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Application of ventilation management programs for improved mine safety

De Souza Euler

Department of Mining Engineering, Queen's University, Kingston K7L3N6, Canada

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ABSTRACT

The purpose of ventilation management systems is to ensure the health and safety of underground workers by creating and incorporating structured plans, procedures and processes on the day-to-day operations of the mine ventilation system. The application of ventilation management programs consists of audit, verification, and corrective action procedures to: (1) ensure adherence to regulatory standards, or to (2) return to compliance and safety standards when an upset condition arises. This paper describes how a ventilation management program can be developed and implemented to ensure regulation compliance, to increase safety, to improve operational efficiency and to reduce the operating costs of an operating mine. Two case applications are presented in this paper. The first case is presented to demonstrate use of a ventilation management program in response to a site inspection and audit, with follow-up application of corrective actions. The second case application describes how air quality conditions has been substantially improved with the development and implementation of a ventilation management program for an operating underground hard rock mine.

1. Introduction

Mine ventilation systems must not only provide for the health and safety of underground personnel but also operate in compliance with regulatory bodies. Studious day-to-day management of the mine ventilation system is crucial to meet all the objectives of the ventilation system. A ventilation management system is used to provide, measure, and control the quantity and quality of airflow throughout the mine ventilation network. Ventilation management programs consist of an iterative framework, through which the mine ventilation department maintains the ventilation system in compliance with regulatory bodies and company policies. It consists of structured documents forming standardized procedures and guidelines for auditing the system and providing corrective actions when an upset condition arises, such that a safer and more efficient system is maintained. Proper implementation of a ventilation management program will result in significant benefits including increased operational effectiveness, increased safety, improved engineering efficiency, reduced appliance (fans, doors, regulators, ducting, etc.) maintenance costs and reduced energy costs. Quality management will allow mining operations to proactively apply mitigation techniques before environmental conditions underground become unsafe, thus shifting away from undesirable reactive practices. The case studies presented in this paper will demonstrate the direct benefits of a ventilation management program.

2. Ventilation management program structure

A quality management program is defined as a tool for organizations to meet performance expectations through the provision of quality assurance and control, and to offer a means to optimize performance though improved control of system processes [1,2]. A quality management program is supported by seven fundamental requirements, used to assess the company's ability to meet regulatory requirements as well as its internal policies: purpose, policy, planning, implementation, measurement, review and improvement. The ventilation management system consists of a series of documents which describe means of auditing and controlling the mine ventilation system in order to ensure the system meets all regulatory and safety requirements [1].

Five main document types form the structure of a ventilation management system: standards and guidelines, code of practice, procedures, work instructions and directives (Fig. 1). These documents provide guidelines for applying audit, verification and correction processes used to ensure the mine ventilation system operates within compliance standards.

E-mail address: euler.desouza@queensu.ca

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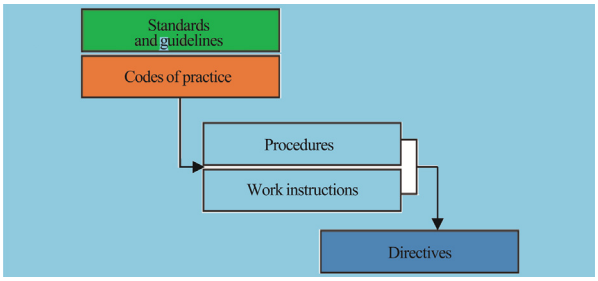

Fig. 1. Typical Structure of a ventilation management system.

The ISO 9000 Quality Systems Handbook defines work instruction, procedures and codes of practice [1]. Work instruction is defined as instructions that inform people what task to complete and when the completion of the task is needed. Procedures are defined as instructions that inform people how to do a certain task. Codes of practice are defined as constraints on how the processes in a business should be carried out in order for the result to be within the boundaries of regulating bodies.

The author has developed the framework of management programs for a specific for mine ventilation system [3]. The standards and guidelines constitute the foundation of the management program. This support documentation is a handbook providing a detailed description of the ventilation system, including all design and operational aspects of the ventilation network. The code of practice is a documentation that defines the minimum operating standards and action levels based on regulatory bodies and provides appropriate corrective and emergency action plans when an upset condition exists. Procedures are documentation that explains inter-departmental activities and each department's or individual's role in specific work procedures. Work instructions are documentation describing the process of a specific procedure and task, including who is involved, how to do the task, and what materials or supporting documentation is needed. Directives are documentation issued for any changes to the ventilation that will ensure the correct installation or change to any design, equipment, or condition. The author has implemented ventilation management programs in several mining operations, and notable mentions include system implementations in a potash mine and a uranium mine [4,5].

3. Execution of ventilation management program

The execution of a ventilation management program follows an iterative process, illustrated in Fig. 2. Management plans, which are carried out daily, is an audit of the state of the entire mine ventilation system. It includes detailed inspections of all components and appliances, pressure and flow surveys of the network and air quality surveys. Verification programs are used to assess the information collected from the management plans in order to verify if the ventilation system is in compliance and if it meets all defined objectives of the program. If the verification process indicates the system not to be in compliance, then action plans and ventilation directives are initiated to restore the system to compliance. Action plans and corresponding directives can also be directly launched in response to upset ventilation conditions or when problems are encountered during an inspection.

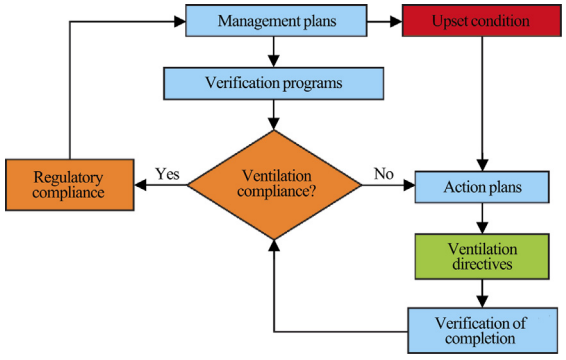

Fig. 2. Execution process of a ventilation management program.

4. Opportunities and benefits

The easy to implement iterative framework of a ventilation management program (Fig. 2) allows mining operations to efficiently and consistently audit the mine ventilation system.

Significant benefits can be gained from day-to day management of the mine ventilation system. It ensures that: (1) the ventilation system performs according to design; (2) all ventilation appliances operate efficiently and economically; (3) an adequate air supply to all active workings is provided; (4) the mine atmosphere meets quality conditions; (5) compliance with all regulatory requirements is met; (6) safety is improved; (7) and improved system economics is achieved.

5. Case application 1

This case application is used to demonstrate routine use of the ventilation management program in an operating mine. In a work shift, an upset condition (inadequate flow supply) is encountered and actions are prepared and used to restore the ventilation system back into compliance. The application follows the steps presented in Fig. 2. A flowchart for the specific case is presented in Fig. 3. In preparation for a flow survey on a primary airway with an anemometer, the procedure and work instructions for anemometer operation, maintenance and calibration, are followed. Procedure and work instructions for traverse drift surveys are then observed during the flow survey (management plan). The results of the survey are audited (verification program) and found that the survey

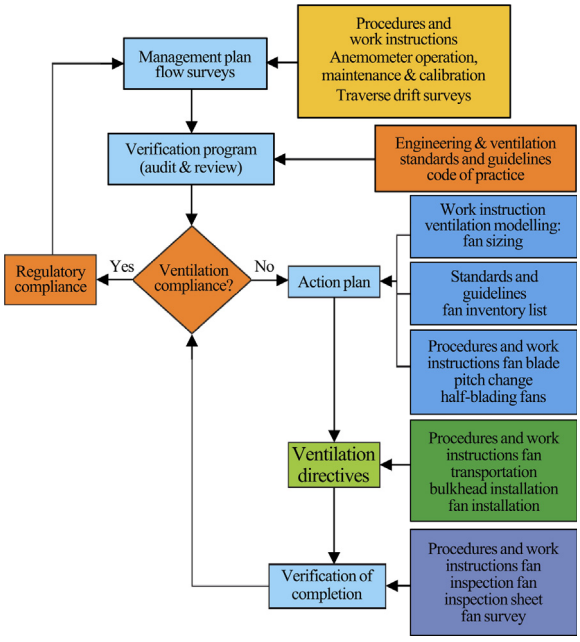

Fig. 3. Case Application of a ventilation management program.