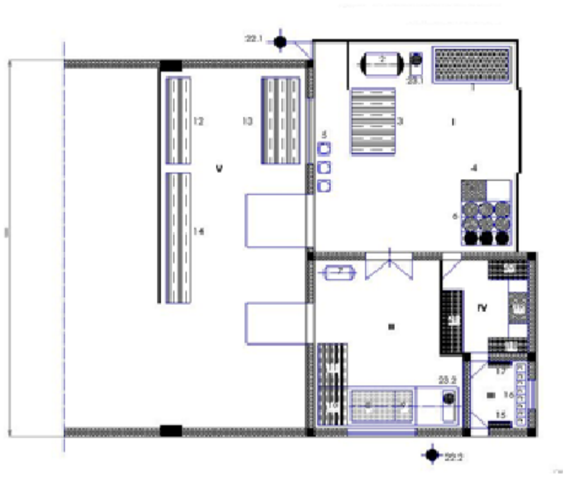
Table 1. *Utilization of waste oil in the EU*

Country	The amount collected (kt)	Degree of collection (%)	Application for energy purposes (%)	Regeneration (%)
Austria	34	74	74	0
France	243	56	37	19
Greece	22	37	28	8
Ireland	17	86	86	0
Italy	200	74	18	55
Netherlands	60	72	72	0
Spain	105	47	31	16

One of the ways to obtain oils for energy or other purposes is the treatment of equipment and parts which are contaminated with oils.

The technological process of treatment of oil-contaminated parts and equipment

The aim of the technological process of treatment of oil and grease-contaminated parts and equipment is to degrease them by controlling the extraction of oils, if there are any in the equipment (oil transformers, oil switches, hydraulic motors, etc.). Combined degreasing equipment is decomposed into appropriate dimensions and it can be completely rationalized in the process of decontamination and removal of the remains of degreasing. The goal of this process is to clean up hazardous waste contaminated with oil from oils and dirt and get a non-hazardous waste that can be used as a secondary raw material.



Legend
I area for treatment of oily large sized equipment
II area for treatment of oily small sized equipment
III area for the electrolysis of fixer
IV area for manufacturing and packaging adhesive
V storage

Figure 4. *Block diagram of the technological process*

The process of degreasing equipment and oil-contaminated parts

Degreasing process is carried out within eight stages or groups of activities:

- reception of oily equipment and parts,
- examination, classification and measurement of equipment and parts,
- extraction of oil from the equipment,
- dismantling of the equipment that was taken without oil and equipment drained of oil,
- degreasing of equipment and parts,
- squeezing and drying equipment parts,
- control of processes and products,
- storing degreased equipment and parts.

The secondary process involves the following activities:

- reduction of the volume-grinding plastic materials separated during decontamination,
- preparation and recuperation solution for degreasing.

Receiving equipment and its parts. The actuator 1 is the plant for oily degreasing equipment and its parts, i.e. treatment and use of metals, plastics, ceramics and others. In the form of oily equipment and parts the same contaminated with oils and greases, hazardous waste is entered by the technical gate where it gets noted received documentation, updated records and equipment brought into the actuator. Movements of Hazardous Wastes are necessarily accompanied by a document on the movement of hazardous waste in accordance with the Law on Waste Management.

Overview, sorting and measuring equipment and parts. After unloading and handover of hazardous oily waste, access to other group the activities i.e. inspection, classification and measurement equipment. The criteria for classification involve:

- The nature and purpose of equipment in the normal state (transformers, switches, motors, pumps, etc.).
- Presence of oils as is (whether the equipment used oil as the working fluid, and whether it has as seen in the equipment).
- The degree of grease soiling equipment and parts.
- Applicability, suitability equipment for treatment depending on the size.

Extracting oils from the equipment. If there is oil in some equipment, it can be extracted. An adequate suction-pressure pump is extracting oils from the equipment and its streaming in prescribed packaging.

Equipment with oil inside is set to a bund of the low dimension 2000x4000x400 mm, consisting of the impermeable metal tubs, the cover of the rigid grid, which can bear a very large weight. By approaching equipment, a forklift descends the same over a supporting grid.

Firstly, it is necessary to remove the expansion containers, dismantle isolators and remove the cover of the transformer which has completely opened. After connecting the intake manifold in equipment, suppressed branch pump plugs into containers (drums) and performs streaming of oil from the equipment in the packaging.

Finally, discharge transformer from oils is performed by opening the valve at the bottom of the transformer which allows complete emptying of the transformer oil. This group the activities primarily is related to the oil distribution transformers that are definitively known that in working condition contain certain amounts of transformer oils.

If the examination of certain equipment determines that there is no oil just grease, it is not subject to the activities of drawing oils but moves to the next stage, which is the decomposition or removal equipment.

Figure 5. *Transformers for degreasing*

Dismantling equipment without oil and oil drained equipment. Equipment free of oil as well as equipment drained of oil on the receiving bund wall exceeds the following group of activities, and that is dismantling of equipment.

The purpose of this group of activities is to apply criteria by which to degreasing is satisfactory, and they involve:

- Criterion of separation tanks in which there were oil as the working fluid,
- Criterion of separation the working parts (cylinder, etc.) where was conducted activity of working potency,
- Criterion by which the assemblies, subassemblies and parts equipment to its dimensions best expose to degreasing process,
- Criterion by which the parts by weight are separated for further processing flow and others.

Degreasing equipment and equipment parts. The further course of treatment, i.e. degreasing surfaces contaminated with oils or greases, takes place in two directions depending on the dimensions as follows:

- degreasing scale equipment will be carried out on site or at the same bund wall at which performs the extraction of oil from the of equipment;
- degreasing parts of components that do not have large dimensions will be carried in the bath for degreasing.

Figure 6. *Tub for degreasing*

Squeezing and drying. This phase is essentially the same, only the dispositional occurs in different places depending on whether the equipment is smaller or larger dimensions. For larger sized drying, equipment is provided at the receiving bund wall where equipment is degreased. Drying equipment is achieved by blow-by blowing compressed air. For equipment of smaller size drying is provided within the room where the tub for degreasing. Drying by means of compressed air is carried out with a mobile compressor.

Control of the process and products. Quality control of the product, and thus the control of degreasing are carried out by n-hexane, and a test strip. The control of equipment large and small sized equipment is the same, with the exception that the disposition is performed in different places.

The first method of control, in the course of setting up the technological process shall be performed using n-hexane in the existing laboratories. N-hexane represents a low boiling hydrocarbon in which floods the filter that was set up and held for a short time on the cleaned surface. If the surface is not well degreased, the filter on it will take a certain amount of hydrocarbons that will be dissolved in n-hexane and their condition to show the state of the quality of the cleaned surface. Usually it is a very small amount of n-hexane from about 50 l. This amount, if contaminated with the appearance of oil after degreasing, is deposited together with other residues occurring treatment.

Another way to control is the control of strip-test. This method is very simple and is based on the fact that, if the surface is in any way degreased, glued to the tape itself, which confirms that there is no oil film on a given surface, and finally confirms the quality degreasing processes.

Storage degreased equipment and parts. After obtaining the desired results, compiling reports on the inspection of the product, after final measuring and marking, finished product, which now represents a non-hazardous waste refers to the space reserved for the temporary storage of de-oiled machinery and its parts.

Reducing the volume, grinding plastic materials separated during disassembly. After treatment of hazardous waste and quality control, it is projected for more rational use of space, to part of non-hazardous waste which is plastic, comminuted in a mill. Plastic defatted pieces of equipment will first be put into a container of raw capacity of 2000 kg, and when they are filled will begin with comminuting. Shredded plastic is packed in jumbo bags and temporarily stored in the same room until removal to another location, recycling center for non-hazardous waste -secondary raw materials for further treatment.

Preparation and regeneration solution for degreasing. For degreasing equipment of large and small dimensions, the same solution is provided (Soluble agent CHIMIGAL Srl Italian manufacturer under the trade name pulmotor), but in different concentration: concentration of 10-15% for degreasing equipment larger size and concentration of 5-10% for degreasing equipment of smaller size.

CONCLUSION

The reasons for further research of waste management in particular categories of hazardous waste, mainly waste oils in the management of quality of working environment, come together with the innovations and implementation of EU Directives relating to this issue (primarily the EU Framework Directive on Waste, Council Directive 75/439 / EEC on the disposal of waste oils, Council Directive 91/689 / EEC on hazardous waste). By ratifying these directives, our country has accepted the obligation to regulate the area of waste management, which involves primarily a series of institutional reforms, improvement and harmonization of legislation in the waste management sector and the introduction of certain financial instruments (primarily subsidies as well as regular payment thereof) which should to serve the realization of defined goals.

The paper presents the possibilities of treatment equipment and oil-contaminated parts as well as their transformation into harmless material, which significantly reduce the risk to human health and the environment. For these reasons, it is necessary to improve the knowledge and obtain information about the prevention and management of waste oils.

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BIOGRAPHY

Danica Ćirić was born in Pirot, Serbia 1990. She graduated from Chemical-technological school in Leskovac, in 2009 and enrolled the undergraduate studies at the Faculty of Occupational Safety in Niš, where she obtained B.Sc. in Environmental Engineering. In 2014 she ended master academic studies at the Faculty of Occupational Safety and obtained master's degree in Safety Engineering.

UPRAVLJANJE ULJIMA KAO OPASNIM INDUSTRIJSKIM OTPADOM

Danica Ćirić

Rezime: *Upravljanje otpadnim uljima predstavlja jedno od nekoliko ključnih pitanja u oblasti zaštite životne sredine. Jedan od vodećih svetskih problema jeste kako upravljati opasnim otpadom, između ostalog i tečnim opasnim otpadom u koji se svrstavaju i otpadna ulja. Zbog sve veće količine ove vrste otpada, opravdana je zabrinutost kako upravljati otpadnim uljima bez ikakvog štetnog uticaja na životnu sredinu. Evidentni problem i nizak nivo upravljanja otpadnim uljima u našoj zemlji poslednjih godina, pre svega se ogleda u nepotpunoj zakonskoj regulativi u ovoj oblasti, a otpadno ulje se uglavnom nelegalno sagorevalo, prosipalo i odlagalo. Usvajanjem Direktive o otpadnim uljima i Zakona o upravljanju otpadom, stvoreni su zakonski okviri za upravljanje otpadnim uljem, a time se i otvara mogućnost investiranja, odnosno poslovanja u ovoj oblasti.*

Ključne reči: otpad, otpadna ulja, upravljanje, skladištenje, tretman.

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INDIKATORI ENERGETSKIH PERFORMANSI TEHNOLOŠKIH SISTEMA

Rezime: *Značaj indikatora energetskih performansi za održivi razvoj tehnoloških sistema varira od države do države, u zavisnosti od nacionalnih prioriteta, energetskih zahteva, kriterijuma održivosti i razvoja, i konačno, ciljeva. Države širom sveta imaju svoje posebne ekonomske okolnosti i geografiju, svoj asortiman energetskih resursa i svoju stručnost. Proces implementacije uslovljen je ciljevima nacionalne politike, raspoloživim mogućnostima i stručnim veštinama, kao i dostupnom energijom. Energetskom politikom države potrebno je definisati najprikladniju alokaciju ljudi i resursa u smeru održivog razvoja i na taj način ostvari najveću korist po pristupačnoj ceni. Energetske performanse su merljivi rezultati povezani sa energijom (na primer, energetska efikasnost, energetski intenzitet, specifična potrošnja energije). Indikatori energetskih performansi su kvantitativni pokazatelji energetskih karakteristika i mogu se iskoristiti za praćenje promena performansi u vremenu. Oni su koncipirani na način da olakšaju sistemsku i stalnu procenu uticaja energetskog sistema. Shodno tome, trebalo bi da budu laki za razumevanje, i da kao takvi imaju važnu ulogu u podeli informacija i povećanju motivacije za kontinuirano unapređenje sistema, ISO 50001 Energy management system - Requirements with guidance for use.*

Key words: indikatori, energetske performanse, tehnološki sistemi.

UVOD

Ključni indikatori energetskih performansi su definisani 2005. godine. Rezultat su zajedničkog rada nekoliko međunarodnih organizacija, svetskih lidera u energiji i statistici i analizi životne sredine: *IAEA* (eng. *International Atomic Energy Agency*), *DESA* (eng. *Nations Department of Economic and Social Affairs*), *IEA* (eng. *International Energy Agency*), *EEA* (eng. *European Environment Agency*) and *Eurostat* (*eng. The Office of the European Union Statistical Office*). Definisani set energetskih indikatora nije definitivan. Oni evoluiraju tokom vremena i prilagođavaju se specifičnim uslovima, prioritetima i mogućnostima pojedinih država. Ovaj skup indikatora je osnova za razvoj sveobuhvatnog i univerzalno prihvaćenog seta energetskih indikatora značajnih za održivi razvoj.

Ključni indikatori energetskih performansi obuhvataju skup od 30 indikatora i to: 4 socijalna indikatora, 16 ekonomskih indikatora i 10 indikatora životne sredine, tabele 1, 2 i 3, *I.A. Vera, L.M. Langlois, H.H. Rogner, A.I. Jalal, F.L. Toth, Energy indicators for sustainable development:guidelines and methodologies*.

Tabela 1. *Energetske performanse i indikatori - Socijalna dimenzija*

Performanse	Indikatori		Komponente
Pristupačnost	SOC1	Udeo domaćinstava (ili populacije) bez struje ili komercijalne energije, ili jaka zavisnost od „tradicionalne“ komercijalne energije	• Domaćinstava (ili populacija) bez struje ili komercijalne energije, ili jaka zavisnost od nekomercijalne energije • Ukupan broj domaćinstava ili populacije
Dostupnost	SOC2	Udeo prihoda domaćinstva potrošenih na gorivo ili električnu energiju	• Rashodi domaćinstva vezani za gorivo ili električnu energiju • Prihodi domaćinstava (ukupno i najsiromašnijih 20 % stanovništva)
Različitost	SOC3	Potrošnja energije domaćinstva za svaku kategoriju prihoda i odgovarajuće kombinacije goriva	• Ukupna utrošena energija za sve platežne moći domaćinstava • Prihodi domaćinstva za svaku platežnu grupu • Odgovarajuća kombinacija goriva za svaku platežnu grupu
Bezbednost	SOC4	Broj smrtnih ishoda unutar energetskog sistema	• Godišnje nastradalih • Godišnje proizvodena energija

Tabela 3.2 *Energetske performanse i indikatori - Ekonomska dimenzija*

Performanse	**Indikatori**		**Komponente**
Ukupna potrošnja	EKO1	Potrošnja energije po glavi stanovnika	• Potrošnja energije (ukupna osnovna energija, ukupna potrošnja i potrošnja električne energije) • Ukupno stanovništvo
Globalna produktivnost	EKO2	Energija koja se koristi po jedinici BDP[1]	• Potrošnja energije (ukupne zalihe osnovne energije) ukupna potrošnja energije i potrošnja električne energije • Bruto Domaći Proizvod
Efikasnost snabdevanja	EKO3	Efikasnost konverzije energije i distribucija	• Gubici u transformaciji sistema, uključujući gubitke u proizvodnji električne energije, prenosu i distribuciji
Proizvodnja	EKO4	RPR[2]	• Sigurne nadoknadive rezerve • Ukupna proizvodnja energije
	EKO5	RPR	• Ukupna procenjena bogatstva • Ukupna proizvodnja energije
Potrošači	EKO6	Potrošnja energije u industriji	• Energija koja se koristi u industrijskom sektoru i proizvodnim granama • Uračunata odgovarajuća vrednost
	EKO7	Potrošnja energije u poljoprivredi	• Energija koja se koristi u sektoru poljoprivrede • Uračunata odgovarajuća vrednost
	EKO8	Potrošnja energije u sektoru usluga ili komercijalnom sektoru	• Energija koja se koristi u sektoru usluga ili komercijalnom sektoru • Uračunata odgovarajuća vrednost
	EKO9	Potrošnja energije u domaćinstvu	• Energija koja se koristi u domaćinstvima i od strane ključnih korisnika • Broj domaćinstava, površina životnog prostora, broj osoba u okviru domaćinstva, pravo svojine nad uređajima
	EKO10	Potrošnja energije u sektoru saobraćaja	• Energija koja se koristi u putničkom saobraćaju, teretnom sektoru i slično • Putnik - kilometar putovanja i podneti (po kilometru prevozni troškovi)
Diversifikacija (smeša goriva)	EKO11	Udeo goriva u energetici	• Zalihe osnovne energije i ukupna potrošnja, proizvodnja električne energije i stvaranje kapaciteta energijom goriva • Kompletne zalihe osnovne energije, ukupna potrošnja, ukupna proizvodnja električne energije i ukupni proizvodni kapaciteti
	EKO12	Udeo ne-ugljenične energije u energetici	• Zalihe osnovne energije i ukupna potrošnja, proizvodnja električne energije i stvaranje kapaciteta ne-ugljeničnom energijom • Kompletne zalihe osnovne energije, ukupna proizvodnja električne energije i ukupni proizvodni kapaciteti
	EKO13	Udeo obnovljive energije u energetici	• Zalihe osnovne energije i ukupna potrošnja, proizvodnja električne energije i stvaranje kapaciteta obnovljivom energijom • Kompletne zalihe osnovne energije
Cene	EKO14	Ukupna cena energije po gorivu i po sektoru	• Troškovi energije (sa i bez poreza/ takse)
Uvezena roba	EKO15	Zavisnost od neto uvezene energije	• Uvezena energija • Ukupne zalihe osnovne energije
Strategija zaliha goriva	EKO16	Zalihe kritičnih goriva u odnosu na njihovu potrošnju	• Zalihe kritičnih goriva (na primer: nafta, gas, …) • Potrošnja kritičnih goriva

[1] *BDP - Bruto Domaći Proizvod je jednak zbiru dodatih vrednosti po delatnostima i ukupnih poreza na proizvode.*
[2] *RPR ili R/R - „The Reserves-to-production ratio“ predstavlja odnos preostale količine neobnovljivih resursa i proizvodnje, izražen u godinama.*

Tabela 3. *Energetske performanse i indikatori - Dimenzija životne sredine*

Performanse	Indikatori		Komponente
Klimatske promene	ŽS1	Emisije gasova staklene bašte iz procesa proizvodnje i potrošnje energije po stanovniku i po jednici BDP	• Emisije gasova staklene bašte iz procesa proizvodnje i potrošnje energije • Naseljenost i BDP
Kvalitet vazduha	ŽS2	Koncentracija polutanata u atmosferi urbanih sredina	• Koncentracija polutanata u vazduhu
	ŽS3	Emisija polutanata iz energetskih sistema u atmosferu	• Emisija zagađujućih supstanci u atmosferu
Kvalitet vode	ŽS4	Ispuštanje zagađujućih materija u rečne sisteme, uključujući ispuštanje nafte	• Ispuštanje polutanata u rečne sisteme
Kvalitet zemljišta	ŽS5	Oblasti gde kiselost zemljišta prelazi dozvoljena granična opterećenja	• Pogođene površine zemljišta • Kritično opterećenje
Šume	ŽS6	Stopa seča šume u cilju dobijanja energije	• Površina šuma u različitim vremenskim periodima • Korišćenje biomasa
Nastajanje i upravljanje čvrstim otpadom	ŽS7	Odnos čvrstog otpada i jedinice proizvedene energije	• Količina čvrstog otpada • Proizvedena energija
	ŽS8	Odnos propisno uskladištenog i ukupno generisanog čvrstog otpada	• Količina propisno uskladištenog čvrstog otpada • Ukupna količina čvrstog otpada
	ŽS9	Odnos čvrstog radioaktivnog otpada i jedinice proizvedene energije	• Količina čvrstog radioaktivnog otpada (kumulativno za odabrani period vremena) • Proizvedena energija
	ŽS10	Odnos čvrstog radioaktivnog otpada koji je potrebno zbrinuti i ukupno proizvedenog	• Količina čvrstog radioaktivnog otpada koji je neophodno zbrinuti • Ukupna količina radioaktivnog otpada

INDIKATORI ENERGETSKIH PERFORMANSI U KONTEKSTU ODRŽIVOG RAZVOJA - SOCIJALNA DIMENZIJA

SOC1: Udeo domaćinstava (ili populacije) bez struje ili komercijalne energije ili jaka zavisnost od „tradicionane“ komercijalne energije

Uloga ovog indikatora je praćenje napretka u dostupnosti i pristupačnosti komercijalnih energetskih usluga uključujući električnu energiju.

Komercijalne energetske usluge su krucijalne za obezbeđivanje adekvatne hrane, skloništa, vode, kanalizacije, medicinske nege, obrazovanja i pristupa komunikacijama. Nedostatak pristupa modernim energetskim uslugama doprinosi siromaštvu i oskudici, i istovremeno sputava ekonomski razvoj. Adekvatne, pristupačne i pouzdane energetske usluge su neophodni garant za održivi razvoj i napredak čovečanstva. Procenjuje se da 2 milijarde ljudi ili, drugačije rečeno, približno jedna trećina svetske populacije, uglavnom zavisi od izvora energije tradicionalnih biomasa; 1,7 milijardi ljudi su bez električne struje. Oko 300 miliona ljudi je povezano na mreže električne energije ili su obezbeđeni modernom biomasom ili drugim oblicima komercijalne energije od 1993. godine. Međutim, u nedostatku adekvatnih mera, onaj broj ljudi kojima nije dostupna komercijalna energija bi ostao nepromenjen ili bi mogao da nastavi da raste, ali po demografskoj stopi koja nije srazmerna sa tempom elektrifikacije u drugim delovima sveta. Dakle, cilj održivog razvoja je da poveća pristupačnost i dostupnost energetskih usluga za siromašne slojeve stanovništva u zemljama u razvoju i samim tim da ublaži siromaštvo i promoviše socijalni i ekonomski razvoj.

SOC2: Udeo prihoda domaćinstva iskorišćenog za gorivo ili električnu energiju

Ovaj indikator obezbeđuje obim pristupa energetskim uslugama za prosečno domaćinstvo ili za najsiromašnije segmente domaćinstava.

Iz perspektive održivog razvoja, važno je proceniti visinu prihoda domaćinstava, imućnost, kao i pojedinačnu dostupnost modernim energetskim uslugama unutar populacije. Država može imati visok BND[3] po stanovniku, ali raspodela prihoda može biti neravnomerna tako da veliki procenat stanovništva nema mogućnosti da zadovolji svoje potrebe za

[3] *BND - Bruto Nacionalni Dohodak jednak je zbiru BDP-a i salda primarnih dohodaka sa inostranstvom.*

energijom u domaćinstvu po tekućim cenama u odnosu na lični nivo zarade. Stoga, postoji potreba da se smanji teret goriva i električne energije u budžetima domaćinstava za siromašne grupe stanovništva u zemljama u razvoju, i upravo tako da se promoviše socijalni i ekonomski razvoj.

SOC3: Potrošnja energije u domaćinstvu u zavisnosti od prihoda domaćinstva i odgovarajuće kombinacije goriva

Ovaj indikator obezbeđuje ocenu kompletne energetske različitosti i dostupnosti. On pruža procenu količine električne energije i goriva upotrebljenih od strane stanovništva u odnosu na njihove prihode i odgovarajuće kombinacije goriva.

Iz perspektive održivog razvoja, neophodno je da se ispita prihod, bogatstvo i posebno dostupnost modernih energetskih servisa širom populacije. Zemlja može imati visok BND po stanovniku, ali raspodela prihoda može biti neravnomerna tako da veliki procenat stanovništva nema mogućnosti da zadovolji svoje potrebe za komercijalnom energijom u domaćinstvu po tekućim cenama u odnosu na lični nivo zarade. Ovo je naročito od značaja za zemlje u razvoju, gde jednoj trećini populacije nisu dostupni komercijalni vidovi energije. Zato postoji potreba da se poveća energetska dostupnost i pristupačnost za siromašne grupe stanovništva u okviru velikog broja zemalja u razvoju i da se na taj način promoviše socijalni i ekonomski razvoj.

SOC4: Broj smrtnih ishoda unutar energetskog lanca

Ovaj indikator pokazuje broj smrtnih slučajeva po jedinici energije proizvedene u energetskim sistemima i srodnim aktivnostima. Indikator se koristi za procenu rizika po ljudsko zdravlje koji potiče iz energetskih sistema, a posebno od strane raznih vrsta goriva po proizvedenoj jedinici energije.

Energetski sistemi imaju ogromni globalni uticaj uključujući i uticaj na zdravu životnu sredinu. Istraživanje uticaja aktuelne prakse obezbeđivanja energije ukazuje da poreklo, transport, korišćenje i upravljanje otpadom podrazumeva značajne opasnosti po zdravlje koje u mnogim slučajevima mogu da rezultiraju smrtnim ishodom. Iako se ovo pitanje često ignoriše, rizici po stanovništvo i stopa povreda na radu i mortaliteta iz energetskih akcidenata su visoki. Eksploatacija i distribucija prirodnog gasa, eksploatacija uglja, transportovanje nafte ili iskorišćavanje hidropotencijala brana, takođe zahtevaju preciznu procenu fleksibilnosti širom sistema kao odgovor na ljudske ili tehničke greške, i samim tim minimizaciju rizika od grešaka i eventualnih posledica potencijalnih situacija sa smrtnim ishodom. Nuklearna energija u ovom kontekstu predstavlja specijalni momenat, u kojoj bi obim potencijalne nesreće mogao da bude veoma veliki. Samim tim se u nukleranoj industriji ulažu i veliki napori pri proceni i upravljanju višestrukim rizikom. U mnogim državama se korišćenje tradicionalnih goriva takođe povezuje sa nesrećama koje rezultiraju smrtnim ishodom usled izazvanog požara i inhalacije dima.

INDIKATORI ENERGETSKIH PERFORMANSI U KONTEKSTU ODRŽIVOG RAZVOJA - EKONOMSKA DIMENZIJA

EKO1: Potrošnja energije po glavi stanovnika

Ovaj indikator ukazuje na ukupnu potrošnju energije po glavi stanovnika, kao i na ukupni energetski intenzitet društva.

Energija predstavlja ključni faktor u ekonomskom razvoju i u pružanju vitalnih usluga koji podižu standard jednog društva. Iako je energija važan uslov za ekonomski napredak, njena proizvodnja, korišćenje i nus-proizvodi imaju veliki uticaj na životnu sredinu, kako sa strane eksploatacije i iscrpljivanja resursa, tako i sa strane zagađenja. Dugoročni cilj predstavlja razvoj i prosperitet kroz napredovanje u energetskoj efikasnosti, pre nego povećanje potrošnje i prelazak na ekološki prihvatljive energetske opcije. Sa druge strane, ograničeni pristup energiji je ogromna prepreka u razvoju čovečanstva, gde je potrošnja energije po glavi stanovnika manja od jedne šestine u industrijalizovanom svetu.

EKO2: Energija koja se koristi po jedinici BDP

Ovaj indikator predstavlja trendove u ukupnoj potrošnji energije u odnosu na BDP, što ukazuje na snažnu vezu između energije i ekonomskog razvoja.

Energija je od krucijalnog značaja za ekonomski i društveni razvoj. Međutim, potrošnja energije utiče na dostupnost resursa i životnu sredinu. Konkretno, upotreba fosilnih goriva je glavni uzrok zagađivanja vazduha i klimatskih promena. Unapređenje energetske efikasnosti i razdvajanje ekonomskog razvoja od upotrebe energije su važni ciljevi održivog razvoja.

EKO3: Efikasnost konverzije energije i distribucija

Ovaj indikator ocenjuje efikasnost konverzije energije i distribucione sisteme u različitim lancima snabdevanja energijom, uključujući i gubitke nastale prilikom prenosa i distribucije električne energije kao i transportovanja i distribucije gasa.

Poboljšanje energetske efikasnosti i smanjenje gubitaka u procesu konverzije i distribucije energije su važni ciljevi održivog razvoja za zemlje širom sveta. Poboljšanje efikasnosti funkcionisanja sistema za snabdevanje energijom istovremeno dovodi i do efikasnijeg korišćenja energetskih izvora i samim tim i smanjenja negativnih uticaja na životnu sredinu.

EKO4: Odnos zaliha i proizvodnje

Cilj ovog indikatora je da utvrdi dostupnost nacionalnih energetskih rezervi sagledavajući određenu proizvodnju goriva. Rezerve predstavljaju resurse koji su poznati i dostupni za ekonomsku eksploataciju i koje su ekonomski nadoknadive u momentu procene. Rezerve su takođe definisane kao one količine za koje geološke i inženjerske informacije ukazuju da mogu biti obnovljene pod određenim ekonomskim i tehničkim uslovima. Ovaj indikator uzima u obzir goriva kao što su nafta, ugalj, prirodni gas, uranijum i obezbeđuje relativnu procenu dužine trajanja ovih rezervi, ukoliko bi se proizvodnja nastavila današnjim tempom.

Dostupnost zaliha energije je ključni aspekt održivosti. Ovaj indikator pruža osnovu za procenu budućih energetskih zaliha u odnosu na sadašnju dostupnost energetskih rezervi i nivoa proizvodnje. Propisno upravljanje utvrđenih energetskih rezervi predstavlja neophodnu komponentu nacionalno održivih energetskih programa.

EKO5: Odnos resursa i proizvodnje

Cilj ovog indikatora je da proceni dostupnost nacionalnih energetskih resursa sa aspekta odgovarajuće proizvodnje goriva. Resursi su uglavnom definisani kao prirodna bogatstva jedne zemlje koja se javljaju u čvrstom, tečnom i gasovitom stanju i u obliku u kome je ekonomski izvodljiva potencijalna eksploatacija. Ukupni resursi obuhvataju poznate i dostupne kao i neotkrivene ili nedovoljno ispitane rezerve. Ovaj indikator ukazuje na ukupnu količinu rezervi nafte, uglja, prirodnog gasa i uranijuma. On obezbeđuje relativnu procenu dužine trajanja ovih resursa u vremenu, ako bi se proizvodnja nastavila na današnjem nivou.

Kategorije dostupnosti i sigurnosti snabdevanja energijom goriva predstavljaju ključne aspekte održivog razvoja. Ovaj indikator pruža osnovu za procenu budućih energetskih resursa u odnosu na sadašnju dostupnost energetskih rezervi i nivoa proizvodnje. Propisno upravljanje utvrđenim energetskim resursima predstavlja neophodnu komponentu nacionalno održivih energetskih programa.

EKO6: Potrošnja energije u industriji

Industrijski sektor je glavni korisnik energije. Ovaj skup indikatora ocenjuje ukupnu količinu upotrebljene energije u industrijskom sektoru. Snaga iskorišćene energije obezbeđuje informacije o relativnoj potrošnji energije po jedinici proizvodnje. Ovaj set indikatora se koristi za analizu trendova u energetskoj efikasnosti i promena u sastavu proizvoda i vrste goriva. Kao posledica ovih promena javlja se direktan uticaj na razvoj određenih grana industrije i intenzitet proizvodnje. Pored toga, ovaj skup indikatora se može koristiti za procenu trendova u unapređenju tehnologije i promena u strukturi industrijskog sektora.

Poboljšanje energetske efikasnosti i redukcija intenziteta korišćene energije u industrijskim procesima su važni ciljevi održivog razvoja zemalja širom sveta. Unapređenja na polju tehnologije i smanjenje količine utrošene energije u proizvodnim procesima direktno utiču na racionalniju eksploataciju energetskih resursa i samim tim smanjuje se negativan uticaj na životnu sredinu.

EKO7: Potrošnja energije u poljoprivredi

Ovaj indikator predstavlja ukupni energetski intenzitet u poljoprivrednom sektoru koji se može koristiti za analizu budućih akcija posebno u oblasti obnovljivih izvora kao i drugih vidova korišćenja energije.

Energija se koristi u svim granama privrede, uključujući i poljoprivredu. Dostupnost energije predstavlja ključan faktor za povećanje poljoprivredne produktivnosti i za poboljšanje životnog standarda seoskih domaćinstava. Ovaj indikator može biti upotrebljen za donošenje političkih i investicionih odluka koje se tiču zahteva za energijom u svim fazama poljoprivredne proizvodnje i energetske efikasnosti. Mogućnost korišćenja obnovljivih izvora energije, kao što su sunce, vetar, bioenergija mogu značajno da doprinesu povećanju efikasnosti rada i raznovrsnosti ekonomskih aktivnosti u ruralnim oblastima.

EKO8: Potrošnja energije u sektoru usluga ili komercijalnom sektoru

Ovaj indikator se koristi za praćenje trendova upotrebe energije u uslužnom i komercijalnom sektoru.

Sektor usluga je manje energetski intenzivan od proizvodnog sektora i rast sektora u odnosu na proizvodnju doprinosi dugoročnom smanjenju odnosa ukupne potrošnje energije i bruto domaćeg proizvoda. Ovaj sektor je istovremeno i veliki potrošač električne energije. U principu, održivi razvoj zahteva povećanje energetske efikasnosti u svim sektorima u cilju smanjenja ukupne potrošnje energije i umanjenja negativnih uticaja na životnu sredinu.

EKO9: Potrošnja energije u domaćinstvu

Ovaj indikator se upotrebljava za procenu utrošene energije u sektoru domaćinstva.

Sektor domaćinstva je glavni korisnik energije sa karakterističnim obrascima potrošnje. Poboljšanje energetske efikasnosti u ovom sektoru predstavlja prioritet za mnoge zemlje, s obzirom da bi ovakav korak vodio ka efikasnijem korišćenju energetskih resursa i smanjivanju negativnih uticaja na životnu sredinu. U hladnijim zemljama, na primer, uređaji za zagrevanje prostora su u centru pažnje mnogih energetskih politika, dok su u skoro svim zemljama električni i svetlosni uređaji još uvek u fokusu većine istih.

EKO10: Potrošnja energije u sektoru saobraćaja

Sektor saobraćaja je jedan od većih korisnika energije i to uglavnom u vidu naftnih derivata, što istovremeno ovaj sektor čini odgovornim za porast globalnih zahteva za naftom. Indikatori sektora saobraćaja ocenjuju koliko se energije utroši u prometu robe i ljudi.

Saobraćaj služi ekonomskom i socijalnom razvoju kroz distribuciju robe i usluga i kroz ličnu mobilnost. Sa druge strane, korišćenje aktuelnih vidova energije za transport direktno utiče na iscrpljivanje resursa, zagađivanje vazduha i klimatske promene. Smanjenje intenziteta potrošnje energije u sektoru saobraćaja imaće direktan povoljan uticaj na životnu sredinu uz očuvanje ekonomske i socijalne koristi.

EKO11: Udeo goriva u energiji i elektrici

Ovaj indikator stavlja na uvid udeo goriva u strukturi zaliha osnovne energije, ukupne potrošnje, proizvodnje električne energije i ukupnih proizvodnih kapaciteta.

Kada je u pitanju ekonomska dimenzija, kombinacija energenata prilikom snabdevanja je ključna determinanta energetske bezbednosti. Dakle, prava kombinacija goriva za određenu zemlju zavisi od količine domaćih ili uvezenih goriva ili od regionalne trgovine gorivima ili izvorima energije. Što se tiče zaštite životne sredine, obezbeđivanje različitih energenata ima važan uticaj, s obzirom na to da se uticaji na životnu sredinu iz različitih izvora ponekada drastično razlikuju i obuhvataju sledeće:

- lokalna ili regionalna emisija polutanata u atmosferu koja potiče od sagorevanja fosilnih goriva (urbani smog, kisele kiše, ...);
- globalne klimatske promene uzrokovane emisijama gasova staklene bašte koji potiču od sagorevanja različitih vrsta goriva;
- eksploatacija zemljišta za širok spektar energetskih delatnosti; ovo se posebno odnosi na rudarstvo i vodene basene hidrocentrala;
- rizici pripisani različitim vrstama goriva (požari, eksplozije, izlivanja ili radioaktivne emisije).

EKO12: Udeo ne-ugljenične energije u energetici

Ovaj indikator ukazuje na udeo ne-ugljeničnih energetskih izvora u ukupnim zalihama primarne energije, proizvodnji električne struje i drugim proizvodnim kapacitetima.

Unapređenje energije dobijene iz ne-ugljeničnih energetskih izvora je od primarnog značaja i ima visok prioritet u smeru održivog razvoja. Povećanje učešća ne-ugljeničnih goriva smanjuje određene emisije - to je emisija po jedinici ukupne i upotrebljene električne energije - gasovi staklene bašte, drugih zagađujućih materija koje utiču lokalno na kvalitet vazduha i na regionalne disbalanse. Ciljevi uvođenja poreza na korišćenje ugljenika, u velikoj meri čine pomak u pravcu većeg učešća ne-ugljeničnih energetskih izvora.

EKO13: Udeo obnovljive energije u energetici

Ovaj indikator procenjuje udeo obnovljive energije u ukupnim zalihama primarne energije i ukupnoj potrošnji, proizvodnji električne energije i drugim proizvodnim kapacitetima (isključujući nekomercijalnu energiju).

Unapređenje energetike, a posebno dobijanje električne energije iz obnovljivih izvora, predstavlja prioritet za održivi razvoj iz više razloga, uključujući bezbednost, unošenje raznovrsnosti u snabdevanju energijom i zaštitu životne sredine.

EKO14: Ukupna cena energije po gorivu i po sektoru

Cena po jedinici energije može biti regulisana internom analizom društvenih troškova i troškova životne sredine, upravljanjem, potražnjom i podsticanjem razvoja alternativnih obnovljivih energetskih mogućnosti. Za zemlje u razvoju, postoji potreba da se uveća energetska raspoloživost i dostupnost, posebno za siromašne grupe stanovništva, kako bi se poboljšao društveni i ekonomski razvoj. Istovremeno, efikasno korišćenje energije u razvijenim zemljama kao i u zemljama u razvoju ima prioritet. Odgovarajući cenovni mehanizmi mogu biti korišćeni za prevazilaženje neefikasnosti.

EKO15: Zavisnost od neto uvezene energije

Ovaj indikator procenjuje u kojoj se meri država oslanja na uvoz kako bi zadovoljila sopstvene potrebe i zahteve za energijom.

Stabilnost u snabdevanju energijom predstavlja osnovni cilj svake politike u težnji za održivim razvojem. Veoma je važan značaj energetske bezbednosti u smislu fizičke dostupnosti materijala kako bi se zadovoljila potražnja po datoj ceni, a u cilju ekonomske i socijalne održivosti. Zato prekidi u snabdevanju energijom predstavljaju neku vrstu sistematskog rizika koji treba da se bavi politikom održivog razvoja. Ovde su uključene dve različite vrste rizika: kvantitativni rizik i rizik cene. Oba rizika se odnose na stepen zavisnosti države od uvoza energije. Dakle, opšta izloženost izvesnim poremećajima u snabdevanju energijom može biti izbegnuta smanjenjem zavisnosti države od uvoza, a što se postiže kroz odgovornu politiku povećanja domaće proizvodnje, energetske efikasnosti, korišćenjem različitih izvora i optimizacijom mešavine goriva.

EKO16: Zalihe kritičnih goriva u odnosu na njihovu potrošnju

Cilj ovog indikatora je da utvrdi postojanje nacionalnih zaliha kritičnih goriva, kao što je nafta, s obzirom na njihovu potrošnju. Mnoge zemlje održavaju svoje zalihe nafte, shodno riziku od mogućih poremećaja pri snabdevanju ovim energentom. Za pojedine zemlje kritično gorivo može predstavljati, na primer, prirodni gas ili pak neki drugi tip goriva. Na primer, etanol predstavlja kritično gorivo za saobraćajni sektor u Brazilu. Ovaj indikator obezbeđuje relativnu vremensku dužinu trajanja zaliha od momenta kada bi snabdevanje bilo prekinuto, ako bi se ukupno funkcionisanje društva održalo na sadašnjem nivou.

Raspoloživost i sigurnost u snabdevanju energijom predstavljaju ključne aspekte održivosti. Ovaj indikator pruža osnovu za procenu bezbednosti snabdevanja energijom ukazujući na vezu između trenutne raspoloživosti zaliha goriva i nivoa potrošnje. Strateško održavanje zaliha goriva predstavlja kritičnu komponentu nacionalnog programa za održivi razvoj. Odnos zaliha i potrošnje goriva je u osnovi ove vrste indikatora, koji bi mogao biti važan za nacionalnu politiku u kritičnim situacijama kao što su, na primer, svetska naftna kriza ili poremećaji u sistemima za snabdevanje prirodnim gasom.

INDIKATORI ENERGETSKIH PERFORMANSI U KONTEKSTU ODRŽIVOG RAZVOJA - DIMENZIJA ŽIVOTNE SREDINE

ŽS1: Emisije gasova staklene bašte iz procesa proizvodnje i potrošnje energije po stanovniku i po jednici BDP

Ovaj indikator ukazuje na ukupnu, po glavi stanovnika ili po jedinici bruto nacionalnog dohotka, emisiju iz procesa proizvodnje energije, tri glavna gasa koji izazivaju efekat staklene bašte i koji direktno utiču na globalne klimatske promene.

Tokom 20. veka, prosečna temperatura površine Zemlje je porasla za oko 0,6 °C, a taj rast se može pripisati povećanju koncentracije gasova staklene bašte u atmosferi. Količina ugljen-dioksida (CO_2), na primer, je porasla za oko 30 % od preindustrijskog vremena i trenutno raste neviđenom stopom od 0,4 % godišnje, uglavnom zbog sagorevanja fosilnih goriva i krčenja šuma. Koncentracije metana (CH_4) i vodene pare (N_2O) su takođe u porastu, zbog energetskih, poljoprivrednih, industrijskih i drugih aktivnosti. Koncentracije azot-monoksida (NO), azot-dioksida (NO_2) i ugljen-monoksida (CO) i nemetanskih isparljivih organskih jedinjenja su takođe rastuće kao rezultat antropogene aktivnosti. Iako ovi gasovi nisu sami po sebi gasovi staklene bašte, oni utiču na hemiju životne sredine i na povećanje u troposferskom ozonu, koji je gas staklene bašte. Rezultat ovog efekta je pojava više različitih i ekstremnih vremenskih prilika nego u prošlosti. U nekim sredinama dolazi do povećanih oluja i padavina, dok druge oblasti trpe sušu. Koliko brzo i gde ove promene mogu da se pojave je još uvek neizvesno, ali zato posledice mogu biti ozbiljne, posebno u zemljama u razvoju, koje su ponajmanje u stanju da se pripreme i odgovore na efekte ekstremnih vremenskih uslova kao što su poplave, klizišta, suše i ostalo.

ŽS2: Koncentracija polutanata u atmosferi urbanih sredina

Ovaj indikator obezbeđuje procenu stanja životne sredine u smislu kvaliteta vazduha koji može dovesti do zdravstvenih problema kod ljudi u urbanim sredinama. Indikator obezbeđuje takođe i indirektnu procenu izloženosti populacije kao i relevantni uticaj na ljudsko zdravlje i vegetaciju.

Procenat stanovništva širom sveta koji živi u urbanim područjima je u stalnom porastu. Visoka gustina naseljenosti, industrija i saobraćaj vrše izraženi pritisak na lokalne sredine. Zagađivanje vazduha iz procesa korišćenja energije u individualnim domaćinstvima, industriji, elektranama i saobraćaju (motorna vozila) je često veliki problem. Kao rezultat toga, najveći potencijal za izlaganje ljudi zagađenom vazduhu kao i kasnije prouzrokovane zdravstvene probleme kod stanovništva imaju urbana područja. Poboljšanje kvaliteta naselja predstavlja značajan aspekt unapređenja održivosti ljudskih naselja. Ovaj indikator može biti iskorišćen za praćenje trendova u zagađivanju vazduha i kao osnov za utvrđivanje prioriteta sprovođenja političkih aktivnosti; mapiranje količine zagađivanja vazduha je neophodno u cilju identifikovanja „vrućih tačaka“ ili oblasti kojima je potrebna posebna pažnja; da pomogne u proceni broja ljudi izloženih visokim koncentracijama zagađujućih materija u vazduhu; praćenje nivoa usklađenosti sa propisanim standardima kvaliteta vazduha; procena efekata politike usmerene na kvalitet vazduha određene sredine i da pomogne pri istraživanju odnosa između kvaliteta vazduha i efekata na ljudsko zdravlje.

ŽS3: Emisija polutanata iz energetskih sistema u atmosferu

Ovaj indikator prati oslobađanje polutanata u atmosferu iz energetskog sektora. On se koristi za procenu uspeha nacionalnih politika u domenu zaštite životne sredine, kao i za prikazivanje nivoa opterećenja u životnoj sredini shodno smanjenju zagađivanja vazduha u energetski usmerenim aktivnostima, uključujući i proizvodnju električne energije i saobraćaj.

Sve je veća zabrinutost zbog prisustva različitih polutanata u vazduhu, a koji uglavnom potiču iz energetskog sektora. Koncentracija zagađujućih materija je u velikoj meri pod uticajem proizvodnje i potrošnje energije, što zauzvrat utiče i na energetski intenzitet i efikasnost. Emisije ovih polutanata su pod uticajem nacionalnih standarda za njihovu kontrolu i smanjenje. Nivo emisije polutanata pruža informacije o uticaju ljudskih aktivnosti na životnu sredinu. Napori jedne zemlje koji se ulažu u cilju smanjenja emisije polutanata u atmosferu se ogledaju u sprovođenju njene nacionalne politike i poštovanju međunarodnih obaveza. Konkretne akcije podrazumevaju strukturne promene u zahtevima za energijom (poboljšanje efikasnoti i zamena goriva) kao i sprovođenje politike kontrole zagađivanja i tehničkih mera. Ovaj indikator može da se koristi za procenu uticaja na životnu sredinu u odnosu na proizvodnju i korišćenje energije, kao i da proceni ekološke karakteristike nacionalnih politika dizajniranih za praćenje četiri glavna uticaja zagađujućih materija u vazduhu na zdravlje ljudi i životnu sredinu:

- kontaminacija zemljišta ili voda zagađujućim supstancama kao što su SO_x i NO_x;
- šteta koja može nastati na zgradama koje su osetljive na te supstance;
- formiranje troposferskog ozona od takozvanih „ozonskih prethodnika“ (VOC_s, NO_x i CO) koje indirektno utiču na zdravlje ljudi i životinja i vegetaciju;
- direktni efekti na ljudsko zdravlje i ekosisteme; na primer, kroz visoke atmosferske koncentracije čestica i VOC_s.

Jedinjenja sumpora i azota su uzročnici pojave kisele sredine u životnoj sredini. Antropogeni azot se uglavnom emituje kao NO_x iz sektora transporta i iz drugih vidova korišćenja energije pri industrijskim procesima. Emisije NO_x iz vazdušnog saobraćaja doprinose i lokalnom zagađivanju kao i obimnom zagađivanju prenošenjem na velike razdaljine kroz atmosferu. Polutanti u vazduhu su usko povezani sa bolestima disajnih puteva izazvanih kod ljudi i sa mortalitetom. Na primer, NO_x mogu da iritiraju pluća i umanje otpor prema respiratornim infekcijama. Efekti kratkoročnom izlaganju su još uvek nejasni, ali je definitivno da kontinuirano i frekventno izlaganje koncentracijama većim od onih koje se uobičajeno sreću u ambijentalnom vazduhu može da doprinese povećanu učestalost akutnih respiratornih bolesti. U prisustvu sunčeve svetlosti NO_x reaguju sa VOC_s i formiraju troposferski ozon i druge oksidirajuće hemikalije koje su toksične za živa bića, uključujući i ljude. Oksidi azota i ugljen-dioksid su takođe supstance koje se mogu javiti sa padavinama (kisele kiše) i koje imaju štetne efekte na vodene organizme, poljoprivredu i staništa. Atmosfersko taloženje NO_x takođe može da doprinese i eutrofikaciji (obogaćivanje neke sredine nutrijentima što može dovosti do preteranog rasta pojedinih i istovremenog nestajanja drugih biljnih vrsta). U nekim oblastima NO_x prethode pojavi čestica u vazduhu. Taloženje azota može biti suvo (u obliku gasova i čestica) ili mokro (u obliku kiše ili snega) ili u vidu kondenzacije (kao magla i oblačne kapljice).

ŽS4: Ispuštanje zagađujućih materija u rečne sisteme, uključujući ispuštanje nafte

Cilj ovog indikatora je praćenje ispuštanja štetnih i zagađujućih materija u okviru energetskih delatnosti, u reke, jezera ili u morske vode, a posebno iz sektora rudarstva, kao i pri eksploataciji nafte.

Slatka voda je deficitaran resurs u mnogim delovima sveta i zbog toga je neophodno da se mudro koristi i da se obezbede održive zalihe čiste vode dobrog kvaliteta. Slatka voda se koristi kao resurs za snabdevanje pitkom vodom, navodnjavanje i obrađivanje useva, uzgoj životinja ili kao stanište za biljke i ribe. Zagađena voda može imati direktan uticaj na ljudsko zdravlje i zdravlje životinja, kao i na kvalitet useva i povećanje prinosa. Morska sredina je takođe veoma važno stanište živih organizama i značajan resurs za ribolov, akvakulturu, turizam i rekreaciju. Slatka voda i morska sredina su često „osetljiva“ staništa, a izbegavanje destrukcije nad ovim staništima predstavlja prioritet za obezbeđivanje održive budućnosti.

ŽS5: Oblasti gde kiselost zemljišta prelazi dozvoljena granična opterećenja

Ovaj indikator opisuje stepen kiselosti zemljišta na nacionalnom nivou. Koristi se za praćenje stanja i kretanja vezana za stepen kiselosti zemljišta izazvanog mokrim i suvim taloženjem tokom vremena, kao i proceni ekološkog učinka nacionalne politike u smanjenju zagađujućih supstanci u vazduhu. Indikator treba da pokaže stepen kiselosti zemljišta koje potiče od ukupnih izvora emisija, ukoliko su dostupni adekvatni nacionalni podaci i kisela sredina koja potiče samo od emisija iz energetskog sektora.

Kada se sumporna i azotna jedinjenja nađu u atmosferi u obliku vlažno nataloženih (kisele kiše) ili suvo nataloženih supstanci (depozicije), rezultujuće kiselosti zemljišta i površinskih voda može da ima neverovatne posledice na život biljaka i vodene faune. Kada zemljište postane kiselo, njegove esencijalne hranljive materije se razvodne i na taj način se smanjuje njegova plodnost. Proces formiranja kisele sredine oslobađa metale koji mogu naškoditi mikroorganizmima odgovornim za razlaganje u zemljištu, kao i pticama i sisarima u višem lancu ishrane, pa čak i ljudima. Efekat kiselosti u oblasti koja se analizira, ne sme da prelazi granice koje se mogu istolerisati pri eksploataciji zemljišta. Formiranje kisele sredine predstavlja prioritetan atmosferski problem o kome je potrebno da se raspravlja, smatra Agenda 21, pri rešavanju problema degradacije zemljišta i resursa površinskih voda. Zato bi trebalo da postoji mehanizam za određivanje značaja ovog pitanja na nacionalnom nivou. Konkretne akcije uključuju strukturne promene u energetskim zahtevima (poboljšanje efikasnosti i zamena goriva), kao i sprovođenje tehničkih mera i politike kontrole zagađivanja.

ŽS6: Stopa seča šume u cilju dobijanja energije

Cilj ovog indikatora je da pokaže promene tokom vremena u oblasti pokrivenoj šumama, a koje se mogu pripisati korišćenju drveta za energetske potrebe.

Šume imaju višestruku ekološku, socijalno-ekonomsku i kulturnu ulogu u mnogim zemljama. Šume pripadaju najraznovrsnijim i široko rasprostranjenim ekosistemima na Zemlji. One pružaju mnoge značajne resurse, uključujući proizvode od drveta, rekreativne mogućnosti i stanište za divlji svet i obavljaju mnoge važne funkcije, kao što su filtriranje zagađujućih materija i igraju ulogu u očuvanju vode i zemljišta. Prisutna je opšta zabrinutost o ljudskom uticaju na šumska prostranstava, prirodne procese šumskog rasta i regeneracije. Procenjuje se da je u periodu između 1980. i 1990. godine globalno šumsko prostranstvo umanjeno za 180 miliona hektara, a da je u periodu od narednih 5 godina, opustošeno još 56 miliona hektara šuma. Agenda 21 eksplicitno razmatra borbu protiv nekontrolisane seče šuma radi obezbeđivanja ogrevnog drveta i drveta namenjenog industriji, a u cilju očuvanja zemljišta, vode, vazduha i biološke raznovrsnosti. Krčenje šuma, posebno zbog ogrevne žetve, predstavlja veliki problem posebno u zemljama u razvoju. Ovo pitanje izaziva manje briga u razvijenim zemljama gde je obim potrošnje ogrevnog drveta neznatan. Raspoloživost tačnih podataka o šumskom području jedne zemlje, što predstavlja osnovni pokazatelj njenih šumskih resursa, neophodan je uslov za gazdovanje i politiku planiranja u okviru konteksta održivog razvoja.

ŽS7: Odnos čvrstog otpada i jedinice proizvedene energije

Osnovna svrha ovog indikatora je da obezbedi informacije o količini i tipu čvrstog otpada koji se proizvede u energetskom sektoru i za čije su pravilno odlaganje neophodni građevinski objekti. Energetski sektor generiše posebne vrste čvrstog otpada koji se javlja u svim fazama, počev od eksploatacije energenata pa do upotrebe finalnog proizvoda, kao što je otpad iz procesa prerade ruda, otpad iz procesa prerade goriva ili njegovog sagorevanja. Količina otpada koja se javlja u rudarstvu ima tendenciju da bude velika, a sama priroda tog otpada ga istovremeno čini i bezbedonosno opasnim. Ukoliko nije zbrinut na adekvatan način, može uticati na pojavu klizišta ili ispuštanje teških metala i drugih zagađujućih materija u vodu ili zemljište. Pored toga, velike količine otpada mogu zauzeti značajan prostor, narušiti izgled predela ili uticati na lokalna staništa divljih životinja. Generalno važi da neadekvatno odlaganje i zbrinjavanje otpada, može umnogome oštetiti i kontaminirati rečni sistem ili zemljište. Štaviše, veliki deo otpada može potencijalno biti iskorišćen kao sirovina, na primer kao građevinska masa, koja bi istovremeno mogla da umanji potrebu za kamenom. Sa druge strane, nekorišćenje ove potencijalne sirovine, definitivno predstavlja rasipanje resursa.

ŽS8: Odnos propisno uskladištenog i ukupno generisanog čvrstog otpada

Osnovna svrha ovog indikatora je da proceni nivo pravilne zbrinutosti otpada iz energetskog sektora. Energetski sektor generiše posebne vrste čvrstog otpada koji se javlja u svim fazama počev od eksploatacije energenata pa do upotrebe finalnog proizvoda. Ukoliko nije zbrinut na adekvatan način, čvrst otpad može reagovati na vatru, pojavu klizišta ili ispuštanje teških metala i drugih zagađujućih materija u vodu ili zemljište. Pored toga, velike količine otpada mogu zauzeti značajan prostor, narušiti izgled predela ili uticati na lokalna staništa divljih životinja. Generalno važi da neadekvatno odlaganje i zbrinjavanje otpada može umnogome oštetiti i kontaminirati rečni sistem ili zemljište.

ŽS9: Odnos čvrstog radioaktivnog otpada i jedinice proizvedene energije

Uloga ovog indikatora je da proceni količinu različitog radioaktivnog otpada koji se javlja u ciklusu nuklearnog goriva po jedinici proizvedene energije. Kako bi se uranijum pripremio za upotrebu u nuklearnom reaktoru, mora da prođe fazu eksploatacije rude i mlevenja, zatim konverziju, obogaćivanje i fabrikaciju, odnosno prevođenje u ingote.

Energija je ključ održivog razvoja, a generisanje svih vidova čvrstog otpada, što se naročito odnosi na čvrst radioaktivni otpad, mora da bude svedeno na minimum. Od suštinskog je značaja takođe, da se osigura bezbedno upravljanje radioaktivnim otpadom, što između ostalog podrazumeva transport, skladištenje i odlaganje i to u cilju zaštite ljudi i životne sredine, posmatrano i kratkoročno i dugoročno. Radioaktivni otpad izaziva veliku zabrinutost sa aspekta životne sredine. Da bi se zaštitilo zdravlje ljudi i životna sredina, neophodna je primena strategija upravljanja otpadom i adekvatna tehnologija, posebno u nuklearnoj industriji. Osnovni principi upravljanja radioaktivnim otpadom podrazumevaju minimiziranje količine otpada i sistematski tretman, uvežbavanje procedura, kao i njegovo propisno skladištenje i odlaganje.

ŽS10: Odnos čvrstog radioaktivnog otpada koji je potrebno zbrinuti i ukupno proizvedenog radioaktivnog otpada

Uzimajući u obzir udeo radioaktivnog otpada koji još uvek nije zbrinut, ovaj indikator pokazuje relativni status postojećeg radioaktivnog otpada u svakom trenutku iz bilo kog energetskog gorivog ciklusa. Sve veće količine radioaktivnog otpada koji još uvek nije zbrinut ukazuju na povećanu potrebu za dugoročnim opcijama njegovog tretmana. Energija je ključ održivog razvoja, a odgovorajuće upravljanje čvrstim radioaktivnim otpadom pri energetskim gorivim ciklusima predstavlja glavni prioritet. Veoma je bitno takođe, da se osigura bezbedno upravljanje radioaktivnim otpadom, njegov, transport, skladištenje i odlaganje i to u cilju zaštite ljudi i životne sredine, posmatrano i kratkoročno i dugoročno. Radioaktivni otpad koji potiče iz različitih sistema proizvodnje energije, a posebno iz nuklearne industrije, izaziva veliku zabrinutost sa aspekta životne sredine. Da bi se zaštitilo zdravlje ljudi i životna sredina, neophodna je primena strategija upravljanja otpadom i adekvatna tehnologija, posebno u nuklearnoj industriji, ali isto tako i u drugim oblastima gde se produkuje čvrst radioaktivni otpad. Osnovni principi upravljanja radioaktivnim otpadom podrazumevaju minimiziranje količine otpada i sistematski tretman, uvežbavanje procedura, kao i njegovo skladištenje i odlaganje.

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BIOGRAFIJA

Dragan Antić je rođen u Nišu 1973. godine. Magistrirao je na Fakultetu zaštite na radu iz oblasti energetske efikasnosti tehnoloških sistema. Nosilac je Laureata - Povelje i nagrada Univerziteta u Nišu, nagrade Fonda za mlade talente Skupštine grada Niša, nagrade Ambasade Kraljevine Norveške u Beogradu ″15 miliona za najboljih 500″ kao najbolji student Fakulteta zaštite na radu u Nišu. Trenutno je na master akademskim studijama na Mašinskom fakultetu u Nišu.

INDICATORS OF ENERGY PERFORMANCE OF TECHNOLOGICAL SYSTEMS

Dragan Antić, Ivan Krstić, Amelija Đorđević

Abstract: *The importance of energy performance indicators for a sustainable development of technological systems varies from country to country, dependent on national priorities, energy demands, criteria for sustainability and development, and ultimately, goals. Countries around the world have their own specific economic circumstances and geography, as well as their the range of energy resources and expertise. The implementation process is conditioned by national policy objectives* and priorities*, available resources and professional skills, as well as the available energy. The State energy policy needs to define the most appropriate allocation of both people and resources in accordance with sustainable development, thus achieving the greatest benefit at an affordable price. Energy Performance refers to the measurable results related to energy (for example, energy efficiency, energy intensity, specific energy consumption). Energy performance indicators are the quantitative indicators of energy characteristics and can be used to track changes in performance over time. They are designed in a way to facilitate a systematic and continuous impact assessment of the energy system. Accordingly, they should be easy to understand, and as such, should have an important role in sharing information and increasing motivation for continuous system improvement, ISO 50001 Energy Management System – Requirements with Guidance for Use.*

Key words: indicators, energy performance, technological systems.

BOOK REVIEW / PRIKAZ KNJIGE

„ERGONOMSKI RIZIK“

Sonja Pavlović-Veselinović

Rukopis pod nazivom „Ergonomski rizik“ autora dr Sonje Pavlović-Veselinović, docenta Fakulteta zaštite na radu u Nišu, sadrži 92 stranice teksta, formata A4, 29 slika, 12 tabela i 200 bibliografskih jedinica, a sastoji se od sedam poglavlja. Rukopis takođe sadrži predgovor i rezime na srpskom i engleskom jeziku.

U prvom poglavlju pod nazivom „Uvod“ su definisani osnovni pojmovi vezani za radom uzrokovane mišićno-skeletne poremećaje i ukazano je na vezu između neodgovarajućih uslova na radnom mestu i pojave mišićno-skeletnih problema vezanih za rad. Diskutuje se rastući trend pojave radom uzrokovanih mišićno-skeletnih poremećaja, veliki broj radova koji se bave proučavanjnjem ovog problema u razvijenim zemljama, nasuprot nedostatku takvih podataka kod nas, kao i potreba za razvijanjem odgovarajućih strategija za prevenciju i alata za kvantifikaciju ergonomskog rizika.

Poglavlje „Istraživanje radom uzrokovanih mišićno-skeletnih poremećaja u svetu i kod nas“ se bavi prikazom stanja i zastupljenošću mišićno-skeletnih poremećaja u različitim zemljama, imajući u vidu težinu zdravstvenih i ekonomskih posledica istih. Na osnovu oskudnih i teško dostupnih podataka, dobijenih istraživanjem autora, prikazan je trend poremećaja kod nas.

U poglavlju „Radom uzrokovani mišićno-skeletni poremećaji“ su date različite definicije za ovu vrsta poremećaja, različite klasifikacije mišićno-skeletnih poremećaja i objašnjavaju se različite hipoteze i konceptualni modeli patogeneze ovih poremećaja.

Poglavlje „Ergonomski rizik“ je najobimniji deo ovog rukopisa. U njemu se definiše ovaj relativno novi pojam, ali se takođe identifikuju i detaljno razrađuju svi faktori rizika za nastanak radom uzrokovanih mišićno-skeletnih poremećaja, koji su brojni i raznoliki (ponavljanje, sila, vibracije, položaj tela, niska temperatura, osvetljenje, antropometrijske dimenzije, pol, godine starosti, loše navike, hobi, tempo rada, rad u smenama, zadovoljstvo poslom, socijalna podrška...). Za svaki od navedenih faktora rizika dato je objašnjenje koje se odnosi na fiziološki odgovor tela.

U poglavlju „Procena rizika od radom uzrokovanih mišićno-skeletnih poremećaja“ su prikazane različite metode koje su na raspolaganju za različite nivoe kvantifikacije ergonomskog rizika, i to pojedinačno i detaljno za svaki od 22 faktora rizika, navedenih u prethodnom poglavlju. Ukazuje se na značaj kompleksne analize radnog mesta, uz preporuku da procena ergonomskog rizika postane sastavni deo obavezne procene rizika na radnim mestima i u radnoj okolini.

Poglavlje „Prevencija i kontrola ergonomskog rizika“ bavi se elementima ergonomskih programa koji imaju za cilj eliminisanje ili smanjenje prisustva uočenih faktora rizika, što je moguće ostvariti prvenstveno primenom inženjersko-ergonomskih mera, ali i administrativnim merama ili, u krajnjem, upotrebom odgovarajućih sredstava lične zaštite.

U delu „Zaključna razmatranja“, naglašena je potreba ponovnog uspostavljanja jedinstvene baze podataka o profesionalnim oboljenjima u našoj zemlji, radi sagledavanje i praćenja stanja vezanog za radom uzrokovane mišićno-skeletne poremećaje. Takođe je naglašena potreba uspostavljanja saradnje različitih profila stručnjaka za rešavanje prisutnog kompleksnog problema mišićno-skeletnih poremećaja, kao i razvijanje odgovarajućih, opšteprihvaćenih alata za procenu ergonomskog rizika.

U Srbiji su se do sada problemom nastanka mišićno-skeletnih poremećaja vezanih za rad dominantno bavili stručnjaci medicinske struke i to uglavnom parcijalno, tj. proučavajući samo jedan ili nekoliko faktora rizika. Predmetni rukopis razmatra ovaj problem na sistematski, sveobuhvatan i razumljiv način.

U predmetnom rukopisu su na konzistentan, interesantan i jednostavan način definisani osnovni pojmovi u vezi sa ergonomskim rizikom i objašnjeni svi pojedinačni faktori rizika. Prikazane su sve do sada primenjivane metode za procenu/kvantifikaciju svakog od faktora rizika i ukazano na kompleksnost problema mišićno-skeletnih poremećaja i potrebu razvijanja alata za procenu ukupnog rizika od nastanka ovih poremećaja, tj. ergonomskog rizika.

Rukopis sadrži brojne ergonomske preporuke koje omogućavaju profesionalcima, ali i zaposlenima sa ovom vrstom zdravstvenih problema da prepoznaju rizik ili čak preduzmu njima dostupne mere u cilju ergonomskog poboljšanja.

Rukopis predstavlja doprinos nauci u oblasti ergonomije, i šire u oblasti bezbednosti i zdravlja na radu, ali može biti od koristi i u oblasti medicine rada.

Publikacija doprinosi boljem razumevanju medicinskog aspekta posmatranog problema za stručnjake inženjerske tj. tehničke orjentacije, odnosno razumevanju inženjersko-tehničkih aspekata stručnjacima medicinske orjentacije.

Prema Pravilniku o postupku i načinu vrednovanja i kvantitativnom iskazivanju naučnoistraživačkih rezultata istraživača (Službeni glasnik RS, BR. 38/08), rukopis ispunjava uslove da se kategoriše kao monografija nacionalnog značaja.

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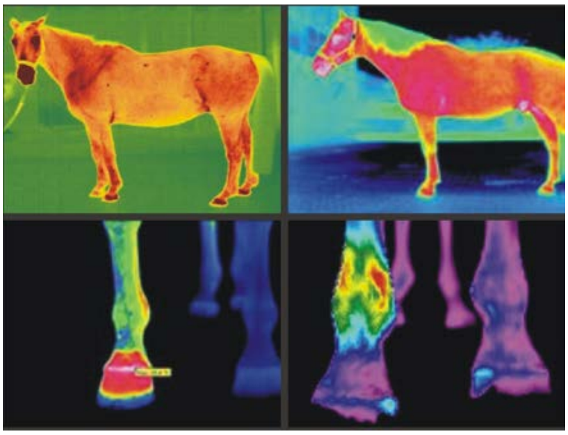

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