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Ensuring safety during operation of a loading and unloading railway overpass at an oil depot

A. V. Fedosov, N. Kh. Abdrakhmanov, A. S. Tikhonova, I. R. Danieva, R. R. Valeeva
Ufa State Petroleum Technological University (Ufa, Russian Federation)

Introduction. The analysis shows that one of the main causes of accidents at refineries is the low reliability of process equipment and technological discipline violation.
Problem Statement. The objective of this research is to study theoretical foundations of loading and unloading railway overpass operation, to identify hazardous factors and to suggest measures to improve safety during operation of this overpass at the oil depot of Bashneft-roznitsa OOO (limited liability company).
Theoretical Part. During loading and unloading operations, many accidents occur annually that pose some risk to workers life and health and cause damage to the ecology and economy of the country. The features of the process are: high pressure, high temperature, the use of dangerous and harmful, toxic chemicals that have a harmful effect on humans.
Technical causes of accidents are wear and unreliability of equipment, violation of production discipline. However, there are also organizational causes of accidents, such as poorly organized production control, as well as low level of industrial safety competence of employees.
Therefore, it is necessary to carry out measures aimed at improving the reliability of the equipment.
The study has also revealed that one of the main technical causes of accidents at oil refining enterprises is the low reliability of technological equipment and violations of production discipline.
Conclusion. The paper presents the study on operation of the loading-unloading railway overpass at the oil depot of Bashneft-roznitsa OOO (limited liability company). There have been developed and proposed measures to improve safety during operation of the loading-unloading railway overpass at the oil depot of Bashneft-roznitsa OOO (limited liability company).

Keywords: security provision, loading-unloading railway overpass, accident, reliability, production discipline, refining.

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Introduction. At the enterprises of the oil refining industry, the compliance with industrial safety is considered as one of the most important tasks, which covers a wide system of technical, sanitary, hygienic, legal and economic measures coordinated to ensure safe and harmless working conditions. Ensuring industrial safety covers all aspects that relate to the activities of the enterprise. Only by following all the rules and requirements of industrial safety, you can organize an effective production.

Problem Statement. The main objective is to increase the operation safety of loading and unloading railway overpass at the oil depot of Bashneft-roznitsa OOO (limited liability company), for which it is necessary to study the theoretical foundations of the operation of loading and unloading railway overpass at the tank farm, to identify hazards in the operation of loading and unloading railway overpass, to propose measures to increase operation safety.

Theoretical Part. Having studied the publicly available statistics of accidents and injuries, it can be concluded that the main reasons for their occurrence at oil refining enterprises are low reliability of technological equipment and technological discipline violation (Fig. 1) [1]. During the study of statistical data, it was noted that the main

organizational causes of accidents are poorly organized production control (PC) and a low level of knowledge on industrial safety (IS) by the employees of the enterprise [2].

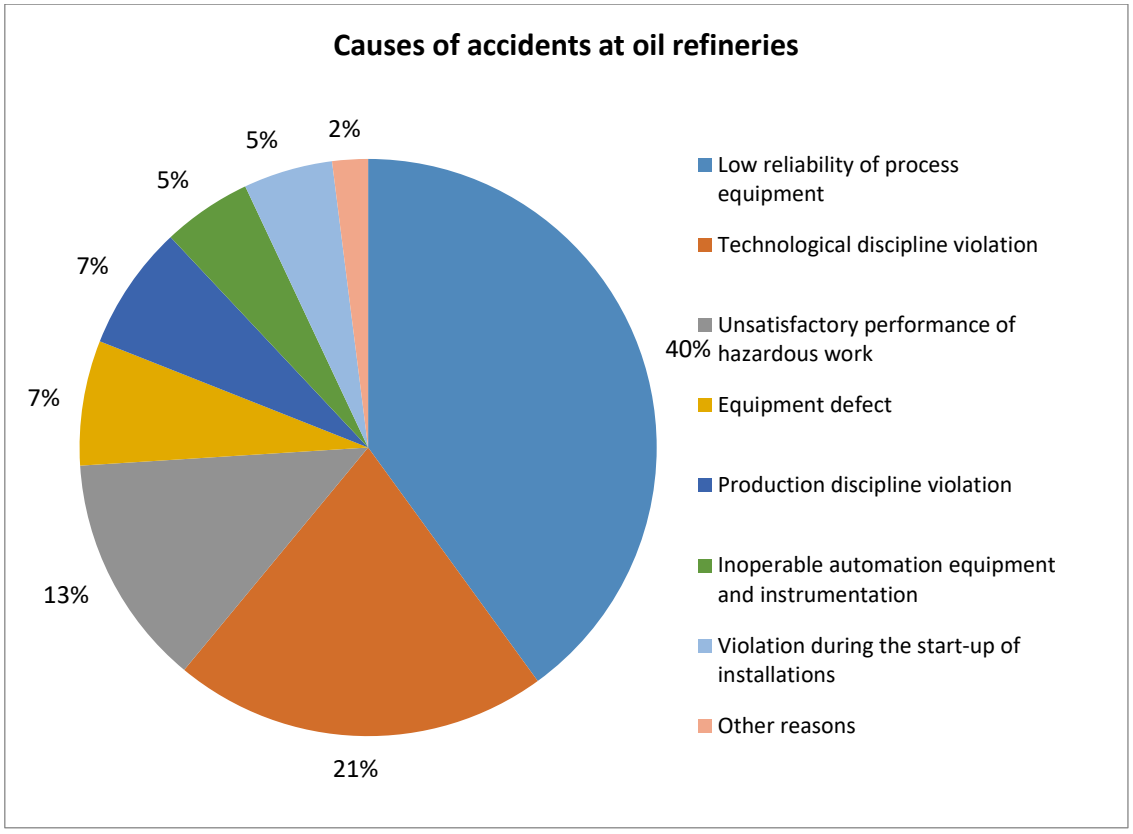

Fig. 1. Causes of accidents at oil refineries

Loading and unloading railway overpasses are designed for loading motor gasoline, diesel fuel, heating oil-100, vacuum gas oil, jet engine fuel (JF), aviation gasoline, as well as for unloading with subsequent pumping into freight fleets or directly into tank cars of motor gasoline, diesel fuel, fuel oil, vacuum gas oil. The production facility includes the following blocks: a 300-meters-long light oil products loading and unloading railway overpass, a 300-meters-long dark oil products loading railway trestle, a dark oil products unloading overpass, a six-car railway draining overpass (21-th railway track), horizontal underground tanks E-1 and E-2, buried at 4.0 m, cylindrical [3].

Technological operations are performed at the oil depot of Bashneft-roznitsa OOO (limited liability company), such as placing tank cars in the loading area, preparing for loading, oil products loading, finishing loading, placing tank cars in the unloading area, preparing for unloading, oil products unloading, finishing unloading, pumping light oil products from buried tanks E-1, E-2.

After studying the technological process, the authors have identified a operating failures that could lead to accidents: absence of oil supply in the centrifugal submersible pump after switching on; submersible pump does not provide the necessary performance; vibration and noise when the submersible pump is leaking oil through the seals or flange joints; oil products at the loading are not received or stopped at the wagon-tank; overflow of drainage channels; visible leakage of oil from hose; doors from the exit platform to the cars do not open or are difficult to open [4-5].

First, in order to increase the level of operation safety of the loading and unloading railway overpass at the oil depot of Bashneft-roznitsa OOO (limited liability company), it is necessary to exclude the most likely causes of accidents. It is necessary to carry out measures aimed at improving the reliability of the equipment. It includes:

— putting into operation modern equipment;

— use of pipes and joints of higher quality (modern material makes it possible to increase the level of industrial safety. An example of such a material is Asmol. This material has an incredible resistance to the negative

effects of corrosion and aggressive environments. Asmol is an asphalt-tar oligomer. The material is get from petrochemical production waste. Functional groups of Asmol (in contact with a metal surface) interact with the crystal lattice of the metal, forming a strong and reliable complex of iron-petroleum polymer);

— use of equipment that transmits signals, an excellent example of it is "Buran-1 CD". This alarm system has the ability to instantly determine the amount of gas contamination during work;

— the employees who carry out repairs and maintenance of equipment must be qualified. In case of an accident, the personnel must do the necessary activities in a particular order [6-7];

— the equipment used in the working process of the enterprise must be subject to industrial safety expertise. At the enterprises using loading and unloading equipment, the expertise should be carried out in the following situations:

a) if there were repairs, during which the design of the equipment was changed or the main materials were changed, if it became possible to return the equipment to the technological process after a serious accident;

b) when using old equipment (more than 20 years of use) without technical documentation;

c) if the regulatory and technical document of this organization does not meet the existing safety requirements;

d) if the period of use of the loading and unloading equipment, which was determined by the manufacturer, has ended, as well as when the permissible operating cycles approach zero [8];

— introduction of the automated process control system (APCS) for the automatic and operational control of the equipment on a railway overpass for loading and unloading of various refined products. The TPA system (APCS) is made using three programmable logic controllers (PLCs) SIE-MENS SIMATIC S7-300 series. The system performs the following functions:

— automated management of loading and unloading of refined products with the established operating methods;

— remote control of the overpass equipment;

— control, as well as data counting;

— getting timely information about the state of the units;

— automatic transfer of data to the "1C: Accounting" system

— manual management of loading and unloading processes;

— automatic emergency protection;

— automatic fire protection.

The system architecture contains the following subsystems: EP — emergency protection, TPA — process automation, AFE — automatic fire extinguishing (Fig. 2).

Each of these subsystems includes three levels:

— field level consists of instrumentation and automation (max level sensors, sensors of position, control over the lower concentration limit of flame propagation, flow meters);

— the lower level consists of programmable logic controllers (PLCs) that provide remote control of equipment, intermediate links, and signal input/output modules.

PLCs are necessary for performing such functions as:

— collecting information about the current state of absolutely all devices, as well as system units and their control mode;

— formation of information notifications about all modifications in the system, management commands and the results of their implementation;

— receiving operator commands;

— automatic control over the devices and aggregates according to the approved algorithms of operation;

— an important component of the third, upper, level is the man-machine interface, represented by the SCA-DA system.

Functions of the third level:

— control over the devices that receive the control signal and act on the control object through the working body or directly;

— registration of available information;

— control over the peripheral devices;

— storage of information.

The best system construction is carried out if the automated work areas are located in the operator room, and the controllers are located directly on the overpass, in specially designed explosion-proof cabinets. Thus, the connection of devices and aggregates with the controller is achieved by the shortest cable length [9].

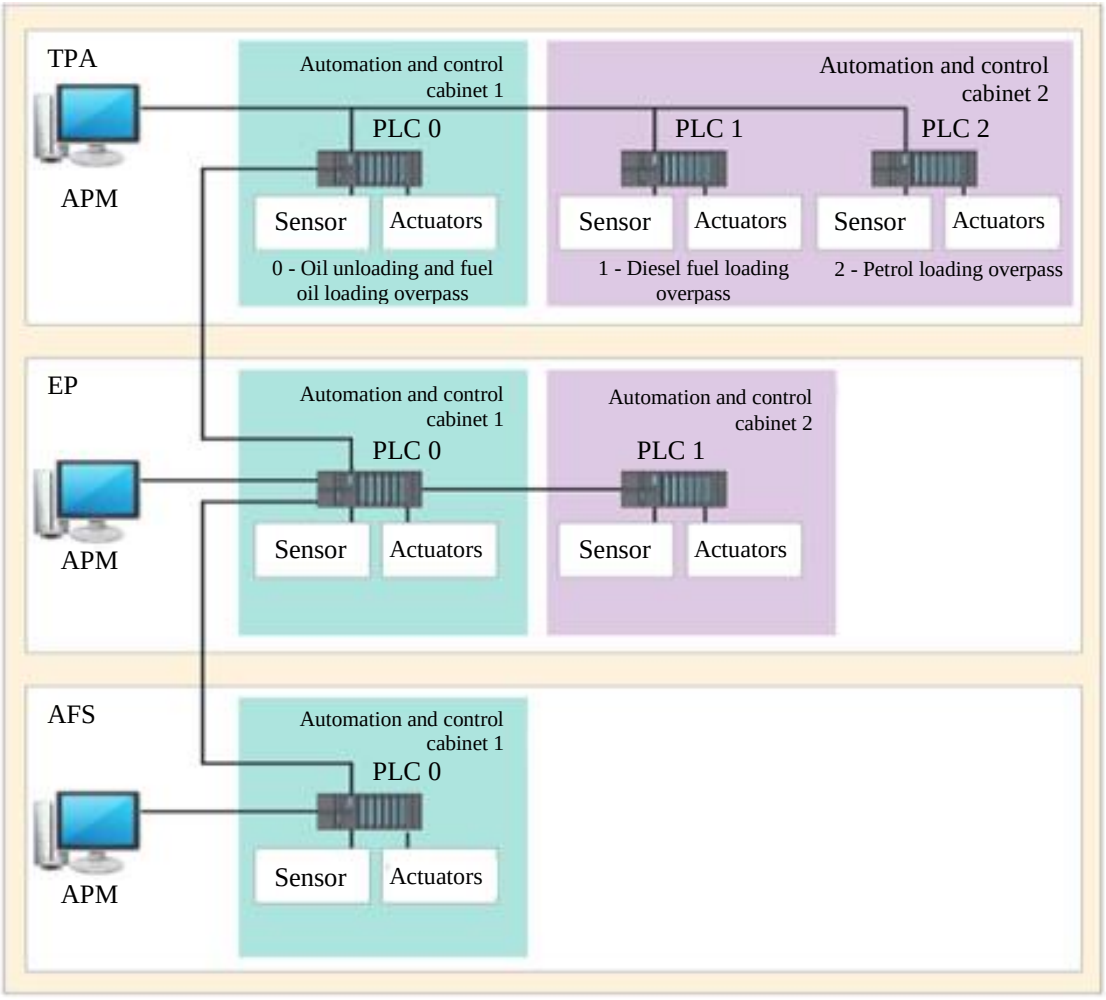

Fig. 2. Architecture of the automated control system of the railway overpass: TPA — automation of the technical process, EP — emergency protection, AFS — automatic fire suppression

It is also necessary to exclude the second most likely factor in the occurrence of an accident at work — violation of technological discipline. To improve the technological discipline, it is required to:

— equip the workplaces with the necessary equipment and tools;

— stiffen daily, special and periodic monitoring;

— think through a system of employee motivation and incentives for compliance with the technological discipline. Incentive measures can be anything: bonuses and allowances (material), certificates of honor and state awards (non-material). Incentive measures develop employees' interest in the proper implementation of the

requirements for technological discipline, and employees also have attitudes to comply with these requirements. There is the difference between the stimulating management, which is used for the promotion of the employee, and the punishing management used to increase staff accountability for their actions/inaction, since for non-compliance with the technological discipline by the employees, they are brought to disciplinary responsibility with the bonus loss [10].

It is necessary to motivate employees with various unconventional methods. Here are some of them:

a) first of all, to encourage by personal example. After studying the statistics, we can say that the cause of all the troubles is often low motivation to perform a certain type of work. An excellent way to increase motivation will be the introduction of uniform standards for all employees of the enterprise;

b) a person has such a feeling as conscience, if you correctly use it, you can achieve an increase in technological discipline. You can hold competitions between the "leaders" in the number of violations of the technological discipline and identify the "winner", and then place a list of those who distinguished themselves on the entrance hall or on the organization's website;

c) at the same time, we must not forget about the employees who try not to violate the technological discipline. It is necessary to encourage their behavior, so that the impulse does not fade away;

— the control over the fact that employees themselves do not make changes to the established technological process (they have the opportunity to make proposals for the rationalization of the technological process in the office of working invention);

— it is necessary to create conditions in which employees can improve their professional skills;

— it is recommended to hire employees on a competitive basis [11].

Great attention is given to the technological discipline in any enterprise, and its non-compliance is not only prohibited, but also punished [12].

Conclusion. The main causes of accidents during the operation of the loading and unloading railway overpass are the low reliability of technological equipment and technological discipline violations. When implementing the measures to improve the operation safety of loading and unloading railway overpass proposed in this article, the probability of an emergency will be reduced, and the negative impact on the environment and economic damage will be minimal.

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Authors:

Fedosov, Artem V., Associate professor, Department of Industrial Safety and Labor Protection, Ufa State Petroleum Technological University (1, Kosmonavtov St., Ufa, RF, 450062), Cand.Sci., ORCID: https://orcid.org/0000-0002-7853-1800, fedsv-artem@rambler.ru

Abdrakhmanov, Nail Kh., Head, Department of Industrial Safety and Labor Protection, Ufa State Petroleum Technological University (1, Kosmonavtov St., Ufa, RF, 450062), Dr.Sci., Professor, ORCID: https://orcid.org/0000-0002-3184-1975, anailx@mail.ru

Tikhonova, Alina S., Student, Department of Industrial Safety and Labor Protection, Ufa State Petroleum Technological University (1, Kosmonavtov St., Ufa, RF, 450062), ORCID: https://orcid.org/0000-0003-0556-1678, alina.tikhonova.95@mail.ru

Danieva, Ilida R., Master's degree student, Department of Industrial Safety and Labor Protection, Ufa State Petroleum Technological University (1, Kosmonavtov St., Ufa, RF, 450062), ORCID: https://orcid.org/0000-0002-3305-3649, ilida.danieva@yandex.ru

Valeeva, Regina R., Master's degree student, Department of Industrial Safety and Labor Protection, Ufa State Petroleum Technological University (1, Kosmonavtov St., Ufa, RF, 450062), ORCID: https://orcid.org/0000-0001-5581-0850, Lyalya.val@mail.ru

Contribution of the authors:

I. R. Danieva and R. R. Valeeva — theoretical research and patent analysis; N. Kh. Abdrakhmanov — formulation of the main idea of the research and article structure, editing; A. V. Fedosov and A. S. Tikhonova — literary, patent analysis and participation in theoretical research.