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APPLICATION OF INFORMATION SYSTEMS TO PREVENT EMERGENCIES AT MINING FACILITIES

The mining industry is a complex infrastructure where the safety of employees and the resilience of facilities to emergencies play a key role. Risks at mining operations can be caused by both technical and natural factors, such as landslides, cave-ins, gas leaks, and sudden changes in weather and climate conditions. These hazards can lead to severe consequences if measures are not taken to detect and prevent them in time. In this regard, control and management of safety at mining facilities requires the use of innovative technologies and integration of modern information systems, which makes this aspect one of the priorities in the mining industry [1,2]. The main purpose of such systems is to create safe working conditions by predicting hazards and promptly responding to critical changes in the production process.

Information systems for monitoring and preventing emergencies include sensor networks, monitoring systems, data analysis software, and warning mechanisms. These components ensure the prompt transmission of data on the condition of mining facilities, which allows timely detection of signs of potential threats, such as cave-ins or gas accumulation. The control system, in turn, can automatically initiate evacuation and equipment shutdown processes [3]. The introduction of such technologies can significantly reduce the risk of accidents at enterprises and increase the level of employee safety, making production processes more controlled and efficient.

Information systems are becoming a crucial part of safety management at mining enterprises, integrating a wide range of data obtained from various sensors, geolocation systems and analytical platforms. This data can be analyzed in real time using machine learning and artificial intelligence algorithms, allowing potential risks to be identified at an early stage.

Studies [1] have made it possible to substantiate the relevance of using integrated monitoring systems at mining enterprises that combine monitoring the condition of equipment and mine structures to significantly reduce the risk of emergencies. Sensors installed on the equipment allow tracking vibrations, temperature, pressure and other parameters, helping to detect abnormalities in advance and prevent breakdowns. At the same time, monitoring systems keep track of rock displacement and the condition of mine structures, preventing possible collapses and destruction. This integrated approach helps to extend equipment life, reduce downtime and create a safe environment for employees.

Integration of data from various sources plays a crucial role in the operation of such systems. Information platforms combine data from meteorological stations, sensors, and equipment, analyzing it using big data and artificial intelligence algorithms. This allows you to get a complete picture of the current state of the facility and identify hidden trends that may indicate possible risks. This analytical approach provides comprehensive control over the facility, improves forecasting accuracy, and reduces the likelihood of accidents.

The automatic emergency response systems discussed in [2] complement the monitoring processes, allowing immediate action to be taken in the event of abnormal indicators. If critical values are exceeded, for example, if the permissible methane concentration is exceeded or the pressure rises sharply, the system can automatically stop the equipment or

trigger an emergency shutdown, minimizing the risks to personnel and equipment. These measures are backed up by alert functions that instantly warn employees of a potential threat, giving them time to evacuate or take protective action.

Automated response, backed by integrated data, creates a multi-level defense system. It allows not only to quickly resolve incidents, but also to prevent them by predicting possible threats and taking action in advance. This approach helps to improve overall safety at mining facilities and minimizes environmental impact, ensuring reliable and sustainable operation of mining enterprises.

The reliability of the emergency response system can be improved by supplementing the existing systems with an additional system of computer monitoring of safety parameters with the functions of continuous monitoring of the performance of the control means in real time, forecasting its change over time and automatic restoration of performance by regulating the parameters of the means, as well as making decisions on the types and levels of intervention in the operation of technological systems based on risk assessment at all levels of management.

In fact, this implies the creation of two-level monitoring systems, i.e., supplementing existing emergency response systems with an additional subsystem of computer monitoring of security parameters, and significantly expanding the system's functions at all levels [4].

Conclusions:

Information systems for monitoring and preventing emergencies at mining facilities have become an integral part of the modern mining industry. Their implementation allows companies to detect potential threats in a timely manner, automatically respond to changes in the production environment, and thereby increase the level of safety and reliability of operations. Combining various data sources and using the latest technologies provides an opportunity for comprehensive monitoring, analysis and prediction of emergency situations, which helps to avoid critical events and improve the overall efficiency of the enterprise. Accident prevention systems are also becoming cost-effective, as they reduce the costs associated with emergency downtime, expensive equipment repairs, reduced productivity, and employee injuries and deaths.

References

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