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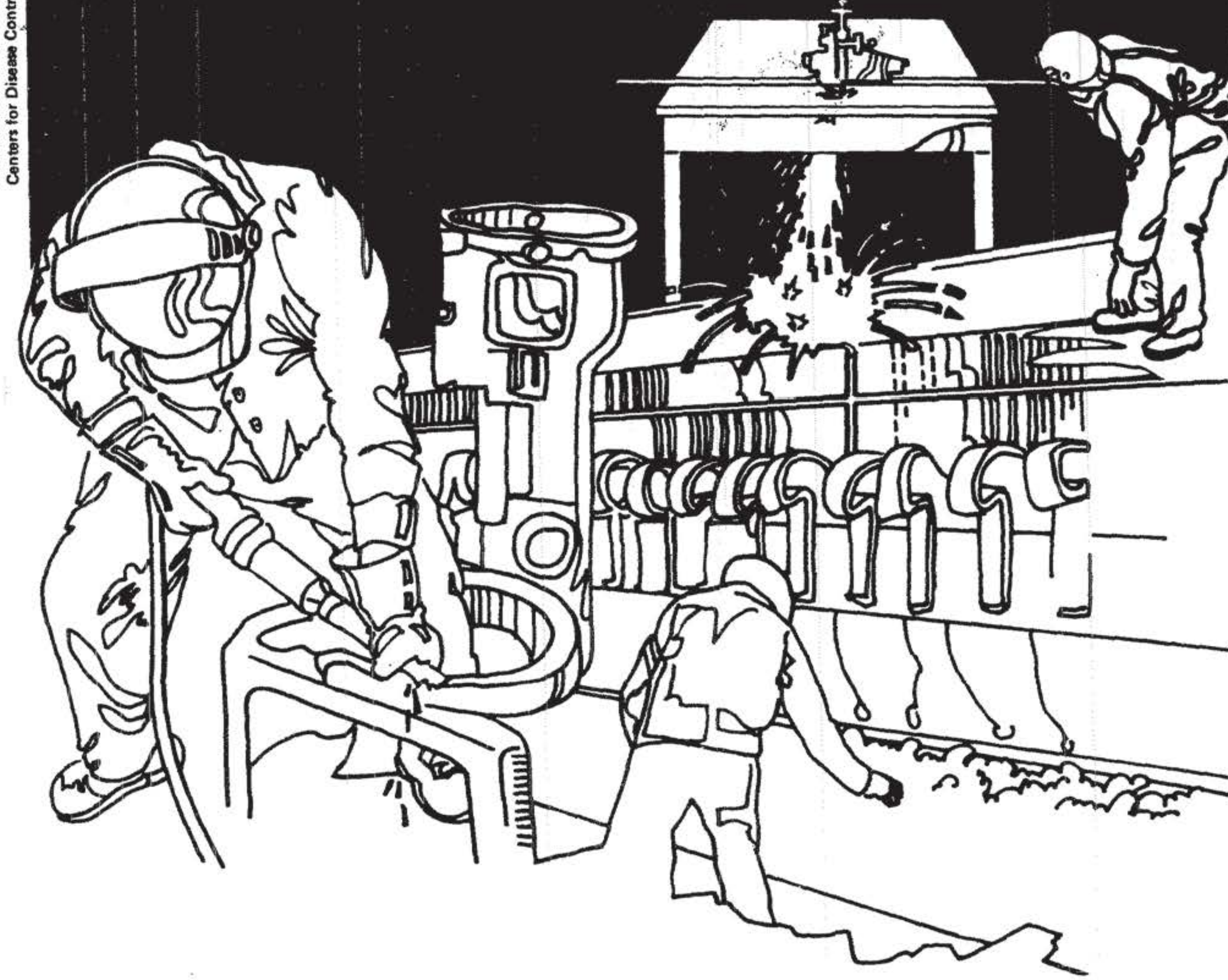

Health Hazard Evaluation Report

HETA 81-425-1124
ELECTRODYNE COMPANY
BATAVIA, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-425-1124
June 1982
Electrodyne Company
Batavia, Ohio

NIOSH Investigator:
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I. SUMMARY

In August, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the management of the Electrodyne Company in Batavia, Ohio, to evaluate employee exposure to lead, and assist in the design and evaluation of controls for reducing this exposure. Electrodyne employs approximately twenty workers in the production of a millable magnetic material from barium ferrite which contains a small amount of lead. No symptoms were reported by employees, but the Occupational Safety and Health Administration (OSHA) had measured airborne lead levels above its permissible exposure level of 50 micrograms per cubic meter (ug/cu meter) and had referred the company to the NIOSH hazard evaluation program.

At the inception of this evaluation, Electrodyne's plans for a local exhaust ventilation system were reviewed by the NIOSH project officer, and comments were made, including recommendations on minimum air velocity and static pressure drops. Airborne lead concentrations were measured on August 12, 1981, and ranged from 9 to 460 ug/cu meter. At this time there was much general but no local exhaust ventilation in the work area. Lead levels were measured again on January 12, 1982, along with total particulates, after installation of exhaust hoods at the two points considered to be the highest contaminant generation locations. During the January measurements there was no general exhaust ventilation. Airborne lead concentrations ranged from 22 to 800 ug/cu meter. During the January visit hood face velocity and duct velocity and static pressures were also measured. Also two lead and dust samples were collected during use of an unleaded ferrite in the banbury operation. Levels here were 22 and 34 ug of lead/cu meter, and 1 and 4 mg of dust/cu meter.

Measurements of lead levels during this evaluation indicated that neither general exhaust ventilation or limited local exhaust ventilation alone were sufficient to reduce exposure of employees working in the old building to below the permissible exposure level. Local exhaust ventilation was shown with limited sampling to reduce airborne concentrations of total particulate to below the recommended evaluation criteria of 10 milligrams per cubic meter (mg/cu meter). Use of unleaded ferrite was shown to reduce lead exposure to below the permissible exposure level on a short time basis. Recommendations presented in Section VIII of this report include the installation of additional local exhaust ventilation as well as implementation of some administrative controls. The continuation of an existing respirator program and biological monitoring is also recommended.

KEYWORDS: SIC 3499 lead, dust, ferrite, ventilation

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, the National Institute for Occupational Safety and Health (NIOSH) investigates the toxic effects of substances found in the workplace. A request to conduct such an investigation and assist in reducing workers exposure to lead and airborne particulate was received on August 10, 1981, from the vice-president of the Electrodyne Company, Batavia, Ohio. The company became aware that some employees were exposed to potentially toxic concentrations of lead as a result of an Occupational Safety and Health Administration (OSHA) inspection, and was referred to the NIOSH Health Hazard Evaluation program by the OSHA compliance officer. The request ask that NIOSH assist in the design and evaluation of controls for reducing employee exposure.

An initial visit was made to the plant on August 12, 1981, during which a walk-through evaluation was conducted to determine potential exposure to toxic substances, environmental measurements were made to determine airborne lead concentrations, and current and proposed control measures were discussed with management and employees. On September 15, 1981, an interim report was sent to the requester discussing the proposed ventilation system. Results of environmental samples were reported on September 29, 1981. Also during September the NIOSH project officer met with the requester to present and discuss drawings showing various options regarding local exhaust ventilation.

Subsequent to the installation of a significant portion of the proposed local exhaust system, a follow-up environmental study was conducted on January 12, 1982. Environmental measurements were made for lead and total particulate, and pressure and velocity measurements were made on the ventilation system. Results of these environmental and ventilation measurements were reported on September 29, 1981, and September 15, 1981, respectively.

III. BACKGROUND

The Electrodyne Company employs approximately twenty people in its Batavia, Ohio, plant in the production of a millable magnetic material. The product is manufactured in a batch process by physically combining small amounts of synthetic rubber with magnetizable barium ferrite. The barium ferrite powder is dumped manually from bags into a banbury mixer to which the rubber plasticizer has been added. Complete mixing of components is effected in a short time and the material is dropped into the bottom of the banbury in the form of particles of various sizes. The material is then shoveled into drums or a rotary mixer. The next production step is a fine grinding operation which reduces the size of the larger particles before they are then sent through a roller mill to produce a sheet of desired width and thickness. The final processes are a punch press operation to produce the finished product in its proper shape, and a gaussing operation to instill the desired magnetic properties. Scrap from the presses and other operations is sent through a coarse grinder and then blended with virgin material from the banbury to be reintroduced to the system.

The barium ferrite powder in use at the initiation of this evaluation contained approximately three percent lead by weight to provide specific properties, and it is the lead that is of primary interest in this evaluation. The banbury operator is the individual with the highest potential exposure, resulting from manual material handling. A second exposure group is the operators of the fine grinder and the roller mills who also handle the material prior to compacting into sheet form, and the scrap grinder operator. All of these employees (a maximum of six) transfer the blended material by shoveling from barrels into machine hoppers, and are potentially exposed to dust from this operation as well as dust created by the grinders and mills. All of these operations are located at one end of the plant, and create the possibility of cross-contamination from one operation to another.

At the inception of this evaluation the company had initiated the installation of local exhaust ventilation for the most dusty operations with the fabrication of a baghouse for particulate collection. A decision was made to collect environmental samples prior to completion of the local exhaust ventilation system, and resample when ventilation was in place. In addition to the installation of ventilation, the possibility of substitution of an unleaded material was also discussed.

IV. EVALUATION DESIGN AND METHODS

Subsequent to the receipt of this request for a health hazard evaluation in August, 1981, the NIOSH project officer contacted a representative of the Electrodyne Company to obtain information regarding materials and processes. Current and proposed protective practices were discussed, along with previous environmental and biological monitoring. In light of the proposed ventilation system, it was decided to make measurements in the plant prior to installation of any exhaust hoods or air moving devices, and repeat measurements after installation of this equipment.

Environmental measurements of lead and particulate were made using battery powered personal sampling pumps operated at 1.5 liters per minute (Lpm) for up to full shift duration. Samples for lead were collected on mixed cellulose ester filters and analyzed by atomic absorbtion spectrophotometry (P & CAM Method No. 173).[1] Airborne particulate samples were collected on preweighed polyvinyl chloride filters and the filters were subsequently reweighed to determine loading. In some cases, the particulate samples were also analyzed for lead.

Measurement of air velocity at various locations, especially at points of local exhaust ventilation, were made using smoke tubes and a thermal anemometer. Air flow measurements inside exhaust ducts were made with a standard pitot tube and an inclined manometer on a six point traverse.

V. EVALUATION CRITERIA

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once adsorbed, lead is excreted from the body very slowly. Adsorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs. These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/deciliter whole blood are considered to be normal levels which may result from daily environmental exposure. The new Occupational Safety and Health Administration (OSHA) standard for lead in air is 50 ug/M^3 calculated as an 8-hour time-weighted average for daily exposure.[2] The standard also dictates that workers with blood lead levels greater than 60 ug/deciliter must be immediately removed from further lead exposure and, in some circumstances, workers with lead levels of less than 60/ug/deciliter must also be removed. Removed workers have protection for wage, benefits, and seniority for up to 18 months until their blood levels decline to below 50 ug/deciliter and they can return to lead exposure areas.

The evaluation criteria for airborne particulate or "nuisance dust" is based on its ability to reduce workshop visability, create unplesant deposits in the ears, eyes, and nasal passages, or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous cleansing procedures necessary for its removal. A concentration of 15 mg/cu meter is recommended as a maximum occupational level.[3]

VI. RESULTS

Measurements of personal exposure to lead indicated that, on both sampling days, some employees were overexposed to that material. The banbury operator was the most highly exposed worker, having an eight hour average exposure in August of 450 ug/M^3, and an exposure during the leaded run in January of 800 ug/M^3. While the employees move from one work area to another throughout the plant, in general the exposure of employees in the old building was above the evaluation criteria of 50 ug/cu meter for lead, while the exposure of employees working in the new building was below that level. Measurements of airborne lead in the old building ranged from 35 to 800 ug/M^3; all measurements made in the new building were below 50 ug/M^3. Neither of the measurements for airborne dust (both in the old building) were above the recommended criteria. Tables I and II, attached as part of this report, show the results of lead and particulate measurements.

In addition to the samples listed in the tables, a short duration (38 minute) sample was collected in the exhaust stream of the baghouse in January. This sample indicated a lead concentration of 160 ug/cu meter in the air exhausted from the baghouse. Due to the high velocity of the air at this point, the unsteady orientation of the sampler due to the vibration of the unit, and other variables, the measurement made by this sampler is not considered to be accurate. However, it is estimated that a significant concentration, probably in excess of the 50 ug/cu meter standard, emanated from the baghouse.

During the visit in January, measurements were made to determine the static pressure and air velocity in the vertical ducts entering the baghouse, coming off of the banbury, and coming off of the fine grinder. These measurements were made within three hours after the baghouse shakedown. Face velocities, both before and after the shakedown, were measured at the hoods over the banbury loading port, and above the fine grinder hopper. Values are shown in Table III. The banbury hood slightly exceeds design recommendations, while the finegrinder hood falls slightly short of the recommended face velocity.

Duct velocity measurements are also shown in Table III. The velocities shown are averages of velocities calculated from velocity pressure measurements made in a six point traverse. Again the data shows that the banbury portion of the system meets recommended values, but the first leg (farthest from the fan) is below the recommended duct velocity.

VII. DISCUSSION

A comparison of the measurements made in January, 1982, with those made in August, 1981, indicate that lead concentrations are higher with the addition of the ventilation system. However, on closer inspection of the working conditions on those two days, this anomaly is not surprising. The January samples were taken in a tightly enclosed building (outdoor temperature ranged from 0 to 10°F on that day), and the material being processed was described by employees as containing an unusually high concentration or "virgin" material which has a smaller particle size, and therefore, would be both more likely to become initially airborne and less efficiently removed by the baghouse. The August samples were collected with all doors, including two large overhead doors, open; exhaust fans operating in the west and north walls of the plant; and a man cooling fan between the banbury and fine grinder pushing dust away from those employees. Observations of work practices indicate that a considerable portion of an employees work shift is spent at some location away from the exhaust hoods. The area sample on top of the banbury control box tends to confirm the opinion that the majority of the banbury operators exposure now occurs during the unloading of the banbury and other procedures in that general location. Prior to the installation of the hood at the loading port this had been the high exposure area. An analogous situation would be expected for the fine grinder operator.

During the afternoon when the banbury operator was running the unleaded ferrite, he still experienced a measurable lead exposure (34 ug/M^3). This, again, is not an extraordinary finding. Possible sources of lead include dust from the other operations which were still using the leaded ferrite, emissions from the baghouse, and leaded material in and around the banbury from the morning run.

A cursory examination of the environmental measurements would seem to indicate that measures taken between August, 1981, and January, 1982, to reduce airborne concentrations of lead and dust had just the opposite effect. However, when all factors are considered, that is not the proper conclusion. Steps were taken which reduced the greatest potential exposure, namely the loading of the banbury and fine grinders, and the employees are now receiving exposure from what previously had been secondary sources. Due to the lack of general ventilation from open doors and other factors mentioned above, employees during the January visit received a high dose. Along with the completion of the local exhaust ventilation system, the continuation of planning for material handling equipment for unloading the banbury and the other processes discussed is encouraged. This now appears to be the greatest potential exposure, and therefore, the point to be attacked next. In the interim, the banbury operator should continue to wear a respirator, and the periodic blood tests for lead should be continued. These blood tests should be extended to anyone spending most of his workshift in the old building, if this is not already the case.

VIII. RECOMMENDATIONS

One approach to controlling occupational exposure to potentially hazardous materials is to group control procedures into three categories: (1) personal protective equipment, (2) engineering controls, and (3) administrative controls. Aspects of each could be utilized to reduce exposure at Electrodyne.

Personal protective equipment, in this instance air purifying respirators, is the least desirable form of control, and is recommended only as an interim measure until other methods can be implemented. NIOSH-approved respirators were being used, and should continue to be used as long as respirators are needed. Other requirements for an occupational respirator program[3] which are in practice or should be implemented include: regular cleaning of respirators; storage in clean locations; and inspection for worn parts (valves, straps, etc.).

Engineering control, while usually the most expensive, is also generally the best and most effective method for controling environmental contaminants. One engineering-type control method whose effect is seen dramatically in the comparison of the two sets of sample data is general exhaust ventilation. By allowing as much general air movement through the plant as possible with open doors and windows, enhanced with the use of wall and man cooling fans, contaminant concentration can be diluted significantly.

Local exhaust ventilation, used to remove contaminant at its point of generation prior to release into the general plant environment, is another effective method of engineering control. Completion of the local exhaust ventilation system, as discussed during the January visit, is encouraged. Design recommendations based on data from the ACGIH Industrial Ventilation Manual[4] were presented in detail in a letter dated September 15, 1981, and will not be repeated here. Recommended face and duct air velocities, however, are shown in Table III of this report. The following changes are recommended as the system is completed and put into effect:

1. Extending the exhaust from the baghouse through the roof would eliminate the contamination of the work area with dust emitted from that source. In order to reduce the cost of heating make-up air during cold weather, a device to direct air either outside or back into the plant (or in some combination) could be installed. Since the January tests indicate the exhaust air contains a significant amount of lead, however, the exhaust from the baghouse should be vented to the outside when leaded material is being run.

2. The second baghouse might be best located nearer the fine grinder to service just those two (or three) machines, instead of on top of the current unit as now planned. Since an additional fan was to be procured for this expanded unit, the additional expense might be acceptable. One unit could then handle the fine grinders, and the other could handle the banbury and scrap grinder. This would increase the static pressure drop in the branches near the fine grinder and raise slightly the hood face velocities on both systems. Either unit should then have enough spare capacity if a small mill or other machine was to be added at a later date.

The installation of material handling equipment on the banbury or other machines would be another example of engineering control of environmental contaminant. These devices, especially if enclosed and/or exhausted to a baghouse, should significantly reduce employee exposure to airborne material.

The use of unleaded ferrite in the production process is shown by the January measurements to significantly reduce lead exposure. Emissions from other machines still using leaded material, in addition to residual lead from earlier batches, and exhaust from the baghouse, combined to cause measurable lead concentrations during the run of unleaded material in the banbury, but these measurements were below the permissible exposure level. Certainly the problem of lead exposure would be eliminated if it were possible to go to unleaded ferrite completely, and the limited dust measurements indicate that total particulate exposure is controlled by the local exhaust system even under the worst conditions.

The third category of control procedures, administrative control, is defined as "any adjustment of the work schedule to reduce the exposure,"[5] and should be used in conjunction with the other catagories. By rotating various employees between the old and new buildings (between exposed and unexposed jobs), any one individual's exposure would be reduced when averaged over time. Also, by alternating production between leaded and unleaded ferrite, employee's average daily (or weekly, or monthly) exposure to lead could be reduced, yet some leaded material could still be manufactured. This type of control means, however, that other workers must assume part of the toxicologic burden of the worker who had worked on the specific job in question, and that these employees should, therefore, be included in the periodic blood lead tests. It is important that the periodic blood lead tests be continued as long as workers are exposed to lead in the workplace.

Upon completion of control measures, it is recommended that another industrial hygiene evaluation be conducted. Periodic visual inspection, static pressure checks, and routine maintenance functions should become common practices with regard to local exhaust and all control equipment.

IX. REFERENCES

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5. Patty FA. Patty's industrial hygiene and toxicology. Vol III--theory and rationale of industrial hygiene practice, 3rd revised ed. New York: John Wiley & Sons, 1978.

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1. Electrodyne Company
2. NIOSH, Region V
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

AIRBORNE LEAD CONCENTRATIONS

ELECTRODYNE COMPANY
BATAVIA, OHIO
HETA 81-425

August 12, 1981

DESCRIPTION	DURATION	CONCENTRATION
Big Mill Operator	07:00-11:14	81 ug/M^3
Big Mill Operator	11:14-14:36	40
Banbury Operator	07:02-11:13	450
Banbury Operator	11:13-11:30 12:40-14:32	460
Scrap Grinder	07:05-11:12	86
Scrap Grinder	11:12-11:30 12:40-13:35	91
Slitter Operator	07:10-14:36	14
Area Sample - on table in front of punch press operator	07:11-14:36	12
Plant Superintendent	07:12-11:26 12:40-14:36	Sample invalid
Magnetizer	07:15-14:36	9
Area Sample - on sorting table in front of sorter	07:18-14:36	9
Area Sample - on table in shipping area	07:21-14:38	15
Area Sample - southeast corner of plant	07:29-14:33	44
Area Sample - approximately 15' behind banbury	07:31-14:36	35
Fine Grinder Operator	08:45-12:44	270
Fine Grinder Operator	12:44-14:38	64
Fine Grinder Operator	08:45-12:42	310
Fine Grinder Operator	12:42-13:30	220
Area Sample - breathing zone level on second column south of scrap grinder	10:26-14:36	35
Area Sample - breathing zone level on column nearest magnetizers	10:29-14:38	13

Maximum permissible exposure level 50

TABLE II

AIRBORNE LEAD AND DUST CONCENTRATIONS

ELECTRODYNE COMPANY
BATAVIA, OHIO
HETA 81-425

January 12, 1982

Location	Duration	Concentration Lead	Concentration Dust
Banbury Operator	7:02am-10:55am	800 ug/M^3	-
Banbury Operator	10:55am-11:25am 12:15pm-2:00pm	34	3.9 mg/m^3
Finegrinder Operator	7:05am-2:30pm	690	-
Scrap Grinder Operator	7:10am-11:25am 12:13pm-2:30pm	190	-
Little Mill Operator	7:15am-11:25am 12:05pm-2:30pm	490	-
Area Sample - on top of banbury control box	7:50am-11:00am 11:00am-2:30pm	91 22	- 1.1
Area Sample - between hoppers of the two finegrinders	8:02am-2:02pm	430	-
Permissible Exposure Level (8-hour time-weighted average)		50	15

TABLE III

VENTILATION DUCT MEASUREMENTS

ELECTRODYNE COMPANY
BATAVIA, OHIO
HETA 81-425

January 12, 1982

	Duct					Hood		
Location	Diameter	Measured Velocity*	Recommended Velocity	Volume	Static Pressure	Calculated Face Velocity	Measured Face Velocity	Recommended Face Velocity
Verticle Duct Entering Bag House	8"	3,500 fpm**	3,500 fpm	1,200 cfm***	2.3 in H_2O	-	-	-
Verticle Duct Coming Off Of Banbury Hood	6"	3,500 fpm	3,500 fpm	690 cfm	1.4 in H_2O	335 fpm	360 fpm	300 fpm
Verticle Duct Coming off of Fine Grinder Closest to Door - Grinder Not Running	6"	1,860 fpm	3,500 fpm	365 cfm	0.14 in H_2O	250	210	300
Same as Above But Grinder Running	6"	1,820 fpm	3,500 fpm	360 cfm	0.14 in H_2O	245	-	300

* All measures taken within 3 hours after shakeout of baghouse
** Feet per minute
*** Cubic feet per minute