

The Air Quantity Estimator (AQE): A New Computer Software Tool for Large-opening Mine Ventilation Planning

Objective

To provide operators of large-opening mines with a ventilation planning tool that will help them develop a healthier, safer, and more efficient ventilation system in the underground workplace.

Background

In 2002, regulatory standards were enacted in the United States that limit the allowable diesel particulate matter (DPM) concentrations in underground mines. Mine operators have several engineering controls available to reduce DPM emissions from engine exhaust, including the use of catalytic converters, filters, low-sulfur fuel, and cleaner burning engines. In addition, administrative controls, such as regulating the length of time a diesel-powered vehicle operates underground, may also effectively reduce DPM concentrations. Finally, DPM concentrations can be reduced by increasing the overall ventilation airflow in the mine. Increased ventilation airflow can be achieved by installing large-volume fans and using stoppings or auxiliary fans to direct this ventilation air to the working face of the mine. To help mine operators evaluate their site-specific conditions for DPM control as part of the mine planning process, NIOSH engineers have developed a computer software tool called the Air Quantity Estimator (AQE). The AQE addresses the ventilation needs of large-opening (typically at least 40-ft-wide and 20-ft-high) metal/nonmetal mines.

Using the AQE

The AQE is a tool to help operators of large-opening mines in estimating adequate underground mine ventilation based on site-specific diesel engine emissions. It is a user-friendly personal computer program that operates under all Microsoft Windows operating systems of Version 95 or later. The AQE is a stand-alone software package and is not dependent on the installation of any commercial spreadsheet program. It contains a User's Guide and a Help Menu to assist in running the program.

Before running the AQE program, specific engine data and operating parameters must be entered into the base spreadsheet

(Figure 1). Engine emissions data, including the DPM emission rate, must be known or estimated with reasonable accuracy. To aid in this process, the program has features to help determine the DPM emissions input data for those engines approved by the Environmental Protection Agency and the Mine Safety and Health Administration. For engines where emissions data are not available, guidelines are provided for estimating the required input values. Operational assumptions associated with each engine used underground, such as the percent of underground operating time (percent of DPM emission time per shift), must be made to limit the variability of the program output.

Once the input data are entered into the program, the AQE calculates and displays an estimate of the total ventilation airflow needed to dilute DPM emissions to the statutory interim concentration of $308_{EC} \mu\text{g}/\text{m}^3$ (Figure 2). The AQE also determines the air quantity required for the $160_{TC} \mu\text{g}/\text{m}^3$ DPM concentration level that is proposed for the future. The two calculated air quantity estimates will provide mine planners with a starting point for long-term ventilation planning, including choosing properly sized fans to provide the required ventilation airflow.

Another benefit of the AQE is that it allows the mine operator to conduct "what if" evaluations by varying the input parameters to achieve the most efficient and practical fleet of diesel-powered vehicles and ventilation system configuration. Theoretical changes to the operating engine input, such as the addition of filters, use of cleaner engines, and administrative controls, can be evaluated with the AQE. The results of the "what if" evaluations allow the mine operator to determine which current vehicles are contributing the greatest amounts of DPM into the main airstream of the mine. A systematic plan for using available engineering controls or replacing these vehicles can then be developed to minimize their impact on the current mine-wide ventilation requirements, including reducing DPM emissions.

Summary

A combination of engineering, administrative, and ventilation controls will eventually be required in many large-opening mines in the United States to meet the regulatory DPM concentration limits. The AQE is an excellent tool for mine planners to use to estimate site-specific ventilation requirements for

Ventilation Estimator based on Concentration DPM Limits										
File Edit View Tools Help										
	Type of Vehicle	Year of Diesel Engine	Make and Model of Engine	Engine Type (New Direct) (Old Direct) (Indirect)	HP	RPM	% UG Operating Time (min/min)	Engine DPM Emission Rate (g/hp-hr)	Catalytic Converter Efficiency (%)	Filter Efficiency (%)
1	Pickup 1	1999	xxx-xxx-xx	New Direct	250	1400	10	0.100	20	0
2	Pickup 2	2000	xxx-xxxx-xxxx	New Direct	150	1000	20	0.100	20	0
3	Pickup 3	1989	xxx-xxx-xx	New Direct	200	1000	10	0.200	20	0
4	Service Trk 1	1987	xxx-xxx-xxxx	New Direct	250	1200	10	0.350	20	0
5	Service Trk 2	1986	xxx-xxx-xxxx	New Direct	250	1500	10	0.300	20	0
6	Rock Trk 1	1975	xxx-xxx	New Direct	500	1200	50	0.250	20	0
7	Rock Trk 2	1999	xxx-xxxx-xxxxxxx	New Direct	500	1250	65	0.100	0	0

Figure 1.—AQE spreadsheet with sample input values.

Ventilation Estimator based on Concentration DPM Limits					
File Edit View Tools Help					
	Average Vehicle DPM Contribution (g/min)	Sum of Average Vehicle DPM Contribution (g/min)	Total HP	Estimated Air Quantity to meet 308 micrograms/cubic meter Standard (cfm)	Estimated Air Quantity to meet 160 micrograms/cubic meter Standard (cfm)
1	0.03	11.70	7,361	1,073.766	2,067.000
2	0.04				
3	0.05				
4	0.12				
5	0.10				
6	0.83				
7	0.54				
8	0.54				
9	0.89				
10	0.89				
11	1.72				

Figure 2.—AQE spreadsheet with sample output results.

their mine, as well as to evaluate options to meet the regulatory DPM concentration limits. The AQE reduces the reliance on trial-and-error practices for ventilating large-opening mines. Its use will result in more efficient and effective ventilation systems and a healthier underground workplace for large-opening metal/nonmetal mines.

How to Order the AQE

For more information on the AQE, contact Roy H. Grau III (412-386-6562; RGrau@cdc.gov) at the NIOSH Pittsburgh Research Laboratory.

A free copy of the AQE software can be downloaded from: www.cdc.gov/niosh/mining/products/product4.htm. You may also contact Joy Lamars at 412-386-6472, e-mail: JLamars@cdc.gov. Or you may complete the order form below, detach, and mail to: Joy Lamars, NIOSH Pittsburgh Research Laboratory, Cochran Mill Rd., P.O. Box 18070, Pittsburgh, PA 15236-0070, or fax to 412-386-6595.

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G Please send me a free CD containing the AQE software (includes User's Guide).

Name _____

Title _____

Organization _____

Address _____

City _____ State _____ Zip Code _____

Country _____

E-mail _____ Phone _____