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## Analysis of the causes of accidents occurring in drilling

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### Abstract

The article examines the causes of drilling injuries (based on case studies) in the oil and gas industries. Examples of drilling accidents are described on the website of the Federal Service for Labour and Employment. The author analyzed the drilling accidents that occurred from 2014 to 2017. The article shows that one of the main causes of industrial injuries during hazardous work is human factor, which is associated with the maximum psychophysiological workload of work under conditions of the Far North. The research resulted in the development of measures to prevent injuries based on models where the “human factor” presents the greatest risk, since human labour activity includes both mental and physical factors. This direction becomes a key to the prevention of industrial injuries.

*Keywords:* Well drilling, safety, injuries, mechanism; human factor;

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### 1. Introduction

Oil and gas industry engineers have not yet resolved the safety issues in drilling of both methodological and technical nature.

In this regard, the task of improving the mechanisms for ensuring production safety during drilling is important and relevant. At present, the human factor plays a major role at hazardous production facilities, as it is present in 70-75% of accidents[. In this regard, the main focus on improving the sustainability of hazardous production facilities of oil and gas complex and reducing the risk of accidents with serious consequences can be called the introduction of the principles of mutual monitoring of personnel and increasing responsibility for taking operational measures and informing about identified cases of violations of industrial safety requirements [11, 2].

Industrial injuries are considered by most researchers as a complex of industrial accidents. The causes of occupational injuries are classified as follows: sanitary and hygienic are associated with violation of the requirements for humidity and temperature (sanitary standards) when organizing a workplace; organizational measures include those associated, for example, with violation of the rules for the operation of vehicles and equipment, violation of work and rest schedules, violation of safety regulations and others; psychophysiological causes of occupational injuries are associated with violation of labour discipline (being intoxicated, intentional self-injury, and others); technical causes of industrial injuries are related to design flaws (malfunction of machines, mechanisms,

imperfect technological process, insufficient mechanization and automation of heavy and harmful work) [6].

## **2. Materials and methods**

The key to this study was the analysis of industrial injury cases from 2014-2017. Based on the analysis of 4 cases, a conclusion was made about the significance of the human factor in occupational injuries. I analyzed the cases of industrial injuries that are in the public domain on the website of the Federal Service for Labour and Employment [1].

## **3. Analysis of causes of industrial injuries during drilling**

The author conducted a study on the causes of accidents based on the analysis of cases. The causes of accidents on the industry is the human factor.

*Case 1.* [1]

A serious accident occurred on September 19, 2014 at 00 hours 42 minutes (0:42 a.m.) in LLC "Engineering Technological Service", Nizhnevartovsk.

Information on the conduct of briefings and training on labour protection:

Introductory briefing – 02.08.2013.

Briefing at the workplace (repeated): 16.07.2014.

Internship: from 02.08.2013 to 12.08.2013.

Training in labour protection by profession: not conducted.

Testing of knowledge on labour protection by profession: conducted (Protocol of testing knowledge of labour protection from 12.08.2013 № 54).

Brief description of the place (facility) where the accident occurred:

The working platform is a part of the mobile drilling rig ZJ40CZ (E) - 00 at well No. 19476 of the pad No. 2411 of the Samotlor field of the OAO RN-Nizhnevartovsk in 84 km. to the north-east from the town of Nizhnevartovsk.

Description of accident:

18.09.2014 at 20:00 the watch of the drilling crew No. 2, where the victim was a member, made their shift. Before starting the work, the assistant to the drilling master was instructed by the members of the team on occupational safety and health with a record in the shift log. The assistant driller gave the task to driller E. and the first assistant driller B. to flush the well and lift the drill string to the surface.

At 00:40 hours after the well had been washed, the watch was preparing for the lifting of the drill string. The first assistant driller B. was near the levers controlling the hydraulic key and adjusted it for the lap of the drill pipe. Assistant driller A. was opposite the longitudinal axis of the key at a distance of about 0.8 m and watched the actions of assistant driller B. who turned the head of the key counter-clockwise and briefly stopped its rotation. At this time assistant driller A. noticed that the position of the lower and upper jaw prevented the capture of the pipe for its lapel. He went to the hydraulic key and put his right hand into the jaw-holder to fix the position of the dice. Assistant driller B. did not notice the presence of worker A. in the dangerous zone of the key and brought the key into rotation. As a result of the rotating head of the key, the right hand was clamped between the jaw holder and the body of the hydraulic key.

According to the medical certificate issued by BU "Nizhnevartovsk city hospital № 1" on September 19, 2014 the worker A. received the following injuries: Traumatic amputation of the

right forearm at the level of the middle third, shock of 2-3 degrees; severe injury. The state of alcoholic intoxication: absent.

The reasons that caused the accident:

Unsatisfactory organization of work production, namely, lack of control by the management over observance of workers' labour and production discipline as well as requirements of rules and instructions for the safe conduct of work; admission to work at a dangerous production facility of an employee who did not undergo in due course the knowledge check (test) of labour protection requirements; lack of control by officials who are responsible for ensuring the safe production of work.

Conclusion on the people responsible for the violations of legislative and other regulatory legal and local regulatory acts which were the causes of the accident:

1. The Deputy Chief Engineer for HSE, LLC "Engineering Technological Service" did not notify the forthcoming inspection of the assistant driller of operational and exploratory drilling of wells for oil and gas of the 5<sup>th</sup> category A.

2. The driller allowed to independent work of the assistant driller who did not pass in the established timeframe;

3. Assistant driller did not ensure compliance with the staff of the drilling crew requirements and rules for safe work, and the use of safe work practices.

4. The manager of the work did not organize the management of the work, did not exercise constant control over the safe conduct of work, and also did not ensure labour and production discipline, labour protection and industrial safety instructions by members of the watch;

5. The first assistant driller of operational and exploratory drilling of wells for oil and gas of the 5<sup>th</sup> category activated the mechanism of the hydraulic key, without being convinced of the absence of personnel in the hazardous zone of the operating equipment;

6. The second assistant driller of operational and exploratory drilling of wells for oil and gas of the 5<sup>th</sup> category was in the radius (zone) of the hydraulic key operating, performing work not provided for in the job description.

Qualification and accidents: The investigation of the accident was completed on 02.10.2014. Established type of accident: Impact of moving and rotating parts and mechanisms. Accident occurred with gr. A., in accordance with Art. 229 TC RF, pp. 3.23 "Regulations on the specifics of the investigation of accidents at work in certain industries and organizations", is qualified by the commission that conducted the investigation, as an accident related to production. Accident is subject to registration and registration in LLC "Engineering Technological Service."

Measures to eliminate the causes of the accident, deadlines:

All employees must know the circumstances, the causes and measures to prevent an accident. Term – until October 17, 2014. Extraordinary instruction of drilling crews by profession, according to the training programs at the workplace, should be carried out outside the plan. Term – until October 17, 2014. Extraordinary testing of knowledge in the field of industrial safety for drilling masters should be carried out unscheduled. Term – until 10.10.2014. Extraordinary testing of knowledge on labour protection for watch workers is unscheduled. Term – until 10.10.2014.

To introduce amendments to the Manual on labour protection and industrial safety in the operation of hydraulic keys: to define a hazardous area, which is prohibited by the presence of workers when operating hydraulic key mechanisms. Term – until 20.10.2014. Develop instructional and technological maps for the types of work for drilling crews. Term – until 25.10.2014.

Send a request to the supplier of the hydraulic key about the possibility of installing additional locking devices preventing free access to the moving parts of the mechanisms. Term – until 25.10.2014.

*Case 2 [1]*

The accident occurred on the morning of June 30, 2017 on the territory of the branch of JSC HC "Yakutugol" section "Neryungrinsky" with the driver of the drilling rig.

06.30.2017 Engineer of the drilling rig underwent a medical examination and received an order to work on drilling wells. The injured operator of the drilling rig, who suffered the change, reported that the complete switchgear outdoor – 12 switching point (hereinafter KRUN 12 PP) did not work and another switch point should be mounted. At some point, the excavator driver noticed the injured man standing on the ground from the side of the high-voltage door that was open. He saw the victim lying on the ground and reported about the accident, the workers immediately began to perform resuscitation measures, soon a medical assistant of the health center arrived and stated the death of the driver of the drilling rig.

According to forensic evidence, death came as a result of destruction by technical electricity. Also, in accordance with the extract of the examination, ethanol was found in the victim's blood. The main cause of the accident was the employee's violation of the work schedule and labour discipline, expressed in being in the workplace in a state of intoxication and performing work in an electrical installation not provided in the work order.

As a result of the investigation, the accident was found to be related to production and the employer was instructed to conduct a set of measures to eliminate the causes of the accident.

*Case 3 [1]*

The State Labour Inspectorate in the Khanty-Mansiysk Autonomous Okrug – Ugra completed the investigation of a serious accident that occurred on July 7, 2015 with an assistant driller for the well workover of the NFC CJSC SCC, Nefteyugansk. As a result of the blow, a metal splinter broke away from the metal sledgehammer; it damaged the eye of the driller's assistant. According to the scheme for determining the severity of health damage, in case of accidents at work, the trauma received by the employee was classified as severe. During the investigation it was established that the reasons for the accident were unsatisfactory content and shortcomings in the organization of workplaces. There was faulty equipment on the site. The equipment was not suitable for use in the workplace. The supervision by managers and specialists in the course of work and the use of personal protective equipment were lacking. Based on the results of the accident investigation, measures were developed to eliminate the causes of the accident. In addition, the employer was brought to administrative responsibility under Part 1 of Art. 5.27.1 of the Code of Administrative Offenses of the Russian Federation in the form of a fine.

*Case 4 [1]*

As a result of the fall from the 17-meter height, the employee of KATOIL-Drilling Ltd. was seriously injured

Gostrudinspektsiya completed the investigation of the accident, as a result of which a 31-year-old assistant driller of operational and exploratory drilling of wells for oil and gas of the 5<sup>th</sup> category of OOO KATOIL-DRILLING was seriously injured.

Results of the investigation: On January 17, 2018 the driller's assistant (as part of the drilling crew) was working on the preparation (stitching, patterning) of the shank for lifting to the rotor platform (according to the work plan) in the Samotlor field 15 km. from the city of Nizhnevartovsk.

When changing and transferring the watch at the site of the riding worker, the worker unhooked the rifle carbine J.R.G. with a pulling cable heading along the platform of the riding worker towards the ladder. It resulted in the fall onto the rotor platform from a height of 17 meters.

Workers of the watch (they were on a rotary platform) saw the incident (accident?) and gave first aid (they brought a stretcher, shifted the injured and transported him to the warm car of the residential town). The victim was taken to the trauma department of Nizhnevartovsk District Hospital No.1 by an ambulance brigade. The diagnosis was a combined catatrauma, numerous fractures and a traumatic shock of 1-2 degree.

The commission investigating the accident came to the conclusion that the main causes of the accident were: unsatisfactory organization of work during the downhill operations, individual protective equipment was not used, the driller's assistant did not apply the safety device, in the failure of the worker to take security measures while climbing the riding-top balcony (having risen on the top of the balcony, the changer did not lower the platform for the crossing), and also was not satisfactory. The drill master did not control workers to comply with labor protection requirements at height.

The employer received a precept to eliminate the causes of the accident. The legal entity and officials were brought to administrative responsibility under Part 1 of Art. 5.27.1 of the Code of Administrative Offenses of the Russian Federation in the form of fines for the amount of 50 thousand rubles and 5 thousand rubles respectively.

#### **4. Discussion**

According to the analysis of the cases, it was concluded that the human factor in the causes of industrial injuries remains dominant. Analyzing most drilling injury cases, one can distinguish psychophysiological causes attributed to a lack of attention and/or fatigue.

Statistics on accidents at oil and gas facilities indicate a high role of the "human factor" in the causes of emergencies and escalation of emergencies [3, 4, 7].

Researchers Schennikov N.I. and Pachurin G.V. note that "When studying the causes of industrial injuries, it turned out to be an effective study of errors in connection with labour movements, functions, and psycho-physiological qualities." [9]. The key direction in the complex of measures is the transition to zero injury through fixing micro traumas, analysis, identification and elimination of risk factors at an early stage, as well as the shift of financial costs from compensatory measures to preventive ones.

Analysis of statistics shows that a fatal event is the peak of the pyramid. At the base of this pyramid there are unreported violations, minor injuries are higher, injuries with temporary disability are even higher, and closer to the top there are accidents with grave consequences. And finally, there are fatal cases. One death case is preceded by 10-30 cases of severe injuries, 100-300 minor injuries, 1000-3000 microtraumas and 10-30 thousand so-called dangerous factors [9]. If no preventive actions are taken at the base of this pyramid, then fatal occurrence becomes natural and inevitable.

#### **5. Conclusion**

To reduce the impact of the human factor on the accident rate, it is necessary to create modern simulation and training systems; improve professional selection procedures; assess working conditions and the actual functional state of a person in the working environment; pay special attention to those jobs that are high-risk, including the creation of motivational conditions for employees [3, 4, 11, 10].

Currently, a Concept has been developed to increase the effectiveness of ensuring compliance with labour legislation and other regulatory legal acts containing labour law norms for 2015-2020.

This Concept assumes a transition from the current "model of sanctions" to a "compliance model", which is based on proactive actions aimed at preventing violations. With this in view, a self-testing service, Electronic Inspector and functions on the Rostrud website help to independently carry out an assessment and bring the organization's local documentation into compliance with the requirements of labour legislation.

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