MINISTRY OF EDUCATION AND SCIENCE OF 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

Anelya Yezhenova Aidarovna

Implementation of labor protection management system on the example of "Kainar-AKB"

DIPLOMA PROJECT

Major 5B073100 – Life Safety and Environment Protection

Almaty 2020

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Allowed to the Defence
Head of Department of Chemical
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_____Yeligbayeva G.Z.
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Research mentor
Batessova F.K
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ASSIGMENT
On the completion of diploma project

Student Anelya Yezhenova
Topic: Implementation of labor protection management system on the example of "Kainar-AKB"
Approved by the order of University Rector №762-b from 27.01.20
Deadline for completion of work
Initial data for the thesis
Summary of the thesis:
a) Information about company's activity
b) Features of the technological process
c) Occupational Risk Analysis
d) Suggestions for Improvement
The list of graphical material (with an exact indication of the compulsory drawings) shown in: *17* slides of presentation work
Recommended main bibliography: *21 references*

Almaty 2020

SCHEDULE
on preparation of thesis

Name of sections, list of questions considered	Submission deadline	Note
Review of sources for diploma project	20.01.2020 – 05.02.2020	
Characteristics of the company	06.02.2020 – 07.02.2020	
Production process activities	08.02.2020 – 09.02.2020	
Occupational risk analysis	10.02.2020 – 11.02.2020	
Improvement of the efficiency of PPE	12.02.2020 – 13.02.2020	

Signatures

Section Names	**Consultants (academic degree, rank)**	**Date of signing**	**Signature**
Review of Sources for Diploma Project	Batessova F.K.. C.t.s., ass.prof.	20.01.2020	
Characteristics of the company	Batessova F.K.. C.t.s., ass.prof..	06.02.2020	
Suggestions for Improvements	Batessova F.K. C.t.s., ass.prof..	09.02.2020	
Improvement of the efficiency of PPE	Batessova F.K. C.t.s., ass.prof.	12.02.2020	
Normcontroller	Batessova F.K. C.t.s., ass.prof.	15.05.2020	

Research mentor _____ F.K. Batessova

The student accomplished the task _____ A.A. Yezhenova

Date «____» _____ 2020

АННОТАЦИЯ

Дипломная работа на тему «Внедрение системы управления охраной труда в компании АО «Кайнар» содержит 30 страниц текста, в том числе 7 таблиц и 14 рисунков, и включает следующие составные части: Введение; О компании АО «Кайнар»; Производство батарей; Опасные производственные факторы; СУОТ в компании; Преимущества и недостатки СУОТ в компании; Аттестация производственных объектов по условиям безопасности; Мероприятия по улучшению условий безопасности труда на основе анализа риска и травматизма на производстве; Мероприятия по улучшению на основе эффективности СИЗ (респираторы); Заключение; Список использованной литературы.

АҢДАТПА

«Қайнар» компаниясында еңбек қауіпсіздігі және еңбекті қорғауды басқару жүйесі» тақырыбындағы диссертация 30 бет мәтіннен тұрады, соның ішінде 7 кесте мен 14 суреттен тұрады және келесі бөліктерін қамтиды: Кіріспе; «Кайнар» компаниясы туралы мәлімет; Батарея өндірісі; Қауіпті өндіріс факторлары; Компаниядағы еңбек қауіпсіздігі; Компаниядағы еңбек қауіпсіздігі жүйесінің артықшылықтары мен кемшіліктері; Өндірістік объектілерді қауіпсіздік тұрғысынан тексеру; Өндірістегі қауіпті және жарақаттану жағдайларын талдау негізінде еңбекті қорғау жағдайларын жақсарту жөніндегі шаралар; респираторлардың тиімділігіне негізделген жетілдіру шаралары; Қорытынды; Пайдаланылған әдебиеттер тізімі.

ABSTRACT

The thesis on “Implementation of labor protection management system on the example of “Kainar -AKB”. The project contains 30 pages of text, including 7 tables and 14 figures, and includes the following components: Introduction; Main information about the company; Production process of batteries; Hazardous industrial factors; Advantages and disadvantages of safety management system; Results of certification of production facilities for occupational safety conditions within “Kainar-AKB”; Measures to improve work safety conditions on the basis of workplace certification; Enhancement measures based on quality efficacy of the PPE (respirators); Conclusion; Bibliography.

TABLE OF CONTENTS

INTRODUCTION

According to paragraphs 25) Clause 2, Article 23 and paragraph 2 of article 201 of the Labor Code of Republic of Kazakhstan (the Code), the implementation of internal control over work safety and labor protection is the full responsibility of the employees [1]. With the aim to complying with established safety and work protection rules and regulations at workplaces employees should take instant measures to remove potential violations at workplaces.

This, in return indicates lack of enough attention to the safety conditions of the employers and scarcity of determination of the administration to conform to the national rules and regulations. Therefore, it leads to taking inappropriate measures to improve the workplace conditions on site of industrial objects [2]. The aim of this diploma project is to develop elaborated safety management system by ensuring the provision of safety of life and health of the employers in “Kainar-AKB” company. Moreover, the major tasks include but not limited to the creation of the essential legislative enforcements for the effective decision-making between the employer and employee and the national legislative organizations.

According to the assessment of 2018 year it was found that economical losses from the inadequate incorporation of rules and regulations was almost 36% in “Kainar-AKB” company [3]. They were mainly attributed to the inappropriate workplace conditions of the industrial object [3]. On the other hand, despite the economic shortcomings due to the increase of hazardous factors, the company had significant social impacts such as increased societal values and secured working ethics. Therefore, this project investigates advantages and disadvantages of safety management system from economical and social perspectives in the given company. Moreover, it analyzes the audit of workplace conditions according to all the legislative acts in “Kainar-AKB” company. In addition, it gives some insights to the proper use of PPE such as respirators in terms of practicality and efficiency. In the end it proposes possible solutions such as economic benefits from the replacement of particular PPE by more sophisticated ones within the latter company.

1 Brief information about “Kainar-AKB” company

The company “Kainar-AKB” for the production of storage batteries was founded in 1970 and was based in Taldykorgan city. The first battery was given out on the 14th of January. The company then became one of the largest battery producers and exporters in the Soviet Union [3]. Nowadays, the company is one of the leading national manufacturers of the accumulation batteries all over Kazakhstan. In addition to the sophisticated production process that “Kainar-AKB” company offers to its customers, it has a prolific production cycle of all the components of the storage batteries including the recycling process of enhanced flooded batteries. To this account the final price for the batteries tend to be significantly lower than that on the economic market [3].

The facilities for the production of the batteries were originated from the countries such as Italy, USA, Germany, Canada and China. The recycling process of those batteries is also highly enhanced and meets all the international standards. The new technology of the production of the storage batteries allows conforming to the existent rules and regulations in the field of safety and environmental engineering. The official partners for the technological components include but not limited to “Digatron” USA, “BTS” Canada, “Sanhuan” and “Haitian” from China, “Sovema” Italy [3]. According to the recent statistical data over 60% of export for the batteries is carried by the company “Kainar-AKB” on the national scale [3]. Over the nine months period in 2019 the total number of 1,7 million batteries were produced within the company. 939 000 of them were purchased by the international partners [3].

Image 1 – “Kainar-AKB” official building

This was mainly achieved due to the sophisticated process of the production starting from the oiling of the details till the final assembly process of the major parts. Moreover, within the company the elaborated process of the waste management takes place over the cycle of the whole production, which includes but not limited to the

recycling process of the misused batteries, including the thorough purification of the lead in order to get the relative kinds of alloys [3].

1.1 Meteorological conditions of the industrial object

The geographical location of the company is within the mountainous area of the Tian Shan Mountains, which in its origin tend to have good weather conditions. Moreover, meteorological conditions generally tend to be pleasant within the region of the industrial object. Due to the excellent location of the factory and the vicinity to the mountainous area, precipitation tends to take place more than in other parts of the country. The average amount of precipitation is found to be 480 mm per year [3]. The maximum amount takes place in spring, especially in April and May. Moreover, maximum amount of wind velocity tend to increase to 22 m/s in winter and 18 m/s in the summer. In addition to it, the region of the industrial object has days with snowy precipitations for about 65 days each year.

Moreover, there could be heavy snowfalls during winter times. The maximum height of the snow tends to be between 26 and 29 cm. The following summary of the meteorological information is presented in the table below [3]. The highest concentrations of the pollutants under this air velocity of the winter winds. Within the company there is an ecological department that takes monitors the amount of the pollution thrown away to the environment from the production of the storage batteries.

Table 1 – Weather conditions in the vicinity of "Kainar-AKB"

The name of characteristics	SI Unit	Values
Average annual air temperature	°C	5,2
Average air temperature in January	°C	-13
Average air temperature in July	°C	24
Average amount of precipitations	mm	420-580
Maximum height of the snow	cm	26-29
Predominant direction of the wind	-	Winter - south; Summer – varied;
Maximum value of wind velocity	m/s	Winter- 20,0 Summer – 20,0

As it is known from the scientific data the waste from the heavy metals such as lead is very detrimental to the surrounding living sites [4]. Under the influence of the lead the central nervous system of human being is exposed to the serious negative changes. Moreover, the kidney failure, lack of the red blood cells is all could be attributed to the detrimental effects of the heavy metals [4]. Heavy metals from their nature from the atmosphere by air go to the water bodies and soil thus affecting flora and fauna of this region. In the soil, however, the rate of the reproduction is

diminished significantly due to the presence of the cationic penetration ability. Nonetheless, the prolonged ambience of those cations inside the soil leads to the alteration of the structure of soil itself [3].

Therefore, the ecological takes care not only the environmental of the company site itself, but the surrounding flora and fauna, too. The take the samples of the soil and air on the quarterly month basis so that to avoid increased deterioration of the natural habitat itself from one side and to avoid legal prosecution for the environmental damage from the other side [4].

1.2 The production cycle of the batteries

The main exporting countries of the company are considered to be the bordering countries such as Russia, China, Belorussia, Kyrgyzstan, Uzbekistan, and others. However, long-term commitments are exercised with countries such as Germany, South Korea, Japan, USA, and Spain.

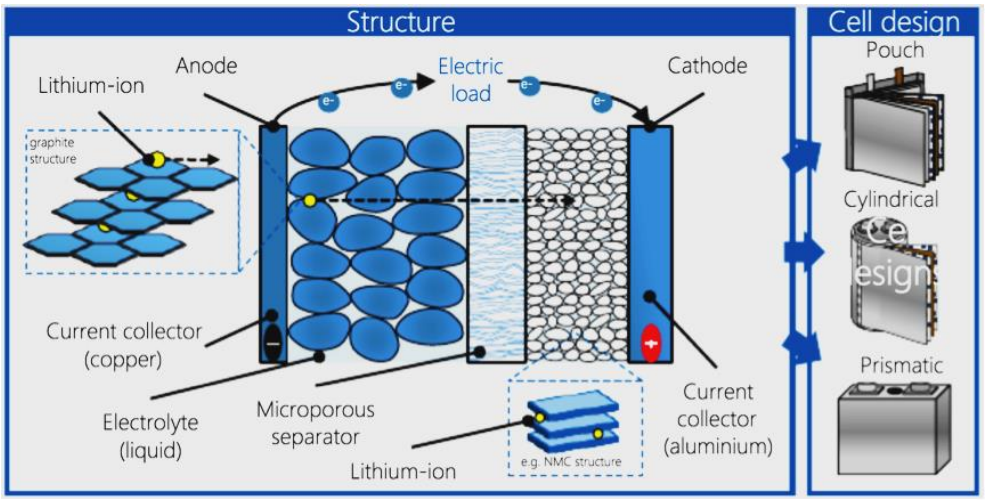

Image 2 – Production cycle of batteries

The company has well-qualified, highly trained personnel who endeavor to achieve best results in their productions accomplishments with the use of modern technological advancements. Most of the chief executives of the company are from the very first launch of the storage battery production. This mainly demonstrates long-term relationships between the employers and strong attachment to the company by the workers. The local population constitutes the major part of employer's contingency [3].

The implementation of the technologies such as data science technologies, the high resistant materials, and specific agents to the main materials flow allows to make the production of batteries with compliance with all the international rules and regulations [3]. Since the batteries production cycle has undergone the comprehensive quality control checks according to the national standards (ST – CZ) and the Russian Standard (PCT), the batteries tend to have strong durability features

and proper quality controls [3]. There are three major inherent stages in the production of the batteries: electrode manufacturing, assembly of the battery, and the cell recovery. The battery type does not influence the electrode production and cell recovery processes. However, it is indispensable that the cells form and shape are taken into account before the production cycle [4].

The constituents of the unit of the battery cell are two electrodes and a separator. This does not depend on the cell form. Moreover, the purpose of the separator is to divide the electrodes so that there will be no electric load between them. That is why both of the holes of each electrode (positive and negative) and the void spaces within the cell will be thoroughly filled by the ion-conductive electrolytes [5].

1.3 Inherent risks associated with production process

Safety of the worker's operation strongly depends on the care and attention of all the personnel on site of the industrial object. Most of the safety precautions are a matter of common sense and good housekeeping and are detailed in the various manuals available within the company. However, records show that even experienced operators sometimes neglect safety precautions through over-familiarity and the following basic rules must be remembered at all times [5].

It is always better to not continue to operate any machine or equipment, which appears to be potentially unsafe or dangerous and always report such a condition immediately. The worker should all the time make points of testing of all safety equipment and devices regularly. Moreover, it is always advisable to test safety trips before starting any equipment. In particular, over speed trips on auxiliary turbines must be tested before putting the unit to work. In addition to it, under no circumstances the worker should ignore any unusual or suspicious circumstances, no matter how trivial they can be. Since small signs often appear before a major failure occurs.

It is not advisable to underestimate the fire hazard of petroleum products, whether fuel oil or cargo vapor. That is why it is safer to start a machine remotely from the cargo and engine control room with confirming visually that the machine is able to operate satisfactorily.

In the design of equipment, protection devices have been included to ensure that, as far as possible, in the event of a fault occurring, whether on the part of the equipment or the operator, the equipment concerned will cease to function without danger to personnel or damage to the machine. If any of these safety devices are bypassed, overridden, or neglected, then the operation of any machinery in this condition is potentially dangerous.

In many cases the reason for the techno-genic pollution is the various human activities, which makes it easy for the pollutants to get into the environmental site and spread the chemicals and their bonds into the air. The latter spread of the chemicals take place due to the process and factors of migration [5].

2 Safety management system

In the modern society safety plays a crucial role, especially safety in the workplace of industrial objects. The safety management system itself is a sophisticated system, which envisions all the operation risks in the performance of the company. The system of safety management is a comprehensive part of the system that provides the necessary risk assessment criteria in the field of Occupational Health and Labor Safety work related to the operation process.

The system of safety management considers the operation of the organizational, scientific, and technological works so that to allow us to achieve practical results and minimize potential hazards. For that reasons it is indispensable to create the safety departments in the industrial workplaces in order to promote the systems of safety management according to the international safety standards.

The safety management system in Kazakhstan includes the organizational structure; the work related to the planning of safety managements; analysis of industrial risks and methods to minimize the risks of the workplace injuries. Moreover, it monitors the procedure of following the rules and regulations in the field of safety management on the national level, which is predominantly associated with the work of the employees [6].

Image 3 – Recycling process of the EFB batteries

In every company both industrial and commercial the first concern of the chief executive board should be the safe working conditions for the employers and the upkeep of the physical and mental health of the employers. Some employers pay attention only to physical harm in the industrial worksite. However, in this project the mental and moral extent of the injuries will be also investigated in the scope of this project. Especially in the industrial field, which includes the work with toxic and

harmful fumes and gases and the risks are highly distinguishable. For this it is essential to have elaborated safety management system that provides good working conditions for both parties involved [7].

2.1 The main advantages of the SMS within the company

In "Kainar-AKB" as in any industrial company as was discussed earlier there is an integrated system of industrial safety management.

The main goal of the system is to provide the appropriate safe working conditions for the employers. The system of safety management includes but not limited to auditing of the working places, the provision of personal protective equipment (PPE) such as gloves, safety shoes, glasses, hard helmets, respirators that ensure the optimal working conditions [7].

The main advantages and benefits of the SMS system are following: minimized industrial costs of the potential failure. This could be linked to conformity with the rules and regulation. Due to the fact that the fines from misconduct are tend to be high and company could undergo a great amount of financial losses to retain the company well being, it is of essential advantage for a company to implement the proper safety management system. Moreover, the long-term benefits from implementation of the SMS tend to be enhanced working community and improved communication between employers.

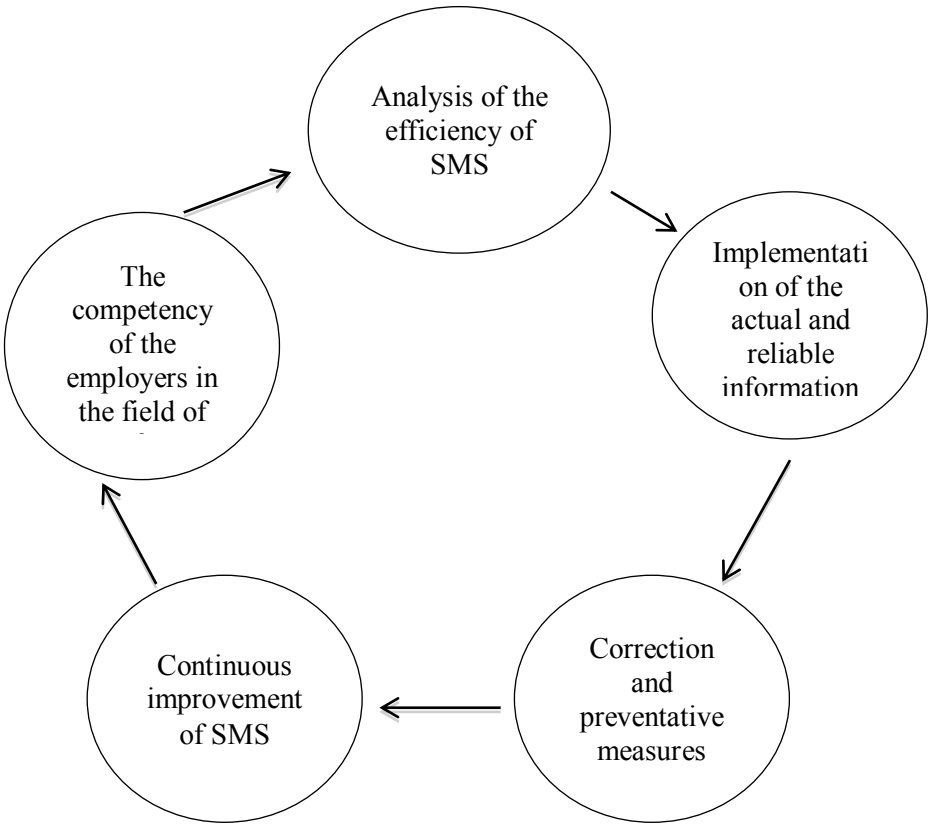

Image 4 – The safety management system chart flow

The system of safety management controls the availability of the personal protective equipment (PPE) such as safety shoes, gloves, helmets, safety glasses, and other means of industrial protection. Moreover, it takes part in the assessment of the working conditions. On the other hand the system takes measures to prevent and eliminate any kind of incidents in case of the occurrence of such situations [7].

The safety officer provides and looks over any orders from the national legislative committees. He or she checks the safety of necessary facilities and equipment. Moreover, officer performs safety trainings; medical examinations, psychiatric examinations from the employer's orders.

The system generally takes part in the training process on labor protection, as well as on providing first aid to people that was injured in industrial accidents. The system provides participants in administrative and public control over the state and conditions and labor protection at their workplace [7].

The main responsibility of the employer is to keeps its workplace clean. Moreover, before the start of the working day, he inspects his workplace and reports about any kind of shortcomings in the workplace itself. The worker has the privilege to use in right place and choose personal protective equipment. In case of an incident he or she acts in conformity with the regulations such as Labor Code and acts according to the rules and regulations [2].

2.2 The main disadvantages of the SMS within the company

There are some inherent disadvantages to the safety management system. Some of them include but not limited to he higher costs for implementation of appropriate safety management system due to political and economic pressures. Then it is connected to the lack of risk-management experience and analytical skill-sets in the company. Moreover, the presence of stubbornness of the safety officers to any kind of alteration due to the influence of the Soviet Union culture both within the regulatory agency and the industry is creating uneasiness in the operation process. Therefore, there are shortcomings in implementing the SMS system on a national scale application. That is why there is an inherent tension in the relationship between the regulator and the operators that oversees it. The individual characteristics in the operation culture should be taken into consideration such as areas where accident rates are already very low. Therefore, there may be limited potential gains from SMS but significant risks if it is improperly implemented can create larger safety risks [6].

As can be seen from the image (figure 1, Annex A) the system of safety management consists of objects of the direct management and the objects of indirect management. Then they both unite into the system of set assessment criteria or Labor Protection. From that point they go to the general and particular indicators the former including economic efficacy of measurements, the total accidents' rate, and the development of occupational diseases. The latter consist of personnel trainings and drills that should be performed on the regular basis; compliance with the measurements, mostly specific ones; and finally instructions and behavior based

safety that plays a significant role in mitigation process of the employers' operation processes [7].

When it comes to the assessment of the efficiency of the SMS, there the cyclic flow is taken into consideration. From the image 4, it can be noted that the after the necessary evaluation criteria are set and working borders are established then it can be gone to the next stage that is the implementation of the actual and reliable information. After that it goes to the implementation of the preventative measures and correction. Here, mistakes that were committed during the operation of the employer would be analyzed by the special surveys and questionnaire. Every member of the community should take part in the evaluation process [7].

From it goes to the continuous improvement area, where all the assessments are reconsidered and put on the circle of the prolonged enhancement. Then the competency of the employer in the scope of safety management is questioned accordingly, which include but not limited to the full commitment of the worker to the safety working procedures. The competency of the employer constitutes the major part in the safety hierarchy, since it is the decision of the person and only person that makes the stages of the operation process to move. Despite the fact that, the machinery plays a vital role in the proper implementation of the process production such as drilling different battery parts and hammering the sensors to the right compartment; the machinery cannot be classified as Artificial Intelligence (AI). However, the future holds that may be next stage of the production process might be the development of the decision making process by AI and robots. There, those processes will be inherently controlled and constantly monitored by the machinery itself, which will make the presence of the worker not adherent [7].

If the reference will be taken to the Annex A, the schematic overview of the safety management system could be analyzed. From the beginning the labor management facilities are going to the main functions of the safety management. After that, there are four major areas where the planning takes place. These are the planning of work of labor protection union, monitoring of the LP and SMS, assessing the risks and potential hazards, and finally the controlling of labor management facilities. This presumably goes to the major tasks of the safety management. In total there are ten fields and branches that are listed in the scheme. The first one goes to the safety processes compliance, after that it goes to the safety of industrial machinery, after that it goes to the safety of buildings and objects, the it goes to the compliance of hygiene requirements.

This then goes to the trainings of all the personnel. As it is well-established process to test and instruct all the new coming workers before they go to work on site of the industrial object. The training process does not end from it, the career ladder in the company is constituted in the way that if the employer would like to go up from one positions to the other, it is obligatory to take part in the trainings programs on a regular basis. The professionals from the chief executive committee offices conduct the trainings or they come from overseeing companies [8]. Provision of PPE is one of the most important parts of the safety management system, as it directly exonerates the influence of the detrimental nature of the machinery and the tools [7].

3 Auditing and assessment of workplace conditions

The audit report about the attestation of the workplace object was accomplished within the framework of the contract on the performance hygiene and physiological investigations between “Kainar-AKB” and LPP “Geek Partners”. The assessment was performed by the latter organization.

The right of Geek Partners LLP to conduct certification of production facilities is confirmed by: No.0040038.

According to the attestation of workplaces in 2017 safety conditions were questioned and it was found out that some of the workplaces are not in conformity with the safety regulations, the industrial noise results in particular.

The major measures to ensure the optimal working conditions within the organizations are:

a) Insurance of the rational usage of the working time;
b) Organization of the shift load regime;
c) The provision of the breaks and shift rest within the framework;
d) The upkeep of the high quality productivity of the employers by providing necessary financial and moral incentives [8].

3.1 The results of auditing of the luminance

From to the results of the table 2 measurements of the luminance, it can observed that there is no need for further improvements of the light conditions since the workplaces are in proper norm of the light according to the regulation [9]. The allowed value for the luminance is 150 lx, the value according to the auditing was between 240 and 250 lx between years 2016 and 2019. Due to the fact, that actual value tends to be within the safety range according rules and regulations, further alterations, and improvements are out of the scope and interest for the company [10].

Table 3 – Results of the measurements of the illuminance

N	The year	The SI	Normal	Actual value
1	2016	Illuminance, lx	150	250
2	2017	Illuminance, lx	150	240
3	2018	Illuminance, lx	150	230
4	2019	Illuminance, lx	150	240

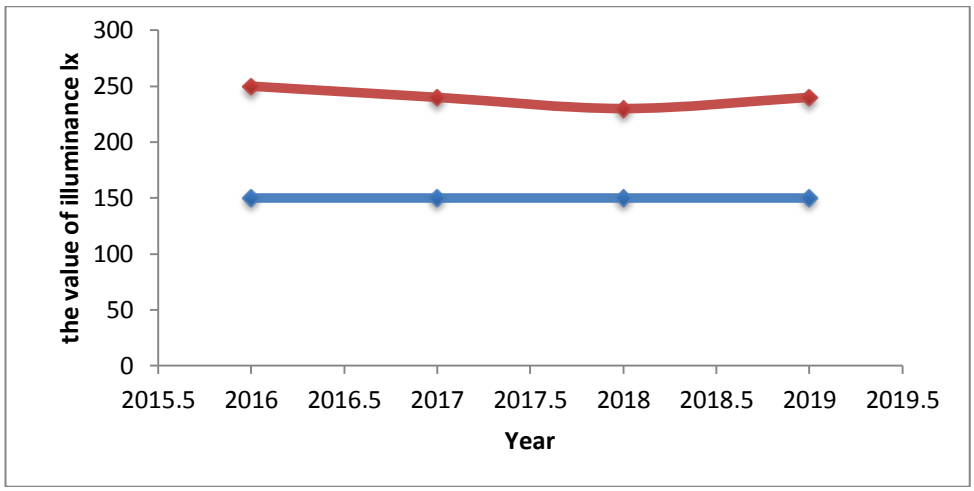

Image 5 – The relationship of the luminance versus time

3.2 The results of auditing of the microclimatic conditions

According to the instrumental measurements of the values of temperature it can be concluded that the workplace conditions in terms of temperature levels are in compliance with the rules and regulations, since average temperature between four years tend to be about 24 C, and it is in accordance with the 2nd hazard class, which is allowed in the workplace conditions [11].

Table 4 – The results of the microclimate measurements

Year	Actual value			Normal		
	Temperature, C°	Humidity, %	Air velocity м/с	Temperature, C°	Humidity, %	Air velocity м/с
2016	25	47	0,03	22	60	0,1
2017	24	54	0,03	22	60	0,1
2018	24.5	55	0,035	22	60	0,1
2019	26	56	0,037	22	60	0,1

The microclimatic conditions involve the presence of the following scalars such as the air temperature, the humidity levels on site of the industrial object and the air velocity of the particles. As can be observed from the table the levels of those macroscopic elements tend to be within the range of the normal conditions and therefore provide the proper working place for the employers [12]. Moreover, the microclimatic conditions such as the optimal level of humidity and the velocity of the air particles are particularly within the good figures. Therefore in the latter part the air quality of the company will be empirically tested by means of the monitoring the usage of respirators.

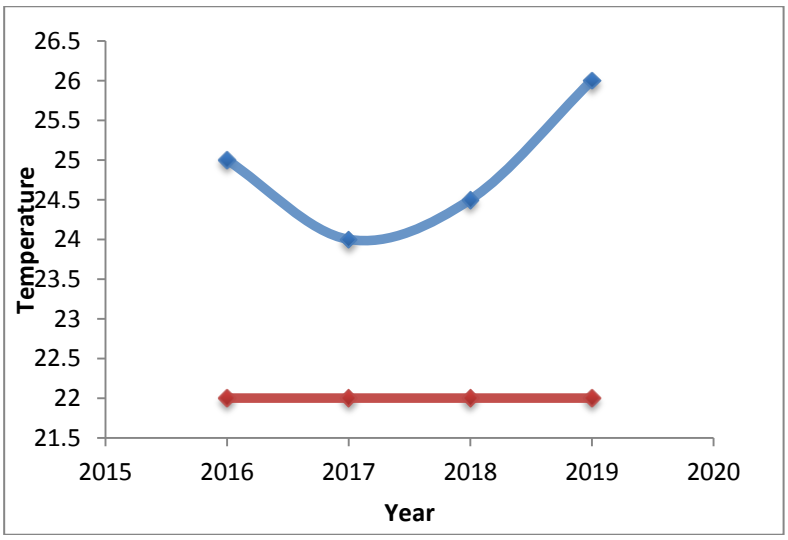

Image 6 – The relationship between the temperature and time variation

According to the instrumental measurements of all the values in the workplace and in all the spots the humidity values are in not in compliance with the allowed value. Therefore, the company should minimize the values according to the regulations. From 2016 to 2017 year it can be observed that the humidity value had increased from 47% to 54% and then it became steady around the value of 55% for the rest of the period. [11]

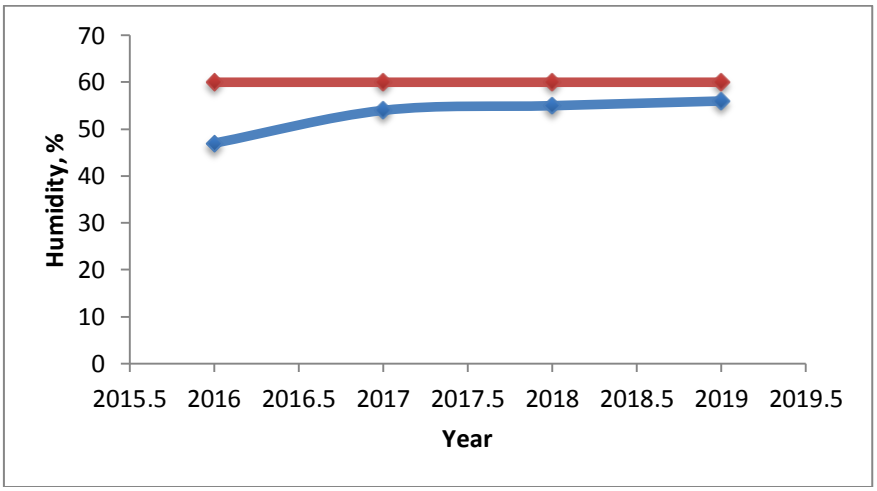

Image 7 – Relationship of humidity versus time

From both the table and the graph of the air velocity on site of industrial object, it can be deduced that the air velocity values are in appropriate range within the company policies and in particular with rules and regulations. From 2017 to 2019 the values for air velocity were from 0.030 to 0.037 m/s and according to the rules it should be within the range of 0.1 m/s [12].

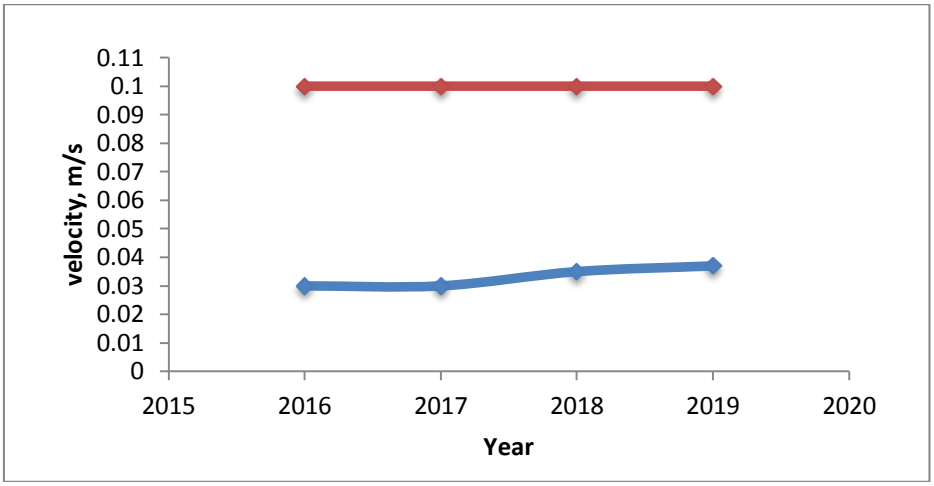

Image 8 – The relationship between air velocity and time

3.3 The results of auditing of the industrial noise

As a result more comprehensive hearing aid could be introduced on site of the industrial objects: for example earplugs, ear mugs, ear canal cap-covers. Those are the disposable types of hearing protection. However, those types of aids could lessen the productivity of the worker, since one of receiving canals would be inhibited and that's why the employer could not operate to the fullest. Moreover, it could affect the operation of the eyesight as well as smell since the nerves of the ears and eyes are strongly connected [13].

Table 5 – The results of measurements of the industrial noise

№	The year	The SI	Normal value	Actual value
2	2016	Noise, dB	94	90
3	2017	Noise, dB	94	96
4	2018	Noise, dB	94	89
5	2019	Noise, dB	94	90

According to the results of the auditing taken place in the company noise levels are not in compliance with the rules and regulations. Therefore, other methods of hearing protection are required. For example, collective methods of hearing protection could be introduced on sites where the noise concentration is at higher levels such as during drilling operation processes. Therefore, noise-absorbing screens could be placed on those spaces [13]. The proper utilization of protective means is one of the major responsibilities of the employer on site of the working place. It mainly shows the discipline and the appropriate compliance of company to the rules and regulations and literally gives the spirit of the healthy behavior of the worker [15].

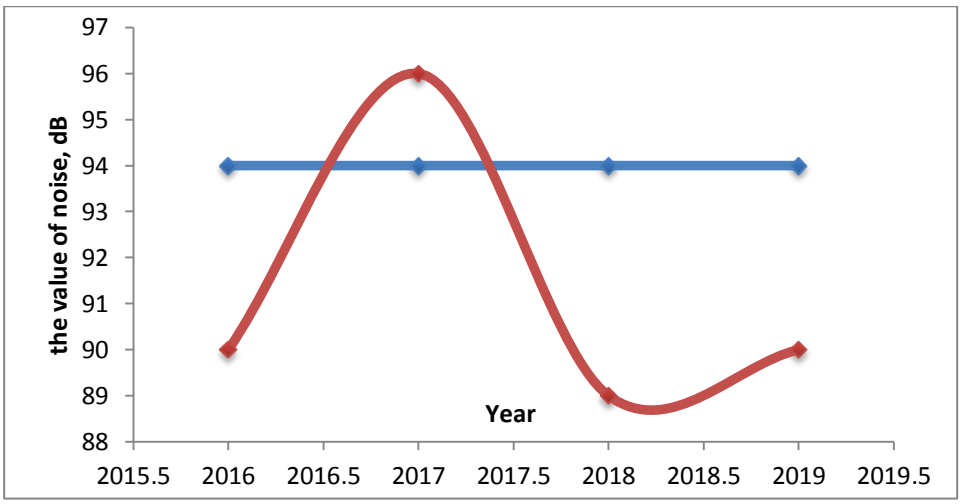

Image 9 – The relationship of the noise versus time

The noise-absorbing screens can be installed to protect the workers from the noise in the working places. The efficiency of the screens solely depends on the presence of the screen shadow, where all the sound waves are concentrated. In other words, the resistance of the screening absorption is directly proportional to the relationship between the size of the screen and the wavelength of the shadow. That is why the screening method is predominantly used when there is a middle or high frequency noise waves. For low frequency waves the screening is not effective due to the presence of diffraction phenomenon [13].

Image 10 – Personal Protective Equipment (PPE)

The screens are effective when there is no influence of diffraction, or when the objects are in open-space areas, which are acoustically operated. In the presence of diffractive waves the use of the screens is not practical; and therefore, the employer relies on the individual means of hearing protections such as headphones and earplugs. The usage of the former ones involves the presence of the bulkiness, especially when they are put on the head. The employers reportedly expressed this fact, and the administrative measures were taken to improve the ergonomics pattern of the protective devices in the company [15].

4 Statistical analyses of the industrial injuries within the company

Industrial injuries are the main problems in the assessment of upcoming years, and unfortunately the number of injuries are not lessening from year to year despite the fact that retarding actions are taken on a regular basis [16]. “Kainar-AKB” is not an exception, since the incident rates within the company are steadily rising within the couple few years. As can be seen from the table 6 where the assessment rates are taken into consideration in 2018 and 2019, there were 8 incident in the former and 12 incidents in the latter year. It could be mainly attributed to the increase of the number of working personnel, if the situation will be considered from the positive perspective. However, the presence of bias could not be substantially omitted, therefore, the other side of the issue shows that the potential alterations should be made to the existent safety management or present regulations should be reconsidered. The positive background from the report can be the absence of the mortality rates in 2019. However, the heavy incidents taken place in 2019 outweigh the ones in 2018.

The two latter rows of the table are derived from the statistical methods, which will be explained below. The statistical analysis is accomplished by identifying the frequency and the load of the risks within the company “Kainar-AKB”. In order to identify the frequency parameter in the table R_f, the following formula is utilized [17]:

$$R_f = \frac{M \times 1000}{N} \quad (1)$$

where M – the number of the registered injuries for the reported period; N – the average number of employers in the company for the given period of time; and P – the number of sick leave days due to the injuries:

$$R_f = \frac{12 \times 1000}{1197} = 6.68 \text{ (2018)}$$

Now we will find the risk of the injuries within the company:

$$R_r = \frac{P}{M} \quad (2)$$

$$R_r = \frac{48}{12} = 4$$

Using above formulas, the same could be applied to the year of 2019 and to the calculation of the heavy incidents rates. In 2019 the frequency rate of the incidents was 2.4 and the heaviest among them constituted 14.4, which is by 1.2 higher comparing to the previous year.

$$R_f = \frac{8 \times 1000}{1197} = 6.4 \text{ (2019)}$$

$$R_r = \frac{48}{8} = 6$$

Table 6 – Assessment of the incidents

Year	2018	2019
Incident number	12	8
Fatal incidents	2	-
Heavy incidents	3	2
Frequency figure	6.7	6.4
Heaviness rate	13.4	12.2

Analysis of the on-site industrial injuries showed that most than 80 percent of them due to the human failure. All the rest, about 20 percent of injuries are associated with the operation failure [16]. As the human factor plays a significant role in the constitution of the proper operation process, it is vital to find out the nature of those errors. As it was subtlety mentioned earlier, the main issue involving the human failure is the overfamiliarity of the operator with the working process or machinery. Since most of the employer working in the company have the working time of over 15 years, that means that the worker in some point of his or her working experience will exhibit the present of compliancy. That means he or she will neglect the visionary presence of indicators such as the absence of caps on the machinery or strange noise from the batteries. From that, the following scenario could be observed, the given worker will ignore the signs of potential danger, and then the incident occurs. There are, actually, many examples that can be put in the context of this analysis and they all show the implication of the human nature on the working process.

According to the incident report, there were taken some definite measures to prevent the incidents from happening in the future with detailed description of each of the occurred failure. Due to the fact that, it is of utmost importance to take into account every small detail of every failure that was taken place on site of the industrial object and take following appropriate preventative measures. Moreover, the financial part of the injuries was taken into account in the report by ensuring the right expenditures of the company's budget on the recovering measures [18]. Therefore, enhancement of the safety management of the company is the key-identifying factor of the future success implementation of the system itself.

5 Safety enhancement and efficiency of PPE (respirators)

Another important measurement that can, not only improve the working conditions of the workers, but also increase the economic efficiency of the company is the proper provision of PPE. Due to the fact that PPE plays a significant role in the operation process of the company itself, the efficiency and productivity of the workers are influenced by the appropriate provision of the PPE. In the scope of the project, breathing respirators will be analyzed within the given company. Moreover, new coefficients will be introduced here, so that to show the efficacy of the replacement of the PPE [19].

Image 11 – PPE for different safety purposes

Under the law regulation of Republic of Kazakhstan every worker must wear RPD (Respiratory Protective Devices), if he or she is working under conditions of the influence of dust, aerosol or any kind of airborne particles [1]. Some employers tend to think that dust and substance particulates, are not so dangerous and harmful, since they are not visible to the human eyes. Therefore, under this incorrect assumption they tend to wear the respirators less or even lessen the process of wearing RPD. Nowadays, mostly all of the industrial companies are quite safety-obsessed with the laws and regulatory prohibitions and by it they want to minimize the fine rate that could be inflicted upon them; and therefore they put the risk of the human contamination on the second place. As has been discussed by statistical and research data the main trigger to wear RPD in particular and PPE in general is the human consciousness. In the scope of this project some popular national respirators will be analyzed and some advancements to the existent types will be proposed [20].

The quality characteristic of the usage of PPE is the direct cost of PPE. The cost of PPE strongly depends on the usage time and the quality of PPE. In order to get the value that is independent of the time usage it is necessary to divide the cost over time of the usage [9]. The name for this figure is the specific cost usage (SE):

$$\text{Specific Efficiency} = \frac{CU}{4 \times T} \times 100\% \quad (3)$$

$$\text{Specific Efficiency} = \frac{440}{4 \times 91} = 12\%$$

$$\text{Efficiency Rate} = \text{Size of the respirator} \times \text{A:B (ratio of average)}$$

SE shows the expense of the budget for one PPE for the worker in one shift. The smaller the value of the specific cost value, the better and the cheaper the usage of the PPE under the same protective qualities and conditions. Using this date for the whole PPE bought for one year, the ranking of the efficient PPE could be made. In order to choose the better brand or model for the enhancement of the qualities of PPE, it is necessary to introduce new coefficient, which is the coefficient of the relative efficiency, which is:

$$\text{Coefficient of relative efficiency} = \frac{\text{SCU}_1}{\text{SCU}_2} \times 100\% \quad (4)$$

$$\text{Coefficient of relative efficiency } (3M) = \frac{440}{570} \times 100\% = 75\%$$

$$\text{Coefficient of relative efficiency } (KC) = \frac{550}{690} \times 100\% = 86\%$$

$$\text{Efficiency Rate} = 54 \times 52 \times 10^{-4} \times (0.75 \div 0.86) = 24.4$$

Where SCU_1 – the specific cost usage of the old PPE and SCU_2 is the specific cost usage of the new PPE respectively. In case of C_{ef}>75%, then the usage of the PPE is ecocomically beneficial and if the C_{ef} <75%, then it is not economically relevant. In our case the quality efficiency of the respirators was investigated.

The classification of respirators (refer to Annex B) goes as follows. Respirators are divided into anti-dust, anti-gaseous and aerosol according to the aim of the usage. If the type and ergonomics of the respirator is taken into consideration, then they are half mask and half mask with breathing filters. Finally according to the time longevity they are divided in disposable and multiple use respirators.

If particulates are taken into consideration, then dust is regarded as tiny and minute particles of the solid and liquid substances that are chaotically mixed within the air. There are two types of dust: aerosol and settled dust. The hazard from the dust is directly proportional to the size of the dust particle. It is mainly due to the fact that the dust stays in the air for the prolonged period of time, dust particles go quickly inside the lung alveolus. If the skin membrane is taken into consideration, then the dust penetrates the sweat hormones and inhibits the proper thermal state of the human body [19].

PEL (Permissible Exposure Limit) is a concentration of dust that is conditioned by the daily work exposure within 8 hours per day and not more than 40 hours per

week, along the whole working time of the employer and does not inflict on the state of the health of the worker both not in the short and long term periods [19]. To see how the dust and all the airborne particulates can be so dangerous, the main airborne diseases will be introduced such pneumoconiosis and silicosis. Pneumoconiosis is a set of diseases, which are caused by the presence of the large quantities of the dust particles inside the lungs in a prolonged period of time. This occupational disease is predominantly found in the employers with a work experience of 10 and more years [19]. Silicosis (Image 12) is another most widespread and popular occupational respiratory disease among workers, which is predominantly caused by the prolonged inhalation of the dust particles that contain SiO_2 [19].

Image 12 – Silicosis of the lunges

According to the recent research respirators with the mechanical filtration allow the dust to pass through the 99.1% of the hazardous particles (less than 2,5 mkm) [19]. On the national scale the most popular respirators are considered to be anti-aerosol respirators 3M Aura 9300. The filtrating respirators ANT 200 and ANT 201 are the four panel respirators that provide protection against harmful and hazardous substances and also liquids within the concentration until 12 PEL [20].

There are three kinds of obstacles in the good operation of breathing of every human being One of them is aerosol that is a disperse system, which enables to mingle the hard and soft particles in a gaseous environment [19]. In this picture (image 13) the integration of the modern respirator with some modified parts is proposed.

F1 – Filter that is situated above the hard cap;

F2 – Filter that is located beneath the hard cap;

F3 – Filter that is located on the side of the helmet;

1 – Inflatable pneumatic obturator;

2 – Particle filter of the speech diaphragm;

3 – The flashlight or torch (in case the employer works under the dim light).

In the modified type of the respirator it is of essential importance to provide the worker appropriate conditions for the effective and productive work.

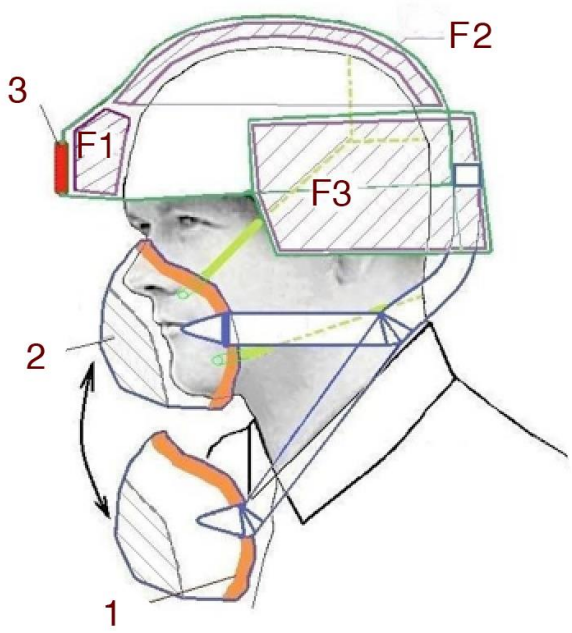

Image 13 – Modified type of respirator

Let us consider the parts of the modified respirator one by one. The first part obturator is an essential part of the prolonged exposure to the dust particles. Moreover it can be used as the second respirator when the first is no longer of use [21]. As a matter of fact, the second part is the speech diaphragm so that the words of the worker can be distinguishable. The third part introduced as a torch can be used as a means to work under the conditions of no light. The filter number one is the filter that is situated above the helmet and that allows the worker to particulate dust that will be coming from upside of the worker. The last but not least is the third filter that is situated directly in the upfront position of the human face and nose. This respirator is considered to be the most effective and protective part of the whole system.

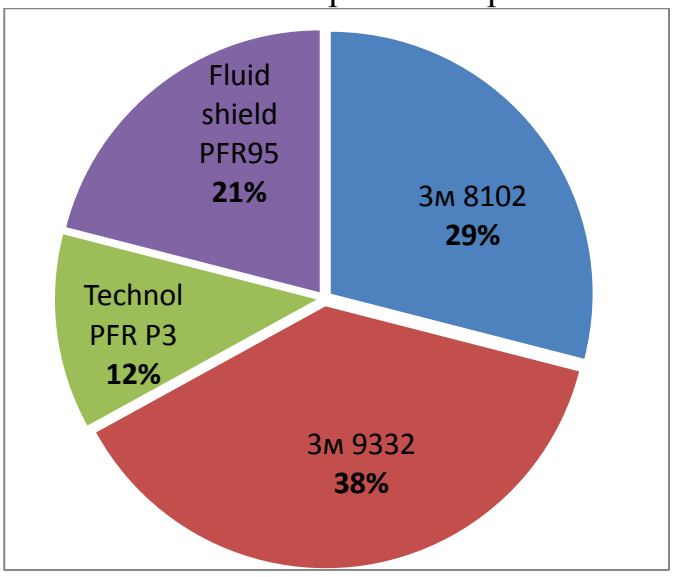

Image 14 – the preferences of respondents

Therefore, this issue is resolved by means of introduction of the speech diaphragm or the speech modifier. It is a tiny remote control device that is insulated into the respirator and is controlled by the sensors of the medium frequency waves that are emitted by the communication signals [21]. As a matter of fact, the second part is the speech diaphragm so that the words of the worker can be distinguishable. The third part introduced as a torch can be used as a means to work under the conditions of no light. The filter number one is the filter that is situated above the helmet and that allows the worker to particulate dust that will be coming from upside of the worker. The second filter is situated beneath the helmet and provides protection from aerosol that comes mainly from the horizontal exposure to dust [21]. The last but not least is the third filter that is situated directly in the upfront position of the human face and nose. This respirator is considered to be the most effective and protective part of the whole system.

Table 7 – Comparison between different types of respirators

Type of respirator	Respiratory	Cardio-vascular	Discomfort	Ergonomics
3M 8102	Little breathing resistance	Speech communication	Tightness; pain	May interfere with vision
3M 9332	Cough difficulty	Smell interference	Tightness; pain	May interfere with vision
Technol PFR P3	Large breathing resistance	Air flow sound interference	Thermal load	Increased dead space
Fluid shield PFR95	Cough difficulty	Speech communication	Thermal load	Loose fitting mask

In 2019 a particular poll on effectiveness of respirators was conducted among different respondent groups including male and female employers (the age of workers were from 26 to 59 years old) [19]. The results of the questionnaire (Image 14) were summarized in terms of respiratory, cardio-vascular, discomfort and ergonomics features (Table 7). It was identified that 3M 8102 and 3M 9332 or four-panel respirators exhibit pretty similar characteristic in terms of breathing resistance and cough difficulty to fluid shield PFR95. As for negative sides, the thermal load and tightness were emphasized in Kimberly-Clark respirators.

However, from ergonomics behavior those respirators tend to have fewer shortcomings and even excel 3M respirators. If the Kimberly-Clark respirators will be considered, the breathing difficulty and thermal load of these respirators are also similar to 3M respirators [21]. Moreover, they tend to trigger cough difficulty and create airflow sound interferences associated with the speech flow of the employer. As for ergonomics features, Kimberly-Clark respirators might not interfere with visionary fittings; nonetheless, only 12% of respondents preferred the PFR95. Therefore, the integrated usage of both types of respirators should be exercised, so that the worker could choose for himself, which one will be the best option for the specific type of operation under the given circumstances.

CONLUSION

To sum up, after thorough investigation of safety management system within «Kainar-AKB», it could be concluded that safety management system of the workplaces is in accordance with the national rules and regulations. This work explored advantages and disadvantages of safety management system within “Kainar-AKB” and proposed possible solutions to the risks associated with safety operation of the industrial object. Along with the investigation it was found out that there were some inherent harmful industrial factors that were the result of the increased potential hazards on site of industrial object. However, the analysis of the injuries has shown that the number of incidents taking place within company is falling steadily mainly due to the implementation of new technological advanced PPE and due to modernization of safety management system.

Moreover, with the help of the results of auditing the main purpose of which was to investigate the proper conditions of workplaces, it was found out that the values of luminance, humidity, air temperature and air velocity respectively are in compliance with the rules and regulations. Nonetheless, the only figures that were found defective under the scope of this project were the figures of industrial noise. Therefore, it was proposed to enhance the hearing PPE of employers by replacing them with modern and sophisticated means of hearing protection. Moreover, the collective method of hearing protection such as noise-absorbing screens was proposed to be implemented on site of the industrial object.

In the end the accident rates and efficiency of PPE within safety management system were questioned accordingly. Accident rate within the company is reducing from year to year. The accident frequency parameter of 2019 is 0.3% lower than of 2018 and what is more there were no fatality rates in the former year. Due to the fact that the cost of PPE within the company tends to take one of the company’s largest budgets, the efficiency aspect was analyzed by comparing different types of respirators. Namely, 3M 8102/9332 and Kimberley-Clark respirators were investigated from ergonomics and safety perspectives. It was found out that if the company increased expenditure on 3M respirators by 24% (formula 3), then both company’s economical efficiency and employer’s safety and productivity would be enhanced in the long run. Moreover, according to the poll conducted within the company the majority of respondents gave preferences to the use of 3M 9332 respirators, the least votes (12%) were given to the Technol PFRP3 respirators due to the presence of large breathing resistance and loose fitting features. 21% and 29% of preferences were distributed between Fluid shield PFR95 AND 3M 8102 respectively. Given the fact that 3M respirators are more economically efficient and preference-biased, they tend to legitimately outweigh the benefits of Kimberley-Clark respirators.

List of symbols and abbreviations

KAKB	Kainar Accumulator Batteries Company
OHSAS	Occupational Health and Safety Assessment Series
SMS	Safety Management System
RK	Republic of Kazakhstan
PPE	Personal Protective Equipment
ILO	International Labour Organization
LLP	Limited Liability Partnership
EFB	Enhanced Flooded Batteries
PEL	Permissible Exposure Limit
RPD	Respiratory Protective Devices

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13 GOST 12.1.050-86 Occupational safety standards system. Methods for measuring noise in the workplace;

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ANNEX A

Figure 1 – Safety management system overview

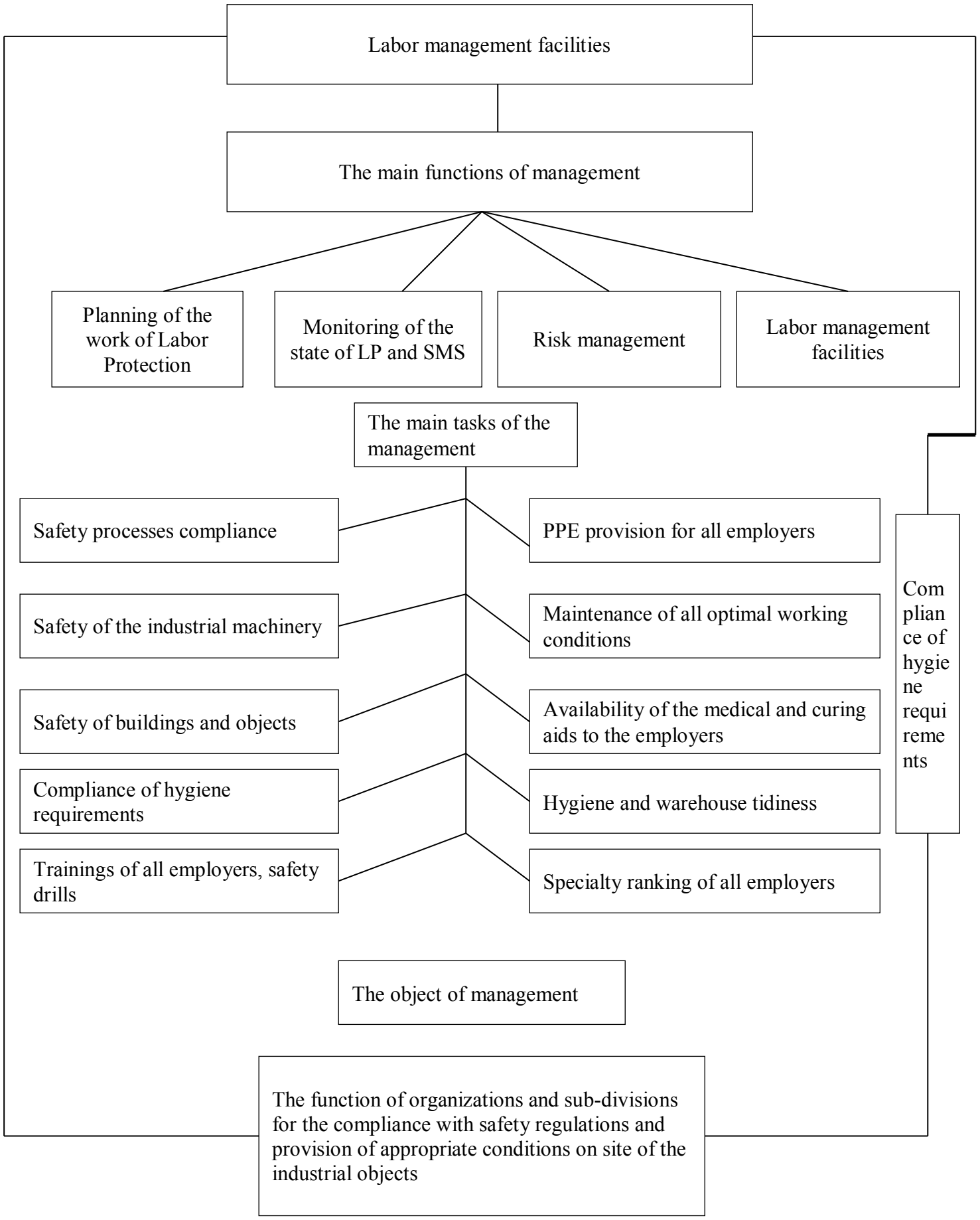


Figure 2 – Classification of hazards

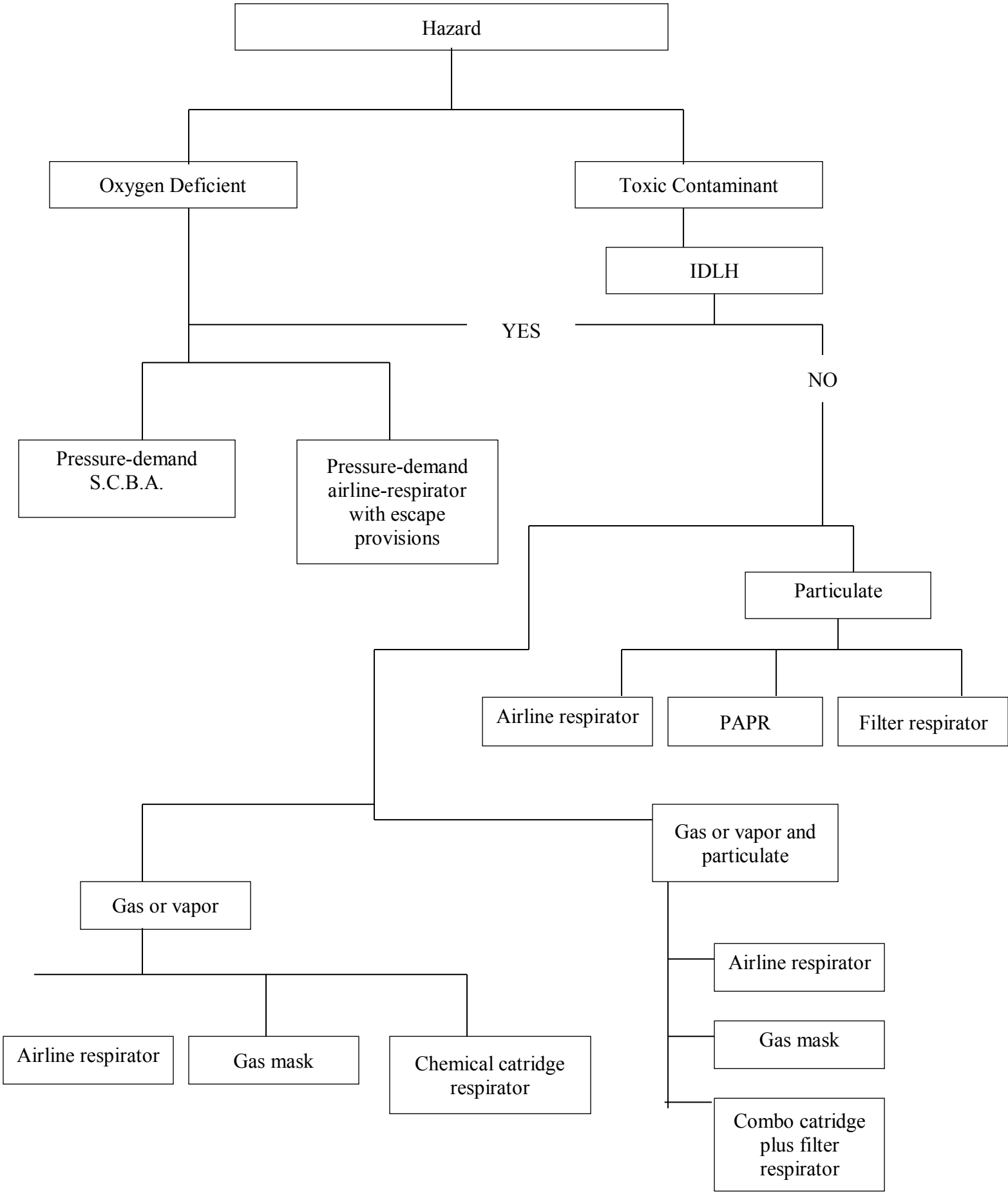
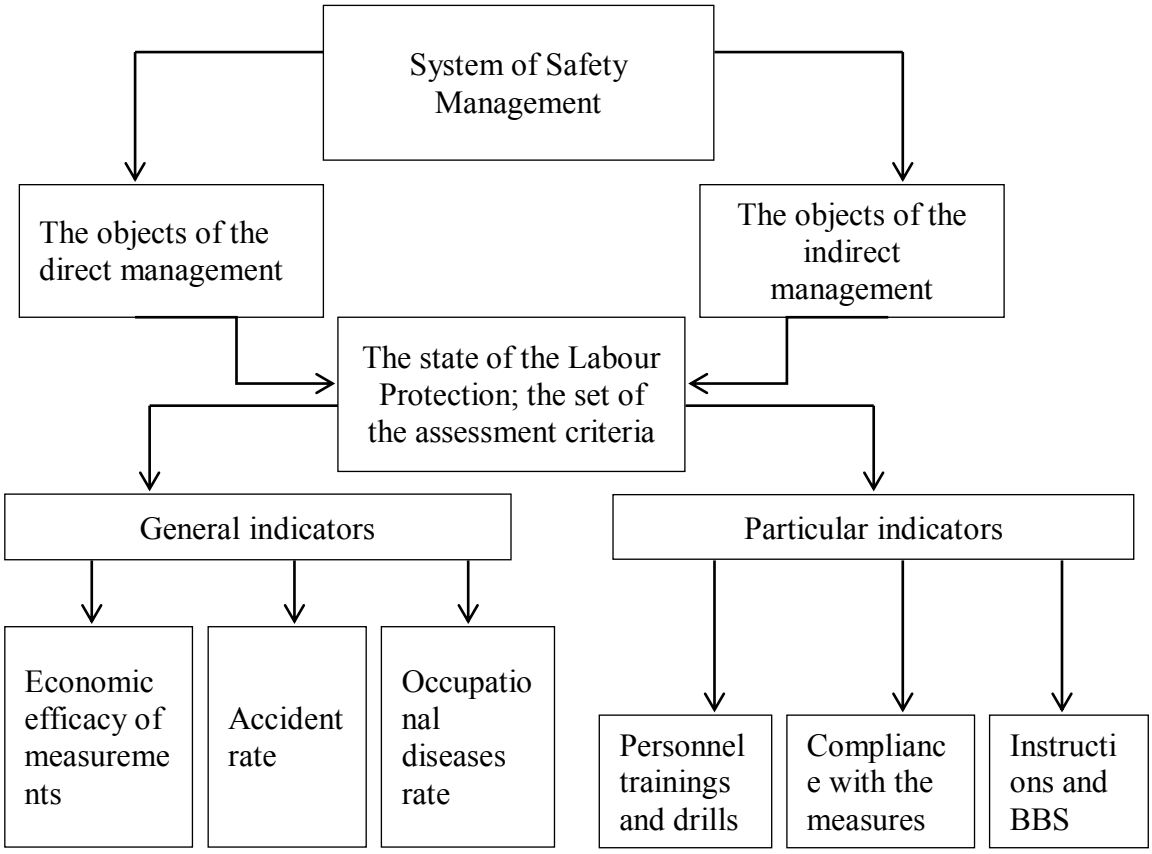
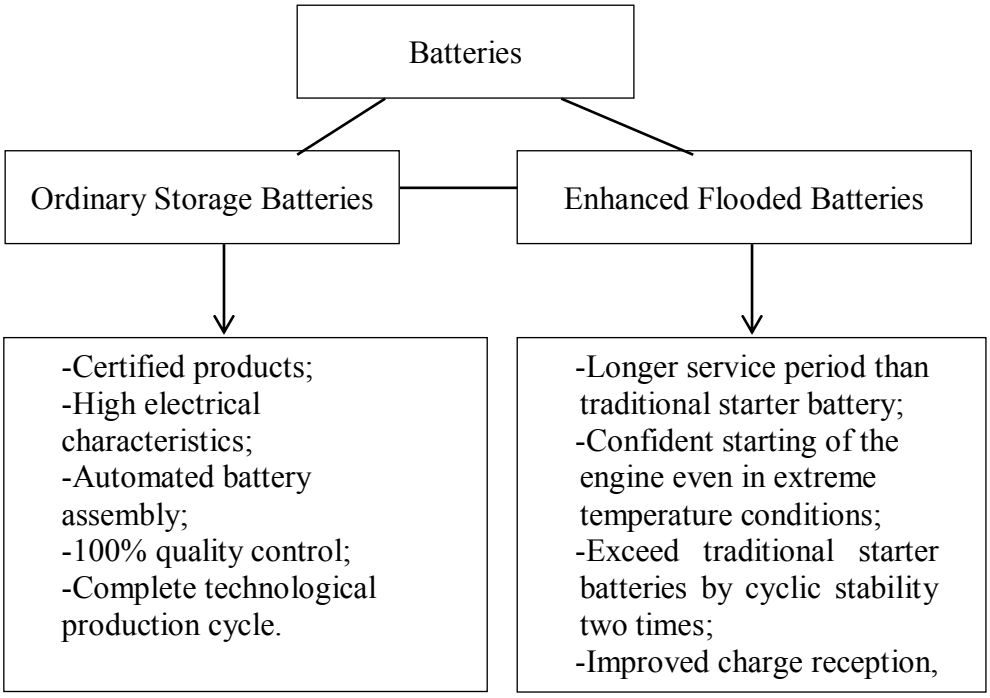


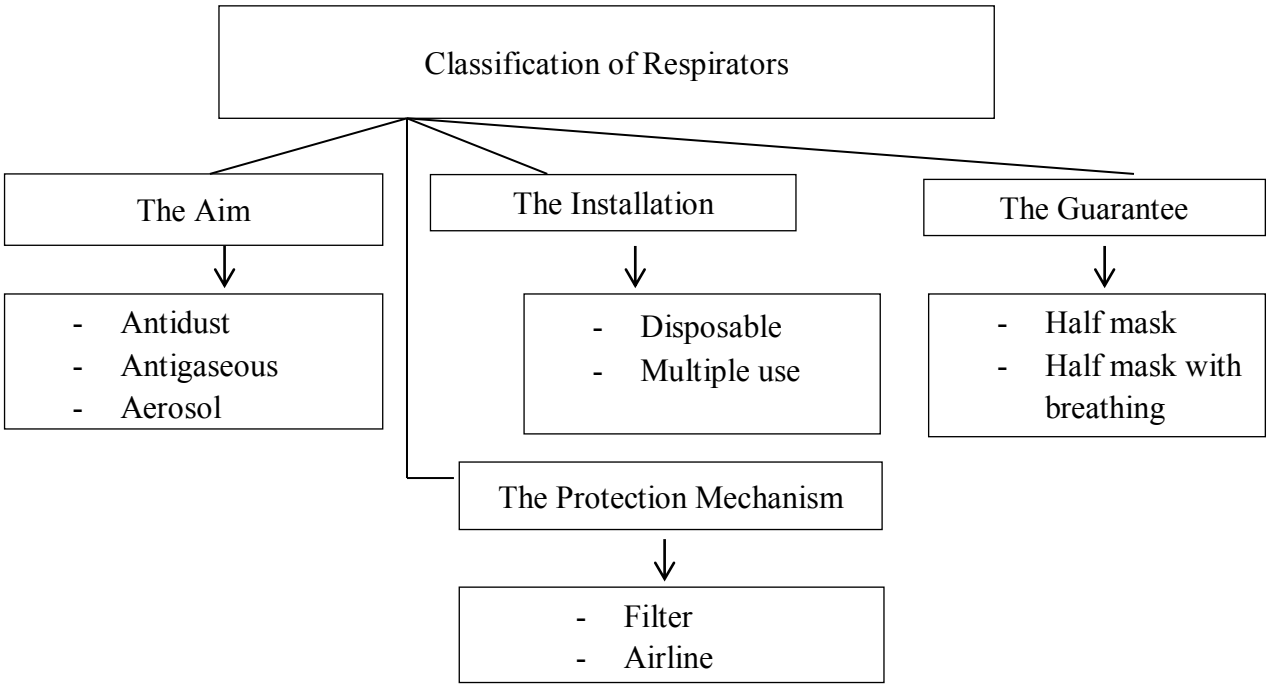
Figure 3 - The safety management system of the company





ANNEX B

Figure 4 – Classification of respirators



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Предупреждение и сигналы тревоги

В этом разделе вы найдете информацию, касающуюся манипуляций в тексте, с целью изменить результаты проверки. Для того, кто оценивает работу на бумажном носителе или в электронном формате, манипуляции могут быть невидимы (может быть также целенаправленное вписывание ошибок). Следует оценить, являются ли изменения преднамеренными или нет.

Замена букв Использование символов из другого алфавита - может указывать на способ обойти систему, поэтому следует установить их использование.	2	показать в тексте
Интервалы Количество увеличенного расстояния между буквами (просим определить является ли расстояние имитацией пробела, так как исходно слова могут быть написаны слитно).	0	показать в тексте
Микропробелы Количество пробелов с нулевым размером - необходимо проверить влияют ли они на неправильное разделение слов в тексте.	0	показать в тексте
Белые знаки Количество символов, выделенных белым цветом, пожалуйста, проверьте не используются ли белые символы вместо пробела, соединяя слова (в отчете подобия система изменяет автоматически цвет букв в черный, чтобы их сделать видимыми).	0	показать в тексте

Заимствования по списку источников

Просмотрите список и проанализируйте, в особенности, те фрагменты, которые превышают КП №2 (выделенные жирным шрифтом). Используйте ссылку «Обозначить фрагмент» и посмотрите, являются ли выделенные фрагменты повтояющимися короткими фразами, разбросанными в документе (совпадающие сходства), многочисленными короткими фразами расположенные рядом друг с другом (парафразирование) или обширными фрагментами без указания источника ("криптоцитаты").

10 самых длинных фраз (1,52 %)

Десять самых длинных фрагментов найденых во всех доступных ресурсах.

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1	Development of newborn children clinical treatment process automation system *International IT University (Компьютерная инженерия и информационная безопасность)*	Мадина Умирбекова, Арман Киалбеков, Батыржан Жетписбаев	28	0,32 %
2	Улучшение условий труда на основе аттестации рабочих мест Karachaganak Petroleum Operating b.v *Satbayev University (ИХиБТ)*	Бекмухамбетова Асель Каиргалиевна	19	0,21 %