

# OPERATIONAL SAFETY MANAGEMENT OF THE PUMPING INSTALLATIONS OF THE PUMPING STATION OF THE MACHINE IRRIGATION SYSTEM

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**Abstract.** The article presents the tasks of operational safety management of a pumping installation of a pumping station, control methods and an algorithm for operational safety control of a pumping installation, including: diagnostics, calculating the risk of a pumping installation, probabilistic analysis of pumping installation safety using a neural network and taking corrective measures.

Currently, the safety management of pumping installations (PI) of pumping stations (PS) is becoming an important problem due to their long service life. The existing PS of the machine irrigation systems of the Republic of Uzbekistan are approaching the stage of wear out by age. This period of operation is characterized by an increase in the rate of failures and accidents, an increase in the consumption of electrical energy and resources per unit volume of pumped water. Therefore, safety management of the pumping unit of the pumping installation of the pumping station of the pumping system is an urgent task.

As noted in [1], the risk management process covers various aspects of working with risk, from identifying and analyzing risk to assessing its acceptability and determining the potential for risk reduction through the selection, implementation and control of appropriate management actions.

The tasks of operational safety management of pumping units (PI) are:

- creation of a database of violations;
- calculation of indicators characterizing the severity of violations, i.e. determining the value of the risk;
- establishing the baseline value of the safety indicator;
- analysis and assessment of PI safety;
- selection of optimal management of corrective measures
- implementation of corrective measures.

Taking into account the above tasks, an algorithm for the operational safety control of the pumping unit was developed, the block

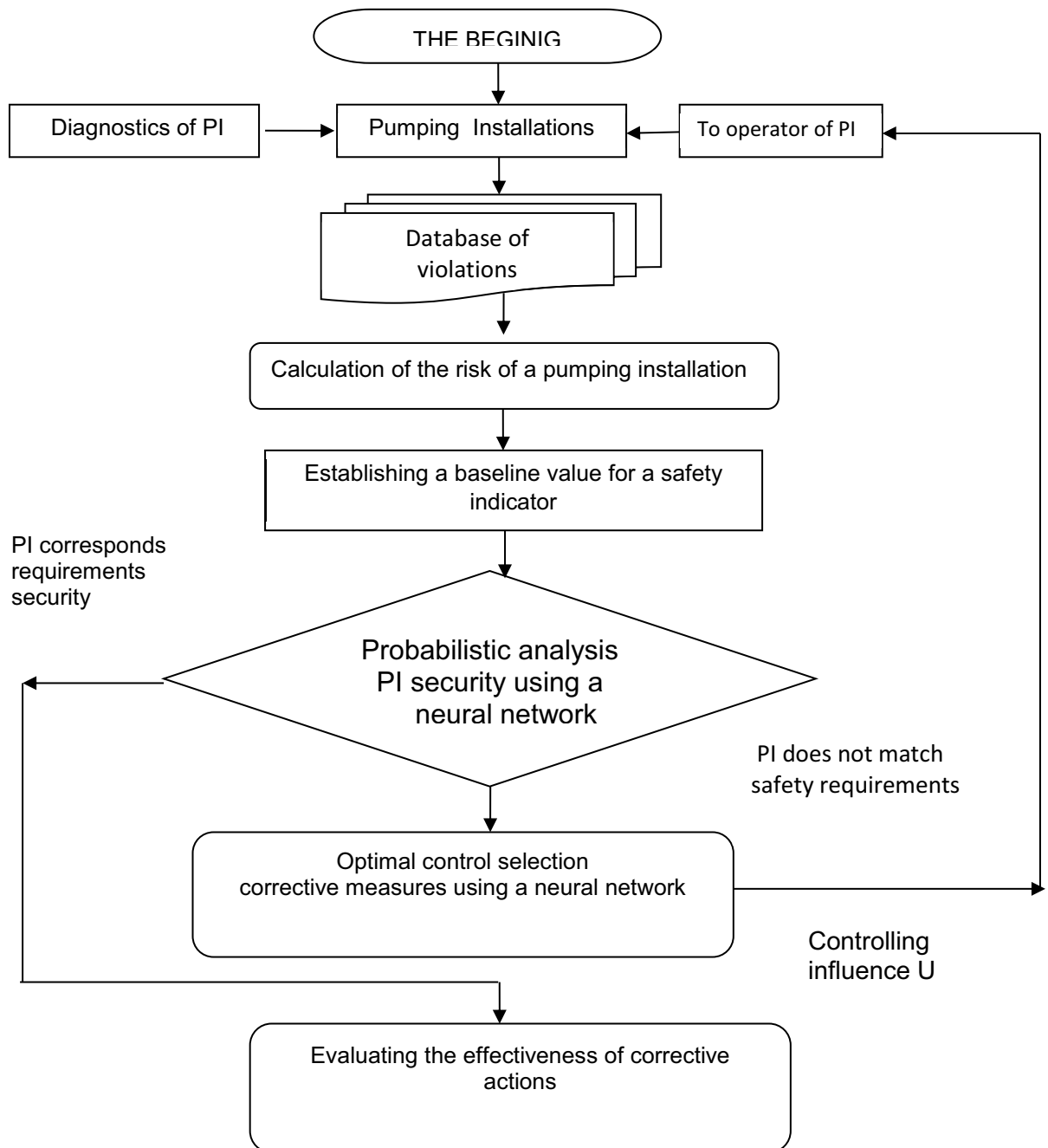
diagram of which is shown in Fig. 1.

In the "PI diagnostics" block, the serviceability of the pumping unit elements or their operability is checked, and defects are searched. The study of defects is carried out in order to determine their nature, causes and probabilities of occurrence, physical conditions of their manifestation, conditions of detection, etc. [1, 2]. Here is information about the technological state of the pumping unit, obtained from the outputs of the algorithms for assessing the state of the main parts of the pumping unit: electric motor; upper crosspiece of the electric motor; temperature states of the winding, core, upper and lower guide bearings, motor bearing;

assessment of the state of radial low-frequency vibration and beating of the pump shaft, diagnostics of radial low-frequency (1 - 8 Hz) vibration on the upper guide bearing of the pump is transmitted to the software and hardware complex of the automated control system (SHC ACS) of the pumping station. The conclusion about the presence of a malfunction is made according to decision-making algorithms with the issuance of further actions by the operating personnel of the station in case of detected defects

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**Fig. 1.** Algorithm of operational safety control of the pumping unit

In the block, the database on violations, the processing of information about the failures of the PI equipment is performed, i.e. assessment of reliability and safety according to operating data. Here the reliability indicators are determined - the probability of failure-free operation of the pumping unit, taking into account the data obtained from the outputs of the algorithms for

assessing the state of the main parts of the pumping unit. Taking into account the structural layout of PI, the reliability calculation is carried out taking into account the type of connection of PI. The probability of failure-free operation of the pumping unit –  $R_{PI}$  is determined by the formula given in [4].

The basic value of the safety index is usually taken as the value of the safety index [S] - regulated in regulatory documents (state or industry standard, rules and regulations on safety). The baseline value can be established based on the economic safety analysis [5]. The

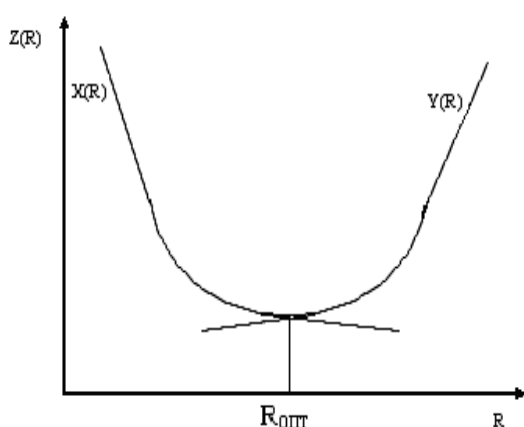
criterion for the optimum level of safety is the minimum of the value Z, which is the sum of two components: X (R) - reduced costs associated with maintaining the safety of the PI characterized by risk R; Y (R) - direct damage due to risk R.

The establishment of the base value of the PI safety indicator is carried out by the expression:

$$R_{opt} = \arg \min_R Z(R) = \arg \min [X(R) + Y(R)] \quad (1)$$

Using the graph (Fig. 2), we search for the optimal value of the  $R_{opt}$  risk.

The value of the  $R_{opt}$  risk can be taken as the criterion value [S].



**Fig. 2.** The graph of the search for the optimal value of the risk  $R_{opt}$ .

We carry out a quantitative assessment of the PI safety by comparing the calculated safety indicator (risk) with the accepted baseline value.

When analyzing and assessing the safety of PI, the values of the risk  $R_{PI}$  determined accordingly by the formula are compared by indicators characterizing the severity of violations with the optimal value of the risk  $R_{opt}$ . when  $R_{PI} > R_{opt}$ , the choice of the optimal control of corrective measures is carried out using a neural network [6,7,8].

If the PI meets the safety requirements, i.e. if  $R_{PI} < R_{opt}$ , then the effectiveness of corrective measures is assessed.

Using the control algorithm, we can diagnose the technical condition of the pumps, calculate the risk, determine the severity of each violation and assess the safety of each element of the pumping unit, referring to each of them, display their states on the computer screen and effectively identify emergency factors, take the necessary emergency corrective measures aimed at increasing the safety of the pump, which prevents an emergency situations at the pumping station.

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