Effectiveness of Cabs for Dust and Silica Control On Mobile Mining Equipment

Joseph J. Garcia and Ronald E. Gresh
Coal Mine Safety and Health, District 2
Hunker, PA-USA-15639

Mary Beth Gareis and Robert A. Haney
Pittsburgh Safety and Health Technology Center
Pittsburgh, PA--15236

INTRODUCTION

In many cases an environmental cab serves as the primary method of dust control for operators for both surface and underground mobile equipment. Historically, when the operator of a piece of mobile equipment has had a dust problem, a cab could be installed to correct the situation. With more and more awareness of the problems associated with silica exposure on surface mining operations, a cab by itself can no longer be assumed to resolve the problem.

As part of its surface dust initiative, Coal Mine Safety and Health has initiated a program to determine the dust control limitations of cabs. The purpose of this study was to determine the effectiveness of cabs for dust and quartz control and to determine what types of improvements could be made to cab air filtration systems.

Types of Controls

The airflow for the recirculating system is typically 200 to 300 cfm. This airflow is cooled and filtered. The filtration system uses either a foam filter or a pleated filter paper filter. The air conditioning capacity is nominally 20,000 BTU.

Cabs on new equipment are designed to meet ISO standard 10623. This standard provides for a 50 Pascal (0.20 inches of water) cab pressure and a minimum 25 cfm of intake airflow into the cab. To achieve this design standard, cabs are tightly sealed and equipped with a fresh air intake system, a filtered recirculating system and an air conditioner.

Cabs are sealed by placing rubber gaskets around the window and door seals. Tight latches and jams are also placed on the windows and doors.

Intake air typically ranges from 25 to 75 cfm. This air flow is limited by the air conditioning capacity. A higher airflow would exceed the capacity of the air conditioning system. A lower airflow could make the operator feel stuffy and would result in the operator opening windows. The intake air filtration system typically consists of a pleated paper element. Some filtration systems have a prefilter in front of the pleated paper intake filter.

When both intake and recirculation airflow are supplied by the same fan, changing a filter(s) media without adjusting the resistance on the system can result in a loss of cab air pressure. While many filtration materials are available,

operators are generally limited to the filter cartridge supplied by the manufacturer, as each machine has a different size filter cartridge. Some after market filter cartridges are available.

Evaluation of Cab Air Filtration Systems

To evaluate the effectiveness of a cab, dust samplers were placed inside and outside of a cab. The samplers were operated for the entire shift and the respective dust concentrations were calculated. The efficiency of the cab was determined by taking the difference between the outside and inside dust concentration and dividing by the outside dust concentration. Cab pressure was measured with a Magnihelix water gage with the windows and doors closed.

Three types of cab air filtrations systems were tested. These included:

1. standard factory installed systems,
2. improved filter media on a factory installed system, and
3. a retrofitted cab pressurizing system.

Retrofitting an existing cab with the original equipment manufacturer's air filtration system is not often feasible. The OEM has a detailed parts list for the air filtration system. It is difficult for a local supplier to get all the parts necessary. There is one manufacturer of retrofit cab pressurizing units (Red Dot). They also distribute cab air conditioning units.

Tests were conducted at surface coal mines and underground nonmetal mines. A total of fourteen tests were conducted on ten pieces of equipment.

Results of Tests

Table 1 shows the results of the cab efficiency for dust and quartz, inside dust level and cab pressure for each of the factory installed systems evaluated. Table 2 shows the results of the cab efficiency for dust and quartz, inside dust level and cab pressure for each of the field retrofitted systems evaluated.

The systems tested had a wide range of performance. The best system had a prefilter followed by a pleated paper inlet filter and a foam recirculating filter. The worst system had both an inlet air and recirculating filter but had not been maintained which rendered the systems ineffective. The wire mesh filter also had a low performance.

The use of improved filtration media reduced the dust and silica exposures but in one case resulted in a deterioration in performance because the system airflow was not balanced with the new filter. Since silica is a product of its percentage and the respirable dust, reducing either the percentage or the amount of dust will contribute to reducing the actual amount of silica exposure.

Increased positive pressure will reduce the dust concentration inside the cab keeping unfiltered air out of the cab. Some cabs were effective with pressures below the design level of 0.20 inches of water, however when the cab pressure was below 0.04 inches of water, the cab was ineffective. When the window was opened, the differential pressure dropped off to zero, indicating that in order to maintain a positive pressure within the cab, a good seal around windows and doors on the cab is critical. Additionally, a good seal around the filter cartridge is essential to avoid intake air contamination.

Good housekeeping and hygiene practices should be followed to avoid contamination of the cab.

Summary

In May 1998, the Mine Safety and Health Administration met with Caterpillar to discuss the issue of mobile equipment operator silica exposure. At that meeting Caterpillar was invited and accepted an invitation to participate in field testing of cabs on several pieces of mobile equipment at a surface coal mine. Following the initial testing, Caterpillar and Donaldson, fabricated filter cartridges that contained a higher efficiency filter media. The same equipment was retested to compare standard and improved filter media.

The second part of the program is to develop and evaluate retrofitted cabs for older equipment. For this part of the program, Cab Air Filter, Defiance, Iowa, under contract from NIOSH, is developing a retrofit cab which will utilize the Red Dot pressurizing unit. Several filter alternatives will also be evaluated. These

Based on these tests and test results on other pieces of mobile equipment, a number of conclusions and recommendations for cabs on mobile equipment have been developed.

Conclusions and Recommendations

1. In most cases, factory installed cab air filtration systems can reduce dust levels inside the cab to below 0.2 mg/m^3.

2. In situations where the quartz content of the dust exceeds 50 percent, it may be necessary to replace standard cab filters with higher efficiency filters. When this is needed the operator needs to make sure that the higher efficiency filters do not restrict or unbalance the cab airflow which can result in a loss of cab pressurization.

3. Field tests on an improved efficiency filter, (with improved filter seals) indicated that in some cases, a 98 percent reduction in silica could be achieved.

4. To be effective, a cab should be pressurized (0.2 inches of water, minimum), have a filtered intake air supply and a filtered recirculating air conditioning system.

5. Because of heavy dust loading, filters should be replaced either at the manufacturer's recommendation, weekly, or when the cab air pressure drops below one-half of the clean filter value. (A clogged filter can render a cab ineffective for dust control.

6. A pressure indicator should be installed to indicate when filters should be replaced.

7. A cab without additional controls provides some additional protection to the worker, because it protects the worker from peak concentrations.

8. A commercially available pressurizing unit reduced dust levels inside the cab by approximately 90 percent.

9. Based on the interest demonstrated during this project, Caterpillar is developing a retrofit kit for filtering and pressurizing cabs.

10. Housekeeping practices should include vacuuming or wet wiping the cab interior daily, replacing filters as necessary, periodically cleaning the inside of air duct work and making sure doors and windows are sealed. In addition, the equipment operator should wear clean cloths and clean boots to avoid contamination of the cab.

Table 1. Evaluation of Factory Installed Cab Filtration Systems

Manufacturer	Type of Equipment	Type of Filters	Percent Dust Reduction	Percent Quartz Reduction	Dust Level Inside Cab mg/m^3	Cab Pressure inches water
Caterpillar (Sur. Coal)	D11R Dozer	Std. PP-OS Std. PP-IS	68	71	0.21	0.16 - 0.30
Caterpillar (Sur. Coal)	D11R Dozer	New PP-OS Std. PP-IS	45	78	0.08	0.06 - 0.21
Caterpillar (Sur. Coal)	992G Loader	Std. PP-OS Std. PP-IS	86	92	0.06	0.24 - 0.62
Caterpillar (Sur. Coal)	992G Loader	New PP-OS New PP-IS	93	98	0.02	0.29 - 0.69
Komatzo (Sur. Coal)	D375A Dozer	Std. PP-OS Std. PP-IS	54	83	0.10	0.02 - 0.14
Komatzo (Sur. Coal)	W600 Loader	Std. PP-OS Std. FM-IS	0	49	0.30	0.00 - 0.04
Volvo (Ug. Metal)	L330C Loader	Std. FB-PF Std. PP-OS Std. FM-IS	94	99	0.10	0.28
Euclid (Ug. Metal)	R-65 Truck	MM-OS FM-IS	68	50	0.36	--
Caterpillar (Ug. Metal)	992C Loader	Std. PP-OS Std. PP-IS	80	70	0.45	--
Caterpillar (Sur.Metal)	980F Loader	Std. PP-OS	72	78	0.05	0.04

Table 2. Evaluation of Retrofit Cab Pressurization Systems

Manufacturer	Type of Equipment	Type of Filters	Percent Dust Reduction	Percent Quartz Reduction	Dust Level Inside Cab mg/m^3	Cab Pressure inches water
Euclid (Ug Metal)	R-35 Truck	MM-OS	13	0	0.93	0.00
Euclid (Ug Metal)	R-35 Truck	Std. PP-OS	91	91	0.10	0.04
Euclid (Ug Metal)	R-50 Truck	MM-OS	40	42	0.80	0.00
Euclid (Ug Metal)	R-50 Truck	Std. PP-OS	92	91	0.07	0.04

PP - Pleated Paper
FB - Fiber
FM - Foam
MM - Metal Mesh
OS - Outside
IS - Inside