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ANA STOJKOVIĆ[1]

[1]Faculty of Occupational Safety
University of Niš, Serbia

[1]*anasstojkovic@gmail.com*

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.

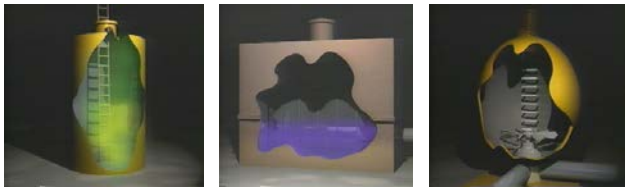

Figure 1. *Examples of confident space*

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).

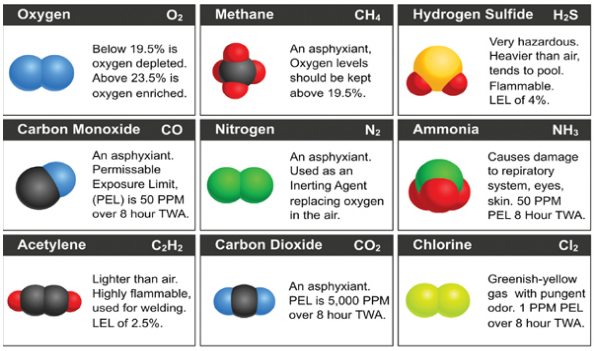

Figure 2. *Hazardous gases found in confident spaces*

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.