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CONTROL MODEL OF SAFETY MANAGEMENT ON GASSY MINES

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Abstract

For ensuring the safety and production control on gassy mines the monitoring and control systems are used which enable permanent monitoring and management of a mine by inspection service and production dispatcher. The goal of this project is to create an intelligent model of safety control and, with suitable software, to verify its behavior (e.g. program Graf_Síť). Further, this intelligent model of safety control is to be tested on monitoring and control system MTA 11.00 in the Paskov Mine, plant Staříč. The intelligence of this solution consists in the fact that the measured values will be utilized for deduction of further information which will not be obtained by direct measuring but follow from mutual relationships of automatically measured values. It is necessary, for fulfilling of the above mentioned targets, to analyze the existing state of monitoring and control systems in underground mines. Further, to carry out the complex analysis of monitoring and control system MTA and, subsequently, to go to proposal of algorithm of switching in monitoring and control system with relation to network model of a mine. In a simplified way but accurately the target of this project can be characterized as proposal of the system which would evaluate all information obtained from a mine and related to safety nearly so well as if it is done by a man who monitors permanently the computer terminal in dispatching

Keywords: MTA, mine, monitoring, dispatche, safety

1 INTRODUCTION

Technological process of the existing underground coal mining requires maximum ensuring of safety. That is why the basic task of monitoring and control systems is the remote monitoring and control of safety parameters of a mine (prescribed by State Mining Administration) and, subsequently, also of production parameters of a mine (for increasing the effectiveness).

The primary question of mine environment safety is the management of dangerous gases. The most problematic, from the safety point of view, is methane which is present in coal seams accompanying rocks and makes the coal reserves mines. The existing technique enables to solve this question by monitoring and control of mine equipment units. The methane occurrence can be prevented, or eliminated by means of certain models and experience. With the help of monitoring system the coal output can be maximized, for instance up to certain percent safety limit together with the minimization of the idle times. Further important observed value is carbon monoxide which occurs in coal with the tendency to spontaneous ignition, mostly in squeeze. The increasing concentration of carbon monoxide is also the accompanying phenomenon of arising fire in case of belt conveyors.

Measuring of methane and carbon monoxide concentration is prescribed by State Mining Administration which determines the basic measuring places. The permanent control of methane concentration must be carried out in gassy mines especially: in separately ventilated mine working with electrical equipment where driving or mining is running, with the exception of separately ventilated gateways at room-and-pillar exploitation; on working places with movable machine driven by electrical drive which is ventilated by through-circulating current and where the increase of methane concentration over 1 % cannot be eliminated; in return current of separate ventilation section and ventilation area; in return current from the working place where the increased methane concentration was permitted; in gassy mines of the 2nd class of danger in return current from each working face; in seams with danger of coal and gases outbursts in return current from each working place where driving is running; in operation of trolley traction of locomotive transport without danger of methane explosion (SNM 0) in places of contact with mine workings included into the environment class with the increased danger of methane explosion (SNM 2); in further places determined by a mine manager. Further, the permanent control of carbon monoxide concentration must be carried out in gassy mine especially: in return current of each separate ventilation section and in return current of ventilation area; in seams with the tendency to spontaneous ignition in intake current of separate ventilation section and in return current of working face and separately ventilated mine workings where driving or mining is running, with the exception of working face corridors of separately ventilated working faces; in intake shaft where the danger of CO from surface source leakage into mine exists; in further places determined by a mine manager.

Further often measured parameter is the quantity of nitrogen for preventive liquidation of possible spontaneous ignition in squeeze, quantity of degassed gas and another necessary information. The following factors are observed as well: run of main ventilators, run of auxiliary ventilators, state of ventilation door, state of air lock objects, pressure of fire water, speed of winds, barometric pressure, depression of single ventilation sections and further additional information. On the basis of this monitored information the managing, or control of mine technological process for ensuring the safety is carried out, i.e. especially automatic switching off the electrical power in case of exceeding of set limits of methane concentration.

The basic characteristic property of mine monitoring and control systems is that the monitored and controlled working place is changing what leads to repositioning of sensors. For this reason, the monitoring and control system must enable an easy and unambiguous reconfiguration in case of cancellation, reposition and new localization of measuring points, or sensors with simple demands on service. These requirements lead to system specification,

so also the program part must meet easy user changes of sensors and maps, and in any time instant in real time so that the presented information would correspond with the placing of sensors in a mine.

The whole system which is used for ensuring the safety must meet the requirements of the decree of State Mining Administration. That is why any connected sensors must be approved by State Mining Office and connected into system professionally. Information obtained in this way are transferred further into the surface equipment, and from it into the operator terminal where they are displayed at present in the SCADA program. The presentation of information is carried out on operator terminals. These operator terminals are determined for inspection service (permanent 24-hours supervision over mine safety), the respective production dispatching and furthermore, this information can be utilized for example for transport dispatching etc.

2 ANALYSIS OF THE EXISTING STATE OF MONITORING AND CONTROL SYSTEMS IN UNDERGROUND MINES

Technological process of the existing underground coal mining requires maximum ensuring of safety. That is why the basic task of monitoring and control systems (Figure 1) is the remote monitoring and control of safety parameters of a mine (prescribed by State Mining Administration) and subsequently also the production parameters of a mine (for increasing the effectiveness). In the Ostrava-Karviná District, in the time being, the following monitoring and control systems are used: system MCS 02 and system MTA 11.00, at the same time, in Poland the system MICON 2P is widely used.

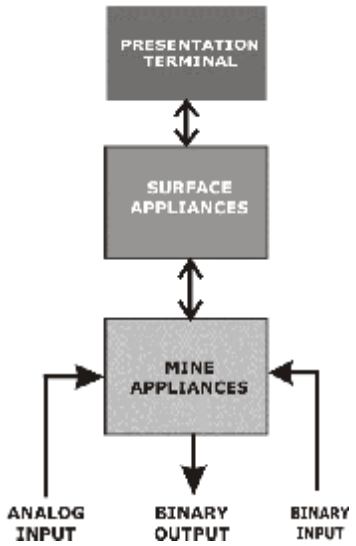

Figure 1: Basic monitoring and control system

3 ANALYSIS OF AUTOMATICALLY MEASURED DATA AND SEARCHING FOR THEIR INFORMATION CONTENT SPECIALLY ORIENTED ON MUTUAL CORRELATION OF THESE DATA

Among important tasks related to the intent of solvers there is the analysis of information content of the measured signals (Figure 2). It follows from the above that it is necessary to analyze the courses – time series from the viewpoint of their statistical analysis but this is only

one part of the problem which is to be dealt with. The second part of the task is given by the fact that the time series would be compared with the system characteristics created from the viewpoint of safety parameters in typical mine section with working face and headings. It is expected that on the basis of such proper analysis the connections will be found which the experienced technicians in mines know but which have not been described by mathematical and logic relations sufficiently well and so they cannot be included into the automatic processing by computer. The main expected result then would be to make the guide how to analytically obtain information from measured values which can be now obtained only by experienced technician. Then computer „can behave“ nearly as the experienced technician.

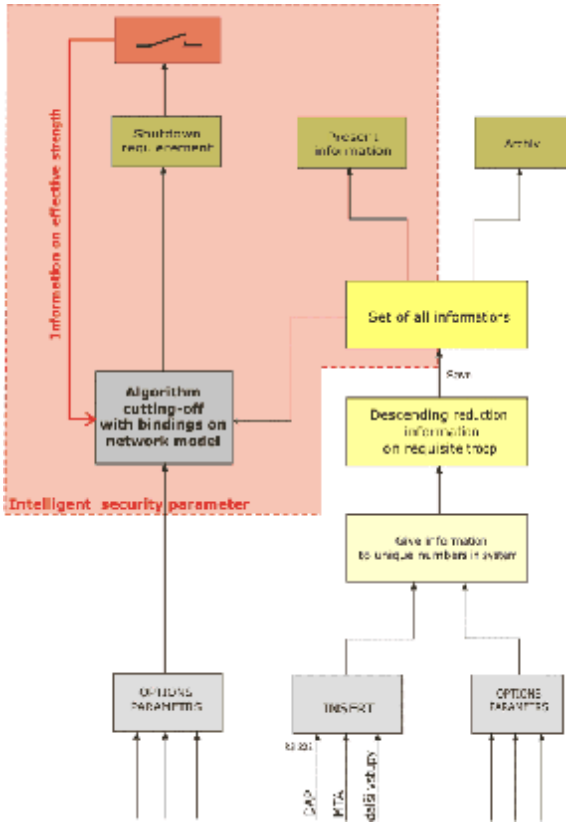

Figure 2: Scheme informations in monitoring and control system

The created algorithm of switching off in monitoring and control system will be included into the intelligent model of safety control. Further basic document for creation of intelligent model of safety control will be document describing the ventilation network with placing the sensors and placing the switching off points with the relation to electrification. This intelligent model of safety control should be the strong instrument in the sphere of mine safety, respectively in monitoring and control systems (Figure 3 – demonstration input data from the map). For the testing of intelligent model of safety control the suitable program tool will be used. We presuppose the usage of available program Graf_sit which should meet the substantial part of requirements.

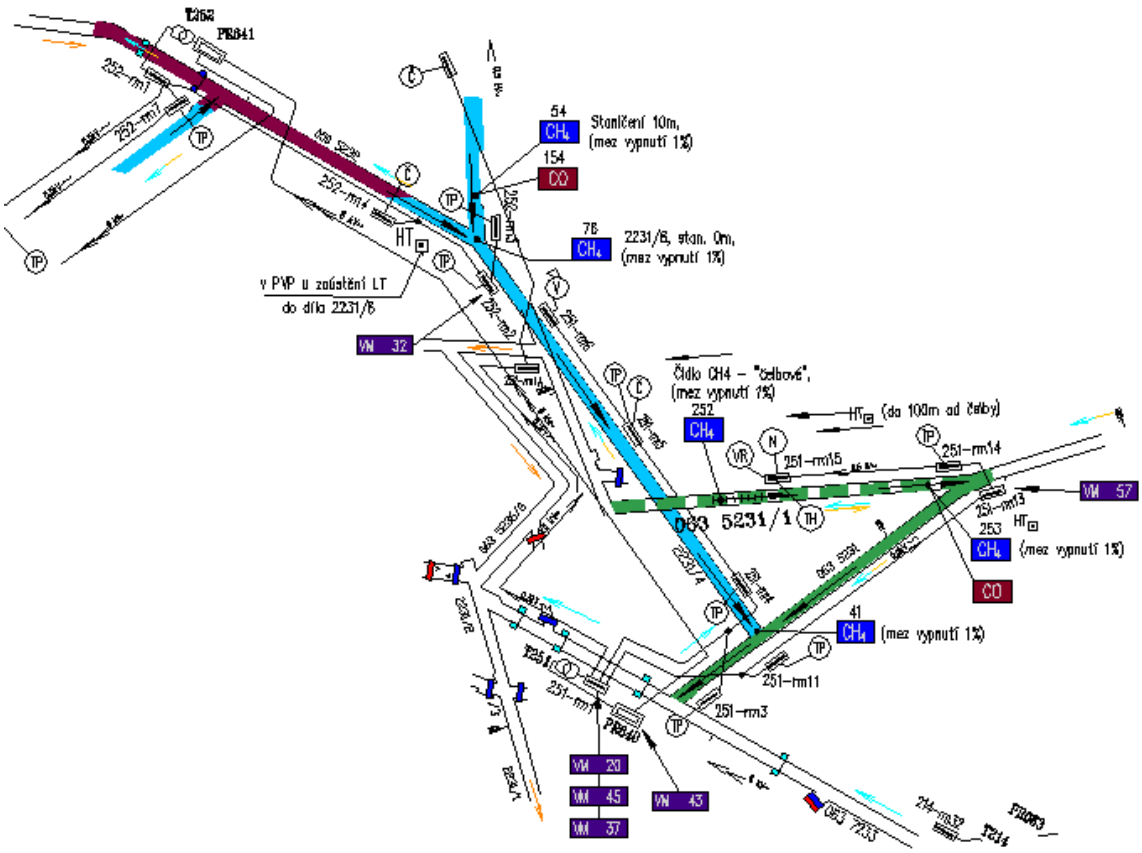

Figure 3: Demonstration mine map (original structure)

Ventilation network of a mine contains in its scheme all equipment units in underground mine, includes all activities which are running during mining, lead in the fresh air to working places and lead off all gaseous harmful substances. From a certain view, the ventilation network is the base of all mine activities, or, said in other words, this is the base of workers' safety in mines, even when the sources of danger arise both from rock environment and from mine mechanisms activity. The ventilation network (Figure 4) represents the access and escape paths. So, the ventilation network includes nearly all conditions of safety stay of mine workers in the underground. Therefore, this is the network which is the bearer of large quantity of information concerning the safety conditions for work of people in the mine. That is why the effort of solvers is aimed at utilization of this unique position of ventilation network for obtaining the greatest quantity of information which will help to disclose in time many dangerous states which affect the safety of workers in the underground.

It is possible, on the basis of fulfilling of preceding partial tasks, to approach to a proposal of a program system which will make use of modern management method possibilities and network model, and on the basis of evaluation of measured signals, it will evaluate, monitor permanently the safety parameters in mine workings, namely without permanent attention of a dispatcher. The dispatcher will be informed in time about a situation which, according to "knowledge" of the proposed program system, can be dangerous for stay of workers in the underground, or, it will inform the dispatcher about non-logic situation which cannot be solved by program alone - and this is the main goal of this project.

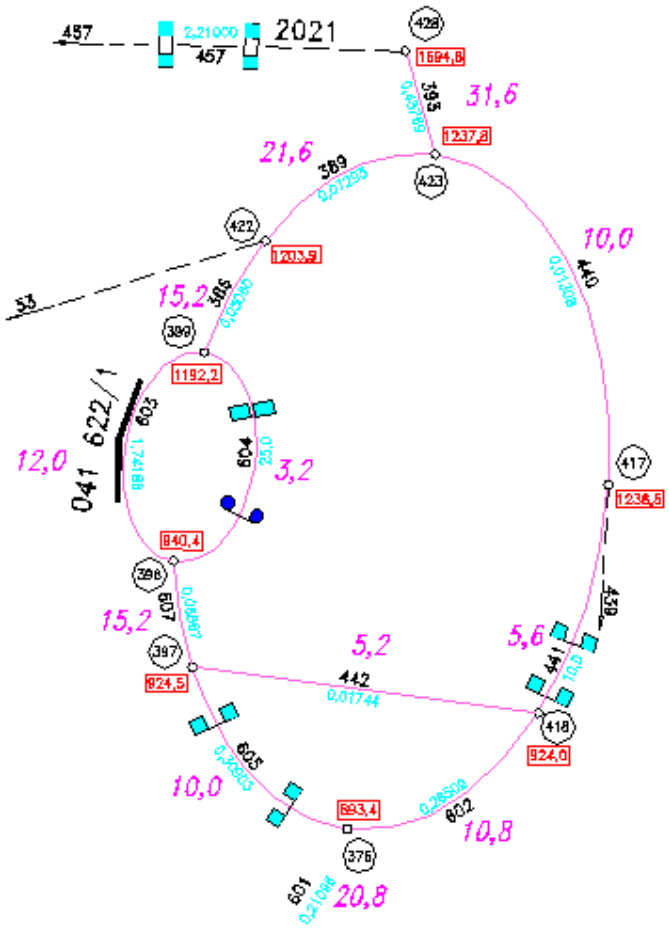

Figure 3: Demonstration ventilation map

4 CONCLUSION

The partial task described in Section 3 is directly interconnected with the preceding ones, respectively the above obtained intelligent model of safety control, according to preliminary agreement, will be applied directly into the monitoring and control system which will provide relevant maps and further materials of the area suitable for this application. In final materials the measuring places of the MTA system will be given and force elements for switching off including proposal concerning the usage of intelligent control algorithm. The advantage of this realization and reason for cooperation of workers from this mine is the fact that the proposed solution lays practically no additional costs demands on realization.

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