DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

RISK ASSESSMENT AND MANAGEMENT IN ENVIRONMENTAL ENGINEERING LABORATORIES TO DETERMINE BIOLOGICAL RISK FACTORS

by
Ayşenur BÖLÜKBAŞ

September, 2017
İZMİR

RISK ASSESSMENT AND MANAGEMENT IN ENVIRONMENTAL ENGINEERING LABORATORIES TO DETERMINE BIOLOGICAL RISK FACTORS

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Master of Science of
Occupational Health and Safety

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September, 2017
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M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"RISK ASSESSMENT AND MANAGEMENT IN ENVIRONMENTAL ENGINEERING LABORATORIES TO DETERMINE BIOLOGICAL RISK FACTORS"** completed by **AYŞENUR BÖLÜKBAŞ** under supervision of **PROF. DR. O. ALPARSLAN ERGÖR** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ACKNOWLEDGEMENTS

I am grateful to my supervisor, Prof. Dr. O. Alparslan ERGÖR, for his advices to the subject. I am extremely thankful and indebted to his for sharing expertise, and sincere and valuable guidance and encouragement extended to me.

I express my warm thanks to Assoc. Prof. Dr. Görkem AKINCI and Dr. Elif Duyuşen GÜVEN for their support.

I wish to express my thanks to M.Sc. Gökçe GÜNEY for being such a nice roommate and accompanying me all the way through graduate studies.

I would like to thank the Dokuz Eylül University Occupational Health and Safety Team for sharing their knowledge and experience with me.

I am thankful to my best friends, Meltem Nihan AKSOY, Melody SHOARGHAFFARİ, Betül DİLER and Gülten GÖKAYAZ, for their friendship and support.

I would also like to thank my family. They were always supporting me and encouraging me with their best wishes. Especially I would like to thank my nephews, Arda and Alp BÖLÜKBAŞ, for that make me smile and their endless love.

Ayşenur BÖLÜKBAŞ

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ABSTRACT

Occupational accidents and occupational diseases increase expeditiously. In parallel with this situation, awareness of people about occupational health and safety increases and the importance of taking necessary precautions are seen clearly. The significant obligations have been become valid by the change in the legislation. Thereafter, public institutions have to establish and apply occupational health and safety systems. In departments consisting of laboratories, like environmental engineering, occupational health and safety has more importance. Hazards in work environment and risks caused by the hazards have to be defined to provide safety for employee and students.

Biological materials like soil, wastewater, wastewater sludge and solid waste are studied directly in environmental engineering laboratories. Hence, determining the biological risk factors with other types of risks in the environmental engineering laboratories and understanding the importance of the biological risk factors among other risk factors are aimed. DEU risk assessment method and FMEA have been used to determine risks in the laboratories. Moreover, surveys were applied to workers and laboratory managers.

As a result, it was determined that the DEU risk assessment method evaluates existing situation. It considers the working hours of the workers with hazard and the positive effect of taken measurements. On the other side, FMEA evaluates the risks as there is no precaution. Moreover, the workers have the highest work perception for workplace conditions. In a similar manner, workplace problems were found as very important in both risk assessments. 60 percent of the workers have high risk perception for biological and ergonomic risks. Moreover, biological and ergonomic risks were evaluated as important with DEU risk assessment method and as very important with FMEA. The numbers of workers having high and low risk perception

for physical, chemical and psychological risks is equal. To conclude, the workers have awareness about the risks in their workplaces but not all of them have. The reason can be that they don’t know what the risks are or they suppose that they have knowledge about risks. As a result of the risk assessment, it was found that chemical and biological risks have more importance than others in the environmental engineering research laboratories.

Keywords: Occupational health and safety, laboratory safety, environmental engineering research laboratories, risk factors, biological risks, risk assessment, failure mode and effect analysis (FMEA)

ÇEVRE MÜHENDİSLİĞİ ARAŞTIRMA LABORATUVARLARINDA BİYOLOJİK RİSK ETMENLERİNİN TESPİTİ İÇİN RİSK ANALİZİ VE YÖNETİMİ

ÖZ

İş kazaları ve meslek hastalıkları hızlı bir şekilde artmaktadır. Buna paralel olarak insanların iş sağlığı ve güvenliği farkındalıkları da artmakta ve gerekli önlemlerin alınmasının önemi açıkça görülmektedir. İş sağlığı ve güvenliği ile ilgili mevzuat değişerek önemli zorunluluklar gelmiştir. Artık kamu kuruluşlarının da iş sağlığı ve güvenliği sistemini kurmaları ve uygulamaları zorunlu hale gelmiştir. Bünyesinde laboratuarlar bulunduran bölümlerde iş sağlığı ve güvenliği önlemleri daha büyük bir öneme sahiptir. Çalışanların yanı sıra öğrencilerin de güvenliğini sağlamak amacıyla öncelikle ortamda bulunan tehlikeler ve bunlardan kaynaklı risklerin belirlenmesi gerekmektedir.

Çevre Mühendisliği laboratuvarlarında direkt olarak toprak, atıksu, katı atık, atıksu çamuru gibi biyolojik materyaller ile çalışılmaktadır. Bu sebeple bu tez kapsamında Çevre Mühendisliği Laboratuvarlarındaki biyolojik risk etmenlerinin belirlenebilmesi ve biyolojik etkenlerin diğer etkenler arasındaki önemi ve yerinin anlaşılabilmesi amaçlanmıştır. DEÜ risk değerlendirme yöntemi ve HTEA laboratuvarlardaki riskleri belirlemek için kullanılmıştır. Ayrıca çalışanlara ve laboratuvar yöneticilerine anket uygulanmıştır.

Sonuç olarak, DEÜ risk değerlendirme yönteminin var olan durumu değerlendirdiği tespit edilmiştir. Bu yöntem çalışanların tehlikeye maruz kaldıkları süreyi ve alınan önlemlerin olumlu etkisini dikkate almaktadır. Diğer bir yandan, HTEA riskleri sanki hiçbir önlem yokmuş gibi değerlendirmektedir. Ayrıca çalışanlar en fazla çalışma koşulları için yüksek risk algısına sahiptirler. Benzer şekilde çalışma koşulları sorunları her iki risk değerlendirme yöntemiyle çok önemli olarak değerlendirilmiştir. Çalışanların yüzde 60'ı biyolojik ve ergonomik riskler için yüksek algıya sahiptir. Bunun yanında biyolojik ve ergonomik riskler DEÜ risk değerlendirme yöntemiyle önemli, HTEA ile çok önemli olarak

değerlendirilmişlerdir. Fiziksel, kimyasal ve psikososyal riskler için düşük ve yüksek algıya sahip olan çalışan sayıları eşittir. Özetle çalışanların riskler hakkında bir farkındalıkları vardır ancak bu bütün çalışanlar için geçerli değildir. Bunun nedeni çalışanların risklerin neler olduğunu bilmemesi veya riskleri bildiklerini varsaymaları olabilir. Risk değerlendirmenin sonunda kimyasal ve biyolojik risklerin çevre mühendisliği laboratuvarlarında daha fazla öneme sahip oldukları anlaşılmıştır.

Anahtar kelimeler: İş sağlığı ve güvenliği, laboratuvar güvenliği, çevre mühendisliği araştırma laboratuarları, risk etmenleri, biyolojik riskler, risk analizi, hata türü ve etki analizi (HTEA)

CONTENTS

Pages

LIST OF FIGURES

Pages

LIST OF TABLES

Pages

CHAPTER ONE
INTRODUCTION

1.1 Occupational Health and Safety

Occupational health and safety is a field of study consisting of many special subjects. The main aims of it are:

- Providing and maintaining optimum conditions for physical, mental and social well-being of workers,
- Preventing workers from adverse effects of working conditions,
- Protecting workers from risks resulting from adverse effects,
- Providing a working area adjusted with respect to physical and mental needs of workers,
- Adjusting of work to workers (International Labour Organization (ILO), n.d).

In other words, occupational health and safety aims the social, mental and physical well-being of workers (International Labour Organization (ILO), n.d).

Occupational health and safety programs should involve both employee and employer in order to provide effectiveness and sustainability. Moreover, it should consist of occupational medicine, industrial hygiene, toxicology, engineering safety, ergonomics, psychosocial health etc. The significant issue is that both health and safety must be considered (International Labour Organization (ILO), n.d).

The extent of the working area is wide; in other words, it can be anywhere workers carry out their work. It can be a factory, a school or a street. In general, the definition of boarders for working area is possible with legislative regulation. In Turkey, there are a lot of laws, regulations and statements; the most important one is 6331 Occupational Health and Safety Law.

The aim of this law is providing occupational health and safety in workplaces and defining duties, authorizations, responsibilities, rights and obligations of employer

and employee in order to improve health and safety conditions. The law encompasses all works and workplaces belonging to private and public sectors and is applied all workers including employers, representatives of the employer, all workers, trainers and apprentices. 6th and 7th articles encompass employing occupational health and safety expert, occupational physician, occupational nurse and other health workers, ensuring coordination between these employees, providing place and equipment to carry out occupational health and safety services and supporting services. These articles have been valid for private sector having workers more than 50 since 2013. However, they will be valid for public sector on 1st of July 2020. Therefore, the occupational health and safety services will be a part of public workplaces such as universities. It is a complicated issue for universities having research laboratories. Research laboratories are places that there are several experimental settings and instruments which have different hazards. Hence, research laboratories require more attention.

It is possible to mention general hazards in research laboratories; however, each science field has different hazards with similar ones. For example, the real hazards which can cause risks in the environmental engineering laboratories aren't known in detail. Generally chemical risks in these laboratories are defined; however, precautions are still insufficient. But there are not only chemical risks; there are also other risks such as biological, physical, ergonomic and psychosocial risks. Especially, biological risks are important because the main materials handled in the environmental engineering laboratories are wastewater, sludge of wastewater, soil, water and solid wastes which are biological and can cause several diseases.

However, risk types cannot be assessed alone; they should be considered together by observing their effects on each other. In order to provide assessment and management consisting of all risks, laboratory safety program should be used.

1.2 Laboratory Safety

The laboratory is a workplace including several potential hazards such as corrosive, flammable, reactive and toxic substances, biological hazards, radioactive hazards, cryogens, pressure and vacuum systems, glassware, electrical hazards, mechanical hazards and other physical hazards in order to carry out scientific research and experiments (University of Toronto, 2012).

Laboratory workers are generally subjected to these potential hazards like chemical, biological, physical, radioactive and psychosocial hazards (Occupational Safety and Health Administration (OHSA, 2011).

In USA The Laboratory Safety and Chemical Hygiene Plan is required by the Occupational Safety and Health Administration (OSHA) for providing safety and healthy environment in the university research laboratories (Northwestern University, 2015).

In university research laboratories an effective and successful laboratory safety program is not only about an annual audit. A laboratory safety program is an ongoing process consisting of daily responsibility of every worker in order to provide a safe and healthy working environment. The main aim of laboratory safety programs should be protecting employees and students from hazardous materials and unsafe work conditions (Foster, 2004).

In order to provide effective laboratory safety program;

- Laboratories must be constructed properly or adjusted according to safety rules,
- The responsibilities of workers and supervisor must be defined,
- The necessary labelling of materials and equipment must be conducted,
- The training and education of workers must be provided,
- The personal protective equipment must be supplied and ensured usage by the workers,

- The procedures about safety must be written and posted in the laboratory,
- The necessary and effective waste management system must be settled especially for hazardous and biological wastes,
- The system to report accidents and near miss events must be carried out,
- The emergency procedure must be prepared and documented,
- The implementation and effectiveness of the program must be monitored (University of Toronto, 2012).

1.3 Risks

The hazard is defined in 6331 Occupational Health and Safety Law as that harm and damage potential caused by internal and external factors which can affect workers and workplace. On the other hand, the risk is explained as loss, damage, injury and other harmful effects caused by the hazard.

The Department of Microbiology Reference Laboratories defined the hazard like that anything can harm workers, other people, laboratory and environment in the Laboratory Safety Manual. The risk is described as the probability of damaging result caused by a hazard (The Department of Microbiology Reference Laboratories, 2014).

There are mainly five types of risks like physical, chemical, biological, ergonomic and psychosocial which can cause work accident, occupational disease or near miss events.

1.3.1 Physical Risks

Heat, electricity, compressed gases, low and high temperature, hazards causing slip and fall and noise are some physical hazards. Moreover, ionizing and non-ionizing radiation are other physical hazards (The Department of Microbiology Reference Laboratories, 2014).

Low and high heat can cause damage on the skin. High heat results in burns. In laboratory six types of burns caused by bowl out, heat contact, fire, electricity, chemical and radioactive can be observed. Bowl out burns can be resulted from autoclave. Contact burns can be caused by autoclave or by water bath. Fire burns can be result from open fire such as spirit stove. Frostbite and freezing connected with low temperature can be observed under -10 ^{o}C if liquid nitrogen, dry ice and deep-freezer are used in the laboratory (The Department of Microbiology Reference Laboratories, 2014).

Equipment working with electricity is dangerous due to causing both fire and electric shock. The reasons of electrical risks can be that:

- Over capacity
- Wrong usage
- Inadequate/improper maintenance
- Damaged installations (The Department of Microbiology Reference Laboratories, 2014)

In laboratories generally three types of compressed gas are used like:

- Liquefied gases (Propane, carbon dioxide etc.)
- Non-liquefied gases (Oxygen, nitrogen etc.)
- Melt gases (Acetylene)

These gases must be stored stably and if possible out of the laboratory. The control of pressure regulator must be done regularly (The Department of Microbiology Reference Laboratories, 2014).

Split and falls can be caused by wet and rough floors, shelves, cabinets and devices mounted improperly, unorganized cables and pipes. Moreover, inadequate lighting can cause falls in the laboratory (The Department of Microbiology Reference Laboratories, 2014).

Noise is loud and undesired voice. Noise can result in hearing loss, mental illnesses and other health problems by depending on sound intensity, exposure time

and exposure frequency. The noise exposure limit in one working day (8 hours) was determined as 80 dB(A). Over 80 dB(A) noise can cause hearing loss. Moreover, long time exposure under 80 dB can cause hearing loss. Decreasing in productivity can be result from noise. In laboratory, there are many noise sources such as fume hood, centrifuge, deep freezer and other devices (The Department of Microbiology Reference Laboratories, 2014).

Some occupational diseases can be seen in the Table 1.1.

Table 1.1 Some physical hazards and risks (Zencir, 2014)

Hazards	**Risks**
• Electricity and electrical devices • Electromagnetic field • Lighting • Indoor air • Ventilation • Hot-cold-moisture • Slippery floor • Hot equipment • Compressed gases • Cuts (glassware, needle etc.)	• Cancer • Respiratory tract diseases • Accidents • Dermatologic diseases • Eye diseases • Psychological diseases • Burns • Falls • Electric shock • Sharp object injuries • Falls

1.3.2 Chemical Risks

In laboratories several chemicals such as acids, bases, solvents, dyes, buffer solutions, mediums, disinfectants, surface detergents and compressed gases are used. Compressed gases can be categorized as both physical and chemical hazard (The Department of Microbiology Reference Laboratories, 2014).

Laboratory chemicals consist of carcinogens, toxins which affect the liver, kidney and nervous system, irritants, corrosives, sensitizers and agents affecting lungs, skin, eyes or mucous membranes (Occupational Safety and Health Administration (OHSA), 2011). Local and systemic effects of chemicals can be observed together and also the effects can be acute or chronic. Moreover, chemicals can damage the devices and laboratory. Besides these effects chemicals can be dispersed to water and

soil via sewage system (The Department of Microbiology Reference Laboratories, 2014).

Safety Data Sheets are important for chemicals because of that they include information about potential hazards and safety precautions of these chemicals. Moreover, they contain the properties of the chemicals, exposure ways, handling procedures, chemical waste management etc. The chemicals can be exposure via respiration, skin or oral (The Department of Microbiology Reference Laboratories, 2014).

Corrosive chemicals such as strength acids and alkaline, dehydrated agents and oxidizing agents can damage the materials and tissues. The degree of damage depends on the exposure time and part on the body.

Oxidizing chemicals are chromic acid and chromates, nitric acid and nitrates, perchloric acid and perchlorates, permanganates, peroxides and hypochlorite. Oxidizing chemicals provide oxygen and ease burning and cause ignition of flammable materials easily. Moreover, without a heat source they can cause fire with flammable and explosive materials. They can form toxic gases because of reaction with other chemicals (The Department of Microbiology Reference Laboratories, 2014).

Toxic chemicals are agents being harmful to human and environment by taking via respiration, oral and skin. Toxic chemicals can affect fast and seriously or their effect can be long-term (The Department of Microbiology Reference Laboratories, 2014).

Carcinogenic chemicals can cause cancer by depending on the genetic of person, dosage and exposure time and other environmental factors. Vapors of strength acids, formaldehyde, ethylene oxide and compounds of cadmium are carcinogenic chemicals (The Department of Microbiology Reference Laboratories, 2014).

Mutagens which damage chromosome and teratogens which cause damage on fetus are important chemicals used in the laboratory (The Department of Microbiology Reference Laboratories, 2014).

Irritants can cause reversible damage on human tissue. Several organic and inorganic chemicals can be categorized as irritant. Formaldehyde and iodine can be examples for irritants. Allergens can cause allergic reaction on the normal tissues. Chrome, nickel, latex, aldehyde derivatives and phenol derivatives are allergens (The Department of Microbiology Reference Laboratories, 2014).

Combustible and flammable chemicals can be divided their flash points. Most of the laboratory fires are caused by flammable solvents such as alcohol, ether and chloroform (The Department of Microbiology Reference Laboratories, 2014).

Reactive chemicals are sensitive to shock, pressure and heat increase and can explode. They can form combustible or toxic gases by reacting with water (The Department of Microbiology Reference Laboratories, 2014).

Explosive chemicals can release huge thermal and physical energy. Nitrogen compounds, chlorate and perchlorate, nitrogen compounds, picrate, peroxides and azides are some explosive materials used in the laboratory. Some chemical hazards and risks can be seen in the Table 1.2 (The Department of Microbiology Reference Laboratories, 2014).

Table 1.2 Some chemical hazards and risks (Zencir, 2014)

Hazards	**Risks**
• Disinfectants with alcohols • Ethylene oxide • Glutaraldehyde • Chemical wastes • Compressed gases • Latex • Mercury • Other chemicals	• Allergy • Asthma • Dermatological diseases • Liver toxicity • Cancer • Teratogenic and mutagenic effect • Headache • Eye diseases • Respiratory tract diseases • Fatigue • Angriness • Poisoning

1.3.3 Biological Risks

Many laboratory workers are exposed to biological hazards. These hazards can be found in blood and body fluids, culture specimens, body tissues etc. (Occupational Safety and Health Administration (OHSA), 2011). For environmental research laboratories the risks can be caused by wastewater, wastewater sludge, solid wastes and microbiological materials.

The biological factors threatening human health are parasites, fungi, bacteria, viruses, prions and toxins of microorganisms. People can be affected by biological factors via respiration, skin (by contact and from cuts) and oral. For example biological factors caused by centrifuge can affect people as aerosol, or they can enter the body via mucosa by splashing, or from cuts caused by sharp objects. Especially in the microbiology laboratories the biological factors can enter the body during usage of sharp objects, loop and pipette, processing of samples and cultures or by spill and splash. According to a research done by Belgium Public Health Institute, between 2000-2012, infections caused by laboratory infected people with 46 % aerosol, 28 % cuts, 20 % oral and 6 % contact. The infections caused by laboratory resulted in due to disobeying laboratory rules for 73 % and human mistake for 24 % (The Department of Microbiology Reference Laboratories, 2014).

According to another research done in 1979, during 30 years more than 5000 laboratories were analyzed and 3921 cases were reported. Over 80 % of these cases infections caused by aerosol were determined and the death ratio was found as 4.2 %. In order to handle biological risks, biological laboratories were categorized as in the Table 1.3 (Ortatatlı, Kenar, Yaren, & Karayılanoğlu, 2005).

Table 1.3 Biosafety levels (Ortatatlı, Kenar, Yaren, & Karayılanoğlu, 2005)

Biosafety level	**Definition**
1	The possibility causing diseases is very low. For example teaching microbiology lesson in elementary schools. Working with microorganisms like Bacillus subtilis, Naegleria gruberi, E. coli etc.
2	Causing intermediate hazard and treatable diseases. Working with microorganisms like salmonella, toxoplasma, hepatitis B viruses etc.
3	Can cause lethal diseases infected via respiration, huge financial loss, working with biological agents having diagnosis and treat. Mycobacterium tuberculosis, Shigella dysenteria type 1 and Echinoccus granulosus can be given as examples.
4	Can cause untreatable diseases, protecting ways are unknown and infection by contact and aerosol. Ebola and crimean-congo hemorrhagic fever viruses are examples.

Biological agents can cause Hepatitis B, Hepatitis C, HIV(AIDS), tuberculosis, brucellosis, respiratory system diseases, crimean-congo hemorrhagic fever and anthrax. (Zencir, 2014)

Moreover, there are other biological hazards such as snakebites and scorpion stings. In hot and temperate zones, snakebites and scorpion stings may be important hazards for defined categories of workers such as agricultural workers, woodcutters, building and civil engineering workers, fishermen, mushroom gatherers, snake charmers, zoo attendants and laboratory workers employed in the preparation of antivenom serums. Furthermore, snakebites and scorpion stings could be possible hazards during sampling in the open area (International Labour Office (ILO), n.d).

1.3.4 Ergonomic Risks

In industrialized countries, work related muscle-skeletal disorders are common health problems. They result in decreasing productivity, high working day loss and unwanted economic outcomes. Work related muscle-skeletal disorders result from repetitive and forcing motions, bad body position during working and poorly designed equipment. These disorders generally affect hands and waist and can cause tendon stretch, tendinitis, herniated disk, cervical disc hernia, calcification and nerve entrapment (Özcan, 2011).

Work related muscle-skeletal disorders affect not only physical conditions of the workers but also psychological state and so work productivity. Moreover, these disorders increase the health spending. Providing education, ergonomic equipment and exercises are some example of precautions for these disorders (Özcan, 2011).

Some routine laboratory procedures such as pipetting, using microscopes and keyboarding are repetitive motions. Furthermore, standing and working in bad positions in front of the devices or fume hoods can cause ergonomic problems (Occupational Safety and Health Administration (OHSA), 2011).

In summary, the aims of the ergonomics are balancing the abilities of the workers and job requirements, providing occupational health and safety, increasing productivity and quality of work (Karakoç, 2014).

1.3.5 Psychosocial Risks

Problems with coworkers and superiors, problems with customers or students, making decision problems, oral violence, working hard, time constraint, mobbing, night and weekend works can cause psychological problems and stress. Psychosocial problems can result in accidents and muscle-skeletal disorders hence the work can retard or the productivity and efficiency of workers can decrease.

Some psychosocial hazards and risks can be seen in the Table 1.4.

Table 1.4 Some psychosocial hazards and risks (Zencir, 2014)

Hazards	**Risks**
Shift and over work load Stresses related work life Aging Stresses caused by new technologies Depression Lack of sun light Abusing by coworkers Mobbing Working alone Drug addiction	• Mental disorders • Burnout syndrome • Chronic sleeplessness • Fatigue • Migraine • Suicide • Lack of concentration • Amnesia

1.4 Risk Assessment

Risk assessment is an analytic method used to estimate the probability and results of risks with respect to human health and safety also environment and to define the precautions for risks. The risk assessment methods depend on the decision making procedure and work type. These methods can be Hazard and Operability (HAZOP), Fault Tree Analysis (FTA), Event Tree Analysis (ETA) and Failure Mode Effect and Analysis (FMEA) (Silvianita, Khamidi, & John, 2011).

In other words, risk assessment is a systematic way to define possible accidents and estimate the severity of the hazards. Risk assessment is a detailed analysis to define different risks. Generally, the results of risk analysis have some uncertainty due to the uncertainty in the data and estimations of the probabilities or frequencies. It is difficult to estimate the probability of an accident especially if there is no or rare data. In order to obtain accurate results, the primary data should be as complete and right as possible. The risk assessment methods can be formed with respect to purpose, result, system description etc. (Alverbo, Nevhage, & Erdeniz, 2010)

1.5 Precautions for Occupational Health and Safety

In order to protect health of workers, there are some steps:

1. Determination of situation- defining risks
2. Defining risk-health relation (Affecting, dosage, route, limits etc.)
3. Determining groups under risk
4. Evaluation of protection systems, methods and tools
5. Analysis-assessment
6. Monitoring (Ergör, 2010)

Determination of risks is one of the important steps of the protection system for workers. Some criteria, indicators and tools are as following to define risks in work life.

- Epidemiology and its criteria
- Risk assessment methods (HAZOP, Fault tree etc.)
- Job exposure matrix (JEM), task exposure matrix (TEM)
- Threshold values
- Biological monitoring, workplace monitoring
- Records, surveillance
- Data (Ergör, 2010)

In order to protect workers from risk factors, there are different ways with respect to target. Generally below scheme shows the interference points for precautions (Ergör, 2010).

Risk factors ⟶ **Employee** ⟶ **Result**

There are three types of protection with regard to target. In primary protection, the target is risk factor. Removing factor, changing factor with less hazardous one, isolation and ventilation can be examples for primary protection. In secondary protection, the target is affected people, in other words employees. Personal protective equipment like mask, gloves and safety helmet, employment medical examination and periodical medical examination are examples for secondary protection. In tertiary protection, the target is result. Monitoring and improvement are tertiary protections (Ergör, 2010).

Protection measurements are also classified as engineering, administrative and personal. The precautions affecting the system and equipment are engineering measurements like ventilation and changing the system. On the other hand, the precautions like education, drill and regular maintenance are can be classified as administrative. The measurement such as personal protective equipment is personal precaution.

CHAPTER TWO
MATERIAL AND METHODS

Risk assessments have been conducted for the “Halle” building in Environmental Engineering Department of Dokuz Eylül University (Figure 2.1). There are Solid Waste and Soil Pollution Laboratory, Graduate Students Laboratory, Microbiology Laboratory (2 rooms), 2 rooms connected with Wastewater Sludge Laboratories, other 2 rooms, downstairs and upstairs open areas. 10 people work here actively and the number is changeable. The studies are carried out under the responsibilities of 5 academicians. The permission was taken from the Head of Halle, Assoc. Prof. Dr. Görkem AKINCI. The permission document can be seen in the Appendix-1.

Figure 2.1 The Halle building in Environmental Engineering Department

Solid Waste and Soil Pollution Laboratory consists of a fume hood, a drying oven, an incubator, cabinets for chemicals, vacuum equipment, spectrophotometer and other laboratory materials like glassware and plastic bottles (The figure 2.2). Graduate Students Laboratory comprises 2 incubators, a fume hood, an oven, water treatment system, biochemical oxygen demand determination system, water baths, jar test system, a calorimeter with an oxygen tube, two centrifuges, a shaker, a microwave oven, heaters, chemicals, other laboratory materials and systems for experiments

(The figure 2.3). Microbiology Laboratory has a fume hood, nitrogen tubes, a shaker, aquariums for fish acute toxicity test etc. (The figure 2.4). Other rooms and open areas include a few cabinets, shelfs not connected to the wall, several experiment setups etc. (The figure 2.5).

Figure 2.2 Solid Waste and Soil Pollution Laboratory

Figure 2.3 Graduate Students Laboratory

Figure 2.4 Microbiology Laboratory

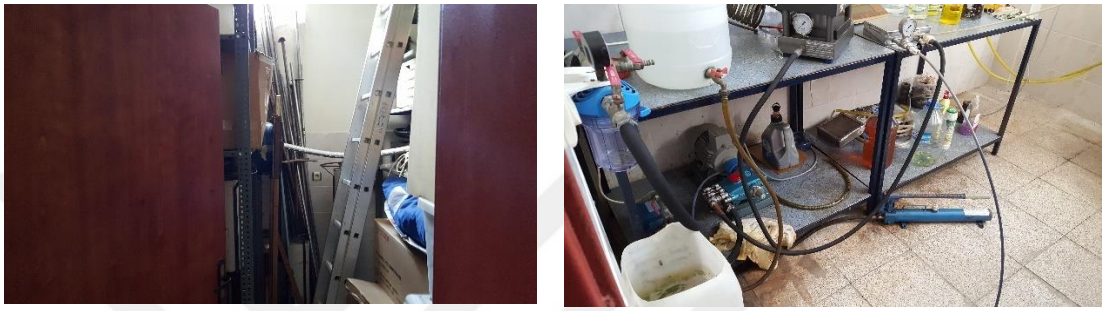

Figure 2.5 Other rooms in Halle

2.1 Methods of Risk Assessment

There is various risk assessment methods used for different sectors. Environmental research laboratories consist of varied hazards and risks and also there is a worker motion hence the risk assessment method must be based on workplace. Therefore, in the study the risk assessment method based on 5 x 5 matrices and Failure Mode and Effect Analysis (FMEA) have been chosen. The risk assessment method based on 5 x 5 matrix was modified with respect to daily dosage for workers and taken measurements like engineering, administrative and personal. The method has been developed by the Department of Workplace Health and Safety in the Hospital of Dokuz Eylul University (DEU) and also used in the Dokuz Eylul University Occupational Health and Safety Project. (See Appendix-2) Hence the applicability of the method has been proven and developing day by day. On the other hand, FMEA has been selected due to the detectability factor in order to observe the awareness of the workers.

Risk assessment is a part of the risk management system. The general process of the risk management system can be seen in the Figure 2.1.

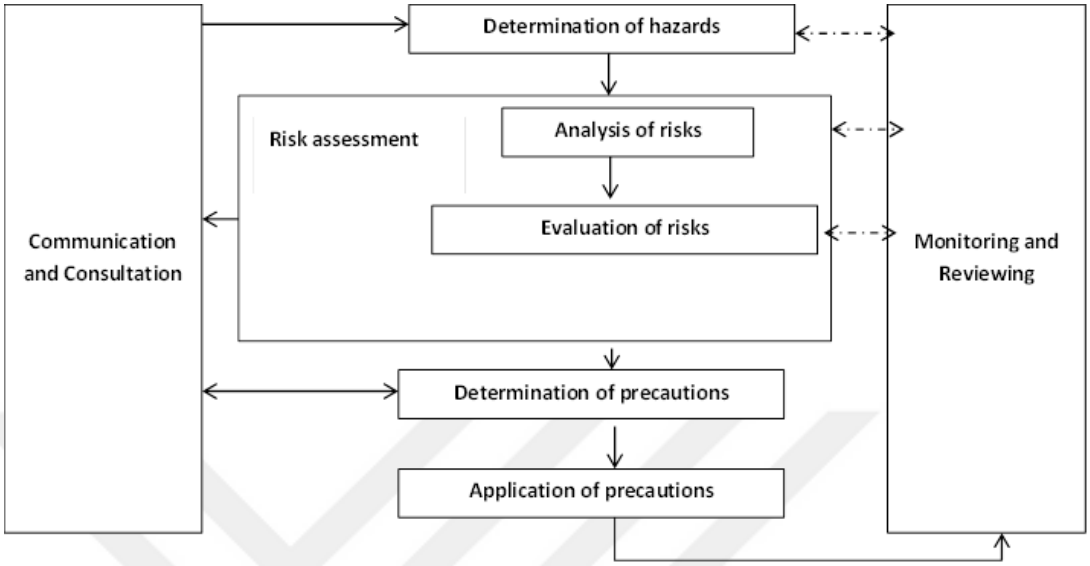

Figure 2.6 The process of the risk management system (Kahraman & Demirer, 2010)

2.1.1 DEU Risk Assessment Method

In 5 x 5 matrices severity and probability are important parameters. The probability defines the possibility of that the event occurs and the severity shows the results of the risk. The severity and probability degrees can be defined as in the Table 2.1.

Table 2.1 The levels of severity and probability

Level	**Severity**	**Probability**
5	Catastrophic/fatal	Almost certain
4	Major	Likely
3	Moderate	Moderate/possible
2	Minor	Unlikely
1	Negligible	Rare

After defining severity and probability, the daily dosage is chosen with respect to time during that worker is exposed in a day. The daily dosage levels are given in the Table 2.2.

Table 2.2 Daily dosage factors

Level	Factor
Very high	1
High	0.75
Medium	0.5
Low	0.25

There are different categorizations for the risk level. Generally, 3 or 4 color definitions are used. In the study, 5 colors were used to define the risk level. The table 2.3 shows the risk levels without applying taken measurement factor. The pre-risk point is found as that:

$$\text{Pre-risk point} = \text{Probability} \times \text{Dosage} \times \text{Severity} \quad (2.1)$$

Table 2.3 The risk levels without applying taken measurement factor

SEVERITY	PROBABILITY					
	5	4	3	2	1
5	25	20	15	10	5
4	20	16	12	8	4
3	15	12	9	6	3
2	10	8	6	4	2
1	5	4	3	2	1

In order to apply the taken measurements factors, firstly measurement level factors are defined as 0.11 if adequate, 0.33 if medium, 0.66 if inadequate and 0.99 if not. Then the below formulations are used.

$$\text{Engineering measurements} = 0.6 \times \text{measurement level factor} \quad (2.2)$$

$$\text{Administrative measurements} = 0.3 \times \text{measurement level factor} \quad (2.3)$$

$$\text{Personal measurements} = 0.1 \times \text{measurement level factor} \quad (2.4)$$

Measurement level factor for engineering measurements is multiplied with 0.6 because engineering applications are the most effective ones to prevent or decrease risks. As a result, the Table 2.4 is obtained.

Table 2.4 Factors of taken measurements

Measurement	Adequate	Medium	Inadequate	Non
Engineering	0.066	0.198	0.396	0.594
Administrative	0.033	0.099	0.198	0.297
Personal	0.011	0.033	0.066	0.099
Total	0.11	0.33	0.66	0.99

The final risk point can be calculated as following:

Final risk point= Pre-risk point x Taken measurement factor (2.5)

The risk levels with taken measurement factors can be observed in the Table 2.5.

Table 2.5 The risk levels with taken measurement factors

SEVERITY	PROBABILITY					
		5	4	3	2	1
	5	20.6-25	20.5	12.6	12.5	
	4	20.5				
	3	12.6	12.5		6.5	
	2		6.6	6.5		1.6
	1				1.6	0.1-1.5

After defining the risk level, the reaction type can be determined as in the Table 2.6.

Table 2.6 The risk levels and definitions

Color	Point	Final Point	Definitions
Green	1	0.1-1.5	The hazard exits but doesn't pose risk.
Blue	2-6	1.6-6.5	The hazard exits but the hazard is under control.
Yellow	7-12	6.6-12.5	The hazard can cause serious health problems and controlling is problematic.
Red	13-20	12.6-20.5	The hazard can cause quickly health problems, very serious, controlling is difficult.
Purple	21-25	20.6-25	The controlling of the hazard is important for the life of people, the results can be fatal, and the work has to be stopped.

To conclude, the process is done as following:

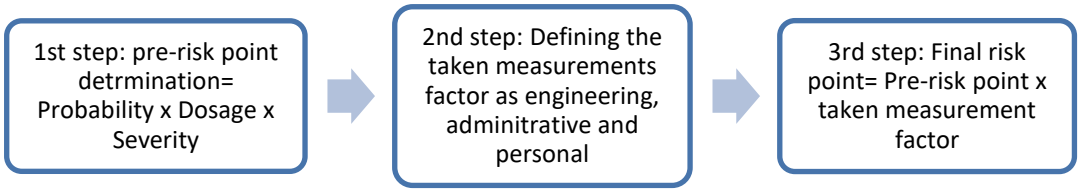

Figure 2.7 The process of determination of risk point

2.1.2 Failure Mode and Effect Analysis (FMEA)

FMEA is an analytic method used to define and eliminate faults or deviations in a system before causing a problem. It is a qualitative method and the results are shown in a table. The table shows the causes of failure, effects, probability, severity and detectability (Alverbo, Nevhage, & Erdeniz, 2010).

FMEA was chosen because of that it can analyze how system works, doesn't require high experience and can be used in all types of sector. Moreover, in contradistinction to other risk assessment methods it has detectability factor. FMEA can forecast the faults and prevent before occurring. Instead of taking measurements for all faults, it determines the faults having the biggest effects on the system and finds precautions for them (Kahraman & Demirer, 2010).

At first FMEA has been developed and started to use by American Army in 1949. They used FMEA to find the faults of system and equipment and to define the effects of them. Later on it has been used by NASA between 1960 and 1965 for moon travel programs. The method has been kept secret for a long time. The method has been used in USA aircraft industry between 1970-1975, was used in Ford Company in 1972, for computer production in 1975 and was used by Japanese NEC Company. It was accepted as general standard by Chrysler, Ford and General Motors in 1988. At the present time, it is an obligation in several quality management systems such as QS 9000, ISO/TS 16949 and ISO 9001:2000 (Kahraman & Demirer, 2010).

In FMEA, possible faults are determined, the effects of them are calculated and their detectabilities are found. Finally risk priority number (RPN) is calculated as following:

$$\text{RPN} = \text{Severity (S)} \times \text{Occurrence (O)} \times \text{Detectability (D)} \quad (2.6)$$

The general process of FMEA can be seen in the Figure 2.8.

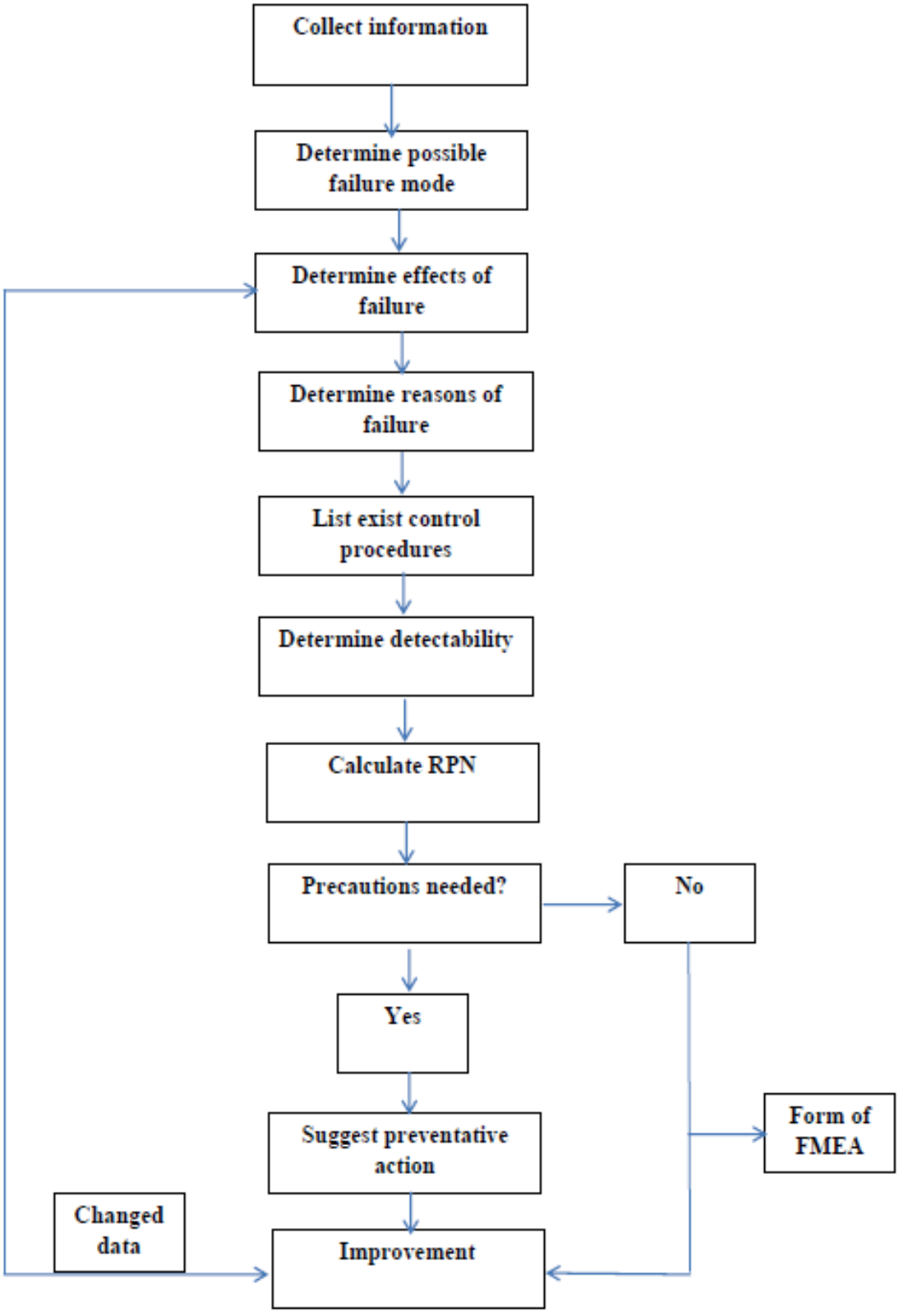

Figure 2.8 FMEA process

Occurrence (Probability) is defined as in the Table 2.7, severity can be determined as in the Table 2.8 & 2.9 and detectability can found as in the Table 2.10.

Table 2.7 The scores and probabilities of the occurrence (Kahraman & Demirer, 2010; Y. Jiang, H. Jiang, Ding, & Liu, 2015)

Occurrence	Probability	Score
Very high: Failure is nearly inevitable	More than 1/2	10
	1/3	9
High: Repeated failures	1/8	8
	1/20	7
Medium: Occasional failure	1/80	6
	1/400	5
Low: Relatively rare failure	1/2000	4
	1/15000	3
Very low: Failure unlikely to occur	1/150000	2
	Less than 1/150000	1

Table 2.8 The scores and effects of severity (Kahraman & Demirer, 2010)

Effect	Effect of severity	Score
High hazard without warning	Able to result in catastrophic effects and coming without warning	10
Hazard without warning	Can cause high damage and multiple deaths and coming without warning	9
Very high	Can damage the system completely and cause severe injuries, 3rd degree burns, acute death etc.	8
High	Can damage the equipment completely and cause death, poisoning, 3rd degree burns, acute death etc.	7
Medium	Affecting the performance of the system and causing loss of limb and organ, severe injuries, cancer etc.	6
Low	Causing fractures, permanent small disabilities, 2nd degree burns, concussion etc.	5
Very low	Causing traumatism, small cuts and bruises, contusion etc., small injuries and temporary ailment	4

Table 2.9 The scores and effects of severity (continued)

Effect	Effect of severity	Score
Slight	Retarding the system	3
Very slight	Causing confusion in the system	2
No effect	No effect	1

Table 2.10 The scores and probabilities of the detectability (Kahraman & Demirer, 2010)

Detectability	Probability of detectability	Score
Unable to detect the error	Impossible to detect the failure and its reason	10
Very slight	Very remote to detect the failure and its reason	9
Slight	Remote to detect the failure and its reason	8
Very low	Very low to detect the failure and its reason	7
Low	Low to detect the failure and its reason	6
Medium	Moderate to detect the failure and its reason	5
Medium-High	Moderately high to detect the failure and its reason	4
High	High to detect the failure and its reason	3
Very high	Very high to detect the failure and its reason	2
Absolute certainty of detecting the error	Absolutely certain to detect the failure and its reason	1

After defining occurrence, severity and detectability, RPN is calculated and evaluated according to the Table 2.11.

Table 2.11 Evaluation table of RPN (Kahraman & Demirer, 2010)

RPN score	Precaution
RPN<40	No need for precaution
40≤RPN≤100	Precaution can be taken
RPN>100	Precaution must be taken

2.2 Surveys

The application of risk assessment is a subjective procedure and depends on the abilities and experience of the evaluator. Hence in order to see different perspectives of the workers surveys are important. Especially the workers knowing the process and workplace can be helpful for the evaluator.

In the study to find out the risks and understand the awareness of the workers a survey was applied and to learn the processes of the laboratories a different survey was applied to the managers of the laboratories. The surveys applied can be seen in the Appendix-3 &4.

2.2.1 Questions of Survey

In the survey applied to the workers have four parts in Turkish. First part consists of 26 questions and the answers can be like that: never, rarely, sometimes, often and always. The questions of the first part as following:

- How often do you have problems with electrical system during your work?
- How often are you exposed to noise and vibration during your work?
- How often does dust/vapor/gas occur during your work?
- Do you have to hold chemical materials by hand during your work?
- Do you use compressed gas during your work?
- How often do you use fume hood during your work causing dust/vapor/gas?
- How often do you contact with biological factor during your work?
- How often do you have sharp object injury?
- Do biological factors splash to your eyes?
- How often do you work on foot while work?
- How often do you work on the sitting situation while work?
- How often do you lift heavy objects while work?
- How often do you use devices having a screen during your work?
- Do you have time constraint about your work?
- Do you have to work hard?

- Are you exposed to physical violence during your work?
- Are you exposed to oral violence during your work?
- How often do you have communication problems with students?
- How often do you have problems with your colleagues?
- Do you have making decision problems?
- Do you have problems with your superior?
- Do chemicals spill during your work?
- How often do you work at night/on weekend?
- Do you have mobbing during your work?
- Do you eat/drink in the workplace?
- Do you use personal protective equipment (Gloves, goggles, mask etc.) during your work?

Second part contains 11 statements and the answers are like that: certainly don't agree, partly don't agree, partly agree and absolutely agree. The statements of the second part as following:

- Cleaning/hygiene of the workplace are enough.
- Heights of the bench/tables are suitable for you.
- Chairs which you sit while working are ergonomic.
- Lighting of the workplace is adequate.
- Temperature of the workplace is proper.
- The workplace is organized.
- Necessary precautions for chemical accidents are taken.
- The number of workers is enough.
- Resting areas are enough.
- Bathroom/toilet/hand washing utilities are adequate and clean.
- Ventilation of the workplace is adequate.

Third part is to learn which biological material workers use. The next question is asked.

- Which sample/s do you work? Answers: Wastewater, wastewater sludge, solid waste, microorganisms and soil.

Last part includes informational questions to learn workplace and procedures in detail. The 17 questions asked are as following:

- Who cleans the workplace?
- If you clean the workplace which detergents/disinfectants do you use?
- After experiments/analysis with which detergents/disinfectants do you clean experiment equipment?
- Which type of gloves do you use?
- Did you have an allergic reaction to latex gloves?
- In your studies which chemicals do you use? (Acids, solvents, mercury, lead, tin, iodine etc.)
- Do you use glue/rust solvent/silicone etc.?
- Do Material Safety Data Sheets of used chemicals/detergents/disinfectants exist in your workplace?
- Did you have an accident while work?
- Did you get poisoned because of work materials or workplace?
- Which type of compressed gas tubes do you use during your work?
- Did you get occupational health and safety training?
- Did you undergo medical check-up before starting to work?
- Did you get emergency and fire training and attend a drill?
- Do you know first aid and fire contact peoples of the building?
- Are there emergency telephone numbers and instructions visibly in workplace?
- Do safety, warning and emergency exit signs exist in workplace?

2.2.2 Evaluation Methods of Surveys

The surveys were applied to 10 workers and 3 laboratory managers. After application, the results were organized with Microsoft Excel. In order to evaluate statistically, SPSS program of IBM has been used. There were two parts in the

survey and the answers of first part can be never, rarely, sometimes, often and always and the answers of second part can be absolutely agree, partly agree, partly don't agree and certainly don't agree.

After applying SPSS, the maximum risk perception was calculated each risk groups. For example, the workers could give maximum 5 point for a question in the first part and if there are 3 questions for a defined risk group, the maximum risk perception can be 15. SPSS gave the mean values and the percentages of high and low risk perception were calculated according to mean value.

CHAPTER THREE
RESULTS AND DISCUSSION

3.1 Results from Risk Assessments

It is important to mention that the researcher has taken the occupational health and safety education and she is an occupational health and safety specialist. The results were obtained with respect to the subjective investigation of the researcher as a matter of course. The risk assessments were carried out for the laboratory building named Halle which consists of mostly laboratories used for experiments and analyses.

3.1.1 Results of DEU Risk Assessment Method

Physical, chemical, biological, ergonomic, psychosocial risks, accidents, safety precautions, working conditions and biological/microbiological/chemical wastes have been evaluated with risk assessment method of DEU.

If we look at the general view of the laboratories, the following results were obtained. Electricity-electromagnetic field as physical risk was found as having important priority; hence the hazard can cause serious health problems and controlling can problematic. Precautions such as giving breaks and buying improved equipment have to be taken.

Latex gloves as chemical risk are other problematic risks. On the other hand, flammable- explosive chemicals like oxygen, nitrogen tubes, chemical mixtures and fire extinguisher were found as having very important and the hazard can cause quickly health problems, very serious, controlling is difficult. Hence the precautions have to be taken as soon as possible. These precautions could be storing the chemicals according to their hazard categories, storing the oxygen and nitrogen tubes properly, putting fire extinguisher to a proper place and supplying nitrile gloves instead of latex ones.

Working with sharp objects, being exposed respiration-droplet-aerosol, working with wastewater, wastewater sludge, solid waste, microorganisms and contaminated soil were obtained as important biological risks which affect during analyses and experiments. These risks can cause important health problems and controlling them is problematic. The studies with these biological hazards must be done under the fume hood, masks and gloves must be wore. Moreover, these hazards must be stored in proper conditions.

Bad body position was found as important risk for many laboratories; besides, working on the sitting situation, working with devices having screens, reflecting-shining and thermal comfort are important risks for office. The necessary precautions such as supplying proper screen equipment and buying ergonomic chairs should be taken.

Falling due to unorganized workplace and wet floor, contacting with biological factors, forcing muscle-skeletal system, hitting by object, poisoning due to chemicals, wastes and fume hood, burning were determined as possible accidents having important effects. To prevent these accidents, the workplace must be organized according to work, chemicals and wastes must be stored properly, the maintenance of fume hood must be done. In addition, electrical accidents and explosion were defined as serious accidents having very important effects and requiring important precautions. For preventing electrical accidents, electric system must be changed.

Working fast and hard is important psychosocial risk because of time constraint and over capacity work. Moreover, oral violence, communication problems with students and coworkers, making decision problems and superior-subordinate relation problems were determined as possible psychosocial risks. In order to prevent psychosocial risks, the occupational health and safety education is important. The education must be given to all workers and managers.

Safety precautions for all laboratories are inadequate and the workers haven't attended any training and drill. Cleaning of the laboratories and toilets are inadequate and there is no dressing room and resting area. Furthermore, standard protection is inadequate and there is no continuous supply for personal protection equipment. Working after shift and at weekends is possible. In order to provide hygienic workplace more employees are needed. Drinking and eating in the laboratories are possible. Ventilation is also inadequate to provide proper temperature and clean air.

There are biological, microbiological and chemical wastes in the laboratories. Because the samples analyzed in the laboratories are already waste and chemicals are used very often to analyze them. There is no proper waste management system but improvements are carried out. The waste management system must immediately set up to prevent any problem from these biological and chemical hazards.

There are 8 workplaces and risk assessments were applied to all of them. The results of DEU risk assessment methods can be seen in the Appendix-5.

As a result, as it can be understood easily that the occupational health and safety education must be given properly and periodically; moreover, necessary emergency drills must be carried out while taking other necessary measurements. Furthermore, students and new workers must be given education before starting to work in the laboratories.

3.1.2 Results of FMEA

Failure modes such as mechanic, chemical, biological, radiation, thermal, electric, fire and explosion, working environment, human related hazards and general hazards have been evaluated with Failure Mode and Effect Analysis.

In mechanic failure modes, noise which can cause stress and equipment which can cause injuries as result of accidents were evaluated as very serious so precautions

have to be taken. These precautions could be supplying new technology equipment, using noise barriers and personal protective equipment etc.

Detergents and disinfectants were evaluated as important. They have important effects such as allergic reactions and poisoning as a result of not using quality detergents and disinfectants, not taking necessary precautions, inexperienced workers and lack of training. Hence precautions can be taken such as education and proper storage. On the other hand, allergens like latex gloves, corrosive materials, environmentally hazardous materials, irritants, acids, solvents and toxic materials have very serious importance because necessary precautions haven't been taken, usage of fume hood is not common and storage conditions are not proper. Therefore, precautions must be taken as soon as possible. These precautions are giving education about usage of the fume hood and chemicals, storing chemicals with respect to their hazard category, substitution of latex gloves with nitrile ones.

Biological failure modes like microorganisms, respiration-droplet-aerosol, wastewater, wastewater sludge, solid waste and soil have serious priority since they can cause infectious disease. The proper storage must be supplied for these samples, the necessary education for biological hazards must be given and usage of personal protection equipment must be encouraged.

Electromagnetic field as radiation failure mode is very significant for all workplaces and ultraviolet is very important failure mode in microbiology laboratory and upstairs open area. Therefore, the system working with ultraviolet must be isolated and necessary personal protection equipment must be supplied to workers as soon as possible.

Because of uncared and old electric lines, not taking necessary precautions and lack of training, electric shock and fire can be caused. Moreover, because of wrong usage and storage of compressed gases, fire extinguishers and chemicals, fire, explosion, death, injuries and damage on physical structure can be occurred. Their risk priority number is over 100 so necessary precautions have to be taken. The

maintenance of electric system must be done, the storage conditions of compresses gases, fire extinguishers and chemicals must be improved.

Working environment failure mode like closed and confined area was found important because of inadequate benches, inadequate storage area, disordered equipment placing and unstable cabinets. Moreover, dust is another important factor especially when working with solid waste and sludge samples. Inadequate lighting because of insufficient windows and high ceiling, working with devices having screen, reflecting-shining and unorganized workplace are other important factor hence they need precaution. The working area must be organized according to work conditions and needs. The cabinets must be connected with the wall to prevent toppling. The usage of fume hood must be encouraged while working with dusty materials.

Bad body position or extreme body stress due to non-ergonomic equipment, inadequate breaks, working on the sitting position, working on foot, lifting heavy objects and repetitive motion can cause muscle-skeletal system disorders and stress. To prevent adverse effects from these hazards adequate breaks must be given and ergonomic equipment must be supplied. Other human related hazards such as working by disobeying rules, mental pressure and stress, communication problems, inability in compliance with human anatomy, absence and daydreaming, extreme self-confidence and feeling tired and sick are very important failure modes. Therefore, the education must be given to show the results of these failure modes.

Wastes have very important effects because of insufficient storage and carrying conditions and carrying by uneducated personals. Furthermore, inadequate safety precautions and environment hygiene were found as very important. Waste management system must be set up and necessary education must be given to laboratory workers and other workers helping to carrying wastes. The necessary personal protection equipment like mask, googles and gloves must be supplied by administrator.

Working at height is an important failure mode for some rooms having high shelves. General hazard failure mode as caused by construction and building has very serious effects. These failure modes can be service elevator and stairs for downstairs and upstairs open areas. Therefore, the ladder must be proper for working at height, the necessary warning signs must be put for the elevator, non-slip strips must be applied to stairs.

There are 8 workplaces and risk assessments were applied to all of them. The results of FMEA can be seen in the Appendix-6.

As a result, similarly with the results of DEU Risk Assessment Method, the occupational health and safety education must be given properly and periodically; moreover, students and new workers must benefit from this education before starting to work in the laboratories. Furthermore, necessary emergency drills must be carried out while taking other necessary measurements.

3.2 Results from Surveys

The surveys were applied to 10 workers and 3 laboratory managers. The surveys applied to workers were evaluated with SPSS and results are given in the Table 3.1. According to result of the surveys applied to laboratory manager, number of workers is changeable because graduate and doctorate students generally work in the laboratories. There is no laboratory safety manual or emergency action plan. There is no waste management system and the wastes are collected by cleaning workers. There is a system for chemicals buying and storage for parts connected main wastewater sludge laboratory and microbiology laboratory; however, other parts don’t have a system for chemicals. Moreover, material safety data sheets don’t exist in the workplaces.

According to the Table 3.1, the workers have the highest work perception for workplace conditions. In line with this result, workplace problems were found as very important in both risk assessments. The workers having high risk perception for

biological and ergonomic are more than ones having low risk perception. Biological and ergonomic risks were evaluated as important with DEU risk assessment method; on the other hand, they evaluated as very important with FMEA.

The numbers of workers having high and low risk perception for physical, chemical and psychological is equal. Physical risks were found as important, chemical risks were evaluated as very important and psychological risks were determined as possible with DEU risk assessment method. On the other hand, physical, chemical and psychological risks were evaluated as having very serious effects with FMEA.

Table 3.1 Participants risk perceptions and summary of risk assessment methods

Risks	Possible Maximum Risk Perception	Mean	Participant Risk Perception Distribution by Percentage		DEU Risk Assessment Method	FMEA
			Low Risk Perception	High Risk Perception		
Physical	15	9.1 ±1.6	50	50	Electricity-electromagnetic field was defined as having medium risk because of electrical devices and computers.	Electricity, electromagnetic field and noise were evaluated as very important so they need precautions as soon as possible.
Chemical	20	10.7 ± 3.06	50	50	Latex gloves were found important. Moreover, flammable-explosive chemicals like compressed gases and fire extinguisher were determined as very important.	Latex gloves were found very important as allergens. Chemicals used in the experiment and analysis were evaluated as having very serious results.
Biological	15	8 ± 2.75	40	60	Working with sharp objects, respiration-droplet-aerosol, working with microorganisms, wastewater, wastewater sludge, solid waste and contaminated soil were evaluated as important risk factors.	Respiration-droplet-aerosol, microorganisms, wastewater, wastewater sludge, solid waste and soil were found very serious failure modes and required precautions as soon as possible.
Ergonomic	20	13.8 ± 2	40	60	Bad body position and forcing muscle-skeletal system were defined as important ergonomic risks.	Bad body position or extreme body system was evaluated as very serious.
Psychological	50	24.3 ± 8.49	50	50	Oral violence, communication problems and making decision problems were determined as possible.	Communication problems, mental pressure or stress, extreme self-confidence etc. were evaluated as having very serious effects.
Workplace Conditions	44	31.5 ± 7.68	20	80	The organization, cleaning, hygiene, ventilation, resting areas of the workplace were evaluated as inadequate.	Environment hygiene and disordered equipment placing were found as having very serious effects.

CHAPTER FOUR
CONCLUSIONS

Risk assessment has been carried out for environmental engineering research laboratories with DEU risk assessment method and FMEA within the scope of the study. In parallel with the risk assessments, the surveys have been applied to workers and laboratory managers. The results of them were evaluated separately and also compared with each other.

In the results of DEU risk assessment method, the effects of daily dosage and taken measurement factor are very important. As a result of this, physical, biological, ergonomic, psychosocial and working environment risks were evaluated important; in other words, the hazards exist and precautions can be taken. Chemical risks were defined as very important, so precautions must be taken. On the other hand, physical, chemical, biological, ergonomic, psychosocial and working environment risks were assessed as having very serious effects by evaluation with FMEA. Because daily dosage and already taken measurement factor aren't be used in FMEA.

In other words, the DEU risk assessment method evaluates existing situation. It considers the working hours of the worker with hazard and the positive effect of taken measurements. On the other side, FMEA evaluates the risks as there is no precautions and the workers are exposed the hazard during shift. FMEA evaluates the risks as all of them have possibility to occur in any case. As a result, the study area has been evaluated as less risky with risk assessment method of DEU than FMEA.

According to results of the surveys, the workers have awareness about the risks in their workplaces but not all of them have. The reason can be that they don't know what the risks are or they suppose that they have knowledge about risks. Generally, this situation can be solved with detailed occupational health and safety training and also laboratory safety training. For students, instructions hanged in the laboratories can be remindful. Repeating the trainings provide forming of occupational health and safety culture.

In order to prevent physical risks, the devices and electrical equipment must be quality and their regular control and maintenance are important factors.

Chemical risks are important for environmental research laboratories. In order to prevent chemical risks, the ventilation systems must be installed and the maintenance of the system must be done regularly. The filters of the system must be changed regularly. Moreover, fume hoods must be supplied and used, and the maintenance of them done and the filters of them must be changed regularly. Furthermore, usage of quality chemicals is another important precaution. Training of the workers about the chemical risks is also significance and the material safety data sheets of them must be kept in the laboratory as accessible. The necessary devices must be put into fume hood or ventilations system must be settled for them. Personal protective equipment must be quality and supplied regularly. Moreover, training must be given about the usage of PPE. The storage areas of chemicals must be proper and the chemicals mustn't be stored in the laboratories. Nitrile gloves must be supplied to prevent allergy caused by latex.

Ergonomic risks are other important issue for the laboratory workers. Generally, the workers are unware of their position while working. Hence firstly they must take education then regular breaks and exercise must be applied. Some computer programs can be used to remind their position to the workers.

Psychosocial risks are invisible factors in the laboratories. The solution of them is generally possible with administrative measurements. The working hours must be regulated and task sharing must be done fairly and by considering the capacity of workers. The breaks and resting areas are important factors to solve these risks.

Workplace conditions are more visible for workers. In order to improve working conditions, firstly the storage areas must be done and organized. The benches must be suitable for workers. The unstable stuffs like cabinets must be immobilized.

The biological risks are most important risks for environmental research laboratories because the samples analyzed in these laboratories are biological and they are wastes of people. In other words, the materials undesirable and disgusting are the main subjects of the environmental engineers. These materials are wastewater and wastewater sludge in other words feces, solid wastes in other means garbage, and microbes. The workers generally are aware of what they study with; however, over time they can ignore the effects of these materials. Firstly, the repeated education is very important. The effects and diseases caused by these factors must be explained in detail. During the collection of these materials, proper PPE such as gloves, face mask or goggles and coats must be supplied by administration. After that analyzing those with devices fume hood and effective respiration system must be founded. Moreover, regular maintenance of these systems must be done. Again, PPE is important precaution while analyses. Moreover, laminar cabinets are important while working with microorganisms. Administration must provide proper standard protection equipment to prevent diseases. Furthermore, the workers must undergo regular medical check-up and be vaccinated.

To conclude, the environmental engineering research laboratories consist of all types of risks. Chemical and biological risks have more importance than others. The chemical risks are known commonly and the awareness for them is much more. On the other hand, although the main materials in these laboratories are biological, the workers can ignore the effects of them. One half of the workers are aware of these risks. In order to increase the awareness, besides personal and engineering protections, administrative protections have to be applied.

In order to provide appropriate working environment for the laboratory workers, all risks must be taken in consider and the precautions must be taken by considering all elements in the laboratory. These can be provided easily by establishing laboratory safety program. In here the most important thing is that all workers must be included in the application of the safety program.

The study about a part of the Department of Environmental Engineering in Dokuz Eylül University can be a step for the entire department risk assessment and management. Moreover, the study can be a basis for the studies about the determination of biological risks.

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APPENDICES

Appendix-1: Permission document given by the head of Halle building

DOKUZ EYLÜL ÜNİVERSİTESİ MÜHENDİSLİK FAKÜLTESİ
Çevre Mühendisliği

11.02.2016

Sayın Ayşenur BÖLÜKBAŞ,

Sözlü olarak yapmış olduğunuz başvurunuza istinaden Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü İş Sağlığı ve Güvenliği Tezli Yüksek Lisans Programı kapsamında Prof.Dr. Alp ERGÖR danışmanlığında yürütmekte olduğunuz "Risk Assessment and Management in Environmental Engineering Laboratories to Determine Biological Risk Factors" başlıklı teziniz kapsamında Çevre Mühendisliği Bölümü Halle binasında risk değerlendirmesi gerçekleştirmenizde bir sakınca yoktur. Saygılarımla.

Doç. Dr. Görkem AKINCI
Halle Binası Sorumlusu

Dokuz Eylül Üniversitesi
Çevre Mühendisliği
Tınaztepe Yerleşkesi
Buca/İZMİR

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Appendix-2: Permission document given by the Department of Workplace Health and Safety in the Hospital of Dokuz Eylul University

T.C.
DOKUZ EYLÜL ÜNİVERSİTESİ
İŞ SAĞLIĞI ARAŞTIRMA VE UYGULAMA MERKEZİ
İSAMER

Sayı : 70552737-604.01.01 /15 18./02./2016
Konu : Risk Analizi Formatı Kullanma izini

Sayın Ayşenur BÖLÜKBAŞ

İlgi:11.02.2016 tarihli yazısı

İş Sağlığı ve Güvenliği yüksek lisans programı kapsamında yürütmekte olduğunuz "Çevre Mühendisliği Araştırma Laboratuvarlarında Biyolojik Risk Etmenlerinin Tespiti için Risk Analizi ve Yönetimi" başlıklı tez çalışması sürecinde bir risk değerlendirme aracı olarak FMEA'nın yanı sıra DEÜ Hastanesi İşyeri Sağlık ve Güvenlik Birimi ekibi tarafından geliştirilip DEÜ İSAGÜ Projesi kapsamında da kullanılmakta olan risk değerlendirme aracını kullanmanız ve karşılaştırmanız Merkezimiz kapsamında çalışmalarını yürüten üretici ekip tarafından da uygun bulunmuştur.

Ancak formlar ve yöntemle ilgili fikri mülkiyet hakları ve patent başvuru süreci devam etmektedir, süreç sonuçlanmadan bu aracın kullanıldığı bir çalışmanın makale ya da bildiri olarak yayımlanması kimi sakıncalar içerebilecektir. Dolayısıyla tezinizden yapacağınız bildiri ya da makaleleri yayımlamadan önce Merkezimizle görüşüp patent sürecinin sonucu hakkında bilgi almanızda yarar olacaktır.

Saygılarımla,
Prof.Dr.Osman Alparslan ERGÖR
İSAMER Müdürü

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Bamsi TÜR
Müdür Yardımcısı

Appendix-3: Example of the survey applied to the workers

Bu anket "Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü İş Sağlığı ve Güvenliği Yüksek Lisans Programı" kapsamında gerçekleştirmekte olduğum "Çevre Mühendisliği Araştırma Laboratuvarlarında Biyolojik Risk Etmenlerinin Tespiti için Risk Analizi ve Yönetimi" konulu tez ile ilişkilidir. Bir başka yerde kullanılması söz konusu değildir. Bu anket sadece HALLE'de gerçekleştirdiğiniz çalışmaları içermektedir. Katkılarınız için teşekkürler.

Yaş: Cinsiyet: Kadın ☐ Erkek ☐

		Hiçbir zaman (1)	Nadiren (2)	Bazen (3)	Sıklıkla (4)	Her zaman (5)
1	Çalışmanız sırasında elektrik sistemi ile ilgili ne sıklıkta sorun yaşıyorsunuz?					
2	Çalışmanız sırasında ne sıklıkta gürültü ve titreşime maruz kalıyorsunuz?					
3	Çalışmanız sırasında ne sıklıkta toz/buhar/gaz oluşuyor?					
4	Çalışmanız sırasında kimyasal maddeyi elle tutmak zorunda kalıyor musunuz?					
5	Çalışmanız sırasında sıkıştırılmış gaz kullanıyor musunuz?					
6	Buhar/gaz/toz çıkışı olan çalışmalarınızda ne sıklıkta çeker ocak kullanıyorsunuz?					
7	Çalışmanız sırasında ne sıklıkta biyolojik etkenle temas ediyorsunuz?					
8	Ne sıklıkta kesici/delici alet yaralanması yaşıyorsunuz?					
9	Biyolojik etkenler gözünüze sıçrıyor mu?					
10	Çalışmalarınızı ne sıklıkta ayakta gerçekleştiriyorsunuz?					
11	Çalışmalarınızı ne sıklıkta oturarak gerçekleştiriyorsunuz?					
12	Çalışmalarınızda ne sıklıkta ağır kaldırıyorsunuz?					
13	Çalışmanız sırasında ne sıklıkta ekranlı araç kullanıyorsunuz?					
14	Çalışmalarınızda süre baskısı var mı?					
15	Çok yoğun çalışmak zorunda mısınız?					
16	Çalışmanızda fiziksel şiddet yaşıyor musunuz?					
17	Çalışmanızda sözel şiddet yaşıyor musunuz?					
18	Öğrencilerle ne sıklıkta iletişim sorunu yaşıyorsunuz?					
19	Çalışma arkadaşlarınızla ne sıklıkta sorun yaşıyorsunuz?					
20	Çalışmalarınızda alınan kararlara katılıyor musunuz?					
21	Üstünüzle sorun yaşıyor musunuz?					
22	Çalışmanız sırasında kimyasallar dökülüyor mu?					
23	Ne sıklıkta gece/hafta sonu çalışmalarınız oluyor?					
24	Çalışmanızda yıldırma (mobing) yaşıyor musunuz?					
25	Çalışma ortamında yiyecek/ içecek tüketiyor musunuz?					
26	Çalışmalarınız sırasında kişisel koruyucu donanım (eldiven, gözlük, maske vb.) kullanıyor musunuz?					

		Kesinlikle katılmıyorum (4)	Kısmen katılmıyorum (3)	Kısmen katılıyorum (2)	Kesinlikle katılıyorum (1)
1	Çalışma ortamının temizliği/hijyeni yeterlidir.				
2	Çalışma ortamınızda bulunan tezgah/masa yükseklikleri size uygundur.				
3	Çalışırken oturduğunuz sandalyeler ergonomiktir.				
4	Çalışma ortamınızın aydınlatması yeterlidir.				
5	Çalışma ortamının sıcaklığı uygundur.				
6	Çalışma ortamı düzenlidir.				
7	Kimyasal kazalar için gerekli önlemler alınmıştır.				
8	Çalışan sayısı yeterlidir.				
9	Dinlenme alanları yeterlidir.				
10	Banyo/wc/el yıkama olanakları yeterli ve temizdir.				
11	Çalışma ortamının havalandırması yeterlidir.				

	Atıksu	Atıksu Çamuru	Katı Atık	Mikroorganizmalar	Toprak
Aşağıdaki numunelerden hangisi veya hangileri ile çalışıyorsunuz?					

1. Çalışma ortamınızın temizliği kim tarafından yapılıyor?

.....

2. Çalışma ortamını siz temizliyor iseniz hangi deterjanları/dezenfektanları kullanıyorsunuz?

.....

3. Deney/analiz sonrası deney araçlarınızı hangi deterjanlar/dezenfektanlar ile temizliyorsunuz?

.....

4. Hangi tür eldiven kullanıyorsunuz?

.....

5. Lateks eldivene karşı bir alerjik durumunuz oldu mu?

.....

6. Çalışmalarınızda hangi kimyasalları kullanıyorsunuz? (Asitler, solventler, civa, kurşun, kalay, iyot vb.)

.....

7. Yapıştırıcı/pas sökücü/silikon vb. malzemeler kullanıyor musunuz?

.....

8. Kullandığınız kimyasalların/deterjanların/dezenfektanların Malzeme Güvenlik Bilgi Formları (MSDS) çalıştığınız ortamda bulunuyor mu?

.....

9. Çalışmanız sırasında bir kaza yaşadınız mı?

.....

10. Çalıştığınız malzemelerden ve/veya ortamdan kaynaklı bir zehirlenme yaşadınız mı?

.....

11. Çalışmanız sırasında hangi sıkıştırılmış gaz tüplerini kullanıyorsunuz?

.....

12. İş Sağlığı ve Güvenliği eğitimi aldınız mı?

.....

13. Çalışmaya başlamadan önce sağlık kontrolünden geçtiniz mi?

.....

14. Acil durumlar ve yangın ile ilgili bir eğitim aldınız mı ve tatbikata katıldınız mı?

.....

15. Binanın ilk yardım ve yangın sorumlularını biliyor musunuz?

.....

16. Acil durumlarda aranması gereken numaralar ve yapılması gerekenler çalışma ortamında görünür bir yerde bulunuyor mu?

.....

17. Çalışma ortamınızda güvenlik, uyarı ve acil çıkış işaretleri bulunuyor mu?

.....

Appendix-4: Example of the survey applied to the laboratory managers

Bu anket "Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü İş Sağlığı ve Güvenliği Yüksek Lisans Programı" kapsamında gerçekleştirmekte olduğum "Çevre Mühendisliği Araştırma Laboratuvarlarında Biyolojik Risk Etmenlerinin Tespiti için Risk Analizi ve Yönetimi" konulu tez ile ilişkilidir. Bir başka yerde kullanılması söz konusu değildir. Bu anket sadece HALLE'de gerçekleştirdiğiniz çalışmaları içermektedir. Katkılarınız için teşekkürler.

1. Kullandığınız deterjanların ve kimyasalların Malzeme Güvenlik Bilgi Formlarını (MSDS) nerede bulunduruyorsunuz?

   .....

2. Kimyasalların alımını nasıl yapıyorsunuz? Bir kayıt sisteminiz var mı?

   .....

3. Kimyasal ve biyolojik atıklar için bir atık yönetim sisteminiz var mı?

   .....

4. Atıklar ne sıklıkta kimler tarafından toplanıyor?

   .....

5. Atıkların ara depolaması nerede yapılıyor?

   .....

6. Atıkların taşınması sırasında kişisel koruyucu ekipman kullanılıyor mu?

   .....

7. Çalıştığınız ortamla ilgili bir acil eylem planı var mı?

   .....

8. Laboratuvarınızın "Laboratuvar Güvenlik Rehberi" bulunuyor mu?

   .....

9. Halle'de bulunan çalışma alanızı kaç kişi kullanıyor? Çalışan sayısı değişken mi?

   .....

Appendix-5: The results of DEU risk assessment methods

NAME OF SUBUNITS	SOLID WASTE AND SOIL CONTAMINATION LABORATORY	
PHYSICAL RISKS	**SOURCE OF HAZARD**	**FINAL RISK SCORE**
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	COMPUTER, ELECTRIC SYSTEM, ELECTRICAL DEVICES	9.9
NOISE	INSTRUMENTAL DEVICES, EXPERIMENTAL DEVICES	5.94
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES	3.828
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	**SOURCE OF HAZARD**	**FINAL RISK SCORE**
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	6.864
POWDER	GLOVES	3.432
IODINE	NONE	0
ACIDS	ANALYSIS, EXPERIMENTS	1.452
MERCURY	THERMOMETERS	3.828
CHEMICAL RISKS	**SOURCE OF HAZARD**	**FINAL RISK SCORE**
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	13.86
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	3.828
SOLVENTS	ANALYSIS, EXPERIMENTS	3.828
OTHERS		0

BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	8.58
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	CENTRIFUGE, JAR TEST, STIRRER ETC.	6.6
WORKING WITH PATHOGENS	MICROBIOLOGICAL EXAMINATIONS	6.6
WORKING WITH WASTEWATER	NONE	0
WORKING WITH WASTEWATER SLUDGE	EXPERIMENTS	8.58
WORKING WITH SOLID WASTE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH MICROORGANIZMS	MICROBIOLOGICAL EXAMINATIONS	6.6
WORKING WITH CONTAMINATED SOIL	ANALYSIS AND EXPERIMENTS	8.58
ERGONOMIC RISKS	**SOURCE OF HAZARD**	**FINAL RISK SCORE**
WORKING ON THE SITTING SITUATION	ANALYSIS,COMPUTER USAGE,EXPERIMENTS	1.98
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.98
LIFTING HEAVY OBJECTS	ANALYSIS, EXPERIMENTS	4.158
BAD BODY POSITION	ANALYSIS,COMPUTER USAGE,EXPERIMENTS	7.92
REPETITIVE MOTION	PIPETTE USAGE	2.97
INADEQUATE LIGHTING	HIGH CEILING, INADEQUATE LAMBS	3.96
WORKING WITH DEVICES HAVING SCREENS	COMPUTER, INSTRUMENTAL DEVICES	2.97
REFLECTING-SHINING	COMPUTER, INSTRUMENTAL DEVICES	2.97
THERMAL CONFORT	IRREGULAR CENTRAL HEATING, UNNECESSARY EXPERIMENTAL AREA	3.96
HEIGHT	NONE	0
ACCIDENTS	**SOURCE OF HAZARD**	**FINAL RISK SCORE**
FALLING	UNORGANIZED WORKPLACE, WET FLOOR	9.9
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	1.914
CONTACTING WITH BIOLOGICAL FACTORS	ANALYSIS, EXPERIMENTS	9.57
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	7.92

ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
CONTACTING WITH CHEMICAL	ANALYSIS, EXPERIMENTS, CLEANING	3.828
HITTING BY OBJECT	CABINETS, FUME HOOD	7.425
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	4.95
CRUSHING	NONE	0
PHYSICAL VIOLENCE	NONE	0
POISONING	WASTES, CHEMICALS, FUME HOOD	7.1775
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	13.86
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE

WORKING CONDITIONS	REASON OF HAZARD
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
TYPE	MICROBIOLOGICAL, CHEMICAL WASTE, SOLID WASTE, CONTAMINATED SOIL AND WASTEWATER SLUDGE SAMPLES
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**GRADUATE STUDENTS LABORATORY**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM, ELECTRICAL DEVICES	9.9
NOISE	INSTRUMENTAL DEVICES, EXPERIMENTAL DEVICES	5.94
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES	3.828
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828

CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	6.864
POWDER	GLOVES	3.432
IODINE	NONE	0
ACIDS	ANALYSIS, EXPERIMENTS	1.452
MERCURY	THERMOMETERS	3.828
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	3.828
SOLVENTS	ANALYSIS, EXPERIMENTS	3.828
OTHERS		0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	8.58
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	CENTRIFUGE, JAR TEST, STIRRER ETC.	6.6
WORKING WITH PATHOGENS	ANALYSIS AND EXPERIMENTS	6.6
WORKING WITH WASTEWATER	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH WASTEWATER SLUDGE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH SOLID WASTE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH MICROORGANIZMS	ANALYSIS AND EXPERIMENTS	6.6
WORKING WITH CONTAMINATED SOIL	ANALYSIS AND EXPERIMENTS	8.58
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	ANALYSIS,EXPERIMENTS	1.98
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.98
LIFTING HEAVY OBJECTS	ANALYSIS, EXPERIMENTS	4.158
BAD BODY POSITION	ANALYSIS, EXPERIMENTS	7.92
REPETITIVE MOTION	NONE	0

ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
INADEQUATE LIGHTING	HIGH CEILING, INADEQUATE LAMBS	3.96
WORKING WITH DEVICES HAVING SCREENS	NONE	0
REFLECTING-SHINING	NONE	0
THERMAL CONFORT	IRREGULAR CENTRAL HEATING, UNNECESSARY EXPERIMENTAL AREA	3.96
HEIGHT	NONE	0
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	UNORGANIZED WORKPLACE, WET FLOOR	9.9
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	1.914
CONTACTING WITH BIOLOGICAL FACTORS	NONE	9.57
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	7.92
CONTACTING WITH CHEMICAL	ANALYSIS, EXPERIMENTS, CLEANING	3.828
HITTING BY OBJECT	CABINETS, FUME HOOD	7.425
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	4.95
CRUSHING	FUME HOOD	0
PHYSICAL VIOLENCE	NONE	0
POISONING	WASTES, CHEMICALS, FUME HOOD	7.1775
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	**REASON OF HAZARD**
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
TYPE	MICROBIOLOGICAL, CHEMICAL WASTE, SOLID WASTE, CONTAMINATED SOIL, WASTEWATER AND WASTEWATER SLUDGE SAMPLES
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**MICROBILOGY LABORATORY (2 ROOM)**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	UV LAMBS	5.346
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM, ELECTRICAL DEVICES, COMPUTER	9.9

PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
NOISE	INSTRUMENTAL DEVICES, EXPERIMENTAL DEVICES	5.94
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES	3.828
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	6.864
POWDER	GLOVES	3.432
IODINE	NONE	0
ACIDS	ANALYSIS, EXPERIMENTS	1.452
MERCURY	THERMOMETERS	3.828
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	3.828
SOLVENTS	ANALYSIS, EXPERIMENTS	3.828
OTHERS		0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	8.58
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	STIRRER	6.6
WORKING WITH PATHOGENS	ANALYSIS AND EXPERIMENTS	6.6
WORKING WITH WASTEWATER	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH WASTEWATER SLUDGE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH SOLID WASTE	NONE	0

BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH MICROORGANIZMS	ANALYSIS AND EXPERIMENTS	6.6
WORKING WITH CONTAMINATED SOIL	NONE	0
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	ANALYSIS,EXPERIMENTS	1.98
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.98
LIFTING HEAVY OBJECTS	ANALYSIS, EXPERIMENTS	4.158
BAD BODY POSITION	ANALYSIS, EXPERIMENTS, COMPUTER	7.92
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	NONE	0
WORKING WITH DEVICES HAVING SCREENS	COMPUTER	2.97
REFLECTING-SHINING	COMPUTER	2.97
THERMAL CONFORT	ISITMA NONE	3.96
HEIGHT	NONE	0
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	UNORGANIZED WORKPLACE, WET FLOOR	9.9
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	1.914
CONTACTING WITH BIOLOGICAL FACTORS	ANALYSIS AND EXPERIMENTS	9.57
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	7.92
CONTACTING WITH CHEMICAL	ANALYSIS, EXPERIMENTS, CLEANING	3.828
HITTING BY OBJECT	CABINETS	6.6825
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	4.95
CRUSHING	NONE	0
PHYSICAL VIOLENCE	NONE	0
POISONING	WASTES, CHEMICALS	7.1775
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	REASON OF HAZARD
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	REASON OF HAZARD
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
TYPE	MICROBIOLOGICAL, CHEMICAL WASTE, WASTEWATER AND SLUDGE SAMPLES
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**OTHER LABORATORIES (4 ROOMS)**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM, ELECTRICAL DEVICES, COMPUTER	9.90
NOISE	AIR PUMP	2.23
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES, WORKPLACE DUST	1.65
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	1.44
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	1.44
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	3.43
POWDER	GLOVES	1.72
IODINE	NONE	0
ACIDS	ANALYSIS, EXPERIMENTS	2.48
MERCURY	THERMOMETERS	2.48
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	13.86
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	2.48
SOLVENTS	ANALYSIS, EXPERIMENTS	2.48
OTHERS		0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	3.59
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	MAGNETIC STIRRER	3.59
WORKING WITH PATHOGENS	NONE	0
WORKING WITH WASTEWATER	ANALYSIS AND EXPERIMENTS	3.59

BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH WASTEWATER SLUDGE	ANALYSIS AND EXPERIMENTS	3.59
WORKING WITH SOLID WASTE	NONE	0
WORKING WITH MICROORGANIZMS	NONE	0
WORKING WITH CONTAMINATED SOIL	NONE	0
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	ANALYSIS, EXPERIMENTS	1.49
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.49
LIFTING HEAVY OBJECTS	DENEY ARAÇ GEREÇLERİ	2.23
BAD BODY POSITION	ANALYSIS,EXPERIMENTS, COMPUTER	2.97
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	HIGH CEILING, INADEQUATE LAMBS	1.49
WORKING WITH DEVICES HAVING SCREENS	INSTRUMENTAL DEVICES, COMPUTER	1.19
REFLECTING-SHINING	INSTRUMENTAL DEVICES, COMPUTER	1.19
THERMAL CONFORT	NO HEATING, UNNECESSARY EXPERIMENT AREA	1.49
HEIGHT	TAKING STUFFS FROM SHELVES	2.23
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	UNORGANIZED WORKPLACE AND TAKING STUFFS FROM SHELVES, WET FLOOR	4.95
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	0.72
CONTACTING WITH BIOLOGICAL FACTORS	WASTEWATER VE WASTEWATER SLUDGE	3.59
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	2.97
CONTACTING WITH CHEMICAL	ANALYSIS, EXPERIMENTS, CLEANING	1.44
HITTING BY OBJECT	CABINETS	2.23
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	2.48
CRUSHING	NONE	0
PHYSICAL VIOLENCE	NONE	0
POISONING	IMPROPERLY STORED CHEMICALS	3.71
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85

ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	13.86
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.40

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	**REASON OF HAZARD**
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES

BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**OFFICE(2 WORKERS)**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	COMPUTER, ELECTRIC SYSTEM, ELECTRICAL DEVICES	9.9
NOISE	NONE	0
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	NONE	0
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS	2.871
DISINFECTANTS	CLEANING WORKS	2.871
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	CLEANING WORKS	5.148
POWDER	CLEANING WORKS	2.574
IODINE	NONE	0
ACIDS	IN WORKPLACE	9.9
MERCURY	NONE	0
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER, COMPRESSED GAS TUBES IN LABORATORIES, CHEMICALS	13.86
RUST SOLVENT	NONE	0
DUST CHEMICALS	IN WORKPLACE	9.9
SOLVENTS	IN WORKPLACE	9.9
OTHERS		0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	NONE	0

BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	NONE	0
WORKING WITH PATHOGENS	NONE	0
WORKING WITH WASTEWATER	NONE	0
WORKING WITH WASTEWATER SLUDGE	NONE	0
WORKING WITH SOLID WASTE	NONE	0
WORKING WITH MICROORGANIZMS	NONE	0
WORKING WITH CONTAMINATED SOIL	NONE	0
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	COMPUTER USAGE	6.93
WORKING ON FOOT	NONE	0
LIFTING HEAVY OBJECTS	NONE	0
BAD BODY POSITION	COMPUTER USAGE	13.86
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	NONE	0
WORKING WITH DEVICES HAVING SCREENS	COMPUTER USAGE	6.93
REFLECTING-SHINING	COMPUTER USAGE	6.93
THERMAL CONFORT	NO GENERAL CLIMATIZATION	6.93
HEIGHT	NONE	0
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	UNORGANIZED WORKPLACE	14.85
SHARP OBJECT INJURY	NONE	0
CONTACTING WITH BIOLOGICAL FACTORS	NONE	0
FORCING MUSCLE-SKELETAL SYSTEM	NONE	0
CONTACTING WITH CHEMICAL	NONE	0
HITTING BY OBJECT	CABINETS	14.85
HITTING TO OBJECT	UNORGANIZED WORKPLACE	9.9
CRUSHING	NONE	0
PHYSICAL VIOLENCE	NONE	0
POISONING	CAUSED BY LABORATORIES	8.91

ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER, COMPRESSED GAS TUBES IN LABORATORIES, CHEMICALS	13.86
BURNING	COMPRESSED GAS TUBES IN LABORATORIES, CHEMICALS	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	POSSIBLE
WORKING HARD	POSSIBLE
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	PROPER
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	ADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	**REASON OF HAZARD**
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	NONE
TYPE	
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	

BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
COLLECTION PLACE	
IS TRANSFER VEHICLE PROPER?	
COLLECTION FREQUENCY	
APPLYING PERSON	
PERSONAL PROTECTIVE EQUIPMENT	

NAME OF SUBUNITS	**DOWNSTAIR OPEN AREA**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM, ELECTRICAL DEVICES	9.9
NOISE	INSTRUMENTAL DEVICES, EXPERIMENTAL DEVICES	5.94
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES	3.828
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
GLUTARALDEHYDE	NONE	0
İLAÇLAR	NONE	0
LATEX	GLOVES	6.864
POWDER	GLOVES	3.432
IODINE	NONE	0
ACIDS	ANALYSIS, EXPERIMENTS	1.452
MERCURY	THERMOMETERS	3.828
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	3.828
SOLVENTS	ANALYSIS, EXPERIMENTS	3.828
OTHERS		0

BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	8.58
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	NONE	0
WORKING WITH PATHOGENS	NONE	0
WORKING WITH WASTEWATER	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH WASTEWATER SLUDGE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH SOLID WASTE	ANALYSIS AND EXPERIMENTS	8.58
WORKING WITH MICROORGANIZMS	NONE	0
WORKING WITH CONTAMINATED SOIL	ANALYSIS AND EXPERIMENTS	8.58
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	ANALYSIS AND EXPERIMENTS	1.98
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.98
LIFTING HEAVY OBJECTS	ANALYSIS, EXPERIMENTS	4.158
BAD BODY POSITION	ANALYSIS, EXPERIMENTS	7.92
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	HIGH CEILING, INADEQUATE LAMBS	3.96
WORKING WITH DEVICES HAVING SCREENS	NONE	0
REFLECTING-SHINING	NONE	0
THERMAL CONFORT	NO HEATING, UNNECESSARY EXPERIMENT AREA	3.96
HEIGHT	NONE	0
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	STAIRS, UNORGANIZED WORKPLACE, WET FLOOR	9.9
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	1.914
CONTACTING WITH BIOLOGICAL FACTORS	ANALYSIS, EXPERIMENTS	9.57
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	7.92
CONTACTING WITH CHEMICAL	ANALYSIS, EXPERIMENTS, CLEANING	3.828
HITTING BY OBJECT	SERVICE ELEVATOR, CRANE, CABINETS	8.91

ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	4.95
CRUSHING	SERVICE ELEVATOR	6.6825
PHYSICAL VIOLENCE	NONE	0
POISONING	GASIFICATION DEVICE, OTHER AIR POLLUTION EQUIPMENTS, WASTES	7.1775
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE

WORKING CONDITIONS	REASON OF HAZARD
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
TYPE	SOLID WASTE, CHEMICAL WASTE, WASTEWATER VE SLUDGE, CONTAMINATED SOILSAMPLESİ
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**UPSTAIRS OPEN AREA**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	UV LAMBS	5.346
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM, ELECTRICAL DEVICES	9.9
NOISE	INSTRUMENTAL DEVICES, EXPERIMENTAL DEVICES	5.94
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	SAMPLES, WORKING WITH INSTRUMENTAL DEVICES	3.828
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
DISINFECTANTS	CLEANING WORKS,CLEANING OF EXPERIMENT EQUIPMENTS	3.828
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	6.864
POWDER	GLOVES	3.432
IODINE	NONE	0
ACIDS	ANALYSIS AND EXPERIMENTS	1.452
MERCURY	THERMOMETERS	3.828

CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
FLAMMABLE-EXPLOSIVE CHEMICALS	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
RUST SOLVENT	NONE	0
DUST CHEMICALS	ANALYSIS, EXPERIMENTS	3.828
SOLVENTS	ANALYSIS, EXPERIMENTS	3.828
OTHERS		0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	ANALYSIS, EXPERIMENTS	8.58
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	STIRRER	6.6
WORKING WITH PATHOGENS	MICROBIOLOGICAL EXAMINATIONS	6.6
WORKING WITH WASTEWATER	ANALYSIS, EXPERIMENTS	8.58
WORKING WITH WASTEWATER SLUDGE	ANALYSIS, EXPERIMENTS	8.58
WORKING WITH SOLID WASTE	NONE	0
WORKING WITH MICROORGANIZMS	ANALYSIS, EXPERIMENTS	6.6
WORKING WITH CONTAMINATED SOIL	NONE	0
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	ANALYSIS AND EXPERIMENTS	1.98
WORKING ON FOOT	ANALYSIS, EXPERIMENTS	1.98
LIFTING HEAVY OBJECTS	ANALYSIS, EXPERIMENTS	4.158
BAD BODY POSITION	ANALYSIS, EXPERIMENTS	7.92
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	HIGH CEILING, INADEQUATE LAMBS	3.96
WORKING WITH DEVICES HAVING SCREENS	NONE	0
REFLECTING-SHINING	NONE	0
THERMAL CONFORT	NO HEATING, UNNECESSARY EXPERIMENT AREA	3.96
HEIGHT	NONE	0

ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	STAIRS, UNORGANIZED WORKPLACE, WET FLOOR	9.9
SHARP OBJECT INJURY	ANALYSIS, EXPERIMENTS	1.914
CONTACTING WITH BIOLOGICAL FACTORS	NONE	9.57
FORCING MUSCLE-SKELETAL SYSTEM	ANALYSIS, EXPERIMENTS, CLEANING	7.92
RADYOAKTİF MADDE BULAŞI	NONE	3.828
HITTING BY OBJECT	SERVICE ELEVATOR, CABINETS	8.91
HITTING TO OBJECT	DISORDERED DEVICES AND STUFFS	4.95
CRUSHING	SERVICE ELEVATOR	6.6825
PHYSICAL VIOLENCE	NONE	0
POISONING	GASIFICATION DEVICE, OTHER AIR POLLUTION EQUIPMENTS, WASTES	7.1775
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER,OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	17.325
BURNING	OXYGEN, NITROGEN,CARBONDIOXIDE,DRY AIR TUBES, CHEMICAL MIXTURES	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	TIME CONSTRAINT
WORKING HARD	OVER CAPACITY WORK
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	POSSIBLE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	**REASON OF HAZARD**
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	**REASON OF HAZARD**
WORKING HOURS	CHANGEABLE/ WORKING AFTER SHIFT AND AT WEEKEND
WORKING IN SHIFTS	NONE

WORKING CONDITIONS	REASON OF HAZARD
WORKING AT NIGHT	NONE
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	YES
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	YES
TYPE	MICROBIOLOGICAL, CHEMICAL WASTE, WASTEWATER AND SLUDGE SAMPLES
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	NO
COLLECTION PLACE	NO
IS TRANSFER VEHICLE PROPER?	NO
COLLECTION FREQUENCY	ADEQUATE
APPLYING PERSON	WORKER OR CLEANING WORKER
PERSONAL PROTECTIVE EQUIPMENT	INADEQUATE

NAME OF SUBUNITS	**TOILETS**	
PHYSICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IONIZING RADIATION	NONE	0
ELECTRICITY-ELECTROMAGNETIC FIELD	ELECTRIC SYSTEM	9.9
NOISE	NONE	0
VIBRATION	NONE	0
VIBRATION (ENTRIE BODY)	NONE	0
DUST	NONE	0
MOISTURE	NONE	0
EXTREME COLD	NONE	0
EXTREME HOT	NONE	0
CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
DETERGENTS	CLEANING WORKS	2.871
DISINFECTANTS	CLEANING WORKS	2.871
GLUTARALDEHYDE	NONE	0
FORMALDEHYDE	NONE	0
LATEX	GLOVES	5.148
POWDER	GLOVES	2.574

CHEMICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
IODINE	NONE	0
ACIDS	NONE	0
MERCURY	NONE	0
FLAMMABLE-EXPLOSIVE CHEMICALS	NONE	0
RUST SOLVENT	NONE	0
DUST CHEMICALS	NONE	0
SOLVENTS	NONE	0
OTHERS	NONE	0
BIOLOGICAL RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING WITH SHARP OBJECTS	NONE	0
BODY FLUIDS	NONE	0
RESPIRATION-DROPLET-AEROSOL	NONE	0
WORKING WITH PATHOGENS	NONE	0
WORKING WITH WASTEWATER	NONE	0
WORKING WITH WASTEWATER SLUDGE	NONE	0
WORKING WITH SOLID WASTE	NONE	0
WORKING WITH MICROORGANIZMS	NONE	0
WORKING WITH CONTAMINATED SOIL	NONE	0
ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
WORKING ON THE SITTING SITUATION	NONE	0
WORKING ON FOOT	DAILY ROUTINE WORKS	2.97
LIFTING HEAVY OBJECTS	NONE	0
BAD BODY POSITION	DAILY ROUTINE WORKS	5.94
REPETITIVE MOTION	NONE	0
INADEQUATE LIGHTING	INADEQUATE LIGHTING, IMPROPER LAMBS	2.97
WORKING WITH DEVICES HAVING SCREENS	NONE	0
REFLECTING-SHINING	NONE	0
THERMAL CONFORT	NONE	0

ERGONOMIC RISKS	SOURCE OF HAZARD	FINAL RISK SCORE
HEIGHT	NONE	0
ACCIDENTS	SOURCE OF HAZARD	FINAL RISK SCORE
FALLING	WET FLOOR	2.97
SHARP OBJECT INJURY	NONE	0
CONTACTING WITH BIOLOGICAL FACTORS	NONE	0
FORCING MUSCLE-SKELETAL SYSTEM	DAILY ROUTINE WORKS	5.94
RADYOAKTİF MADDE BULAŞI	NONE	0
HITTING BY OBJECT	NONE	0
HITTING TO OBJECT	NONE	0
CRUSHING	NONE	0
PHYSICAL VIOLENCE	NONE	0
POISONING	NONE	0
ELECTRICAL ACCIDENT	ELECTRIC SYSTEM, DEVICES	14.85
EXPOLOSION	FIRE EXTINGUISHER, COMPRESSED GAS TUBES IN LABORATORIES	17.325
BURNING	COMPRESSED GAS TUBES IN LABORATORIES, CHEMICALS	10.395

PSYCHOSOCIAL RISKS	REASON OF HAZARD/YES/NONE
WORKING FAST	POSSIBLE
WORKING HARD	NONE
PHYSICAL VIOLENCE	NONE
ORAL VIOLENCE	POSSIBLE
COMMUNICATION PROBLEMS WITH STUDENTS	NONE
COMMUNICATION PROBLEMS WITH COWORKERS	POSSIBLE
MAKING DECISION PROBLEMS	POSSIBLE
SUPERIOR-SUBORDINATE RELATIONSHIP PROBLEMS	POSSIBLE
SAFETY PRECAUTIONS	REASON OF HAZARD
EMERGENCY EXITS	INADEQUATE/NOT PROPER
WARNING SIGNS	INADEQUATE/NOT PROPER
FIRE PRECAUTIONS	INADEQUATE/NOT PROPER
TRAINING-DRILL	NONE
PRECAUTIONS FOR CHEMICAL ACCIDENTS	INADEQUATE
WORKPLACE ORDER-CLEANING	INADEQUATE
WORKING CONDITIONS	REASON OF HAZARD
WORKING HOURS	UYGUN
WORKING IN SHIFTS	NONE
WORKING AT NIGHT	NONE

WORKING CONDITIONS	REASON OF HAZARD
NUMBER OF EMPLOYEES	INADEQUATE
RESTING AREA	NONE
DRESSING ROOM/CABINET	NONE
BATHROOM-TOILET-HAND WASHING-INFECTED WASHING AREAS	INADEQUATE/NOT CLEAN
CLEANING MATERIALS	INADEQUATE
FOOD IN WORKPLACE	NONE
STANDARD PROTECTION (HAND WASHING, PPE USAGE, WORKPLACE ORDER	INADEQUATE
VENTILATION	INADEQUATE
BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE	REASON OF HAZARD
DOES BIOLOGICAL/MICROBIOLOGICAL/CHEMICAL WASTE EXIST?	NONE
TYPE	
COLLECTION EQUIPMENT (BOX/BAG IS PROPER?)	
COLLECTION PLACE	
IS TRANSFER VEHICLE PROPER?	
COLLECTION FREQUENCY	
APPLYING PERSON	
PERSONAL PROTECTIVE EQUIPMENT	

Appendix-6: The Results of FMEA

SOLID WASTE AND SOIL POLLUTION LABORATORY			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Hearing loss, Stress	Working with instrumental and experimental devices	120
Pressure			0
Equipment	Getting injured in accident, death, job loss, sharp object injury	Not taking necessary precautions, inexperienced workers, lack of training	105
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves, Using gloves with powder	144

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210
Environmentally hazardous materials	slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	126
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	294

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Microorganisms and bacteria	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Viruses	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Body fluids			0
Respiration-Droplet-Aerosol	Disease infected by respiration, disease, occupational disease	Centrifuge, jar test, stirrer	294
Pathogens	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Wastewater			0
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Solid waste	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Soil	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet			0
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0

ELECTRIC	EFFECT	REASON FOR FAILURE	RPN
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate benches, inadequate storage area, disordered equipment placing, unstable cabinets	60
Working at height			0

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing	30
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	100
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling , inadequate lighting	72
Working with devices having screen	Visual defect, stress	Working with instrumental devices	60
Reflecting-Shining	Visual defect, stress	Working with instrumental devices	60
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	90
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	240

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	240
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	240
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	240
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	240
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	240
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease, getting poisoned	Insufficient storage and carrying conditions, carrying by uneducated personal	150
Caused by construction and building			0
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

GRADUATE STUDENT LABORATORY			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Hearing loss, Stress	Working with instrumental and experimental devices	120
Pressure			0
Equipment	Getting injured by accident, death, job loss, sharp object injury	Not taking necessary precautions, inexperienced workers, lack of training	140
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	144
		Using gloves with powder	144
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	126
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	294
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Viruses	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Body fluids			0

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Respiration-Droplet-Aerosol	Disease infected by respiration, disease, occupational disease	Centrifuge, jar test, stirrer	294
Pathogens	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Wastewater	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Solid waste	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Soil	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet			0
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192

ELECTRIC	EFFECT	REASON FOR FAILURE	RPN
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate benches, inadequate storage area, disordered equipment placing, unstable cabinets	60
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing, making experiment with water	30

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	100
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen			0
Reflecting-Shining			0
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	90
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	240
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	240
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	240
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	240
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	240
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	240
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease	Insufficient storage and carrying conditions, carrying by uneducated personal	150
Caused by construction and building			0
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

MICROBIOLOGY LABORATORY (2 ROOMS)			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Hearing loss, Stress	Working with instrumental and experimental devices	120
Pressure			0
Equipment	Getting injured by accident, death, job loss, sharp object injury	Not taking necessary precautions, inexperienced workers, lack of training	140
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	144
		Using gloves with powder	144
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	126
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	294
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Viruses	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Body fluids			0

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Respiration-Droplet-Aerosol	Disease infected by respiration, disease, occupational disease	Centrifuge, jar test, stirrer	294
Pathogens	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Wastewater	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Solid waste			0
Soil			0
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet	burns, visual defect, vision loss, long term diseases	UV lambs used in experiments	105
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192

ELECTRIC	EFFECT	REASON FOR FAILURE	RPN
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate benches, inadequate storage area, disordered equipment placing, unstable cabinets	60
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing, making experiment with water (Aquarium vb.)	30

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	100
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen	Visual defect, stress	PC	36
Reflecting-Shining	Visual defect, stress	PC	36
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	90
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	240
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	240
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	240
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	240
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	240
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	240
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease	Insufficient storage and carrying conditions, carrying by uneducated personal	150
Caused by construction and building			0
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

OTHER LABORATORIES (4 ROOMS)			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Stress	Air pump	90
Pressure			0
Equipment	Getting injured by accident, job loss, sharp object injury	Not taking necessary precautions	105
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	96
		Using gloves with powder	96
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	150

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	90
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	180
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	180
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	180
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	180
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria			0
Viruses			0
Body fluids			0

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Respiration-Droplet-Aerosol	Disease infected by respiration, disease, occupational disease	Magnetic stirrer	168
Pathogens			0
Wastewater	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	210
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	210
Solid waste			0
Soil			0
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet			0
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	120
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
Static load			0

ELECTRIC	EFFECT	REASON FOR FAILURE	RPN
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate storage area, disordered equipment placing, unstable cabinets, taking stuff from shelves	60
Working at height	Falling, getting injured	Taking stuff from shelves	60
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing, making experiment with water	30

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	80
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen	Visual defect, stress	PC	36
Reflecting-Shining	Visual defect, stress	PC	36
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	60
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	72
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	192
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	192

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	192
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	192
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	192
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	192
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	192
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease	Insufficient storage and carrying conditions, carrying by uneducated personal	120
Caused by construction and building			0
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	140
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	120

OFFICE			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise			0
Pressure			0
Equipment			0
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	144
		Using gloves with powder	144
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Storing in office	135
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Storing in office	81

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Storing in office	162
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Storing in office	162
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Storing in office	162
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Storing in office	162
Toxic materials			0
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria			0
Viruses			0
Body fluids			0
Respiration-Droplet-Aerosol			0
Pathogens			0
Wastewater			0
Wastewater Sludge			0

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Solid waste			0
Soil			0
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet			0
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	216
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	216
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	216
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	360

FIRE AND EXPLOSION	EFFECT	REASON FOR FAILURE	RPN
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	360
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	360
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	360
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate storage area, disordered stuff placing, unstable cabinets	60
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning	30
Extreme hot environment			0
Extreme cold environment			0
Dust			0
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	144
Working with devices having screen	Visual defect, stress	pc	96
Reflecting-Shining	Visual defect, stress	pc	96

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	60
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Not ergonomic equipment, insufficient break, working on sitting position, usage of computer	120
Working by disobeying rules			0
Mental pressure and Stress	Accident, injury, mental diseases	Fast and hard working	240
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240
Inability in compliance with human anatomy (hand/arm, foot/leg)			0
Absence and daydreaming			0
Extreme self-confidence			0
Usage of Personal Protective Equipment (PPE)			0
Feeling tired and sick			0
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes			0
Caused by construction and building	Distractibility	No heating system	96
Other hazards			0

GENERAL HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

DOWNSTARIS OPEN AREA			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Hearing loss, Stress	Working with instrumental and experimental devices, compressor	120
Pressure			0
Equipment	Getting injured by accident, death, job loss, sharp object injury, getting poisoned	Not taking necessary precautions, inexperienced workers, lack of training, Gasification devices and other air pollution devices	140
CHEMICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	144
		Using gloves with powder	144
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	126
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	294
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria			0
Viruses			0
Body fluids			0
Respiration-Droplet-Aerosol			0
Pathogens			0
Wastewater	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Solid waste	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Soil	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294

RADIATION	EFFECT	REASON FOR FAILURE	RPN
Ultraviolet			0
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320

FIRE AND EXPLOSION	EFFECT	REASON FOR FAILURE	RPN
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate benches, inadequate storage area, disordered equipment placing, unstable cabinets	60
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing	30
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	100
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen			0
Reflecting-Shining			0
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	90
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	240
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	240
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	240
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	240
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	240
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	240
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease, getting poisoned	Insufficient storage and carrying conditions, carrying by uneducated personal	150

GENERAL HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Caused by construction and building	Injury as a result of hitting and crushing, falling, distractibility	Service elevator and stairs, no heating system	105
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

UPSTAIRS OPEN AREA			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise	Hearing loss, Stress	Working with instrumental and experimental devices, compressor	120
Pressure			0
Equipment	Getting injured by accident, death, job loss, sharp object injury, getting poisoned	Not taking necessary precautions, inexperienced workers, lack of training, Gasification devices and other air pollution devices	0

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	144
		Using gloves with powder	144
Corrosive materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	210
Environmentally hazardous materials	Slightly poisoning, allergic reaction	Analysis and experiments, not taking necessary precautions, not using fume hood	126
Hazardous materials	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Irritants	Poisoning, harming skin, allergic reaction, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	252

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Acids	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Solvents	Poisoning, harming skin, irritancy in lungs by respiration, occupational diseases, harming eyes	Analysis and experiments, not taking necessary precautions, not using fume hood	252
Toxic materials	Serious poisoning, harming skin, irritancy in lungs by respiration, occupational diseases	Analysis and experiments, not taking necessary precautions, not using fume hood	294
BIOLOGICAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Microorganisms and bacteria	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Viruses	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Body fluids			0
Respiration-Droplet-Aerosol	Disease infected by respiration, disease, occupational disease	Centrifuge, jar test, stirrer	294
Pathogens	Infectious disease, disease, occupational disease	Microbiological researches, not taking necessary precautions	294
Wastewater	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294
Wastewater Sludge	Infectious disease, disease, occupational disease	Analysis and experiments, not taking necessary precautions	294

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Solid waste			0
Soil			0
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet	burns, visual defect, vision loss, long term diseases	UV lambs used in experiments	105
Electromagnetic field	Stress	Computer, electrical equipment, electrical devices	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
Static load			0
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320

FIRE AND EXPLOSION	EFFECT	REASON FOR FAILURE	RPN
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Wrong usage and storing of compressed gases, fire extinguishers and chemicals	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area	Getting injured as a result of hitting to object, hitting by object, falling and crushing	Inadequate benches, inadequate storage area, disordered equipment placing, unstable cabinets	60
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning, dishwashing	30
Extreme hot environment			0
Extreme cold environment			0
Dust	Allergy, asthma, ophthalmia	analysis and experiments, samples used	100
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen			0
Reflecting-Shining			0

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Unorganized workplace	Falling, getting injured, serious injuries	Inadequate storage area	48
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Non ergonomic equipment, inadequate break, working on the sitting position, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	90
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	240
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	240
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	240
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	240
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	240
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	240
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	240

GENERAL HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Wastes	Infectious disease, disease, occupational disease, getting poisoned	Insufficient storage and carrying conditions, carrying by uneducated personal	150
Caused by construction and building	Injury as a result of hitting and crushing, falling, distractibility	Service elevator and stairs, no heating system	105
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	150

TOILETS			
FAILURE MODES	**EFFECT**	**REASON FOR FAILURE**	**RPN**
MECHANIC			0
Vibration			0
Vibration (Entire Body)			0
Noise			0
Pressure			0
Equipment			0

CHEMICAL	EFFECT	REASON FOR FAILURE	RPN
Detergents	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Disinfectants	Allergic reactions, poisoning, occupational diseases	Not using quality detergents, not taking necessary precautions, inexperienced workers, lack of training	75
Carcinogenic			0
Glutaraldehyde			0
Formaldehyde			0
Allergens	Allergic reaction	Using latex gloves	80
		Using gloves with powder	80
Corrosive materials			0
Environmentally hazardous materials			0
Hazardous materials			0
Irritants			0
Acids			0
Solvents			0
Toxic materials			0

BIOLOGICAL	EFFECT	REASON FOR FAILURE	RPN
Microorganisms and bacteria			0
Viruses			0
Body fluids			0
Respiration-Droplet-Aerosol			0
Pathogens			0
Wastewater			0
Wastewater Sludge			0
Solid waste			0
Soil			0
RADIATION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Ultraviolet			0
Electromagnetic field	Stress	Electrical equipment	192
High frequency			0
THERMAL	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Extreme Hot Materials			0
Extreme Cold Materials			0
ELECTRIC	**EFFECT**	**REASON FOR FAILURE**	**RPN**
High voltage			0
Ruined electric line	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
Static load			0

ELECTRIC	EFFECT	REASON FOR FAILURE	RPN
Short circuit	Electric shock, fire	Uncared and old electric lines, not taking necessary precautions, lack of training	192
FIRE AND EXPLOSION	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Combustible materials	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	320
Flammable materials	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	320
Physical explosion	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	320
Chemical explosion	Fire, explosion, getting injury, death, damage on physical structure	Chemicals, fire extinguisher, compressed gas tubes in the laboratories	320
WORKING ENVIRONMENT	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Closed and confined area			0
Working at height			0
Working in water			0
Slippery floor	Falling, getting injured	Leaving floor as wet after cleaning	45
Extreme hot environment			0
Extreme cold environment			0

WORKING ENVIRONMENT	EFFECT	REASON FOR FAILURE	RPN
Dust			0
Moisture			0
Working at night			0
Inadequate lighting	Visual defect, accident	High ceiling, inadequate lighting	72
Working with devices having screen			0
Reflecting-Shining			0
Unorganized workplace			0
HUMAN RELATED HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Bad body position or extreme body Stress	Muscle- Skeletal system disorders, stress	Insufficient break, working on foot, lifting heavy objects and repetitive motion	120
Working by disobeying rules	Accident, injury, occupational diseases	lack of education, insufficient management, not providing necessary PPE	72
Mental pressure and Stress	Accident, injury	Working fast and hard, over capacity work, inadequate workers	192
Communication problems	Accident, injury, Stress	Superior-subordinate relationship problems, communication problems with coworkers, making decision problems	192
Inability in compliance with human anatomy (hand/arm, foot/leg)	Accident, injury, occupational diseases, Stress	Unqualified and inadequate workers	192
Absence and daydreaming	Accident, injury	Stress, pressure, daily life	192
Extreme self-confidence	Accident, injury	Lack of education, unqualified workers	192

HUMAN RELATED HAZARDS	EFFECT	REASON FOR FAILURE	RPN
Usage of Personal Protective Equipment (PPE)	Accident, injury, occupational diseases	Lack of education, unqualified workers	192
Feeling tired and sick	Accident, injury	over working, pressure, stress, daily life	192
GENERAL HAZARDS	**EFFECT**	**REASON FOR FAILURE**	**RPN**
Wastes	Infectious disease, disease, occupational disease, getting poisoned	Insufficient storage and carrying conditions, carrying by uneducated personal	150
Caused by construction and building			0
Other hazards			0
Safety precautions	Accident, getting injured in emergencies, and death	Inadequate emergency exits, lack of direction and warning signs, improper emergency escape route	175
Environment hygiene	Infectious disease, disease, occupational disease	Insufficient cleaning, unordinary collection of wastes, airlessness	120