УДК 628.3/.4
DOI 10.56525/DIKB2219

RISK MANAGEMENT AT A MUNICIPAL WASTEWATER TREATMENT PLANT: IDENTIFICATION STAGE

Jumasheva K. A., Nurbaeva F. K.
Yessenov University, Aktau, Kazakhstan
e-mail: kamshat.jumasheva@yu.edu.kz, farida.nurbayeva@yu.edu.kz

Abstract. Municipal wastewater treatment plants are complex technical facilities that have a significant impact on the environment and public health. Effective risk management at such facilities allows timely identification of threats, prevention of accidents, and minimization of negative consequences for both the environment and the economy. One of the key stages of the risk management process is risk identification, which involves detecting potential threats, determining their causes, and forecasting possible consequences. Due to the complexity of technological processes and the multi-level nature of treatment, municipal wastewater plants have a high potential for various types of risks: quality, operational, environmental, financial, and those related to the human factor. Several methods are used to identify these risks, including historical data analysis, expert assessments (Delphi method), checklists, brainstorming, environmental analysis, and process mapping. A practical study at the wastewater treatment plant in Aktau showed that the most vulnerable equipment is located at the beginning of the technological line, such as bar screens and the activated sludge circulation chamber. The results emphasize the need for a comprehensive and systematic approach to risk identification and the simultaneous use of multiple methods to enhance the effectiveness of threat management and ensure safe operation of the facility.

Keywords: risk, wastewater treatment plants, risk assessment.

Introduction

The municipal wastewater treatment plant (MWTP-1) of Aktau (Kazakhstan) was constructed and commissioned in 1971. At that time, the capacity of MWTP -1 was 42,000 m³/day. In 1984, an additional treatment unit of the same capacity was built and put into operation. Later, in 1986, a supplementary mechanical treatment unit with a capacity of 30,000 m³/day was commissioned. Therefore, the total designed capacity of WWTP-1 amounts to 72,000 m³/day. However, by 2008, the actual load on MWTP -1 did not exceed 30,000 m³/day. In 1987, the filter media of the additional treatment unit was replaced from a single-layer (quartz sand) to a two-layer system (expanded clay and quartz sand), which significantly increased the throughput capacity of the unit.

The construction of this technological facility was carried out in accordance with the relevant directive documents for the development of municipal utilities for 1971–1975 [1].

In 2000 [1], due to the considerable operational lifespan of the facilities and following inspections of the condition of the structures, pipelines, and networks, as well as the need to bring the level of wastewater treatment in line with current standards, a decision was made to carry out a major overhaul and partial reconstruction of the MWTP -1 complex.

The industrial site also includes:

- ✓ A pump-blower station unit;
- ✓ Administrative buildings;
- ✓ Pumping and filtration station;
- ✓ Mechanical and storage buildings;
- ✓ Chemical tank laboratory; lathe workshop.

Figure 1. – Condition of the wastewater treatment facilities in Aktau

Risk is a common phenomenon that occurs in every company and applies to all types of technical facilities. It is an interdisciplinary concept, defined differently by representatives of various sciences, industries, and fields of economic activity [1]. However, in the most general sense, it can be defined as the probability of a specific loss due to the occurrence of an adverse event [2]. Every company must take all possible measures to eliminate situations that generate risk, and in case such situations arise, take necessary actions to minimize their negative consequences. This is the primary goal of the risk management process.

Risk management involves identifying and evaluating types of risks, as well as measuring and continuously monitoring their level. This process has been divided into stages and systematized. It includes the following phases: risk identification, analysis and evaluation, risk management (i.e., decision-making and actions), and control and monitoring. Each phase involves taking specific measures and drawing conclusions based on them. These conclusions form the foundation for subsequent stages of the process [2].

To better illustrate the stages of this process and the activities carried out at each stage, they are presented in Table 1.

Table 1. Stages of the risk management process [2]

Stage	Actions Taken and Resulting Conclusions
Risk Identification	Identification of risk types; determination of risk causes; identification of subjects exposed to the risk
Risk Analysis	Determination of the level of threat posed by the risk to the company; assessment of the "destructive" power – negative impact of the threat; identification of risk analysis methods; determination of risk management tools
Risk Evaluation	Assessment of the company's ability to manage risks (and, if lacking, measures to acquire such capabilities); identification of possible management options; cost analysis of each option; selection of the best option for the company
Risk Management: Decisions and Actions	Prioritization of the use of specific tools; application of the optimal combination of management options and tools
Control and Monitoring	Evaluation of the effectiveness of implemented measures; modification of the management process to improve efficiency; continued use of effective options and tools

Risk Identification at a Municipal Wastewater Treatment Plant

Risk identification, which is the focus of this study, represents the first phase of the risk management process. Its main goal is to determine which threats exist at the facility, identify the causes of their occurrence, and predict the potential consequences of these events. Essentially, this stage involves observing and understanding the mechanisms of risk emergence [3].

Types of Risks at a Municipal Wastewater Treatment Plant

A municipal wastewater treatment plant is a specialized facility, the primary objective of which is to treat wastewater so that the effluent meets legal and environmental standards. The treatment process involves physical, biological, and chemical stages [4]. Naturally, the number of treatment steps, their specific characteristics, and the number of devices used lead to multiple risk-generating situations. The technological line can be exposed to the following risks [5]:

- Quality risk – causing insufficient wastewater treatment;
- Operational risk – causing changes or even disruption of the treatment process, often related to quality risks;
- Environmental risk – affecting the receiving environment and causing pollution, linked to quality and operational risks;
- Financial risk – causing financial losses associated with repairing damage, paying fines, and compensations, related to all the above risks.

In addition to these technical risks, a wastewater treatment plant also functions as a company and is exposed to other types of risks [2]:

- Economic risk;
- Legal risk;
- Organizational risk;
- Political risk;
- Technological risk.

Human factor risks must also be considered, both for the personnel present at the facility and for workers as potential sources of risk [6].

Methods of Risk Identification

Depending on the type of company, processes, activities, and operational stage, appropriate identification methods should be applied. Among the commonly used methods are:

- Historical data analysis – based on data provided by the company's manager [7];
- Delphi method – using expert knowledge and experience to assess the probability of events [8];
- Checklist method – verifying whether specific risks were considered in the project; effective if applied broadly [9];
- Brainstorming – generating a wide range of potential risk events [8];
- Environmental method – identifying risks arising from current and future conditions of the external environment [10];
- Process mapping method – defining the workflow and identifying potential threats, their causes, and consequences [10].

In the examined wastewater treatment facility, all the above methods were applied. The identification process was primarily based on data analysis provided by the plant's process engineer.

Research Findings

The study showed that the most vulnerable equipment at the facility were the bar screens and the activated sludge circulation chamber. These devices are located at the beginning of the technological line, which subjects them to significant hydraulic loads, pollutant loads, and potential accidental contaminants. The bar screens are designed to trap large debris, protecting downstream equipment, while the activated sludge chamber is the primary unit for biological treatment. The results indicate that these units are most susceptible to threats due to their function within the treatment process.

Conclusions

Risk identification is a key and essential stage in the risk management process for any enterprise, including municipal wastewater treatment plants. This stage involves the systematic identification of threats, analysis of their causes, and forecasting of potential consequences for technological processes, the environment, and the economic stability of the facility. Proper and comprehensive identification enables timely detection of critical elements most susceptible to threats, which is especially important for complex, multi-level facilities such as wastewater treatment plants.

Practical research has shown that the most vulnerable components are the bar screens and the activated sludge circulation chambers, located at the beginning of the technological line. Failure or damage to these units can trigger a chain reaction of disruptions throughout the treatment system, increasing the risk of environmental violations and financial losses. Effective risk identification requires the simultaneous use of several methods — historical data analysis, expert assessments, brainstorming, checklists, and environmental analysis — to obtain the most accurate and reliable information about potential threats.

It should be emphasized that risk identification is not a one-time activity; it must be conducted continuously, with systematic monitoring and adjustment of management decisions. This approach minimizes negative consequences, enhances personnel safety, reduces the likelihood of accidents, and strengthens the facility's resilience in a changing internal and external environment. Implementing a comprehensive risk identification and assessment system forms the foundation of effective risk management at municipal wastewater treatment plants.

.

REFERENCES

1. Report KZhSA "Caspian Thermal Channel", 2022

2. GOST R 51897-2011 / ISO Guide 73:2009 Risk Management. Terms and Definitions. URL: http://docs.cntd.ru/document/1200088035

3. GOST R 58771-2019 Risk Management. Risk Assessment Technologies. URL: http://docs.cntd.ru/document/1200170253

4. GOST R ISO 31000—2019 Risk Management. Principles and Guidelines. URL: http://docs.cntd.ru/document/1200170125

5. Glukhova M.G., Zubarev A.A., Makovetskaya E.G. Systematization of risk factors in oil and gas companies // Bulletin of Voronezh State University of Engineering Technologies, 2016, No. 3 (69), pp. 370–374

6. Grimashyevich O.N. Risk identification of industrial enterprises // Science and Society Journal, Management, Accounting and Analysis Series, 2015, No.2(21)

7. Deberdieva N.P. Methods for evaluating enterprise risks in the oil refining industry under a quality management system // Scientific Conference Bulletin, Tambov, 2019, No.1-2(41), pp. 55–57

8. Ernst & Young Study on Business Risks. Top 10 risks for oil and gas companies. [Electronic resource]. URL: https://gaap.ru/articles/desat-osnovnykh-riskov-dlya-kompanii-neftegazovoi-otrasli

9. Kudryavtsev A.A. Integrated Risk Management. Moscow: Ekonomika, 2018. 655 p.

10. Lankina S.A., Flegontov V.I. Classification and problems of industrial enterprise risk assessment // Internet Journal "NAUKOVEDENIE", Vol. 7, No. 2 (2015) http://naukovedenie.ru/PDF/90EVN315.pdf DOI: 10.15862/90EVN315

11. Urodovskikh V.N. Enterprise Risk Management: Textbook. Moscow: INFRA-M, 2017. 168 p.

ЛИТЕРАТУРЫ

1. Отчет КЖСА «Каспий жылу арнасы» за 2022 год

2. ГОСТ Р 51897-2011/Руководство ИСО 73:2009 Менеджмент риска. Термины и определения. URL: http://docs.cntd.ru/document/1200088035

3. ГОСТ Р 58771-2019 Менеджмент риска. Технологии оценки риска URL: http://docs.cntd.ru/document/1200170253

4. ГОСТ Р ИСО 31000—2019 Менеджмент риска. Принципы и руководство URL: http://docs.cntd.ru/document/1200170125

5. Глухова М.Г., Зубарев А.А., Маковецкая Е.Г. Систематизация факторов риска деятельности нефтегазодобывающих предприятий //Вестник Воронежского государственного университета инженерных технологий. –Воронеж: Воронежский государственный университет инженерных технологий, 2016, № 3 (69), с. 370-374.

6. Гримашевич О.Н. Идентификация рисков промышленных предприятий// Научно - практический журнал Наука и общество. Серия «Менеджмент, учет и анализ». 2015. №2(21).

7. Дебердиева Н.П. Методы оценки рисков предприятия нефтеперерабатывающей промышленности в концепции системы менеджмента качества //Вестник научных конференций. г. Тамбов. 2019г., №1-2(41). стр.55-57

8. Исследование «Эрнст энд Янг» в области бизнес-рисков. 10 основных рисков для компаний нефтегазовой отрасли. [Электронный ресурс]. URL: https://gaap.ru/articles/desat-osnovnykh-riskov-dlya-kompanii-neftegazovoi-otrasli.

9. Кудрявцев, А.А. Интегрированный риск-менеджмент / А.А. Кудрявцев. — М.: Экономика, 2018. — 655 с.

10. Ланкина С.А., Флегонтов В.И. Классификация и проблемы оценки рисков промышленного предприятия // Интернет-журнал «НАУКОВЕДЕНИЕ» Том 7, №2 (2015) http://naukovedenie.ru/PDF/90EVN315.pdf (доступ свободный). Загл. с экрана. Яз. рус., англ. DOI: 10.15862/90EVN315

11. Уродовских В. Н.Управление рисками предприятия: учебное пособие / В.Н. Уродовских. - М.: Вузовский учебник, ИНФРА-М, 2017. - 168 с.

ҚАЛАЛЫҚ КӘМІРСУ СУЫН ТАЗАЛАУ СТАНЦИЯСЫНДА ТӘУЕКЕЛДІЛІКТІ БАСҚАРУ: ИДЕНТИФИКАЦИЯ КЕЗЕҢІ

Джумашева К.А., Нурбаева Ф. К.
Yessenov University, Ақтау қ., Қазақстан
e-mail: kamshat.jumasheva@yu.edu.kz, farida.nurbayeva@yu.edu.kz

Аннотация. Қалалық кәріз суларын тазалау станциялары күрделі техникалық нысандар болып табылады және қоршаған орта мен халық денсаулығына елеулі әсер етеді. Мұндай объектілерде тиімді тәуекелдерді басқару қауіп-қатерді уақтылы анықтауға, авариялық жағдайлардың алдын алуға және қоршаған орта мен экономикалық шығындарды азайтуға мүмкіндік береді. Тәуекелдерді басқару процесінің негізгі кезеңдерінің бірі – тәуекелді идентификациялау, ол әлеуетті қауіптерді анықтау, олардың себептерін талдау және мүмкін салдарды болжауды қамтиды. Қалалық тазалау станцияларында технологиялық процестердің күрделілігі мен көпсатылы тазалау жүйесі әртүрлі тәуекелдердің – сапалық, операциялық, экологиялық, қаржылық және адам факторыға байланысты тәуекелдердің пайда болу ықтималдығын арттырады. Оларды анықтау үшін тарихи деректерді талдау, сарапшылардың бағалауы (Дельфи әдісі), бақылау тізімдері, ми шабуылы, экологиялық талдау және процесс диаграммаларын құру сияқты түрлі әдістер қолданылады. Ақтау қаласының тазалау станциясында жүргізілген зерттеу көрсеткендей, ең осал жабдықтар технологиялық желінің басында орналасқан, мысалы, торлық экрандар және белсендірілген шлам айналым камерасы. Зерттеу нәтижелері тәуекелдерді идентификациялауда кешенді және жүйелі тәсілді қолдану қажеттігін, сонымен қатар бірнеше әдісті бір уақытта пайдалану арқылы қауіптерді басқару тиімділігін арттыру қажеттігін көрсетеді.

Түйінді сөздер: тәуекел, тазалау станциялары, тәуекелді бағалау.

УПРАВЛЕНИЕ РИСКАМИ НА ГОРОДСКОЙ СТАНЦИИ ОЧИСТКИ СТОЧНЫХ ВОД: ЭТАП ИДЕНТИФИКАЦИИ

Джумашева К.А., Нурбаева Ф.К.
Yessenov University, г.Актау, Казахстан
e-mail: kamshat.jumasheva@yu.edu.kz, farida.nurbayeva@yu.edu.kz

Аннотация. Городские очистные сооружения представляют собой сложные технические объекты, оказывающие значительное влияние на экологию и здоровье населения. Эффективное управление рисками на таких объектах позволяет своевременно выявлять угрозы, предотвращать аварийные ситуации и минимизировать негативные последствия для окружающей среды и экономики. Одним из ключевых этапов процесса риск-менеджмента является идентификация рисков, которая включает выявление потенциальных угроз, определение их причин и прогнозирование вероятных последствий. На городских очистных сооружениях сложность технологических процессов и многоуровневость очистки создают высокий потенциал возникновения различных рисков: качественных, операционных, экологических, финансовых, а также связанных с человеческим фактором. Для их выявления применяются разнообразные методы, включая анализ исторических данных, экспертные оценки (метод Дельфи), контрольные списки, мозговой штурм, экологический анализ и создание диаграмм процессов. Практическое исследование на очистных сооружениях города Актау показало, что наиболее подвержены риску устройства, расположенные в начале технологической линии, такие как решетчатые экраны и камера циркуляции активного ила. Результаты исследования подчеркивают необходимость комплексного и систематического подхода к идентификации рисков, а также

использование нескольких методов одновременно для повышения эффективности управления угрозами и обеспечения безопасной эксплуатации объекта.

Ключевые слова: риск, очистные сооружения, оценка риска.