MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

Kazakh National Research Technical University

named after K.I. Satpayev

Institute of Chemical and Biological Technologies

Department of Chemical and biochemical engineering

Falkov Dmitriy Aleksandrovich

Safety analysis of diving operations in the Caspian Sea

GRADUATE WORK

Specialty 5B073100 - Life Safety and Environmental Protection

Almaty 2020

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ALLOWED TO PROTECT
Head of CaBE Department
____________Eligbayeva G.Zh.
"____" ________________2020 г.

GRADUATE WORK

On the topic «Safety analysis of diving operations in the Caspian Sea»

Specialty 5B073100 - Life Safety and Environmental Protection

Performed by Falkov D.A.

Scientific adviser
Shevtsova V.S.
c.t.s., ass. prof.
____
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TASK

To complete the graduate work

Student Falkov Dmitriy Aleksandrovich
Theme: “Safety analysis of diving operations in the Caspian Sea”
Approved by order of the Rector of the University
Deadline for completed work
Initial data for the thesis
Summary of thesis:
a) General information about the HSE system in Kazakhstan and the world
b) The main harmful and dangerous factors of the profession of a diver
c) Calculation of optimal indicators for work under water
The list of graphic material (with an exact indication of the required drawings) presented on ___ slides of the presentation of the work.
Recommended general literature: of ___ titles

SCHEDULE
preparation of graduation work

Name of sections, list of issues to be developed	Deadlines for submission to the supervisor	Note
Browse Sources for Diploma	20.01.2020 – 05.02.2020	
Basic documents in the field of labor protection for divers	06.02.2020 – 07.02.2020	
Characteristics of the Caspian Sea	08.02.2020 – 09.02.2020	
Calculation of requirements for life-supporting equipment	10.02.2020 – 11.02.2020	
Measures to improve working conditions	12.02.2020 – 13.02.2020	

Signatures

Section Names	Consultants, full name (academic degree, title)	Date of signing	Signature
Browse Sources for Diploma	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		
Basic documents in the field of labor protection for divers	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		
Characteristics of the Caspian Sea	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		
Calculation of requirements for life-supporting equipment	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		
Measures to improve working conditions	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		
Normcontroller	Scientific Advisor Shevtsova V.S. c.t.s., ass. prof.		

Scientific Advisor ______________________ Shevtsova V.S.

The student accepted the task ______________________ FalkovD.A.

Date «____» ___________ 2020y

АННОТАЦИЯ

Дипломная работа была выполнена в соответствии с требованиями Приказа Министра внутренних дел Республики Казахстан от 19 января 2015 года № 33 «Об утверждении Правил безопасности при проведении водолазных работ». Данная работа включает в себя информацию о проведении водолазных работ с использованием всех нормативно-правовых актов, касающихся обеспечения безопасности проведения подводных работ, а также в сравнение были поставлены международные нормы, правила и стандарты. Рассмотрены основные вредные и опасные для жизни человека факторы, предложенные меры по улучшению системы организации и проведения водолазных работ.

АҢДАТПА

Диплом жұмысы Қазақстан Республикасы Ішкі істер министрінің 2015 жылғы 19 қаңтардағы № 33 "Сүңгуір жұмыстарын жүргізу кезіндегі қауіпсіздік қағидаларын бекіту туралы" бұйрығының талаптарына сәйкес орындалды. Аталмыш жұмыс су асты жұмыстарын жүргізу қауіпсіздігін қамтамасыз етуге қатысты барлық нормативтік-құқықтық актілерді қолдану арқылы сүңгуірлік жұмыстарды жүргізу туралы ақпаратты қамтиды, сондай-ақ салыстыру кезінде халықаралық нормалар, ережелер мен стандарттар қойылды. Адам өмірі үшін негізгі зиянды және қауіпті факторлар, сүңгуір жұмыстарын ұйымдастыру және жүргізу жүйесін жақсарту бойынша ұсынылған шаралар қарастырылды.

ANNOTATION

The graduate work was carried out in accordance with the requirements of the Order of the Minister of Internal Affairs of the Republic of Kazakhstan dated January 19, 2015 No. 33 “On the approval of the Safety Rules for diving operations”. This work includes information on diving operations using all legal acts related to the safety of underwater operations, as well as international norms, rules and standards were compared. The main harmful and life-threatening factors of the person, the proposed measures to improve the system of organization and conduct of diving operations are considered.

CONTENT

INTRODUCTION

This diploma project reveals the urgency of the problem of industrial accidents, of which there were 1396 by the results for 2019, of which 15 were fatal. Specifically, this work considers the harmful and dangerous factors of diving, measures are taken to prevent threats from various factors, and the same measures proposed to improve the diving safety system.

The aim of this project is to analyze and improve the life support system of divers during operations, as well as the regulatory part affecting the training and preparation of divers for working conditions in our country, and specifically in the Caspian Sea region.

The object of the study is divers working with scuba gear and using air supply systems. The diving area, namely the Caspian Sea, and more precisely, the human impact on the environment during the diving operations and what kind of threat the waters of the Caspian Sea are fraught with, is also an important object.

The design work will be built on the analysis of our regulatory legal acts and international norms and standards applied in similar types of work. A comparison will also be made of existing methods for supporting underwater operations and the possibility of using other life support options for divers in the context of the main types of diving operations, namely, technical surveys at oil production facilities, where the depth of the work generally does not exceed a depth of 20 m.

In this work, aspects of the technical component of any diving work are considered. Since all breathing devices have already been calculated according to quality indicators, in this work specific technical aspects were calculated for work carried out at a depth of 20 m both for scuba gear and air supply systems. The effectiveness of each of the devices is reflected in the duration of work and mobility when using one or another underwater breathing apparatus.

Based on the methods involved in the project, it is possible to build an HSE (health, safety, environmental) management system that will include the conditions and dangers of diving in shallow water in seawater, which will allow other conditions to be considered according to a simplified scheme and with small amendments will allow to adapt under the necessary conditions for creating new diving projects much faster and better.

1 Legal regulation in the Kazakhstan field of diving

To determine the main legal elements that can allow making a competent HSE system, it is necessary to study the legal documents that are used for diving in Kazakhstan today. Everything related to diving operations and the direct organization of safe underwater operations is spelled out in Order No. 33 of the Minister of Internal Affairs of the Republic of Kazakhstan dated January 19, 2015 "On Approving Safety Rules for Diving Activities" .The basic rules used by divers are listed below:

Each diver is required to have a diving school(course) diploma in order to use a certain type of underwater equipment. He / she must also have a diver's journal made in accordance with the standards and a medical record set out in special annexes. The final required part is the annual confirmation of his / her qualification by the Diving Qualification Board.

When carrying out diving operations, complete and functioning diving equipment and diving gear that has undergone a required number of checks must be used.

Divers should only perform tasks specified in the assignment. Any other tasks must be performed only if authorized by the head of diving operations.

All workplaces at the diving station are must be free from foreign objects. Diving gear and dive support equipment must be placed at the diving post in working condition.

In the electric shock risk areas, diving operations must not be performed unless all electrical installations have been completely disconnected from power.

In the case of dives in polluted water, diving gear must be fully sealed to prevent infections and skin diseases.

When working with steel ropes, divers must wear special gloves or gantlets.

The diver's knowledge of special Manual and their medical examination must be carried out annually, with allowed dive depths set by a medical diving board. A diver must not perform dives below his/her allowed dive depth set by the medical diving board.The remaining procedures for the safe conduct of diving operations are also prescribed in Article 189 and are outlined in the next chapter [1].

1.1 Safety procedures before and during diving operations

Dive preparations include the preparation of diving gear dive support equipment, assignment of responsibilities between the station divers, diver briefing, checks of diving gear and dive support equipment and dressing up the diver.

A diving ladder and all the necessary working lines (shot, tether or hog) are set up before deploying the diver. When diving in a wet suit, no working lines are required.

Before each dive, responsibilities are assigned among the divers:

- The first – performs the dive (working diver);
- The second – tends the tether line (tender).

- The third – controls hardwired communications and air supply, he/she is also a standby diver ready to assist the working diver.

A diving supervisor or chief is responsible for preparing the diving station for the dives, with his/her responsibilities including:

- dive supervision:

1) Availability of complete and functioning primary and contingency diving gear at the diving station;
2) Timelines and completeness of checks of diving gear and dive support equipment;
3) Regular checks of air supply in stock cylinders;
4) Safety of diving gear and dive support equipment, their proper use, storage, and repair;
5) Quality of underwater work conducted by the diving station;
6) Proper keeping of diving records.

- assignment of responsibilities among the divers;
- briefing individuals supporting dive operations.

An extra kit of diving gear must be available at the diving station for the standby diver to wear. The second kit, as the first one, must have the same conditions and nature of the underwater works performed by the diver.

Simultaneous dipping of two divers with no trained personnel for dive support is only allowed in emergency cases to rescue people. In this case, non-divers (drivers, all the rescuers authorized for ensuring safety during dive operations) may perform dressing up the diver and controlling air supply.

While conducting dives with subsequent in-water decompression, a tether line is dropped next to the diving ladder, and then a decompression chamber is hauled down.

A standby diver carries out timely and proper function checks of the contingency gear and the decompression chamber, maintains constant hardwired communication with the working diver, ensures uninterrupted air supply and is ready to immediately put on emergency diving gear, go underwater and assist the working diver.

A tender supports the working diver (directs the diver along the signal line from the moment it is connected to the diver`s gear until the diver`s return to the diving station`s deck), passes instructions from the diving supervisor to the working diver using a signal line for pull signals, and also sets up the diving ladder, shot and tether lines [1].

2 Comparison of regulatory acts of the Republic of Kazakhstan and international standards in the diving industry

The best system that our OHS (occupational health and safety) system could equal is the international ISO system of standards. The latest international standard in the Occupational Health and Safety Management System is ISO 45001. This standard is an improved version of the previously used system, based on the OHSAS 18001 standard.

ISO 45001 implements the process and structure of all previous HSE control systems, making integration of multiple ISO management system standards easier, specifically such as ISO 9001 - Quality management systems and ISO 14001 - Environmental management systems, that makes it more completely then previous.

As a basis, it uses a simple plan-do-check-act (PDCA) model, which provides a framework for organizations to plan what they need to put in place to minimize the risk of injury or illness. This model is better known in Kazakhstan as a management and labor protection system ("СУОТ" or MLPS). The measures should address concerns that can lead to long-term health issues and absence from work, as well as those that give rise to injuries.

As a result of comparing the two models, we can distinguish three general and one (fourth) separate part of the construction of the system, which in turn is the main difference and the introduction of which would help increase the efficiency of the previous systems. These parts are:

1. Understand and determine the scope and issues (positive and negative) that can affect how an organization manages the OHS management system
2. Determine risks and opportunities
3. Develop or enhance OHS policy and set objectives
4. Gain a high-quality understanding of needs and expectations of workers and other interested parties (and differences for managerial and non-managerial workers) Issues include conditions, characteristics or changing circumstances that can affect OHS. Internal/ external issues can result in risks/opportunities.Consider external and internal Issues.

<u>External Issues:</u>

- Cultural, political, economic and legal issues
- Natural surroundings
- Market competition
- New competitors, technologies, laws and occupations
- Key drivers and trends in the industry sector
- Relationships, perceptions and values of external interested parties

<u>Internal Issues:</u>

- Organizational structure, roles, accountabilities, capabilities and organizational culture
- Information systems, flows and decision-making
- Introduction of new products, materials, services, tools, premises, and equipment
- Standards, guidelines and contractual relationships
- Working conditions and working time arrangement

For a general comparison of the internal and external interest of the parties, consider the following figure (figure1):

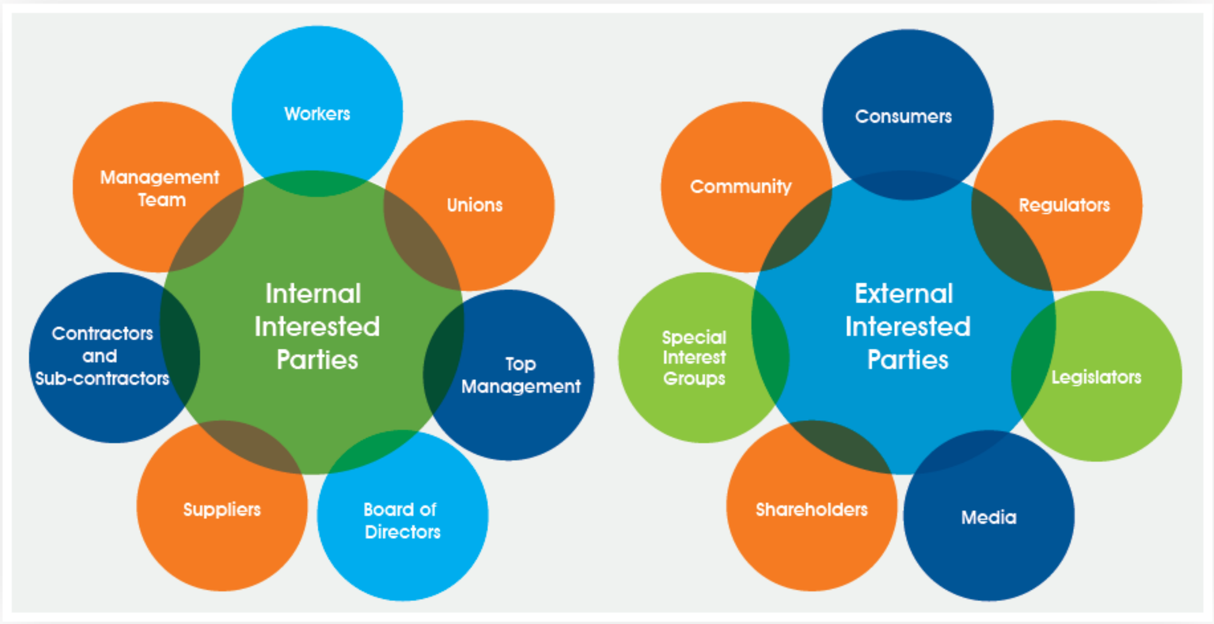

Figure 1 - Internal and external interested parties

The system also leads us to understand the specific distinction between the roles and tasks of managerial and non-managerial staff. In this part, there is a coincidence with the previous system, the employer acts as the Managerial staff and the Non-Managerial staff better known as the labor union (workers' representatives).

<u>Managerial staff</u>

Leadership has been enhanced to ensure commitment and active support from top management in:

– Taking overall responsibility and accountability for the protection of workers' work-related health and safety;

– Ensuring OHS policy and objectives are established;

– Making OHS compatible with the organization's strategic direction;

– Integrating OHS into the organizational business process;

– Allocating necessary resources for OHS (establish, implement, maintain and improve);

– Ensuring active participation of workers and workers' representatives (consultation, participation of workers and removing obstacles);

– Developing internal/external communications supporting OHS;

– Directing and supporting persons to contribute to the effectiveness of OHS;

– Ensuring and supporting continual OHS improvement;

– Supporting relevant management roles to demonstrate their leadership as it applies to their areas of responsibility;

– Developing, leading and promoting an organizational culture that supports the OHS management system.

Non-Managerial Worker Participation

The organization shall:

– Provide mechanism, time, training and resources for consultation and participation of workers (and where they exist workers' representatives) at all levels and functions;

– Provide timely access to clear, understandable and relevant information about the OHSMS;

– Determine and remove barriers for participation and consultation/

Non-managerial worker participation is given additional emphasis, including:

– Identifying hazards and assessing risk;

– Defining actions to control hazards and risks;

– Identifying competence and training needs and evaluating training;

– Determining information (what and how) to be communicated;

– Investigating incidents and non-conformities, and involvement in corrective actions;

– Defining needs and expectations of interested parties;

– Establishing policy;

– Assigning organizational roles, responsibilities, accountabilities and authorities [2].

2.1 Hazard Identification/Assessment of Risk and Opportunities

A key part of any occupational health and safety management system is hazard identification and assessment of risk and opportunity. In this, both systems also have similarities. Consider the main points regarding this topic.

Sources/situations could include:

- How work is organized;
- Routine and non-routine ;
- Emergency situations ;
- People;
- Actual or proposed changes ;
- Changes in knowledge;
- Past incidents.

Planning.

Planning is crucial part of each OHS systems, so, firstly company must determine:

- What works will be done;
- What resources do they need;

- Who will supervise;
- Work deadlines;
- Determine which type of measuring tools will be used and how risks will be measured and monitored;
- Assessment system;
- Try to integrate OHS system in all operation processes.

Documentation availability. Document control.

- All OHS documents always must be available, suitable and easy for understanding;
- Compliance with the correct filling of documents and adequate composed register;
- Well protected and prevented from loss;
- Control of changes;
- Access by all groups of workers, and their representatives, to relevant documents;

Outsourcing

Before outsourcing work start, the organization:

- Shall ensure that the outsourced functions and processes are controlled;
- Ensure outsourcing arrangements are consistent with legal and other requirements with achieving the intended outcomes of the OHS management system;
- Shall provide a relationship, between the organization and providing company, where the process is perceived by interested parties as being carried out by the organization.

Procurement

The company must provide control over all goods (for example products, hazardous materials or substances, raw materials or equipment) and services (for example provided by outsourcing companies) that they strictly comply with the rules and regulations of the OHS management system.

Each procuring goods and services should be accompanied by a series of checks to provide procurement controls, in which company:

- Identify and evaluate potential OHS risks associated with products, materials, equipment, and services;
- Require products, materials, equipment, and services to conform to OH&S objectives;
- Define needs for information, participation, and communications.

Prior to use in workplace:

- Verify that any procured equipment, installations and materials are adequate before being commissioned to ensure they function as designated;
- Ensure goods are delivered to specifications and are tested to ensure they work as intended and specified;
- Communicate and make available usage requirements, precautions or other protective measures [2].

2.2 Risk control and OHS Performance Evaluation

For clarity, the risk control hierarchy recreated in the form of a graph (figure 2) that describes the most and least effective methods of risk control. According to the schedule, it will be noticeable that five main control methods that are involved in both systems can be distinguished. Under the graph, consider each of the five methods in more detail.

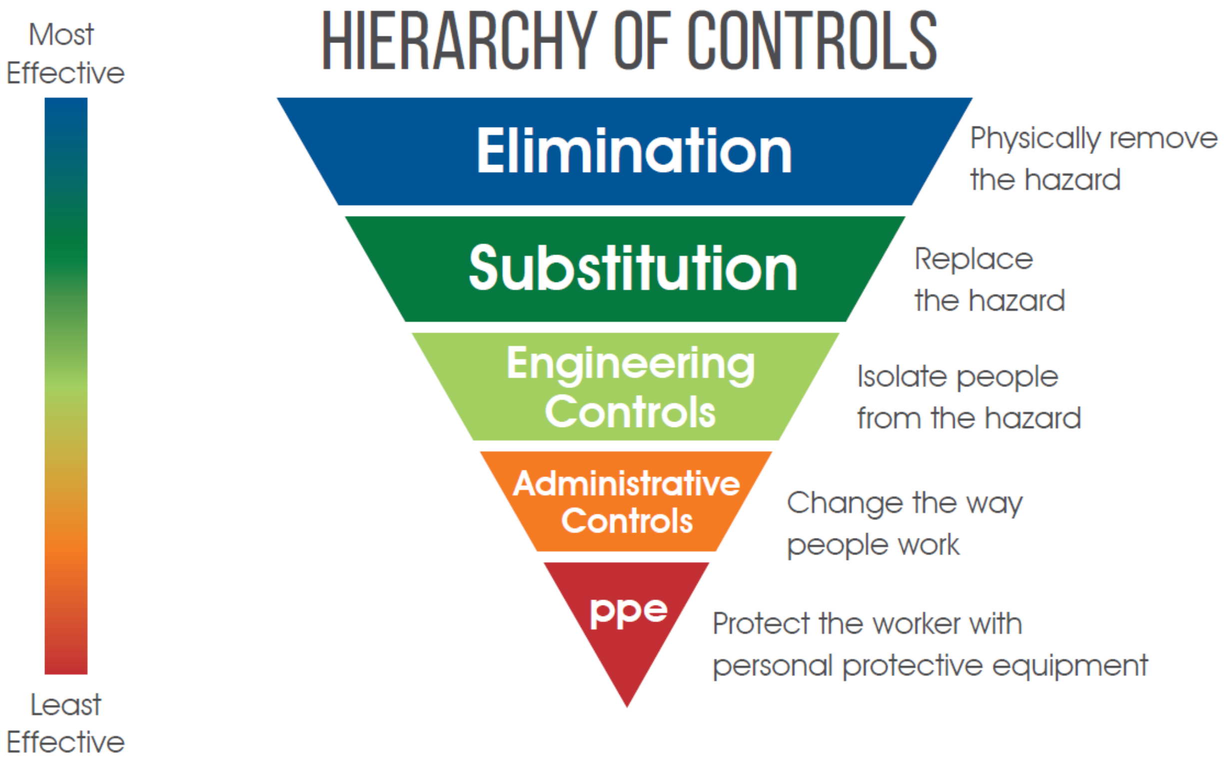

Figure 2 - Hierarchy of risk controls

<u>Hazard elimination:</u> Avoiding risks in working systems (operations, processes) and adapting the workplace to workers, (integrating health safety and ergonomics when planning new workplaces)

<u>Substitution:</u> Replacing the hazardous parts or full systems with the less or non-dangerous

<u>Engineering controls:</u> Implementing collective protective measures (isolation, machine guarding, ventilation, noise reduction, etc.)

<u>Administrative controls :</u>Giving appropriate instructions to workers (lock-out processes, induction, forklift driving licenses, etc.)

<u>Personal protective equipment (PPE):</u> Providing PPE and instructions for PPE use/ maintenance (safety shoes, safety glasses, hearing protection, chemical and liquid resistant gloves, electrical protection gloves, etc.)

<u>OHS Performance Evaluation.</u>

Organizations must establish, implement and maintain a process for monitoring, measurement and evaluation. They must determine what needs to be monitored and measured, including:

Criteria against which the organization will evaluate OHS performance

- Methods for monitoring, measurement, analysis and evaluation, as applicable, to ensure valid results
- When the monitoring and measuring will be performed
- When the results from monitoring and measurement will be analyzed, evaluated and communicated

Examples of what could be monitored and measured include:

- Progress on meeting policy commitments, achieving objectives and continual improvement;
- Occupational health complaints, health surveillance of workers and work environment monitoring;
- Work-related incidents, injuries, ill health and complaints, including trends;
- Effectiveness of operational controls and emergency exercises;
- Proactive and reactive actions affecting OHS performance;
- Competence [2].

3 Analysis of dangerous and harmful factors affecting a person under water

In order to apply specific measures to improve the health and safety management system, it is necessary to understand exactly what risks divers face.

Diving work carries many life-threatening factors, and many divers engaged in deep-sea work can subsequently experience health problems, since breathing at great depths requires the use of gas-air mixtures that are different from those inhaled on the surface or used in air tanks.

Consider all these factors by collecting them into a single list, which will allow us to foresee what potential risks should be protected in the first place and that these methods should not be a consequence of another danger. Below are the main hazards:

Four factors of diving labor that may be dangerous or harmful:

1. Factors of high pressure of the gaseous medium and respiratory gas mixtures
2. Technical means (chambers, diving bells)
3. Aquatic factors
4. Diving equipment factors

Each factor carries certain threats consider each in more detail:

1. Factors of high pressure of the gaseous medium and respiratory gas mixtures:

- Mechanical pressure
- High partial pressure of gases and their excessive penetration into the body
- High density, increased breathing resistance
- High heat capacity and thermal conductivity of water

Pressure can affect a person very negatively, since any organism on earth adapts to its environment, just like a person cannot dramatically change his environment without consequences. The factor of increased pressure can lead to small ruptures of blood vessels and capillaries, which in the worst case can lead to micro strokes and other damage to the blood supply to the facets, including the heart. Pulmonary diseases can also be dangerous, as the properties of air change and vital oxygen can become poison.

2. Technical means:

- Limited confined space
- Lack of habitat
- Change in gas composition (decrease in oxygen content, increase in carbon dioxide and harmful substances and microclimate parameters)
- The accumulation of microflora
- Increased fire and explosion hazard (high oxygen and / or hydrogen)

A confined space can cause phobia, which will lead to panic, fear. A person during a panic attack is more committed to making mistakes, which significantly increases his risk of injury. For example, it is necessary to monitor the content of oxygen, carbon dioxide, etc., to monitor various meters. Also in a confined space there is a higher risk of explosion or fire.

3. Aquatic factors:

- Lack of a gaseous atmosphere suitable for breathing
- Mechanical pressure and high density
- High heat capacity and thermal conductivity
- Distortion of vision and hearing, lack of lighting or its lack

- Hypo gravity in the aquatic environment
- Dynamic impact of the aquatic environment (currents and sea waves)
- Diver isolation from maintenance staff and facilities
- Water pollution from sewage, oil products, bacterial flora, radioactive and chemical substances
- The presence of toxic and dangerous marine animals

The main human habitat is land; water is not a comfort area for humans. The effect of the aquatic environment on humans is completely unexplored. A man in water, in addition to pressure, may experience other discomfort - breathing resistance, difficulty in moving, turbidity, violation of thermal control and so on.

4. Diving equipment factors:

- Increased breathing resistance
- Limiting the visual field, fogging the porthole
- General and uneven compression of body parts due to the presence of rigid parts and folds of equipment
- The presence of gas volume in a spacesuit
- Restriction of the motor functions of the body
- Change in gas composition
- Change in temperature in equipment
- Use of equipment with electric and water heating
- Increased noise level
- Increased or decreased intrapulmonary pressure compared with the surrounding
- The use of absorption and regenerative substances (cartridges)
- Possible malfunctions of the gas supply system and violation of equipment tightness

The main danger is precisely the breakdown or malfunction of the equipment. A person, using experience and calculated data based on this experience, develops equipment that can avoid the first three groups of hazards. Equipment can save you from certain dangers, but if the equipment breaks down, then it is very likely to get injured or even endanger a person’s life. Up to 95% of deaths among divers occurred due to breakdown / failure or malfunction of equipment [3].

Based on all the dangers, the main point on which you need to pay the most attention to this equipment. Particular attention will be paid to technology chapter number 6 and 7.

4 The environmental impact of the Caspian Sea on humans and humans on the environmental component of underwater operations

First, consider what environmental situation the waters of the Caspian have today. Then, consider what threat the natural phenomena for the Caspian Sea can pose. At the end of the chapter, consider the most dangerous human impact on the environment.

Water level fluctuations.

The water level in the Caspian Sea is subject to significant fluctuations. According to modern science, over the past 3 thousand years, the amplitude of changes in the water level of the Caspian Sea amounted to 15 meters. Instrumental measurement of the level of the Caspian Sea and systematic observations of its fluctuations have been conducted since 1837, during which time the highest water level was recorded in 1882 (-25.2 m.), The lowest - in 1977 (-29.0 m.), since 1978, the water level has risen and in 1995 reached the level of −26.7 m, since 1996 there has again been a downward trend. Scientists connect the reasons for the change in the water level of the Caspian Sea with climatic, geological and anthropogenic factors.

Such water drops can cause the ships to run aground, cause big problems for fisheries, since their main work directly depends on fish, which will float further away from the shores of the Caspian with low tide. Diseases that can be caused by microorganisms evaporating from a dried surface and carried by the wind can cause the main threat directly to humans [4].

Microorganisms.

From year to year, scientists discover cholera vibrio and E. coli in the waters of the Caspian Sea. According to the Kazakhstan administration of the Republic Service for Supervision of Consumer Rights Protection and Human Welfare, the number of pathogenic microorganisms in seawater samples sometimes exceeds the maximum permissible concentration by 28 times. In many samples, scientists have discovered the so-called rotaviruses, which cause acute intestinal infections that are quickly transmitted from person to person. This can trigger the occurrence of massive foci of the disease. The main reason for the situation, experts call the banal discharge of waste products from the sewers of coastal cities without special cleaning and disinfection.

It is pollution with waste products of various industries that people cause the most harm to the waters of the Caspian. They began to study the Caspian region for oil production and build oilrigs there before the start of the Great Patriotic War. Today it is difficult to calculate the total number of towers built in the entire Caspian. According to preliminary estimates, the number of towers has already exceeded one hundred. Many of them have already lost their economic benefits for oil companies and therefore they have practically stopped their work, but continue to work on a small scale, and those that are idle and not serviced harm the decomposition of these structures, which can subsequently collapse and sunk, continuing to poison the waters of the Caspian Sea with heavy metals [5].

Oil production.

Returning to oil production, we will consider the region most widespread among industrialists. The Volga region is the most interesting in terms of oil production and therefore is at the greatest risk; consider what is the level of pollution of the Caspian waters at the current time in table 1[4-6].

Table 1 - Average annual pollutant load at the apex and in the coastal part of the Volga delta

Pollutant	unit of measurement	Delta top (1977-1993)	Delta top (1995-2004)	Coastal part of the delta, total (1995-2004)	including the western part	including the eastern part
petroleum hydrocarbons	thousand tons	71.65	54.80	57.10	37.2	19.9
Detergents	thousand tons	5.29	6.96	7.95	4.35	3.60
Phenols	thousand tons	0.70	0.98	1.07	0.68	0.39
Fe	thousand tons			51.05	31.55	19.50
Zn	thousand tons	4.97	9.42	9.45	6.01	3.44
Cu	thousand tons	2.19	1.89	1.66		
Ni	thousand tons			1.49		
Pb	tons			439		
Co	tons			311		
Mn	tons			273		
Cr	tons			186		

5 Assessment of the situation of the Caspian Sea and the difficulties in conducting underwater operations in the Caspian Sea

Seaweed.

Seaweed can be the most dangerous in the work of a diver, since their number and length are difficult to determine by eye under water. They can be most dangerous in coastal zones, where water can be called partially stagnant, since in such water their quantity is most often the largest. The problem of seaweed consists in two aspects: the first is a physical threat to human life; the second is a toxic effect on humans.

Physically, seaweed pose the greatest threat. They are able to wrap around a person's leg or arm thereby restricting his movements, and then, as most often this happens when a person begins to move and try to free himself, these movements create a kind of funnel that draws to the bottom, where further an even greater amount of seaweed wraps around a person due to which movements are almost completely limited. An inexperienced person will start to panic, and as a result of a panic, the following begins: firstly, he begins to move faster, thereby only aggravating the situation and pulling himself to the bottom faster; secondly, a person begins to consume more oxygen, panic at the bottom can increase oxygen consumption 10 times that will inevitably lead to suffocation, loss of consciousness and death. Therefore, each diver should:

1. Undergo mandatory training;
2. Carry a special tool (knife, blade, etc.);
3. Work in pairs;
4. Do not use hose means of air supply.

The second highest risk is the toxicity of seaweed, which is not so often a real threat to the life of a diver. Most often, toxins secreted by seaweed cannot enter the diver's body, as he is in equipment. But, if the diver got a cut during the work and comes into contact with poisoned water, there may be consequences. Depending on the type of seaweed (for example, blue-green, spirogyra, etc.), a person can get toxic poisoning that causes both a common allergy and its severe degree - Quincke's edema. The most dangerous types of blue-green seaweed can affect the nervous system and cause diseases such as Alzheimer's disease, Parkinson's disease and amyotrophic lateral sclerosis (Lou Gehrig's disease).

Also, seaweed can hide in itself garbage and other waste, which over time can begin to decompose and pollute the water. In addition to the deterioration of the water ducts, these waters can also be much polluted. Garbage is various types and forms, which can also be a threat, as there can be fishing lines that can wrap around a diver, sharp debris and other objects that threaten human life [7].

<u>Climate changings.</u>

In any open water work, climate and weather changes can cause adverse working conditions. The most common problems with weather at sea can be a strong wind, water temperature differences, changes in water level.

Strong winds can cause a storm that can damage equipment located on the surface of a diver's life support system underwater.

Differences in water temperatures can occur due to moving water flow, which can be set in motion by the same wind or due to the influx of water from the Supply Rivers. Temperature differences can force to suspend work, as the equipment or equipment of the diver will not allow to work in a new temperature environment. Temperature changes in the winter season are especially dangerous, as some coastal areas or work areas can freeze, which will make it difficult for a diver to leave the water or spoil the air supply or life support system for a diver due to icing of equipment [4].

<u>Turbidity of water.</u>

Turbidity of the water is one of the main hazards for people working underwater. Turbidity of water reduces the field of view of a person, as the transparency of water decreases. Most often, this is due to the presence of organic or inorganic impurities in it. The main threat is the narrowing of the horizons, because a person cannot correctly assess the situation, anticipate adverse circumstances, and ignore the impending life-threatening factors (such as sharp debris, animals, or hauling heavy structures, etc.).

Turbidity of the water is one of the main hazards for people working underwater. Turbidity of water reduces the field of view of a person, as the transparency of water decreases. Most often, this is due to the presence of organic or inorganic impurities in it. The main threat is the narrowing of the horizons, because a person cannot correctly assess the situation, anticipate adverse circumstances, and also ignore the impending life-threatening factors (such as sharp debris, animals, or hauling heavy structures, etc.).

The turbidity of the water in the Caspian in the regions where oil production is carried out is 22 g / m3 or 22 mg / l, which in international units is 169 NTU (Nephelometric Turbidity Unit), which makes it quite turbid. For comparison, consider 3 test tubes with water (figure 3) with different levels of turbidity.

Figure 3 – Water samples with a turbidity of 5, 50, and 500 NTU

WHO (World Health Organization) does not give norms of harmfulness or danger of water depending on the turbidity of the water, but since most often these waters acquire their turbidity because of drilling and production, in addition to rising rocks of the earth, turbidity is increased due to impurities of heavy hydrocarbons and metals.

Such water is unsuitable for drinking. Such water must go through several stages of purification, most often in this case flotation is used or purification by bio organisms, then several more filters pass through, the water can be used for drinking purposes.

Due to the increased turbidity, most often this water is very hard, so it is also not very good for use in everyday life.

Summing up the two previous chapters, we can say that the impact of man on the environment and the state of the Caspian region is really very significant, which ultimately affects the man himself. But nevertheless, it is impossible to belittle the danger of the sea on its own - microorganisms, other fauna and a non-natural habitat for humans can cause damage or even lead to the death of a diver [8, 9].

6 Measures to protect the person during the diving operations to protect from the environmental protection inherent in the Caspian region

Most of the diving operations carried out in the Caspian region take place on coastal areas, which says a lot about the depth of underwater operations. It follows that the work is carried out mainly at a depth of 20 m.

Since such works do not require the use of special installations and tools, such as decompression chambers and bells and many works are carried out with air supplied diving or scuba diving, very often safety requirements are neglected both by project managers and by the divers themselves. Therefore, it is necessary to develop a plan for risk assessment for divers in this category, taking into account the main hazardous factors not only affecting the physical condition, such as increased water pressure, inhaled air mixtures or equipment that are natural for all types of underwater operations, but also the external factors of the terrain in which work.

In this part of the project, the north-eastern and northern parts of the Caspian Sea and external factors that can influence externally on a working diver in the waters of the Caspian region are considered.

In the beginning, we will consider the safety measures currently used by divers and then we can build a new system or supplement the old one, making it more efficient

Since, depending on the depth of the work, the pressure exerted on the person changes, and the work takes place at a depth of 20 m, the water pressure at this depth will be 303.129kPa (3 bar). Temperature conditions are:

- for cylinder - 60 ^{0}C
- for water in the summer - 25 ^{0}C
- for water in winter - from 0 ^{0}C

The use of a scuba is acceptable, but there will be changes in the duration of the operation, since the pressure in the tank itself, initially equal to 30 MPa, will decrease, and accordingly, the time spent under water will also decrease until the air in the balloon ends. It is necessary to calculate the pressure in the tank at a depth of 20m.

Summertime:

1. Simplify the equation by eliminating the variables that will not change. The volume of the tank will not change, so V1 and V2 can be eliminated from the formula in this problem:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

2. Convert Kelvin temperatures to Celsius (absolute) temperatures:
Conversion formula: °K = °C + 273

$$T_1 = 60°C + 273 = 333°K$$
$$T_2 = 25°C + 273 = 298°K$$

3. Rearrange the formula to solve for the final pressure (P2):

$$\text{P2} = \frac{P_1 T_2}{T_1}$$

4. Fill in known values:

$$\text{P2} = \frac{30MPa * 298°\text{K}}{333°\text{K}} = 26.85 \text{ MPa}$$

The gauge reading when you reach bottom will be 26.85MPa

Wintertime:

1.Simplify the equation by eliminating the variables that will not change. The volume of the tank will not change, so V1 and V2 can be eliminated from the formula in this problem:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

2. Convert Kelvin temperatures to Celsius (absolute) temperatures:
Conversion formula: °K = °C + 273

$$T_1 = 60°C + 273 = 333°K$$
$$T_2 = 0°C + 273 = 273°K$$

3. Rearrange the formula to solve for the final pressure (P2):

$$P2 = \frac{P_1 T_2}{T_1}$$

4. Fill in known values:

$$P2 = \frac{30MPa * 273°K}{333°K} = 24.59\ \text{MPa}$$

The gauge reading when you reach bottom will be 24.59 MPa

Since the average air consumption of a diver at a depth of 10 meters reaches 20 liters per minute, and when diving for every 10 meters, the consumption increases by the same amount, the air consumption at a depth of 20 meters will be 60 liters per minute. It is also known that at such a depth of 30 MPa is absorbed by a diver in 15 minutes, but since the pressure also drops depending on the depth, these values will take the following form:

<u>Summertime:</u>

$$t2 = \frac{P_2 t_1}{P_1} = \frac{26.85\text{MPa} * 15\ \text{min}}{30MPa} = 13.425\ \text{min}$$

<u>Wintertime:</u>

$$t2 = \frac{P_2 t_1}{P_1} = \frac{24.59\text{MPa} * 15\ \text{min}}{30MPa} = 12.295\ \text{min}$$

As we can see, the time is just over 10 minutes, and not taking into account the time for diving, accordingly, the diver has about 10 minutes to work, which in most cases is categorically short, but diver in a scuba is very mobile, and this method is cheap to ensure, so, many diving companies and divers resort to such risks of using scuba and constant monitoring of gauge reading.

The best solution for carrying out work at such depth is air supply diving. Air at such a depth does not seriously harm the diver, but it is also harmful, since for every 100m diving, the oxygen content in the supplied air should be reduced by 2 times. Therefore, first consider under what pressure the air should be supplied to the diver at a depth of 20 meters, and then determine the permissible time spent under water at this depth.

Firstly, rearrange the general gas law formula to solve for the formula of air at depth (V_2):

Summertime:

$$V1 = \frac{P_1 V_2 T_2}{P_2 T_1},$$

$$V1 = \frac{30MPa * 0{,}06cmm * 299°\mathrm{K}}{10MPa * 298°\mathrm{K}} = 0{,}181\mathrm{cmm},$$

which means that in order to maintain a stable supply of air to the diver, the volume of air supplied must be at least V_1 = 0,181cmm.

Wintertime:

$$V1 = \frac{P_1 V_2 T_2}{P_2 T_1}$$

$$V1 = \frac{30MPa * 0{,}06cmm * 273°\mathrm{K}}{10MPa * 268°\mathrm{K}} = 0{,}183\mathrm{cmm},$$

which means that in order to maintain a stable supply of air to the diver, the volume of air supplied must be at least V_1 = 0,183 cmm.

Based on the above two options, it is necessary that the generator provides a minimum air volume of 0.2 meters cubic per minute. This amount of air supplied by the generator will not allow avoiding the possibility of insufficient air in case of emergency or work of increased complexity, when the consumption of air increases by 1.5-2 times, which indicates that the generator must operate at extreme power delivering up to 0.4 cubic meters per minute.

Since at such depths the air has almost the same composition, but requires more pressure to feed to the bottom, it is necessary to recalculate the time the diver was under the water.

In order to analyze the maximum possible time of arrival under water at a depth of up to 20 meters, we consider the dependence of time on the amount of air supplied. A plot of these values is shown below (figure 4).

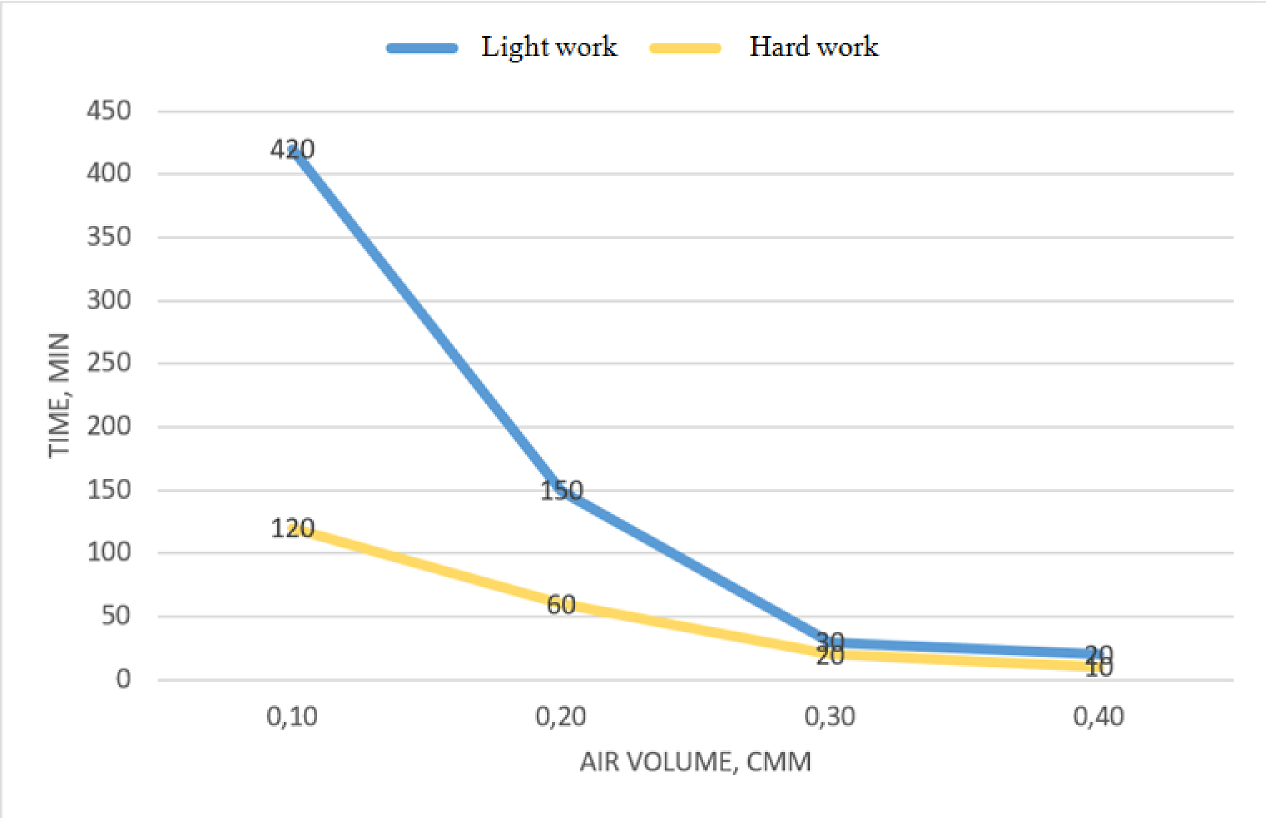

Figure 4 – The dependence of the permissible time under water on the amount of air supplied

Having examined the dependency graph, the conclusion follows from which it is clear that time is inversely proportional to the air pressure with which it is supplied to the diver, respectively, we conclude that the depth very much affects the maximum time under water. Also, a lot of important factor is the type of work, that is, whether they are carried out in tension, with great effort (hard work) or is it simple research or search work (easy work) [10, 11].

7 Introduction of new measures (systems) on labor safety and protection for divers in the Caspian region

First, it is necessary to instill a diver's understanding of the importance of coastal briefings. Most divers do not consider this part important for preparing for work, as they most often believe that they are experienced enough or that the working conditions are constant and they are not in danger. Therefore, they believe that one or two briefings are enough to get to work. In addition, most often there is neglect of the instructor if he is a regular member of the OHC service, and not a current or former diver.

The following measures should be introduced into the OXC system, which should strengthen the weaknesses of our current system:

1. Introduce performance training. Most often, the involvement of divers (any other employee) in activities related to the work process can help. For this, it is necessary to coordinate the work of the OHS manager and the project manager (if the project manager is not responsible for the safety of the work, which practically does not happen). The project manager / OHC manager can introduce models, live stories, and similar cases into the work.

2. Develop template sheets in which the coordinator of work, the project manager will prescribe:

(a) weather
(b) terrain conditions
(c) temperature indicators (water and on the surface)
(d) conditions and type of work
(e) own precautions.

3. Try to inculcate diver's involvement in filling Safe-R Card. The Safe-R Card is a questionnaire in which any employee (diver) who has noticed non-compliance with another employee (diver) will have to report and hand it over to the OHS manager for subsequent explanatory work by the manager, or a warning / reprimand. Such a card consists of the following items:

(a) The employee who committed the violation / gross violation;
(b) What violation was committed;
(c) Likely Consequences / Past consequences;
(d) Troubleshooting Suggestions;
(e) Date and time.

The cards themselves can be signed by an employee who noticed an adverse event, or can be surrendered anonymously.

CONCLUSION

The topic of safety and health protection now has a very great relevance throughout the world. Since every day a person needs a huge number of elements of everyday life, such as electricity, food, water and so on. It is vitally important to have production facilities and services that deal with all this. The profession of a diver helps a lot to a person, starting from cleaning beach areas, fishing and ending with raising sunken ships, drilling oil wells under water. It is easy to imagine how difficult the profession of a diver is, starting even from the fact that all work takes place in conditions not familiar to humans, not in water - but on land.

In this work, diving issues in Kazakhstan were raised. Diving operations are of most relevance in the western part of the country, which is associated with the presence of a large part of the Caspian Sea in this area of Kazakhstan. It was impossible not to affect the interaction of man and this huge, unusual habitat for man. The effect of seawater on humans, as well as the direct human impact on the underwater environment leaves its mark. The influence of these two elements was considered both as a symbiosis and as the warring parties, which is stated in a more detailed form in several chapters of this work.

In the course of the calculations, the influence of the underwater environment on a person was revealed, risks at a depth and danger awaiting a person both during work and upon completion. Also, during the calculations, it was revealed by what means of life support each diver should be provided for carrying out work in the most comfortable and optimal conditions for him. The influence of pressure on a person, the change in the concentration of the air mixture entering the depths of up to 20 m was considered, since most often the work carried out in this region occurs at these depths. Based on the calculations, it was revealed to which specific values each person participating in the process of diving should seek.

The very narrow working conditions of the diver were considered, since the depth of the seas and oceans is not limited to 20m, this work covered only a small spectrum of the real complexity of the work of a diver. For deeper work, completely different equipment is needed and the preparation time for only one underwater descent can take up to a month in the open sea or other conditions. Actual types of underwater operations specifically for Kazakhstan were considered, which suggests that the development trend of divers safe work described in this work can and should develop. This work can help in the further study of this area and the field of diving. The introduction of new measures for conducting safe underwater operations or to complement the safety measures already described above.

LIST OF ABBREVIATIONS USED

1 OHS – Occupational Health and Safety
2 ISO – International Organization of Standardization
3 OHSMS – Occupational Health and Safety Management System
4 OHSAS – Occupational Health and Safety Assessment Series
5 PDCA – Plan-Do-Check-Act
6 MLPS – Management and Labor Protection System
7 PPE – Personal Protection Equipment
8 NTU – Nephelometric Turbidity Unit
9 WHO – World Health Organization

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