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QUALITY INDICATORS OF CONTINUOUS MECHANICAL SYSTEMS FOR PURPOSE OF IMLEMENTATION OF ISO 9000 STANDARDS

Summary. In this paper the quality indicators of continuous mechanical systems for purpose of implementation of ISO 9000 standards are considered. Monitoring of information of mine continuous mechanical systems gives us a measure of satisfaction or dissatisfaction of quality system performance. There are many types of influences on mechanical system performances. Those influences may be classified and derived from corresponding mines technologies, system environment and planned mine operations. For purpose of quality indicators we develop concept of collecting data on the performance of system. Also we can establish the measurable objectives at relevant system functions and levels. On that base we add the concept of organizational self-assessment as a driver of improvement.

WSKAŹNIKI JAKOŚCI CIĄGŁYCH SYSTEMÓW MECHANICZNYCH W CELU WPROWADZENIA NORMY ISO 9000

Streszczenie. W artykule rozważano wskaźniki jakości systemów ciągłych dla wprowadzenia normy ISO 9000. Monitorowanie informacji o systemach ciągłych pozwala na sformułowanie opinii o stopniu satysfakcji z eksploatacji systemu.

1. Introduction

Selection of mine mechanical systems for underground exploitation is based on forecasting of working conditions and machine duty cycles in narrow working space. Degree of efficiency of mine mechanical systems largely depends on quality of predicting of upper conditions as on possible unexpected changes of foreseen conditions. That means that mechanical system selection should be based on a high-quality geological project which enables to define of mine-geological working conditions in design task and selection of mechanical systems. Project team is responsible to become acquainted and to give quality predictions of physical properties of rocks and coal; behavior of rocks massif by extraction of deposit; laws of rocks massif crashing and cutting cost of energy; mutual dependencies of technological processes; methods of building and developing of mining rooms during getting coal process. On that basis should be selected appropriate mechanical systems and controlling

methods for machines, processes and whole mining company, to achieve positive economical results in exploitation of deposit and ecological consequences of mining works.

Results of use of mechanical systems in complex geological conditions of a deposit depend on: quality of machines and reliability of its components, which is to be warranted by (practically verified) producers fame, and on quality of forecast for mechanical systems working conditions, made during design and production of machines. These two preconditions being satisfied, and with good maintenance of mechanical systems during their life cycle, it can be expected reliable work of mechanical systems and stabile production, without bigger unexpected technological breaks, and accordingly positive economic effect of the whole mine.

Continuous mechanical systems [1] are characterized by mutual cooperation of machine system elements. That systems consist of more branches, mostly with miscellaneous connections. Branches itself in continuous mechanical systems are composed of element - machines of different purpose, in serial connection. Monitoring of mine continuous mechanical systems gives us a measure of satisfaction or dissatisfaction of system quality performance. There are many types of influences on mechanical system performances.

Recently, ever increasingly number of mines implements quality system based on ISO 9000 set of standards [2-6]. Quality is totality of an entity that bear on its ability to satisfy stated and implied needs [7]. The term "quality" should not be used as a single term to express a degree of excellence in comparative sense, nor should be used in a quantitative sense for technical evaluations. The achievement of satisfactory quality involves all stages of quality loop as a whole. Sometimes quality may be identified as: quality due to definition of needs, quality due to conformance etc.

System of quality measurement is established to precisely define appearances taken into account during system design and to enable further progress. Reference documentation for a company's quality system is based on following concepts and standards: I grasp (ISO 9000-1); I establish documentation (ISO 9004-x); I demonstrate results (ISO 9001/2/3) and I improve myself (ISO 100xx). Besides establishing quality system in individual companies, it is also established [8] international quality system in some domains.

Quality measurement is performed through: identification of quality criteria and incorporation of quality indicators. Goal of this paper is to establish quality indicators in mine continuous mechanical systems, as well as development of a concept for gathering data about realized system performances.

2. Identification and classification of machine system outages

Processing of machine system downtimes requires their identification and classification, to completely encompass that problem. Identification of downtimes requires registration of all unplanned malfunctioning of system considered. For example, downtimes should be classified

by types of malfunctioning, measured, counted and analysed. In this aspect, collecting the information should be flexible and easy adjustable for:

- production plan configuration of mine;
- real life conditions of mine;
- environmental problems;
- scheme of continuous mechanical system;
- operating characteristic of a particular type of elements of mechanical system;
- total time, capacity and energy requirements of system.

2.1. Defining of machine system downtimes indicators

Quality system indicators do not take into account exploitation neither financial systems. It is essential to trace malfunctioning. For example, actual deviations are measured, than classified by types of malfunctions or disagreement and counted. The same is true for incidents (damages) of machine system.

Quality measurement is conducted by internal indicators, so that it is necessary to:

- define quality indicators on the basis of quality criterions;
- define required performance level and
- establish coherence among internal indicators.

Fundamental criterions significant to these problems, based on upper items, can be classified as follows:

A - Characteristics of system network:

- System elements (cutting machines, powered supports, transporters, ...)
- Network (spread, connections, slopes, reloading points, ...)

B - exploitation time of system

- Working hours (shift duration, number of shifts, number of working cycles per shift, regularity of planned operations, planned work interruptions, ...)
- planned work interruptions (regularity time of technological operations, regularity of time of maintenance, ...)

C - System accessibility:

- Internal accessibility (access to system elements – machines), entry, exit out of system
- Connection with other machine systems

D - taking care of system:

- Engagement of organisation (prizing, innovations)
- Relations with other technological systems (complaints, suggestions, ...)
- Personnel (training, look, behavior, ...)
- Help (in case of accident, to persons in other organisations, inexperienced persons, ...)
- Tariff scale of payment, ...

E - conformity of system:

- Equipment for conformity (seats, phones, food, toilets, ...)
- Ergonomy (concept of machine equipment, easiness of control, easiness of movement, ...)
- Common elements (cleanliness, safety against spill of matters, ...)

F - reliability of machine system elements:

- Random downtimes of machine system elements;
- Reliability of machine system elements.

G - technological operations:

- Space preparation for work of a system;
- Removing of machine system elements;
- Regulating of machine system branches;
- Extension of transporters;
- Other technological downtimes.

H - informing:

- Common informations;
- Informations in normal system working conditions;
- Informations about disturbed working conditions in a system, for all technically possible system states;
- Information connections

I - safety:

- Safety of movement and reviewing (work groups, lighting, points for help invitation and announcements of improper system functioning, ...);
- Safety against accidents (presence of personnel, informations, ...);
- Safety monitoring (network monitoring, clear visibility of safety means, ...).

J - environmental safety:

- pollution (spill of coal - barren soil, dust, gases, radiation, noise, smells, trash, ...);
- spill: energents, lubricants, and so on;
- infrastructure conserving (damaging of routes used by system, vibrations, ...).

K - working surroundings:

- failing surrounding material on system;
- bad layer partings;
- layer faults;
- geological non-homogenity of layers;
- bearing floor stability;
- gases;
- fires;

L - working ambient of a system:

- lighting;
- dustiness;
- airflow velocity;
- moisture content in airflow;
- temperature of working space;

M - climatic and meteorological conditions[1]:

- strong frosts;
- strong winds;
- heavy rains;
- fogs;
- heat;
- torrent;
- high waters.

N - organizational downtimes

- Shortage of repairing equipment;
- Shortage of materials, reserve parts and alike;
- Shortage of repairing personnel;
- Respecting of customer requirements (thermo plants, separations, etc.).

O - reliability of machine system:

- Processing of machine system random downtimes, for all technically possible system states;
- Reliability of system as a whole (achieved (operatively) working time, capacity).

P - relation with other technical-technological systems:

- Depots;
- Separation;
- Bins.

3. Keeping track of outages, choice of tools and minimal level of data processing

ISO 9004-4 proposes certain tools for data processing which can be useful if worked out according to user requirements i.e. according to section 2.0. These tools should be considered as minimally needed i.e. as obligatory, while they can be treated as implementation beginning of set of ISO 9000 standards. Existing evidence should, if it is already not, be brought into accordance with requirements of JUS ISO 9004-4.

[1] For part of system on surface only

3.1. Minimal level of data processing

JUS ISO 9004-4 gives tools and techniques for quality improvement. For this purpose it is minimally needed to work out following tools:

A.1 Data-collection form -systematic data collecting for obtaining clear picture about facts;

Tools and methods for nonnumeric data

A.5 Cause-and-effect-diagram ("Fish bone") – analysis and announcement of relation scheme cause - effect. Facilitating of problem solving starting from symptoms and causes up to solutions.

Tools and methods for numerical data

A.8 Control chart - Diagnosis: evaluation of process stability; Means for diversification of variations originated by definite or special causes from random variations typical of process; Control: to determine when a process needs to be adjusted and when it needs to be left as is; Confirmation: to confirm an improvement to a process

A.9 Histogram - presents data variation model; to communicate visually information about process behavior; to make decisions about where to focus improvement efforts

A.10 Pareto diagram – to display, in order of importance, to contribution of each item to the total effect; Ranking improvement possibilities

A.11 Scatter diagram – to discover and confirm relationships between two associated sets of data; to confirm anticipated relationships between two associated sets of data.

Under minimal level of data processing it is meant data processing in function of time, of excavation mass or of costs. Additional data processing can include not only mathematical extensions of processing but also, for example, tracking of availability of belt conveyor transporters in function of transporters length, availability of cutting machine in function of speed of advancement in a period of time or for a given block length, etc.

3.2. Coherency of downtime indicators

Indicators developed in previous sections should enable:

- Time analysis of system;
- Capacitative analysis of system;
- Economical analysis of system.

To achieve coherency of results obtained by data processing, that processing should encompass:

- Processing of downtimes for machine system as a whole, for its branches and its individual elements;
- Accounting of working times of each machine, of each branch and of machine system as a whole;

- Analysis of temporal results and comparison with requested and/or projected values;
- Accounting of achieved capacity for each system element, each state of system and for system as a whole;
- Analysis of capacitive achievements and their comparison with requested and/or projected values;
- Separation of duration of work and costs of works caused by random downtimes from duration of work and costs of works simultaneously conducted on behalf of other positions of technical maintenance – for the same machine as well as for other machines;
- Tracking of costs on the basis of classified and identified downtimes for each machine and for whole system.

4. Establishing of quality loop in exploitation system with continueous action

Quality loop for the problem treated in this paper, in sense of JUS ISO 9000, consists of:

- Supplier (producer) - Exploitation field-mine
- Desired quality - predicted hours of system work, assigned capacity of machine system;
- Obtained quality - realised hours of system work, realised system capacity

and

- Customers - Thermo plant, separation etc.
  - noticed quality – temporal and quantitative availability of requested coal;
  - expected quality – temporal and quantitative availability of coal as well as agreed coal quality.

Answers to that questions, in sense of capacity, time and costs, can be obtained from positions *F* and *O* in section 2.1. Evaluation of quality, in sense of ISO 9000, can also be extended by other indicators, for example, granularity of delivered coal, coal purity, caloric value of delivered coal, and so on.

5. Conclusion

Implementation of quality system ISO 9000 requires processing of all downtimes and working conditions of machine system. This requires identification of downtimes and their classification so that the problem is completely encompassed. By identification of downtimes it is essential to register unplanned (badly) functioning of system. By quality system

indicators it is essential to track malfunctioning of machine system. For example, actual deviations are measured, than classified by types of malfunctions or disagreement and counted. The same is true for incidents (damages) of machine system.

Quality measurement is conducted by internal indicators so that it is necessary to: define quality indicators on the basis of quality criterions; define required performance level and establish coherence among internal indicators.

For purpose of quality indicators we develop concept of collecting data on the performance of system. Also we can establish the measurable objectives at relevant system functions and levels. On that base we add the concept of organizational self-assessment as a driver of improvement.

That is why it is necessary to create an information system with more levels and to realize organised and systematic tracking and analysis of geological, mining-technical, technological and organisational conditions that can appear during deposit exploitation, as well as conformity with existing technical rules and recommendations for machine system work.

Fundamental criterions significant for problems of machine system work in underground exploitation can be classified as follows: A - characteristics of system network; B - exploitation time of system; C - System accessibility; D - taking care of system; E - conformity of system; F - reliability of machine system elements; G - technological operations; H – informing; I – safety; J - environmental safety; K - working surroundings; L - working ambient (environment) of a system; M - climatic and meteorological conditions; N - organizational downtimes; O - reliability of machine system; P - relation with other technical-technological systems.

ISO 9004-4 proposes certain tools for data processing which can be useful if worked out according to user requirements i.e. according to section 4.0. These tools should be considered as minimally needed i.e. as obligatory, while they can be treated as implementation beginning of set of ISO 9000 standards. Under minimal level of data processing it is meant data processing in function of time, of excavation mass or of costs.

Elements and evidenced data obtained during development of quality indicators and their tracking can be used also for other purposes, for example, for establishing of quality loop with machine system and next system collaborating with that machine system. By that, evaluation of quality, in sense of ISO 9000, can also be extended by other indicators, for example, granularity of delivered coal, coal purity, caloric value of delivered coal, and so on.

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Omówienie

W artykule rozważano wskaźniki jakości systemów ciągłych dla wprowadzenia normy ISO 9000. Monitorowanie informacji o systemach ciągłych pozwala na sformułowanie opinii o stopniu satysfakcji z eksploatacji systemu. Na osiągnięcia systemów wpływa wiele czynników. Czynniki te mogą być sklasyfikowane i są one zależne od zastosowanej technologii górniczej oraz warunków górniczo-geologicznych. W celu oceny wskaźników jakości zaproponowano koncepcję zbierania danych. Sformułowano również kryteria oceny systemów. Podano także koncepcję organizacji samooceny.