Coal Dust Exposure Among Power Station Workers During Normal Operations at Hatfield's Ferry Power Station

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ABSTRACT

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Changes in coal composition could produce higher levels of coal dust exposure than those found in the past at Hatfield's Ferry Power Station. Air sampling was conducted to assess the risk of coal dust exposure among power station workers. The use of Powder River Basin coal may lead to increased coal dust exposure. The two main problems associated with PRB coal are more is needed to produce the same BTUs, and PRB coal is more friable than the standard eastern coals.

Air sampling was conducted to collect data on coal dust, quartz, and cristobalite. A total of sixty-two personal air samples were collected. The samples were collected for thirteen different job tasks.

The results for coal dust ranged from 0.0083 to 2.9 mg/m^3 with quartz ranging from non-detectable (ND) to 0.081 mg/m^3. Out of the sixty-two personal air samples, two employees were above the exposure limit for coal dust. Levels of 1.5 and 2.9 mg/m^3 for coal dust and 0.047 and 0.081 mg/m^3 for quartz were detected. Both of the employees were laborers who clean coal from the floors of the room where coal enters the plant.

As a result of these findings, the following recommendations for potential control measures were made:

- Update the coal chutes to minimize coal dust formation
- Use ventilation systems at transfer points
- Implement a housekeeping plan that meets the requirements of the OSHA NEP Combustible Dust Act
- Hire more employees to maintain cleaning under current conditions
- Replace dry sweeping methods with a wet suppression system
- Ensure that employees adhere to the respiratory protection program

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INTRODUCTION

Allegheny Energy is an electric utility company with more than 4,000 employees and consists of two major businesses: Allegheny Energy Supply and Allegheny Power. Allegheny Energy owns and operates generating facilities and delivers electric service to over 1.5 million customers in Pennsylvania, West Virginia, Maryland, and Virginia. Allegheny Energy uses approximately 19 million tons of coal annually to produce an average of 9,670 megawatts (MW). At this time, ninety-five percent of the energy produced at Allegheny Energy facilities is produced using coal.

Allegheny Energy Supply Company is the part of Allegheny Energy that generates electricity. In total, Allegheny Energy Supply owns and operates twenty power plants. The output for all the power plants in 2007 was 48 megawatt hours (MWH). While eleven stations use coal, the other nine power stations produce electricity using natural gas, coalbed methane gas, and hydro technology. After production, the electricity is distributed to the four states through Allegheny Power.

One of the power plants owned and operated by Allegheny Energy Supply is Hatfield's Ferry Power Station. Hatfield's Ferry is a coal-fueled power station that has a capacity of 1,710 megawatts (MW). Although the process of producing electricity from coal is complex, the basic principle is that coal combustion heats water in a boiler to produce steam that drives the turbines. To properly fire the boiler, the coal needs to be pulverized to a particle size where 65% of it can pass through a 200 mesh screen, about 0.0533 mm. In the turbine, the kinetic energy of the steam is converted to mechanical energy which turns the generator that converts the energy into electrical energy used in houses and industries. For a more detailed picture of a coal-fueled electric utility, please see Appendix A.

There are multiple hazardous chemicals used or produced in a coal-fueled power station. Sulfur dioxide, silica, arsenic, ammonia, and respirable dust are just a few examples. Workers have an exposure risk to these chemicals during daily activities at coal fueled power plants. While air sampling is generally collected during maintenance outages, a power station is most likely running under routine conditions. Since workers are working during routine conditions, sampling was conducted during these times.

Respirable dust exposure is one that is important to monitor. In a power station, there are two main types of respirable dust, fly ash and coal dust. Both are by-products of coal but may primarily be produced at different stages of electricity generation. Coal dust is found in areas where coal is present before the boiler, for example the pulverizer. Fly ash is found in areas after the boiler, for example the bag house. Coal dust can cause a variety of lung diseases including pneumoconiosis, bronchitis, and emphysema. These diseases are generally chronic in nature, but even acute exposure can cause respiratory distress (Groneberg et al 2006). Exposed workers can experience coughing, wheezing, and shortness of breath with acute exposure (OSHA 2008). According to the International Agency for Research on Cancer (1997), coal dust cannot be classified as a human carcinogen; however, there is a large body of published literature that links cancer risks potentially associated with employment as a coal miner.

There is a concern that a number of employees in different departments can be exposed to unhealthy amounts of coal dust. To evaluate the possible exposure, personal air samples were collected to determine personal exposures to coal dust.   The American

Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Value (TLV) was selected as the allowable limit to evaluate personal exposure. Based on past sample analysis and current results, it is known that the coal used in the power station contains less than 5% silica. Two different Permissible Exposure Levels (PEL) are given by the Occupation Safety and Health Administration (OSHA) for coal dust. The PEL used is determined by the percentage of silica found in coal. The PEL for coal having silica content below 5% is 2.4 milligrams per cubic meter (mg/m^3). An equation for the respirable fraction is used when coal has greater than 5% silica (OSHA 2008). Although a power station is governed by OSHA, the ACGIH TLV is used for coal dust, quartz, and cristobalite because the TLV values are lower than OSHA PEL values. Each of these substances has their own TLV values, which are not determined by an equation like the OSHA PEL. The TLV for coal dust is 0.9 mg/m^3 while quartz and cristobalite are both 0.025 mg/m^3 individually (ACGIH 2008).

Silica concentrations reported in this study were based on the X-ray diffraction determined percentage of silica in each individual sample. Sixty of the sixty-two samples coal dust samples collected had percentages of silica below the limit of detection, while two samples had were found to have 2.8% and 3.1% silica. All the samples were found to have percent silica values of less than 5% silica, so the PEL for coal dust less than 5% silica was used.

STUDY OBJECTIVE

The objective of this study was to quantify personal coal dust exposure over an entire task and compare the exposure results to the appropriate ACGIH TLV.

BACKGROUND

Hatfield's Ferry Power Station has approximately 85 employees involved in direct contact with coal or equipment used for coal transport. These 85 employees can be split into four major job titles. The four major job titles include:

- Bulk Materials
- Production
- Maintenance
- Laborer

The power station can also be divided into two major areas, coal yard and power plant. As a general rule, bulk material crews work in the coal yard, and production crews work in the plant. Maintenance/labor crews can work in either location. The coal yard primarily consists of a series of belts, chutes, and coal piles. The employees have their first contact with coal on the barges while unloading the coal onto the first set of belts. From this point, the coal enters the surge bin building where it drops through numerous chutes onto more belts directing coal to the appropriate areas. From this point, the coal will most likely be dropped onto one of many lowering wells where it can be moved for storage or enter the plant. While entering the plant, the coal is transported by belts to one of three units. Dropping through a chute into a pulverizer, the coal will be crushed to the proper size to enter the boiler. The coal dust is then transported pneumatically to a boiler through a series of pipes.

Figure 1 – Coal Yard

Personal air sampling was conducted three years ago to assess the exposure. Samples for this study were collected to continue previous exposure assessments and observe any possible changes in exposure. Changes in exposure may be due to changes in coal composition and handling. The last time a personal coal dust assessment was performed, the employees were only dealing with eastern coal. Since that time, the prevalence of Powder River Basin (PRB) coal has increased. PRB coal is a specific type of coal that is found in Wyoming and Montana. PRB is being used in conjunction with eastern coal at the power station. Differences in properties of PRB coal and eastern coal may significantly impact samples.

There has been ongoing discussion over the use of Powder River Basin (PRB) coal. Although PRB coal has some benefits, it can also be problematic if a power plant is not prepared for its use. This issue will affect Hatfield's Ferry and many other power stations for years to come. In 2007, PRB coal accounted for approximately 40% of all coal used in the United States. There are an estimated 800 billion tons of PRB coal reserves (Peltier and Wicker 2003).

Two of the main reasons Powder River Basin coal has become popular are price and a relatively low sulfur content. PRB coal can be 40-75% cheaper than other eastern coals or western coals. For example, in 2002, PRB coal delivered to eastern markets was $1.06/mmBtu versus $1.62/mmBtu for Appalachian coal. Low sulfur content provides environmental regulation benefits. Most PRB coal contains less than 1.2 lbs of sulfur/mmBtu, but the sulfur content can reach values as low as 0.4 lbs of sulfur/mmBtu. The following graph shows prices, sulfur content, and heating values of coals from different mine regions in 2002.

Table 1 – 2002 Average Prices and Specs of Coal Delivered to Eastern Utilities (Peltier and Wicker 2003)

Mine Region	Delivered Cost ($/mmBtu)	Sulfur Content (lb/mmBtu)	Heating Value (Btu/lb)
Central Appalachia	1.53	1.49	12,414
Northern Appalachia: Northeast	1.16	3.67	12,532
Northern Appalachia: Ohio	1.108	5.57	11,997
Southern Appalachia	1.62	2.06	12,071
Southern PRB	1.064	0.61	8,763
Illinois Basin	1.12	4.40	11,262
Central Rockies	1.474	0.94	11,872

Table 1 illustrates that PRB coal has the advantage of lower cost and lower sulfur content, but also does not have the same heating value as other coals. As a result of lower heating values, more PRB coal is needed to produce the same heat in a boiler. Another downside to PRB coal is the propensity to be friable and brittle. This plays a role in coal dust exposure in that there is a chance more coal dust will be airborne when using PRB coal. The two other downsides to PRB coal are an elevated moisture level and greater amounts of ash compared to eastern coals (Peltier and Wicker 2003).

Due to the difference in PRB coal composition, coal dust exposure may have changed since the last coal dust assessment. Good Industrial Hygiene practice emphasizes the importance of quantifying the exposure if any major change in the production process occurs. Currently, Hatfield's Ferry is using 80% eastern coal and 20% PRB coal. Even though this mixture is only one fifth PRB coal, effects have already been observed which could produce an increase of coal dust. Powder River Basin coal's higher moisture content and greater friability make the coal more susceptible to spontaneous combustion. For this reason, PRB coal needs to be moved more frequently so 'hot spots' do not ignite into fires. The lower heating volume means that more coal needs to go through the belts and chutes leading to a possible increase in coal dust.

While employees who are potentially exposed to coal dust are classified into one of four job titles, there are thirteen different tasks that were analyzed to determine coal dust exposure. The tasks and the job title which performs each task are identified in Table 2.

Table 2 – Job Task (Similar Exposure Group) with Number of Employees for each SEG

Job Title	Job Task	Shift Length	# of employees
Bulk Materials	Barge Handler	8	8
Bulk Materials	Barge Unloader Operator	8	4
Bulk Materials	Clean-Up	8	-
Bulk Materials	Supervisor	8	2
Bulk Materials	Tow Boat Operator	8	4
Bulk Materials	Heavy Equipment Operator (590)	8	4
Bulk Materials	Heavy Equipment Operator (690)	8	4
Bulk Materials	Heavy Equipment Operator (D9)	8	4
Laborer	6th Floor Clean-Up	8	3
Maintenance	General Duties	8 or 10	36
A Operator	Operator Rounds	8	4
B Operator	Operator Rounds	8	8
C Operator	Operator Rounds	8	4

A brief description of the job tasks follows:

Barge Handler

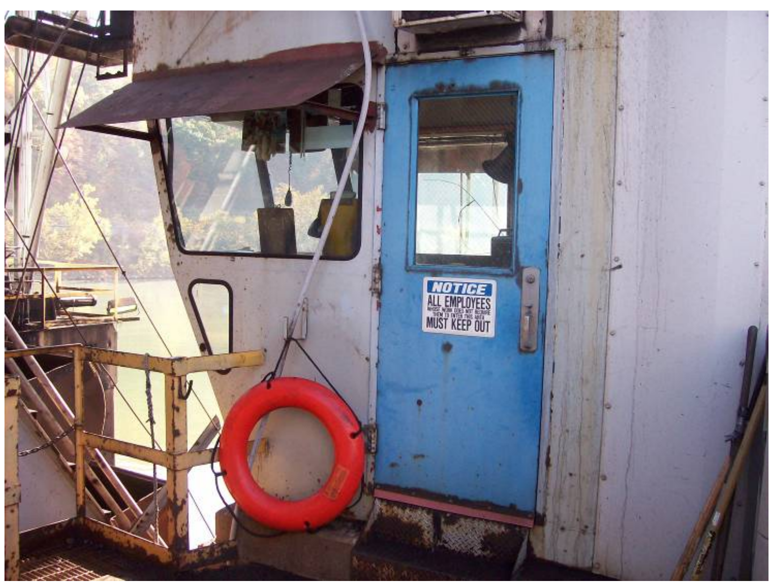
The barge handler spends most of a shift on the river assisting the tow boat operator in moving full and empty barges to be unloaded. He has to climb onto the barge and tie-off the barge to the tow boat in order to move the barge into position. After the barge is in position, the barge handler will untie the barge from the tow boat and ensure that the barge is ready to be unloaded by the barge unloader operator.

Figure 2 – Barge Handler

<u>Barge Unloader Operator</u>

The barge unloader operator spends a shift controlling the barge unloader. He must ensure that the barge is being properly unloaded and that nothing goes wrong during the operation.

Figure 3 – Barge Unloader Operator



Tow Boat Operator

The tow boat operator is in charge of moving all empty and full barges into place. The barges of coal are delivered to the site. The tow boat operator then guides the barges into the proper position to be unloaded. Empty barges are placed along the river for pick up.

Figure 4 – Tow Boat Operator

Heavy Equipment Operator (590, 690, and D9)

The heavy equipment operators' jobs require them to be in one of the bulldozers. They are responsible for pushing the coal onto storage piles or to the feeders, which drop coal onto the belts. There are three different dozers that can be used (590, 690, and D9).

Figure 5 – Heavy Equipment Operator (590)

Bulk Materials Supervisor

The bulk materials supervisors' duties include ensuring that all employees are properly doing their jobs in bulk materials. They are in various locations during different shifts, depending on what occurs that day.

Bulk Materials Clean-up

This is the first task that can be done by any one of the bulk materials crew members. The task includes removing coal and debris from the walkways, on belts, and on coal buildings. The crew members primarily use shovels and hoses to clean down the buildings.

Sixth Floor Clean-up

This task is primarily performed by the labor gang. The sixth floor is where the coal enters the plant. This is a specific task because there is a chance that coal can fall from the belts. They primarily use push brooms and vacuum systems to clean the floors.

Maintenance General Duties

Maintenance workers can be the toughest to sample as an exposure group because there are a wide variety of work tasks done including welding and valve replacement. The task is classified as general duties because of the variety in work tasks.

Operator Rounds

The basic task of operators is to walk down the units and make sure that they are running properly. The production crew is identified as either an A, B, or C operator. Each one has primary equipment to inspect. The A operator's primary equipment is the more complicated turbine and generator systems. The B operator's equipment deals primarily with the coal systems and boiler. The C operator's equipment deals primarily with the bottom ash and water system. Operators perform other duties such as tagging out equipment and shutting the units down or restarting them. The exposure sampling on these individuals will be conducted during normal operation rounds for each operator.

LITERATURE REVIEW

Workers have been overexposed to a variety of chemical hazards while working during outages at coal-fueled power stations. Studies have been collected to show these exposures, but there are few studies on workers' exposures during normal operations at coal-fueled power stations (Hicks and Yager 2006). Normal operations are important to study because most power stations run at normal operations approximately 60-70% of the time. In the past, area samples have indicated that some areas of power stations have elevated levels of respirable dust that would exceed occupational exposure values (Bird et al 2004). This data was collected at five coal-fueled power plants in the southeastern United States. The results showed there was only one overexposure in the five coal-fueled power stations that were sampled for silica/respirable coal dust (Bird et al 2004). The 199 samples that were collected within the limit of detection ranged from 0.13-0.37 mg/m^3. Although these were all under the occupational exposure limit set by OSHA, they would also be under the lower ACGIH TLV of 0.9 mg/m^3. Another important result was of the range of silica found in the coal that was used at the five power stations. The range of quartz silica found in the coal was <0.6-4.4%. For all five power stations, the quartz silica percent is less than the 5% cut point that OSHA uses for its Permissible Exposure Levels (Bird et al 2004).

Although few studies have been published on coal dust exposure in the power generation industry, many studies have been published on coal dust exposure in coal mines. One such study is from Naidoo et al (2006) that measured coal dust exposure among coal miners in South Africa. Although this cannot be directly related to a power generation plant, some information can be gathered about the similar hazard. Naidoo et al separated the miners into three groups: work on surface, underground backbye (away from the coal mining face), and face (directly involved in coal extraction). Since power station employees do not directly extract coal, the best subgroup to compare would be that of underground backbye. This group is important because they are near the area where the coal is being moved. The geometric means at the three mines were 0.71 mg/m^3, 1.51 mg/m^3, and 0.49 mg/m^3. This data shows that one of the geometric means is over the OEL that is used for the coal dust assessment at Hatfield's Ferry. This study shows that even though employees are not directly involved in the work, they can still be exposed by being in the same area as coal that is being moved.

Although coal dust is not considered carcinogenic, coal dust can still cause some harmful effects to the human body. One of the most prevalent diseases is that of coal workers' pneumoconiosis (CWP). One study shows a relationship between CWP, dust exposure, and age (Attfield and Morring 1992). The author used the federal standard of 2 mg/m^3, but at this level, there was a greater percentage of workers with CWP. For the whole study, the overall prevalence was 12% among the 9,023 workers averaging 21 years under ground and at age 44. Coal rank region showed high variability among prevalence percentages. The percentage range was from 4% at high volatile west coal to 41% with anthracite coal (Attfield and Morring 1992). Although CWP is the most known disease, coal dust can also lead to bronchitis, emphysema, Caplan syndrome, and silicosis (Castranova and Vallyathan 2000).

METHODS AND APPARATUS

Air Sampling

Air sampling techniques for all samples were performed using a method similar to that described by Bird et al (2004). These techniques are similar to the methods and materials found in the NIOSH 0600 analytical method. Respirable dust samples of coal dust were used to assess personal exposure. Samples were collected using 5.0-µm polyvinylchloride filters, SKC aluminum cyclones, and MSA Escort ELF personal sampling pumps. The cassettes were placed near the worker's breathing zone, usually on the collar of the shirt. Air was pulled through the cassette at a flow rate of 2.5 liters per minute per the NIOSH 0600 analytical method. The workers sampled were collected based on the specific task that was being performed for the day. The MSA sampling pumps were turned on prior to the worker beginning his/her work task and off at the end of the task. Most of the samples were collected for a full work shift. The tasks of bulk materials clean-up and sixth floor clean-up are not usually performed for a full day, so sampling pumps were only worn during those specific tasks. Start times and end times were recorded for all samples. The Time Weighted Average (TWA) was calculated using the mass and volume from each sample. The 8-hour TWA was calculated using the TWA with assumption of zero exposure during the rest of the shift that was not sampled. For example, if the concentration was 0.39 mg/m^3 over 409 minutes, the concentration over the final 71 minutes was assumed to be zero. This is an appropriate assumption since the rest of the time was spent in the break rooms.

The MSA Escort ELF sampling pumps were calibrated using a Gilian Gilibrator before and after each sample was taken. The average of six recordings was used to determine the flow rate of the sampling pump (see calibration records in Appendix B). If the post calibration was more than a 5% difference than the pre-calibration, the sample was voided.

The following number of samples was collected for each task.

Table 3 – Actual Number of Samples Collected for Each Job Task

Job Title	Job Task	# of employees	Expected # of samples	Actual # of samples
Bulk Materials	Barge Handler	8	7	4
Bulk Materials	Barge Unloader Operator	4	4	4
Bulk Materials	Clean-Up	-	4[a]	4
Bulk Materials	Supervisor	2	2	2
Bulk Materials	Tow Boat Operator	4	4	4
Bulk Materials	Heavy Equipment Operator (590)	4	4	4
Bulk Materials	Heavy Equipment Operator (690)	4	4	4
Bulk Materials	Heavy Equipment Operator (D9)	4	4	4
Laborer	6th Floor Clean-Up	3	6[b]	6
Maintenance	General Duties	36	16	8
A Operator	Operator Rounds	4	4	6
B Operator	Operator Rounds	8	4[c]	6
C Operator	Operator Rounds	4	4	6

a Bulk Materials Clean-Up is not a job title and is completed by whoever volunteers to work an off shift; therefore, samples will be collect when available
b 6th Floor Clean-Up is completed by 3 laborers but temporary hires also perform the work; therefore, the three employees will be sampled as well as some temporary employees
c B Operator has 8 employees but most are training during their shift, so four samples will collected to mimic the other operator positions

The number of samples to be collected was determined in accordance to the NIOSH sampling guidelines. The three factors to take into account are group size, top percent, and confidence level. The number of samples collected from a population was determined such that there was 90% confident of finding the top 10% exposure in the population (Leidel et al 1977). The only examples of this not being the case are when group size varies due to the possibility of temporary employees performing the task or when group size is determined by title and not job duties, i.e. B operator position. The actual number of samples did not match the expected number of samples due to budgetary constraints and company policy. The actual number of samples collected was similar to the recommended number of samples made by Malhausen et al (2006). Malhausen et al recommended anywhere from six to ten samples for each similar exposure group (SEG). This recommendation was made after findings show that beyond six to ten samples, there is a point of diminishing returns where there is little difference in the estimation of the mean and standard deviation.

All samples were collected during day shift. An attempt was made to sample each employee when the size of the group was four or less. This was difficult to accomplish due to schedules and employee participation. For maintenance general duties, samples were collected based on activity location. Maintenance duties were either plant wide or more specific to a piece of equipment that handled coal. Maintenance work on equipment that was not specific for coal was not sampled.

Laboratory Used for Analysis

The samples were shipped to the corporate office before being packaged and sent to Clark Laboratories. Clark Labs is an American Industrial Hygiene Association (AIHA) accredited laboratory. The samples were analyzed by Clark Laboratory using gravimetric analysis for the coal dust and X-ray Diffraction (XRD). The laboratory reported back the mass and concentration of each analyte. Although the concentration was given by the laboratory, the TWA and 8-hour TWA were still calculated using the mass and volume.

RESULTS AND DISCUSSION

The air sampling results and statistical analysis for all job tasks are summarized in Table 4 through Table 17. The results of this study will be discussed in four sections, one section for each job class: bulk materials, laborer, maintenance, and operations. The results of coal dust ranged from 0.0083 to 2.9 mg/m^3, and the results of quartz ranged from non-detectable (ND) to 0.081 mg/m^3. Only two samples out of sixty-two samples, or 3%, exceeded the ACGIH TLV of 0.9 mg/m^3, and only one sample out of sixty-two samples, or 2%, exceeded the OSHA PEL of 2.4 mg/m^3. Only one exposure group exceeded the occupational exposure level. The labor crew had two out of six samples, or 33%, exceed the ACGIH TLV. Although cleaning the sixth floor is a non-routine task for the laborers, dust control methods should be analyzed to decrease their exposure. Even though only 3% of the samples exceeded the exposure limit, the presence of combustible dust is an issue that needs to be addressed. This is discussed further in the "Discussion of Potential Control Measures" section.

Although confidence limits are important in finding the true mean, neither the confidence limit nor upper confidence limit were calculated for this study. The low number of samples and high standard deviation creates large confidence intervals that cannot be used to determine the true mean. More samples will need to be collected to assess the true means of exposure. Each sampling group will be discussed looking at each sample with emphasis placed on whether each sample was <10% of the exposure limit, greater than 50% of the exposure limit, or exceeded the exposure limit. The results greater than 50% of the OEL will be considered the action level. As a general rule, the action level is normally 50% of the exposure limit for exposures. Although 97% of the samples were below the exposure limit, five out of sixty-two samples, or 8%, were in the action level range. The distribution of results is most likely lognormal. Lognormal distribution is assumed due to the standard deviation being larger than the mean and a physical lower boundary for air sampling (Mulhausen et al 2006).

The results are given by sample number. Each sample number represents a different worker, except for the operations crews. The A Operator and C Operator have four employees each and some employees were sampled twice.

Results and Discussion for Bulk Materials

Table 4 – Coal Dust Results for Barge Handler

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
A-1	415	1.04	0.096	0.083
A-2	426	1.07	0.43	0.38
A-3	415	1.00	0.077	0.067
A-4	417	1.08	0.15	0.13

The first similar exposure group (SEG) is that of the barge handlers. Table 4 shows the 8-hour TWA concentration for the four samples. The percentage of silica found in all Barge Handler samples were found to be below detectable limits. Two results were less than 10% of the OEL, but the other two samples were not in the action level range. More sampling will need to be conducted to determine the true exposure. The high level of variability among barge handlers could be attributed to the weather conditions or human variability of working. Since barge handlers are on the river all day long, natural ventilation is present. Each shift is responsible for unloading the same number of barges. All barge handlers unload eight barges during their normal shift.

Types of coal in each barge were not known during this study. Although most results were similar, sample A-2 appeared out of place. Although observations were made, no differences were noted in this worker's job activities compared to the other workers.

Table 5 – Air Sampling Results and Statistical Analysis for Barge Unloader Operator

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
B-1	409	1.06	0.39	0.33
B-2	428	1.03	0.21	0.19
B-3	434	1.09	0.046	0.042
B-4	432	1.08	0.23	0.21

The next job task in bulk materials is that of barge unloader operator. According to Table 5, the exposures ranged from 0.042 to 0.33 mg/m^3. The silica results were all non-detectable. Although it seems like the barge unloader operator should have lower exposure values, the job duties are more extensive than sitting in the barge unloader control room. The barge unloader operators need to go into the coal buildings or on coal belts as needed. These additional duties are most likely to blame for sample number B-3 with a coal exposure level of 0.042 mg/m^3 which seems out of place. This worker did not go into any of the coal buildings like the other barge unloader operators. Sitting in the barge unloader cab appears to have less exposure than entering the coal transfer buildings. If the worker for B-3 went into the coal buildings, the result would most likely show a level near the other samples.

Table 6 - Air Sampling Results and Statistical Analysis for Bulk Material Clean-Up

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
C-1	406	1.06	0.15	0.13
C-2	401	1.00	0.040	0.033
C-3	288	0.72	0.056	0.034
C-4	292	0.73	0.069	0.042

Bulk material clean-up is the next task for bulk materials. The difference between the clean-up tasks versus other bulk materials tasks is that it is not a specific job title. Any bulk materials employee can be a part of a clean-up crew on their off-shift. According to Table 6, the exposure ranged from 0.033 to 0.13 mg/m^3. All the silica results were non-detectable. These appear to be low exposure results for this job task. In fact, three out of four samples were below 10% of the exposure limit. Considering the dirtiness of the environment, these results are relatively surprising. The reasoning would mostly be assumptions of worker involvement in the job task. Through observation it was noted that the workers would take their time throughout the whole task and not clean as vigorously as assumed. Another possibility might be variation in the technique used. The coal was shoveled or swept through the gratings to the ground floor where no one was located. After break, workers would come back through to hose the floors.

Table 7 - Air Sampling Results and Statistical Analysis for Bulk Material Supervisor

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
D-1	431	1.08	0.056	0.050
D-2	442	1.06	0.027	0.025

The next bulk materials exposure group is that of bulk materials supervisor. The exposure ranged from 0.025 to 0.05 mg/m^3. Both silica results were non-detectable.

These values are not surprising because the supervisors spend most of their time in the office or in meetings. The highest result of 0.05 mg/m^3 is less than 10% the TLV. This is a good indication that sampling will not need be performed in future studies unless the job duties or process changes.

Table 8 - Air Sampling Results and Statistical Analysis for Tow Boat Operator

Sample Number	Sample Time (minutes)	Volume (m³)	Conc. (mg/m³)	8-hr TWA (mg/m^3)
E-1	406	1.02	0.089	0.075
E-2	417	1.04	0.038	0.033
E-3	417	1.00	0.0096	0.008
E-4	422	1.06	0.052	0.046

Tow boat operators are the next exposure group for bulk materials. The exposure ranged from 0.0083 to 0.075 mg/m^3. All silica samples were non-detectable. None of these values exceeded 10% of the exposure level. The results are logical considering that the tow boat operator spends his day in the cab of the tow boat. Although he/she is pushing barges of coal around, the distance, enclosure, and environment play a role in him/her having a low exposure to coal dust.

Table 9 - Air Sampling Results and Statistical Analysis for HEO (590)

Sample Number	Sample Time (minutes)	Volume (m³)	Conc. (mg/m³)	8-hr TWA (mg/m^3)
F-1	407	1.02	0.36	0.31
F-2	428	1.03	0.0093	0.0083
F-3	417	1.04	0.019	0.017
F-4	423	1.06	0.038	0.033

Table 9 shows the exposure for operators of the 590 dozer. Exposures ranged from 0.0083 to 0.31 mg/m^3. All silica results were non-detectable. Although three out of four samples were less than 10% of the exposure limit, F-1 appears out of place among the results. Through observation, no difference was noted for this sample compared to the others, but observations could not be made while the worker was on his duty due to the nature of the work. More will be discussed under Table 11.

Table 10 - Air Sampling Results and Statistical Analysis for HEO (690)

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
G-1	404	1.01	0.059	0.050
G-2	432	1.08	0.037	0.033
G-3	414	1.04	0.087	0.075
G-4	431	1.08	0.028	0.025

Table 10 shows the exposure for operators of the 690 dozer. Exposures ranged from 0.025 to 0.075 mg/m^3. All silica samples were non-detectable. All samples collected were less than 10% of the exposure limit. More will be discussed under Table 11.

Table 11 - Air Sampling Results and Statistical Analysis for HEO (D9)

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
H-1	430	1.08	0.23	0.21
H-2	435	1.09	0.13	0.12
H-3	432	1.04	0.19	0.17
H-4	400	1.00	0.2	0.17

Table 11 shows the exposure for operators of the D9 dozer. Exposures ranged from 0.12 to 0.21 mg/m^3. All silica samples were non-detectable. Although the samples were not above the action level, none of them were less than 10% of the OEL. This result differed from the 590 and 690 dozers in that only one of the previous samples were in the action level range.

The difference among dozer operator exposures could be due to the cab seals and the dozer size. For example, the D9 is the smallest of the dozers, and it has the highest geometric mean among all dozers. It is difficult to explain the large range found in the 590 results. The pumps were all in working condition when received. Since it is difficult to observe while the workers are in the cabs of the dozers, it is not known if anything occurred to the pumps during this time. Future samples might show that the 590, 690, and D9 can be sampled as one exposure group.

Results and Discussion of Air Sampling Results for Laborers

Table 12 - Air Sampling Results and Statistical Analysis for Laborer

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
I-1	475	1.19	1.5	1.5
I-2	476	1.19	2.9	2.9
I-3	377	0.94	0.6	0.47
I-4	177	0.46	0.33	0.12
I-5	305	0.76	0.71	0.45
I-6	304	0.76	0.88	0.56

Before any samples were taken, this exposure group was assumed to be one with highest exposure due to past assessments and job tasks. The exposures reported in Table 12 ranged from 0.12 to 2.9 mg/m^3. Sample I-1 had a silica concentration of 0.047 mg/m^3, I-2 was 0.081 mg/m^3, I-3 was 0.016 mg/m^3, I-4 was <0.009 mg/m^3, I-5 was 0.013 mg/m^3, and I-6 was 0.014 mg/m^3. Two samples exceeded the ACGIH TLV and one sample exceeded the OSHA PEL. This exposure group had the highest geometric mean of all exposure groups. The geometric mean would most likely be higher if all samples were collected over the same period of time. Only samples I-1 and I-2 were collected over a full work shift. The other four samples were collected over a partial work day ranging from one hour to four hours. With the hiring of temporary workers, the time spent cleaning the sixth floor varied by day. While more laborers were present, the sixth floor was cleaned more often; therefore, cleaning was not needed throughout the whole day. When the labor gang consisted of only three workers, they would occasionally spend a whole day cleaning. Knowing that the workers were wearing the proper respirator protection and it is a non-routine activity, OSHA would likely not cite this task. While the workers were wearing respirators for all samples, personal protective equipment should be the last resort for protection. In order to reduce exposures, some updates should be made to the system. These updates will be discussed in the section entitled "Discussion of Potential Control Measures."

Results and Discussion of Air Sampling Results for Maintenance

Table 13 - Air Sampling Results and Statistical Analysis for Maintenance

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
J-1	478	1.20	0.25	0.25
J-2	471	1.18	0.19	0.18
J-3	454	1.14	0.089	0.084
J-4	477	1.14	0.15	0.15
J-5	479	1.20	0.093	0.093
J-6	444	1.11	0.99	0.092
J-7	415	1.04	0.24	0.21
J-8	446	1.12	0.35	0.33

Although maintenance work can be one of the hardest groups to sample, the standard deviation for this exposure group was less than that of other groups. According to Table 13, the exposures ranged from 0.084 to 0.33 mg/m^3. All silica samples were non-detectable. Since maintenance work has more variety than the other exposure groups, the maintenance work selected dealt with the coal system. Within these selection criteria, two different tasks were measured: inspection/weekly checks (i.e. inspecting coal feeder shakers) and repairs (i.e. replacing conveyor on 7A coal belt). Although no result was over the exposure limit, most samples were found between 10% and 50%, or the action level. One explanation could be that while maintenance is working, there is a good chance the coal system was not running. Also, maintenance would hose down the area they were working in to reduce the amount of coal dust present. Even if more sampling was conducted, it would be difficult to determine the true mean due to the nature of the work.

Results and Discussion of Air Sampling Results for Operations

Table 14 - Air Sampling Results and Statistical Analysis for 'A' Operator

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
K-1	426	1.07	0.094	0.083
K-2	444	1.11	0.016	0.015
K-3	448	1.08	0.1	0.093
K-4	429	1.07	0.019	0.017
K-5	452	1.13	0.09	0.085
K-6	451	1.13	0.044	0.041

Table 14 showed the exposure for 'A' operators ranged from 0.015 to 0.090 mg/m^3. All silica samples were non-detectable. All samples collected were less than 10% of the exposure limit. The equipment that these operators are responsible for is generally cleaner than the rest of the plant. For example, the turbine hall has no coal systems near it and is swept more often. Since all samples were less than 10% of the exposure limit, we can be fairly confident these operators are not overexposed to coal dust. Samples K-3 and K-4 were collected on the same individual. Also, samples K-5 and K-6 were collected on the same individual.

Table 15 - Air Sampling Results and Statistical Analysis for 'B' Operator

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
L-1	444	1.11	0.42	0.39
L-2	422	1.06	0.12	0.11
L-3	446	1.12	0.11	0.10
L-4	445	1.11	0.55	0.51
L-5	457	1.14	0.07	0.067
L-6	431	1.08	0.19	0.17

Table 15 showed the exposure for 'B' operators ranged from 0.067 to 0.39 mg/m^3. All silica samples were non-detectable. The results showed one sample in the action level range. L-4 was the highest due to an unplanned task of shoveling coal for approximately forty five minutes. Also, sample L-5 appeared out of place due to the low value. This worker was training for the position and spent more of the day in the control room than an established operator.

Table 16 – Air Sampling Results and Statistical Analysis for 'C' Operator

Sample Number	Sample Time (minutes)	Volume (m^3)	Conc. (mg/m^3)	8-hr TWA (mg/m^3)
M-1	446	1.12	0.28	0.26
M-2	438	1.10	0.39	0.36
M-3	451	1.13	0.12	0.11
M-4	452	1.08	0.036	0.033
M-5	448	1.12	0.054	0.05
M-6	459	1.15	0.18	0.17

Table 16 showed the exposure for 'C' operators ranged from 0.033 to 0.36 mg/m^3. All silica samples were non-detectable. The change in samples could be due to human work habits in the position. For example, samples M-4 and M-5 were collected on the same individual. More samples would need to be collected to determine where the true mean would lie. Samples M-1 and M-2 were also collected on the same individual.

Result of Descriptive Statistics

Table 17 – Descriptive Statistics for All Job Tasks

Job Title	Job Task	Actual # of samples	Dust Range (mg/m^3)	GM ± GSD (mg/m^3)	Mean ± SD (mg/m^3)
Bulk Materials	Barge Handler	4	0.067 - 0.38	0.13 ± 2.17	0.17 ± 0.15
Bulk Materials	Barge Unloader Operator	4	0.042 – 0.33	0.15 ± 2.45	0.19 ± 0.12
Bulk Materials	Clean-Up	4	0.033 – 0.13	0.050 ± 1.91	0.060 ± 0.047
Bulk Materials	Supervisor	2	0.025 – 0.05	0.035 ± 1.63	0.038 ± 0.018
Bulk Materials	Tow Boat Operator	4	0.0083 – 0.075	0.031 ± 2.57	0.041 ± 0.028
Bulk Materials	Heavy Equipment Operator (590)	4	0.0083 – 0.31	0.035 ± 4.79	0.092 ± 0.15
Bulk Materials	Heavy Equipment Operator (690)	4	0.025 – 0.075	0.042 ± 1.62	0.046 ± 0.022
Bulk Materials	Heavy Equipment Operator (D9)	4	0.12 – 0.21	0.16 ± 1.26	0.17 ± 0.037
Laborer	6th Floor Clean-Up	6	0.12 – 2.9	0.63 ± 3.00	1.00 ± 1.04
Maintenance	General Duties	8	0.084 – 0.33	0.16 ± 1.67	0.17 ± 0.087
A Operator	Operator Rounds	6	0.015 – 0.09	0.043 ± 2.29	0.062 ± 0.035
B Operator	Operator Rounds	6	0.067 – 0.51	0.17 ± 2.24	0.23 ± 0.18
C Operator	Operator Rounds	6	0.033 – 0.36	0.12 ± 2.55	0.16 ± 0.13

DISCUSSION OF POTENTIAL CONTROL MEASURES

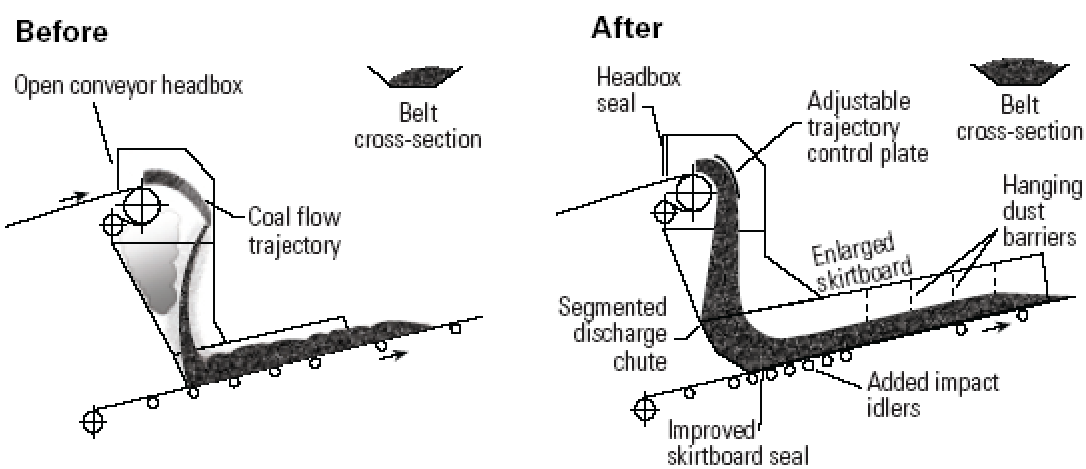
Two of the individual, personal air sampling results from sixth floor clean-up were found to be higher than the ACGIH TLV limit for coal dust. Although the rest of the data shows no other task is over the exposure levels, forty four percent of samples were found to be in the action level range. Control measures should be developed to reduce the coal dust exposure levels for workers at the power station. These measures could include improvements in the coal delivery system, engineering controls, implementing an occupational safety and health program, improvements to housekeeping procedures, administrative controls, use of respiratory protection, and additional sampling. Implementing any one of these measures may not be sufficient to control coal dust exposure, but implementing a combination of these measures can decrease the likelihood of being overexposed to coal dust.

Improving Coal Delivery Systems

Updating the coal delivery system may be the best option for decreasing coal dust exposure. Many of the chutes are in disrepair with leaks where the coal is able to be separated from the system. It is recommended to bring in a consultant with expertise to give a full evaluation. The areas of greatest importance would be anywhere that is enclosed, like in the coal tunnels or the sixth floor where the coal enters the plant. Although coal falling from the belts outside could cause other safety issues, such as a tripping hazard, the likelihood of being exposed to coal dust is low because the areas are outside with natural ventilation and limited work is done in those areas when the system is running.

The main issue is the aging coal transfer chutes. Multiple locations have coal chutes that are deteriorating and have multiple leaks where coal exits the system. Coal dust is produced in the chutes. Dust is created from the impact of falling coal and the distance in which the coal drops. Since the chutes are already in place at Hatfield's Ferry, it will be difficult to reduce the height in which coal drops, but the impaction forces can be decreased by efficient coal chutes. The transfer chute needs to guide the coal smoothly down the chute to decrease impaction. Also, controlling the angles at which coal is transferred onto the belts will decrease dust creation due to the direction of transfer. A properly designed transfer chute should be similar to that of Figure 7. The figure on the right produces less coal dust due to the trajectory control and segmented duct, which directs coal in the same direction as the belt (Schonbach 2003).

Figure 6 – Proper Transfer Chute Design (Schonbach 2003)[1]

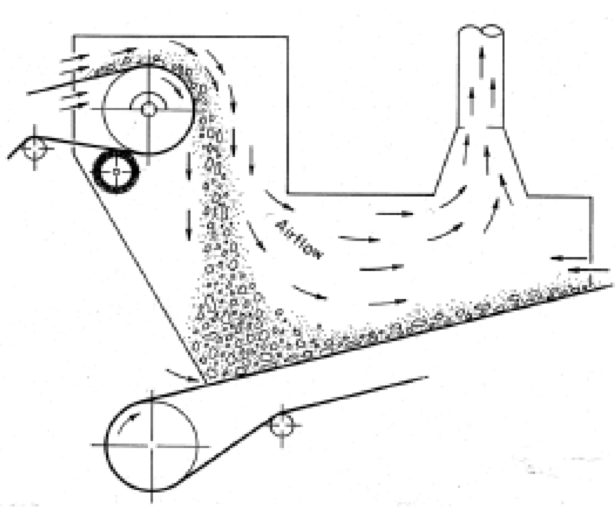


[1] Note. From Power Magazine (2003). Copyright 2003 by TradeFair Group. Reprinted with permission.

Additional Engineering Controls (Ventilation)

Although updating transfer chutes would be the best option to control coal dust, ventilation could also be used especially in transfer points. The best approach would be to enclose the transfer point with an exhaust hood. The dust would then need to be removed by either a dust collection system or filter (Kissell and Stachulak 2003). The ventilation system would provide a slight negative pressure that would draft in ambient air. This draft should direct coal dust towards the hood instead of flowing to areas outside of the chute (Schonbach 2003). Due to entrainment, dusty air will be push out of the bottom of the chutes. Negative pressure will help to offset this effect. In addition, it is suggested that the hood openings are wide enough so the velocity of air exhausted is 500 ft/min or less. Also, the air velocity should be in the range of 3,000 to 4,000 ft/min so coal dust will not settle in the ducts (Kissell and Stachulak 2003). Kissell and Stachulak suggest using a transfer point ventilation system similar to Figure 8.

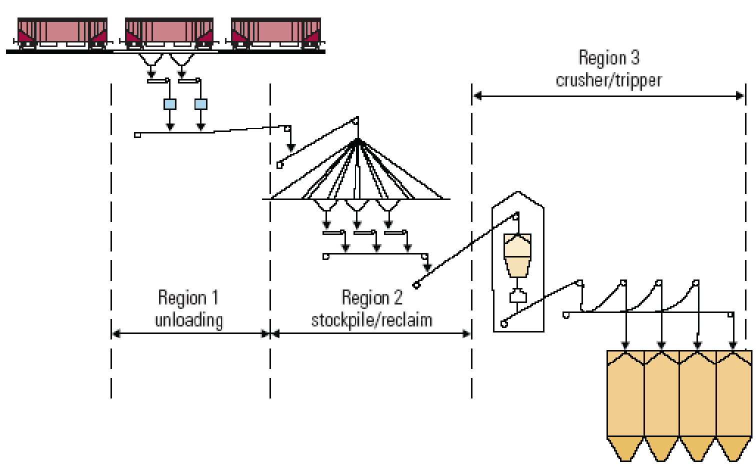
Figure 7 – Proper Ventilation Design for Coal Transfer Chute (Kissell and Stachulak 2003)[2]



[2] Public domain source

Installing a ventilation system for all the transfer chutes would require an extensive and expensive project. There are many transfer points from the barge unloading area to the boilers. It is recommended that an audit be performed to observe the areas of greatest concern. Schonbach shows in Figure 9 that ventilation systems can spread over a large area. He shows three distinct areas in this figure: unloading, stockpile/reclaim, and crusher/tripper. The most important place to have a ventilation system will be in confined areas that are most likely found closer to Region 3. The transfer points in the coal yard are in open areas where natural ventilation can occur. If a system is not already in place, the project can be relatively expensive. Updating of the coal chutes will also need to take place making ventilation projects more expensive. The ventilation system will not properly work if there are holes in the chutes where drafting can occur. It is recommended to update the transfer points before doing an additional audit to see if ventilation is needed at that point.

Figure 8 – Dust Control System at a Power Plant (Schonbach 2003)[3]



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Occupational Safety and Health Program

An occupational safety and health program is an important part of the safety goals at Hatfield's Ferry. Other programs have already been written that focus on specific safety issues such as the respiratory protection program or hearing conservation program. Currently, a new occupational safety and health program is being written to comply with the OSHA proposed legislation of the "Combustible Dust Explosion and Fire Prevention Act of 2008." Although the focus of this legislation is on preventing explosions of combustible dust, the recommendations made in it could directly affect coal dust exposures.

One part of the legislation is to decrease the amount of combustible dust in the facility. NFPA 654 offers the following guidance on dust control:

- Minimize the escape of dust from process equipment;
- Use dust collection systems and filters;
- Clean dust residues at regular intervals;
- Use cleaning methods that do not generate dust clouds if ignition sources are present;
- Develop and implement a hazardous dust inspection, testing, housekeeping, and control program

These are just some of the recommendations made by NFPA. The part of the directive that might directly affect coal dust exposure is when dust needs to be cleaned. OSHA gives a dust accumulation value of 1/32-inch thickness over a surface area of at least 5% of the floor area. This value indicates that housekeeping will need to be at a high level of importance (OSHA comb. Dust).

Housekeeping Plan

Due to the significance and proposed regulation of keeping all areas clean, a housekeeping plan is of utmost importance. Currently, areas are only cleaned on an "as needed" basis. The problem is that the workers scheduled to clean during these times are only cleaning coal for about half of their work shift. A housekeeping plan needs to be in place to make certain groups responsible for days and areas. Currently, the labor gang is responsible to clean up coal piles, but they are also expected to perform their other daily duties. The housekeeping plan should schedule different maintenance, operator, and labor crews for different days. This will be especially important during the first few weeks of implementing a combustible dust plan as certain areas have been overlooked over the course of time. If each group is scheduled to clean on different days of the week in half day increments, each crew will only need to clean about once a week. Another plan could have each crew responsible for a certain section of the coal system instead of everyone being responsible for the whole system. In this case, it may be less likely for crews to leave a mess expecting the next crew to do the work. Since sixth floor clean-up was the only task with exposure over the OEL, using more crews would mean more people could be exposed to coal dust.

Administrative Controls

Administrative controls can also be used to reduce exposure, but cannot be used in lieu of 'engineering out' the problem. First, the procedures must be in place which was addressed in previous recommendations. The important part of the housekeeping plan is to maintain cleaning. The easiest way would be to hire more employees to clean. In addition to new employees' salaries, the new employees would also need to be medically cleared to wear a respirator and have medical surveillance. These are additional costs for the new employee. Currently, three employees are responsible for cleaning the coal belt areas inside the plant. The coal belts and systems in the bulk materials area are cleaned by bulk materials crews on their off shifts. The number of double shifts leads to less workers coming in on an off shift. Cleaning either needs to be scheduled into their regular shift time or more employees need to be hired.

In addition to the cleaning schedule, the employees need to use the proper techniques when cleaning to minimize coal dust. Currently, dry sweeping is utilized to clean up coal that has fallen out of the system. Dry sweeping can cause a greater amount of coal dust due to coal disturbance. The best method to collect coal dust is by wet dust suppression, airborne dust suppression, or stabilization. The simplest way is wet dust suppression. Wet dust suppression is when the entire area is saturated to prevent the dust from becoming airborne. This can be accomplished with plain water, water with additives, or foams. Using plain water would be the cheapest control and may work suitably without using the additives (Smandych et al 1998). Using a wet dust clean-up system would need to be carefully monitored so water does not leak to electrical areas or other areas that cannot come into contact with water.

This method of washing down a surface is used before maintenance activities and appears to be effective, as per the maintenance coal dust results. For example, before the pulverizer is worked on, the labor gang will go in with hoses and hose out the area. This practice should be continued to minimize coal dust exposure.

Respiratory Protection

Although personal protective equipment should be the last line of defense against a hazard, the respiratory protection program that is in place needs to be followed at this time. The following aspects of the respiratory protection program are important to this study. Respirators shall be worn by all those individuals who were overexposed to coal dust. For this study, those workers are only those laborers who cleaned the sixth floor. It is important to note that respirators are still recommended to be worn while cleaning coal in other areas or working on coal systems.

According to the results of this study, a half-mask respirator or disposable respirator meets the minimum requirements of protection against the exposure. The assigned protection factor (APF) of these respirators is ten. Since the occupational exposure level for coal dust was 0.9 mg/m^3, the maximum use concentration (MUC) for a half-mask respirator is 9 mg/m^3. The MUC of 9 mg/m^3 means that a half-mask respirator is appropriate for any exposure values up to that limit (OSHA). For this study, the maximum concentration was 2.9 mg/m^3, so the half-mask or disposable respirator is appropriate protection (OSHA 2008).

In order for employees to wear respiratory protection, they must follow the respiratory protection program that is in place. This program has many sections including fit-testing requirements and training. Before any employee can wear a respirator, they must be cleared through a medical evaluation. Next, the employ must be fit-tested on any respirator they will need to wear during the course of the year. This fit-test will give a quantitative number, if a Porta-Count is used, that will show whether the user is getting a correct seal with that particular respirator. Following fit-testing, the user needs to be trained on "user seal checks." These must be preformed each time a respirator is donned for use to ensure the user that a proper seal is being maintained for that use.

Although the proper respirator is either a half-mask or disposable respirator, the proper filter must also be chosen. The P-100 particulate filters and P-100 particulate disposable respirators currently on site are sufficient in protecting the employee. The P stands for oil proof and the 100 means that the filters are 99.97% efficient. These filters shall be worn only once during a complete shift and disposed of after use.

Additional Sampling

In addition to these recommendations, more personal air sampling should be conducted. This sampling should focus on the tasks with high variability such as maintenance activities and clean-up crews. If a more stringent housekeeping plan is in place, it would be beneficial to sample the clean-up crews to see if their exposure would decrease due to cleaning before the coal accumulates. These samples should include some night shift crews and more observation of crews. Not all samples were conducted with strict supervision of sampling. With more supervision, a better task analysis could be made on daily duties. Finally, additional sampling should be conducted if the composition of coal type changes in the future. Since PRB coal is known to be more brittle than eastern coal, more air sampling should be conducted if the percentage of PRB coal increases.

These results help determine which group(s) should have high priority for evaluation the next time air sampling is conducted on coal dust. The two groups in which one sample exceeded 50% of the OEL should be sampled first. These two tasks are that of sixth floor clean-up (laborers) and operator rounds (B Operator). In addition, more sampling should be conducted on bulk materials clean-up crews. Although the results showed that all samples were approximately 10% below the OEL, the results do not coincide with the high exposures by other clean-up tasks. Tasks that were less than 10% of the OEL do not need to be sampled again unless the task or process changes. The other groups that should have additional sampling are barge handler, barge unloader operator, D9 operator, maintenance workers, and C operators.

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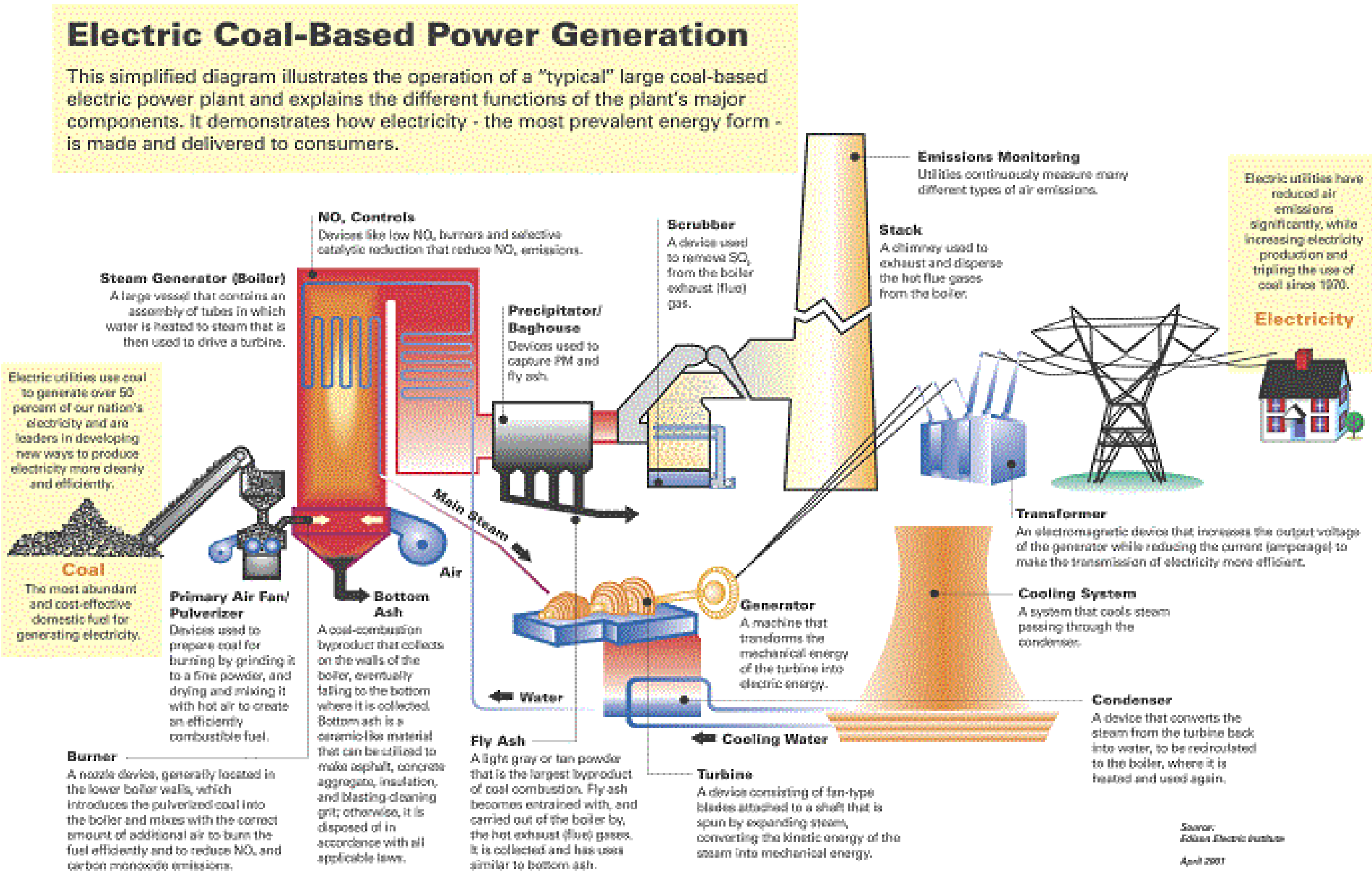
Appendix A – Electric Coal-Based Power Generation



Appendix B – Description of Equipment

MSA Escort ELF Sampling Pump

This model of sampling pump was used to collect the air samples for this study. Five pumps were calibrated daily and used during this study. The flow rate was set at 2.5 lpm to collect coal dust samples.

Sensidyne Gilian Gilibrator 2 Calibration System

The Gilian Gilibrator 2 was used to calibrate the Escort ELF sampling pumps. Each sampling pump was calibrated before and after each sample was collected. The sampling pump sensors were also calibrated every other week per manufacturer's recommendations.

Three Piece 37 mm Polyvinylchloride Cassette with SKC Aluminum Cyclone

The pre-weighed PVC cassette was used to collect coal dust. After collection, the cassette was sent to an accredited lab for gravimetric analysis. The inlet section was removed to fit the cassette onto the aluminum cyclone. The cyclone will separate the particle according to their diameter. The smaller, respirable, particle will be collected on the filter while the larger, non-respirable, particles will settle into the pot of the cyclone.

Appendix C- Example of Sampling Report Received from Corporate Office

, 29-414 REV. 2

Allegheny Energy

November 20, 2007

To: [redacted] Hatfield's Ferry

HATFIELD'S FERRY POWER STATION
MONITORING - COAL DUST
NOVEMBER 2, 2007

The following is your result of the personal air monitoring conducted for coal dust on November 2, 2007.

Sample Location: 6th Floor

Work Activity: Clean-up of coal area

Time-Weighted Average Result (Dust): **1.5** mg/m^3
Time-Weighted Average Result (Quartz): **0.047** mg/m^3

Occupational Exposure Limit (Dust): **0.90** mg/m^3
Occupational Exposure Limit (Quartz): **0.025** mg/m^3

The above results **exceed** our occupational exposure limit for respirable coal dust/quartz. The respirator worn (North 8150P100) is acceptable for up to 9.0 mg/m^3 coal dust and 0.25 mg/m^3 quartz, adequate for the concentrations experienced.

D. L. Bertig
Safety & Health

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REF: 07HT0031CS
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Appendix D – Sample Time and Flow Rate

Sample Number	Start Time	End Time	Time (minutes)	Flow Rate
A-1	0716	1411	415	2.5
A-2	0713	1419	426	2.5
A-3	0710	1405	415	2.4
A-4	0715	1412	417	2.6
B-1	0722	1411	409	2.6
B-2	0730	1438	428	2.4
B-3	0707	1421	434	2.5
B-4	0716	1428	432	2.5
C-1	0732	1418	406	2.6
C-2	0732	1413	401	2.5
C-3	1600	2048	288	2.5
C-4	1557	2049	292	2.5
D-1	0727	1438	431	2.5
D-2	0705	1427	442	2.4
E-1	0724	1410	406	2.5
E-2	0718	1415	417	2.5
E-3	0708	1405	417	2.4
E-4	0714	1416	422	2.5
F-1	0723	1410	407	2.5
F-2	0712	1420	428	2.4
F-3	0715	1412	417	2.5
F-4	0729	1432	423	2.5
G-1	0727	1411	404	2.5
G-2	0726	1438	432	2.5
G-3	0719	1413	414	2.5
G-4	0711	1422	431	2.5
H-1	0725	1435	430	2.5
H-2	0714	1429	435	2.5
H-3	0705	1417	432	2.4
H-4	0732	1412	400	2.5
I-1	0710	1505	475	2.5
I-2	0709	1505	476	2.5
I-3	0708	1325	377	2.5
I-4	0708	1005	177	2.6

I-5	0740	1245	305	2.5
I-6	0739	1243	304	2.5
J-1	0658	1456	478	2.5
J-2	0659	1450	471	2.5
J-3	0714	1448	454	2.5
J-4	0704	1501	477	2.4
J-5	0703	1502	479	2.5
J-6	0627	1351	444	2.5
J-7	0715	1410	415	2.5
J-8	0704	1430	446	2.5
K-1	0700	1406	426	2.5
K-2	0638	1402	444	2.5
K-3	0632	1400	448	2.4
K-4	0653	1402	429	2.5
K-5	0639	1411	452	2.5
K-6	0637	1408	451	2.5
L-1	0644	1408	444	2.5
L-2	0647	1349	422	2.5
L-3	0631	1357	446	2.5
L-4	0635	1400	445	2.5
L-5	0631	1408	457	2.5
L-6	0701	1412	431	2.5
M-1	0642	1408	446	2.5
M-2	0644	1402	438	2.5
M-3	0631	1402	451	2.5
M-4	0636	1408	452	2.4
M-5	0633	1401	448	2.5
M-6	0630	1409	459	2.5