IN-DEPTH SURVEY REPORT

WEIGHING AND BATCHING

AT

BF GOODRICH COMPANY
AKRON, OHIO

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
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PLANT SURVEYED:	BF Goodrich Industrial Rubber Products Division Akron, Ohio
SIC CODE.	30 Industrial Rubber Products
SURVEY DATE:	October 15-18, 1984
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I. INTRODUCTION

Background for Control Technology Studies

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency engaged in occupational safety and health research. Located in the Department of Health and Human Services (formerly DHEW), it was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions carried out by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects of health hazard prevention and control.

Since 1976, ECTB has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. Examples of these completed studies include the foundry industry; various chemical manufacturing or processing operations; spray painting; and the recirculation of exhaust air. The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for or availability of an effective system of hazard control measures.

These studies involve a number of steps or phases. Initially, a series of walk-through surveys are conducted to select plants or processes with effective and potentially transferable control concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities builds the data base of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

Background for This Study

This study was conducted to evaluate sources of worker dust exposure during the weigh-out and transfer of powdered materials from bags or bins to smaller containers. The ventilation used to control dust generated by this operation appears to contain the dust within the hoods. However, these operations always involve some elevation of the worker's dust exposure.[1] The purpose of this study is to determine why ventilation systems for weighing and transfer of powders provide incomplete dust control.

Background for This Survey

This survey was conducted to evaluate dust control at weigh-out and transfer operations. The survey was conducted to determine whether the elevation of the workers exposure occurred because of activities at the weigh-out booth or because other activities associated with this task are elevating the workers' dust exposures.

II. PLANT AND PROCESS DESCRIPTION

This plant is part of BF Goodrich's Industrial Rubber Products Division. This plant is over 50 years old and employs about 1500 workers. The processing area of the plant employs 200 workers who make master batch rubber for use in other operations.

The subjects of this survey are two ventilated booths which are used to control dust generated by the weigh-out and transfer of powdered materials. These powders are assembled into batch lots which are charged into mixing equipment elsewhere in the plant.

Process Description

One of these ventilated booths is called the Ten Cubic Foot Booth and it is used to fill the bin of a Gemco blender. This bin has a ten cubic foot capacity. The Ten Cubic Foot Booth, the Gemco blender bin, and the area around the booth are shown in Figures 1-3. The workers at this booth transport pallet loads of bagged powders to the area around the booth. For each batch, the worker stacks bags of materials on the conveyor belt in front of the booth. Using a recipe, he empties bags of materials into the bin. These bags are simply slit open and the material flows out of the bag and into the bin. The empty bags are placed in a pneumatic conveying system which transports the empty bags to a disposal system. Because the recipes specify precise mass of material, some bags are partially emptied and returned to the pallet. To get the final mass, material is transferred back-and-forth between the bag and the bin.

After the bin is filled, the worker moves the bin to the Gemco blender. He attaches the bin (which is the bottom half of the blending chamber) to the top half of the blending chamber. After blending, the worker sets the blender on top of the mechanism for feeding the powder into a bag filling machine.

The second booth which was studied is pictured in Figure 4 and it is called the South Stationary Booth. At this booth, the worker transfers precise masses of powders from bins or bags to smaller paper and plastic bags. To obtain precise masses, material is slowly added to the smaller bag from a scoop. If material has to be removed from the smaller bag, the worker used his bare hand to transfer material from the bag to the scoop. The filled paper bags are set on a cart behind the booth. (Figure 5)

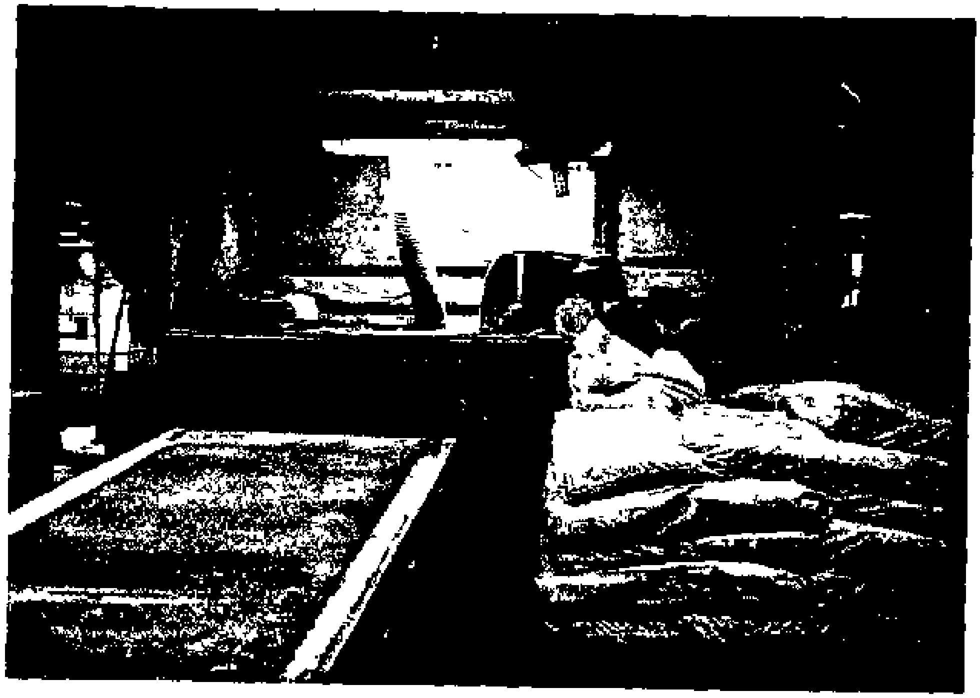

Figure 1. Ten Cubic Foot Booth for filling Gemco blender bins with batch ingredients.

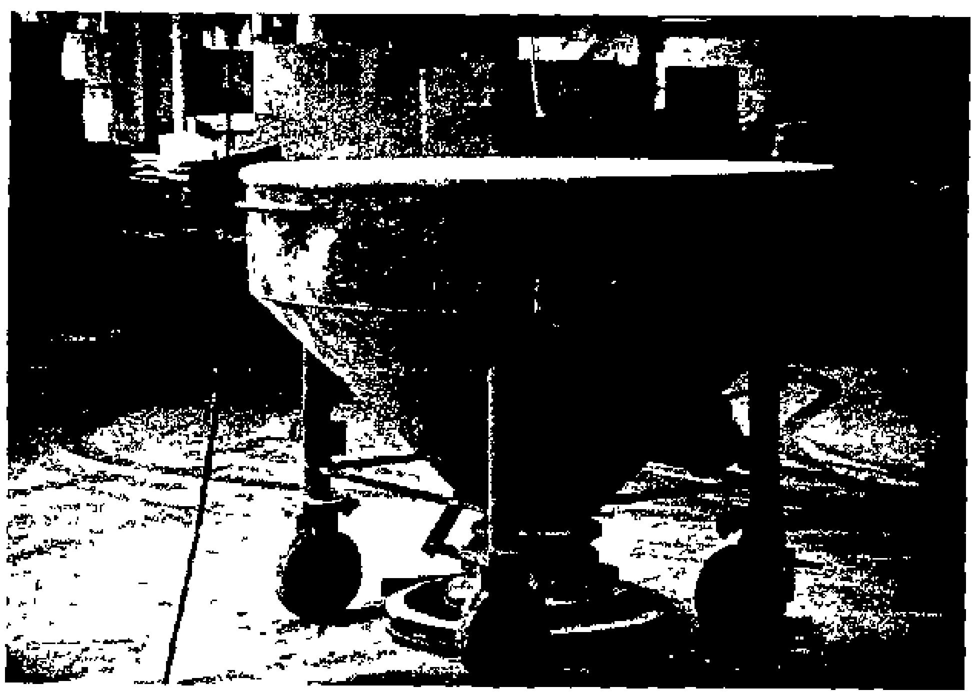

Figure 2. Picture of Gemco blender bin which is discharging powder into a bag filling machine. The bin fits under the work surface in Figure 1.

Figure 3. Picture of area around Ten Cubic Foot Booth.

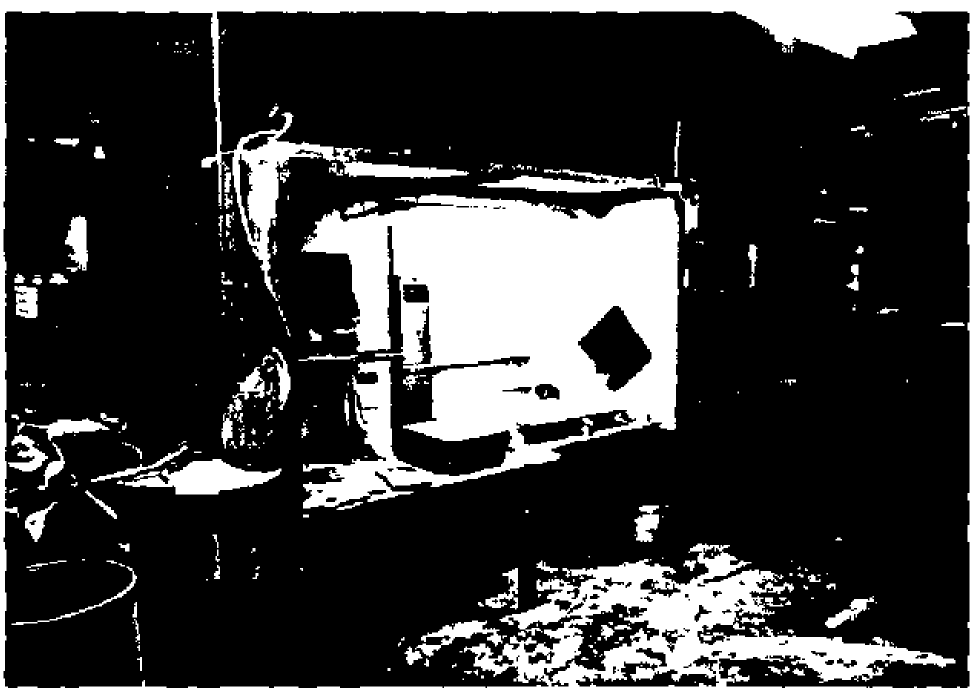

Figure 4. Picture of South Stationary Booth.

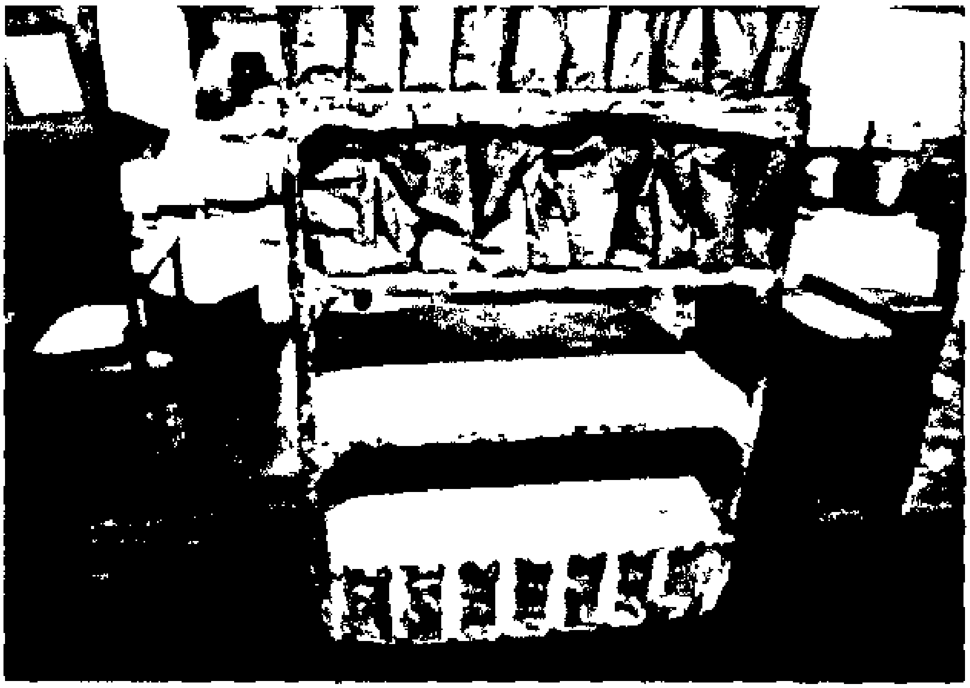

Figure 5. Photograph of cart for transporting bags of powder.

Dust Exposure Sources

This survey was done to evaluate sources of worker dust exposures. The relevant standards for the dust exposures are presented below in Table 1.

Table 1. Summary of Exposure Limits.

Substance	OSHA PEL mg/m	ACGIH TLV mg/m
Nuisance Dust-Total	15	10
Respirable	5	5

At both booths, weighing and transfer activities by the worker created dust exposures which occur in the worker's breathing zone. Additionally, some process equipment in this area was an emission source. The survey's purpose is to establish which of these emission sources is elevating the worker's dust exposure. Specific emission sources are listed below:

At the Ten Cubic Foot Booth

1. Opening, emptying and discarding empty bags. This task creates dust which appears to be controlled by the hoods.

2. Workers placing upper half of body into the hood (Figure 6). This occurs because the bins for the Gemco blenders are over 4 feet in diameter and the worker must empty some bags at the back of the bin. During this activity, dust puffs into their breathing zone.

3. Handling Dusty Bags. The workers must carry these bags from the pallet or conveyor to the booth. The bags appear to be dusty and handling these bags soils the worker's clothing. Contaminated clothing is reported elsewhere to be a source of worker exposure to particulate.[2,3] These bags are 3-ply Kraft bags which leak material from the seams and from small perforations which allow for deaeration of the powder during bag filling. At this operation, partially emptied bags are stored on top of the pallets. These bags spill dust which contaminates the exterior surfaces of the other bags on the pallet.

4. Delumping bags. The powder in the bags can form lumps. These lumps are broken by slamming the bags onto the surface of the bin. This creates a puff of dust which escapes the hood.

5. Discharging the hoppers. The ten cubic foot bins are discharged into another piece of process equipment used for filling small bags. During discharge, the bin empties from the center and a "rat-hole" or "funnel" forms. As the bins empty, powder falls from the side of the funnel and creates a dust cloud.

6. Scraping the sides of the ten cubic foot bins. When these bins are nearly empty, the workers use a tool resembling a hoe to scrape material from the walls of the bin. This creates an obvious dust cloud.

South Stationary Booth

1. Transferring materials from bags or bins to small paper bags. This creates obvious dust emissions which the booth's local exhaust ventilation appears to control.

2. Dusty clothing. The workers handle dusty bags and materials, and this soils their clothes. Soiled clothing can be a dust exposure source.

3. Spillage and resuspended dust. Powdered material is spilled at this booth. The spilled powder can be resuspended by activities at the work station.

4. Head in booth. The worker places his head into the booth during weigh-out operations. When he is scooping material from portable bins, the worker's breathing zone sometimes appears to be between the exposure source and the local exhaust ventilation.

5. Setting filled bags outside of the enclosure. These bags were observed to be emitting dust which flows past the worker and into the hood.

Figure 6. Photograph of man working at booth. Notice how he places the upper half of his body into the booth.

Control Measures

Occupational exposures can be controlled by the application of a number of well-known principles, including engineering measures, work practices, personal protection, and monitoring. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occupational exposure to individuals Controls applied at the source of the hazard, including engineering measures (material substitution, process/equipment modification, isolation or automation, local ventilation) and work practices, are generally the preferred and most effective means of control both in terms of occupational and environmental concerns. Controls which may be applied to hazards that have escaped into the workplace environment include dilution ventilation, dust suppression, and housekeeping. Control measures may also be applied near individual workers, including the use of remote control rooms, isolation booths, supplied-air cabs, work practices, and personal protective equipment.

In general, a system comprised of the above control measures is required to provide worker protection under normal operating conditions as well as under conditions of process upset, failure and/or maintenance. Process and workplace monitoring devices, personal exposure monitoring, and medical monitoring are important mechanisms for providing feedback concerning effectiveness of the controls in use. Ongoing monitoring and maintenance of controls to insure proper use and operating conditions, and the education and commitment of both workers and management to occupational health are also important ingredients of a complete, effective, and durable control system.

These principles of control apply to all situations, but their optimum application varies from case-to-case. The application of these principles is discussed below.

Control Measures

The ventilated booths are intended to capture whatever dusts are generated by the weigh-out and transfer activities. The air flow into these booths is 100-200 fpm and this is intended to isolate the worker from dust generated by transferring the powders from one container to another. Locating the pick-up for the bag disposal system inside the hood avoids worker exposure to dusts generated by handling the empty bags outside of the hood. A central vacuum system was available for use in cleaning the floor. Regular clean up of the spills can minimize the resuspension of settled dust. At the Ten Cubic Foot Booth, the workers wore 3M 8710 disposable respirators.

III. SURVEY METHODOLOGY

This survey was conducted to evaluate sources of worker dust exposure during the manual weigh-out and transfer of powders. Ventilation measurements were made to document hood performance. Air sampling was conducted to evaluate sources of worker dust exposure. The equipment used to conduct this study is listed in Table 2.

Table 2. Equipment List

Item	Use
DuPont P4000 pumps	Dust sampling
GCA Real-Time Aerosol Monitors-1 (RAM)	Respirable dust monitoring at fixed locations.
GCA mini RAMs	Respirable dust monitoring on a worker.
Metrosonics Metrologger 331	Record analog output of mini - RAMs
Apple II plus computer equipped with:	Record the analog output of RAMs and the output of event marking switches.
o - dual disk drives	
o - AI 13 Card (Interactive structures)	Analog to digital conversion
o - The Clock Card (Mountain computer)	Internal clock for computer.
KURZ Digital Velometer	Record Face Velocities.

Ventilation Measurements

Face velocity measurements for the South Statonary Booth and the Ten Cubic Foot Booth are presented in Table 3. These booths function well and appear to capture whatever dust is generated within the booth.

Table 3. Ventilation Measurements and Observations

Measurement	South Stationary Booth	Ten Cubic Foot Booth
Face Velocity (fpm)		
average	128	158
range	100 - 160	100 - 200
Face Area	13 ft^2	31 ft^2
Estimated Volume	4000 CFM	5000 CFM
Observation	Dust stays in hood	Almost all dust stays in hood

Total Dust Concentrations

At the South Stationary Booth and at the Ten Cubic Foot Booth for the Gemco Blender bin, dust concentrations were measured to resolve a number of issues.

These issues are:

1. Is the worker's environment acceptable?

2. Do weighing and transfer activities conducted at these booths elevate the worker's dust exposure.

3. At the Ten Cubic Foot Booth for the Gemco blender, do the activities associated with the operation of the Gemco Blender elevate the worker's dust exposure?

To answer these questions, air samples were collected at the locations described in Figures 7 and 8 and Tables 4 and 5. The first question was answered by comparing the worker's dust exposure to the exposure limits listed in Table 1. At both booths, the second question can be answered by comparing the worker's dust exposure measure while he is actually working at this booth to the background dust concentration. If there is a significant difference between these two concentrations, then the worker's job is elevating his dust exposure.

Leakage of dusty air from the hood's face could elevate the worker's dust exposure. To evaluate this possibility, air samples were collected at the hood's face, just above the worker's head. These Locations are location numbers 3 and 4 in Table 4 and location numbers 7 and 8 in Table 5.

Table 4. Air Sampling Locations for Ten Cubic Foot Booth

Location Number	Location Description	Comment
1	I-beam in front of hood	Background dust concentration
2	worker	
3	Above bag-disposal take-off	About 1 foot below top of hood at the face.
4	Next to scale readout	About 1 foot from the top of the worker's head.

Table 5. Air Sampling Locations at the South Stationary Booth.

Location Number	Location Description	Comment
5	Post near booth	Background
6	worker	
7	Over scale at booth face	At a height near worker's head
8	Over partially filled bags at booth face	At a height near worker's face

The worker at the Ten Cubic Foot Booth is responsible for operating the Gemco Blender and charging the contents of the ten cubic foot bin into the bag filling apparatus. These activities could elevate the worker's dust exposure. Therefore, a set of air samples were taken at the location in Table 4 when the worker was operating the Gemco Blender and moving bins to the Gemco Blender. This sampling was done when the workers were between batches.

The dust concentrations were measured to compare background dust concentrations (C_b) to dust concentrations measured on the worker (C_w) and at the hoods face (C_h). To answer questions 2 and 3, the concentration data is statistically analyzed to choose between the following null (H_o) and alternative hypothesis (H_a):

$$H_o: \quad C_b = C_w = C_h$$

$$H_a: \quad C_b \neq C_w \text{ or } C_b \neq C_h$$

The air samples were taken by drawing air at a known flow rate (between 3.2 and 3.8 LPM) through preweighed, filters mounted in 37 mm polystrene filter holders. The end caps were removed and 4 mm inlet was used for sampling. DuPont P4000 pumps were used to draw air through the preweighed filters. At the South Stationary Booth, these samples were turned off and capped when the worker left for breaks and lunch. At the Ten Cubic Foot Booth, two sets of samples were taken. One set was taken while the worker was at the booth and another set was taken when the worker was doing other duties in the area. This necessitated changing the filters on the pumps and recording start and stop times. The inlet and outlet of the filter holder was capped each time it was removed from the sampling line.

Figure 7. Photograph indicating sampling location at Ten Cubic Foot Booth.

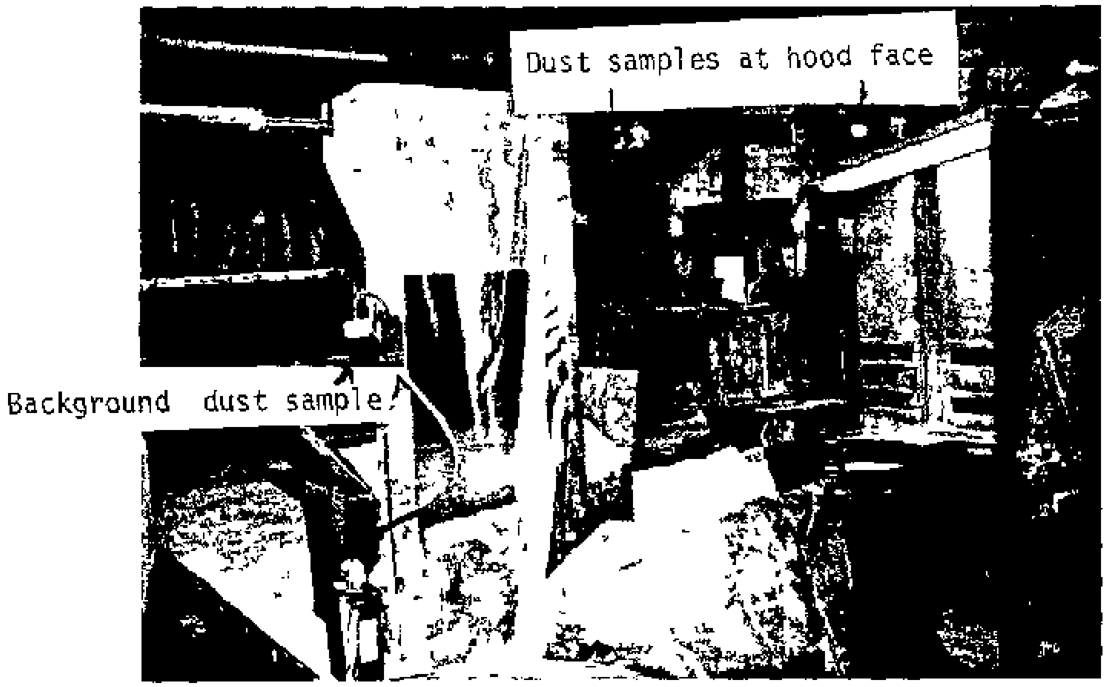

Figure 8. Sampling locations at the South Stationary Booth

Respirable Dust Monitoring

At both booths, the respirable dust concentrations were monitored with GCA RAMs and a mini-RAM. Tables 6 and 7 lists the sampling locations at both booths. The workers dust exposure was monitored for a 10-15 minute period with the GCA mini-RAM. Its analog output was recorded with a Metrologger. At 1 second intervals the Metrologger recorded the analog output of the mini-RAMS. The replaceable precision resistor was replaced with a 1.4 million ohm resistor. This resulted in an input voltage range of 0 - 1.5 volts.

At the same time the worker's dust exposure was recorded with a GCA mini-RAM, the RAM's were used to monitor respirable dust concentrations at several locations listed in Tables 6 and 7. The RAMs were used with a range setting of 0-20 mg/m^3 and a time constant of 2 seconds. The analog output of the RAMs was connected by two wire cables to the input of the AI-13's multiplexer. A one-microfarad capacitor was parallel to each set of leads. This is done to attenuate signal voltages with a frequency greater than 7 Hz.[8] The Apple computer records the time and the voltages of the instruments and indicator switches. These switches were used to note the location of the worker and the metrologger's status, (on or off).

The analog output of the RAMs and mini-RAMs is proportional to the amount of light scattered by the aerosol. Light scattering is a complex function of the aerosol's particle size, composition, refractive index and other factors.[6] Therefore, the results from these devices should be considered relative; they tell when concentrations might be changing. However, the magnitude of the concentration should be interpreted with caution.

Table 6. RAM Sampling Locations at Ten Cubic Foot Booth

Location	Comments
Outside booth, next to bag disposal chute.	Background dust
Near bag disposal tube.	This location is on the booth's work surface. It is about 20 cm inside the hood face. Increased dust concentrations here could be caused by bag disposal.
Under scale readout	On the work surface under the scale readouts, partially emptied bags were stored. The inlet of the RAM was about 20 cm inside of the hood's face. This is an area where dust may be generated.
Background	The RAM was mounted on the monitor for the computer some 10-15 ft. away from the work station.

Table 7. RAM Locations at the South Stationary Booth

RAM Sampling Locations	Comments
Beside booth	Background dust.
Above scale	One RAM was set on top of the booth, above the scale used to weigh powder. This RAM responded to background dust concentration.
Next to scale	A RAM was set next to the scale in the weigh-out booth.

IV. DUST CONCENTRATION MEASUREMENTS AND DISCUSSION

Dust concentration measurements are summarized in Tables 8 and 9 and presented in Appendix I. After log transforming the data, analysis of variance (anova) was conducted separately for the concentration measured at the Ten Cubic Foot Booth when the worker was at the booth, at the Ten Cubic Foot Booth when the worker was performing tasks related to the operation of the Gemco blender, and at the South Stationary booth. For all three data sets, the anova evaluated whether location or specific shift affected concentration. For all three data sets, location significantly affected concentration at a level of confidence greater than 99%. The specific shift during which the concentrations were measured had no affect upon concentration at the Ten Cubic Foot Booth. The Waller-Duncan multiple range test was used to examine the effect of sampling location upon total dust concentration. The General Linear Models Procedure of SAS was used to perform the ANOVA test and multiple comparison tests which are conducted at an overall level of confidence of 95%.[7]

Table 6. Summary of Total Dust Concentrations Measured at the Ten Cubic Foot Booth

Location	Working at Booth			Working on Blender		
	Geometric Mean (mg/m^3)	N	Grouping	Geometric Mean (mg/m^3)	N	Grouping
Worker	4.6	5	A	4.0	4	A
Hood face, near scale	0.2	5	B	0.3	4	B
Hood face, above bag disposal	0.3	5	B	0.3	4	B
Background	0.3	5	B	0.3	4	B

N - number of samples

Grouping - Geometric Means with different letters differ significantly, the grouping is based upon the Waller-Duncan K-Ratio test.

Table 7 summarizes the total dust concentrations measured at the South Stationary Booth. During the day shift of October 18, the worker used a different weighing station for a 15-minute period. This weighing station was mobile and provided very poor dust control. As a result, Table 7 summarizes the data in two ways; with and without the data from the first shift of 10/18. In both analyses the worker's dust exposure is significantly higher than the other sampling results. Excluding the data from the first shift of October 18 from the analysis is appropriate because of the poor dust control at the mobile weighing station. When the data for the first shift of October 18 is excluded from the analysis, there is a reduction in the mean square error and the specific shift was found to affect concentration. This data is presented in Table 8. These is no apparent reason for the differences among the shifts.

Table 7. Summary of Total Dust Concentrations Measured at the South Stationary Booth

Sampling Location	Dust Concentrations[a]			Dust Concentrations[b]		
	Geometric Mean mg/m^3	N	Grouping[c]	Geometric Mean mg/m^3	N	Grouping
Worker	1.8	5	A	1.3	4	A
Over scale, at booths face	0.3	5	B	0.4	4	B
Over partially filled bags at hood's face	0.3	5	B	0.3	4	B
Background	0.4	5	B	0 4	4	B

a - Including the data of 10/18 1st shift
b - Excluding the data of 10/18 1st shift
c - Grouping - Geometric Mean with different letters differ significantly based upon the Waller-Duncan Multiple Range Test.

Table 8. Total Dust Concentrations During Specific Shifts at South Stationary Booth

Specific Shift	Total Dust Concentrations		Grouping
	Geometric Mean mg/m^3	N	
10/16 - evening	0.9	4	A
10/18 - evening	0.5	4	B
10/17 - evening	0.4	4	B
10/17 - day	0.4	4	B

Note. Means with same letter are not significantly different.

Figure 9 and 10 present the RAM and mini-RAM data collected at the Ten Cubic Foot Booth. These concentrations were recorded while the worker was putting material into a bin and transporting material to the workplace. During these activities discreet puffs of dust were observed in the worker's breathing zone and this probably explains the peak dust exposures noted in Figure 9. However, the largest peak occurred when the worker was transporting material to the workstation. The RAM's readings, presented in Figure 10, show peak dust concentrations measured near the bag disposal take-off. As shown in Figure 11, this RAM is essentially under the bag disposal inlet and the dust peaks are probably the result of handling empty bags. This result simply illustrates that bag disposal is properly part of good hood design. Possibly mechanical motion within the hood could force this dusty air out of the hood. There is a slight increase in the background respirable dust concentrations from 0.1 to 0.3 - 0.4 mg/m^3 after the big dust peaks were noted near the bag disposal. Such increases in dust concentrations could have been caused by handling dusty bags outside of the enclosure and resuspended dust from the floor as well as dust leakage from the hood.

Figures 12 and 13 present the mini-RAM and RAM respirable dust concentrations at the South Stationary Booth. Between the times of 0 and 750 seconds the worker transferred material from a 50 pound bag to small sacks. During this activity, the worker's respirable dust exposure appears to be below 2 mg/m^3. During this time period, the RAMs measured relatively low respirable dust concentrations which are generally below 0.2 mg/m^3. Between 900 and 1600 seconds, the worker used the mobile weighing station which was mounted on an overhead trolley.

Weighing at this station caused increased dust concentrations which involved peaks of over 40 mg/m^3. This suggests an average respirable dust exposure of 15-20 mg/m^3 during this period. The worker was in an obvious dust cloud. This suggests that the ventilation was not functioning.

Discussion

At both booths, the air sampling data shows that the worker's dust exposure is elevated above background dust concentrations. Most of the dust generated within the hood appears to be captured by the hoods ventilation. Dust generated by spilling powder and slamming lumpy bags of powder onto the work surface generates dust which appears to escape the hood. These activities create puffs of dust which appear to flow into the worker's breathing zone.

At these booths, the workers place the upper half of their body into the booth. Because the air in the booth can be contaminated with dust, this can increase worker dust exposure. Unfortunately, job demands require the worker to place his head in the booth. For example, if a worker is scooping from the bottom of a portable hopper, he will inevitably place his breathing zone between the point of dust generation and the exhaust slots. When a worker is emptying bags near the back of the Ten Cubic Foot Booth, he will hold the bag close to his chest while emptying the bag. This could place the worker's breathing zone close to the point of dust generation.

The bags of powdered material at this plant appear to be dusty. These bags are dusty because of spillage from partially emptied bags and from the seams and perforations in the filled bags. Handling these bags creates small puffs of dust in the worker's breathing zone and soils the worker's clothing. Soiled clothing has been implicated as a dust exposure source in other studies. Perhaps this explains the bulk of the worker's dust exposure. In Table 6, there is little difference in the worker's geometric mean dust exposure during the two periods. Dust generation from soiled clothing could cause both exposures to be similar. This statement is speculative because duties during both periods involve other sources of worker dust exposure.

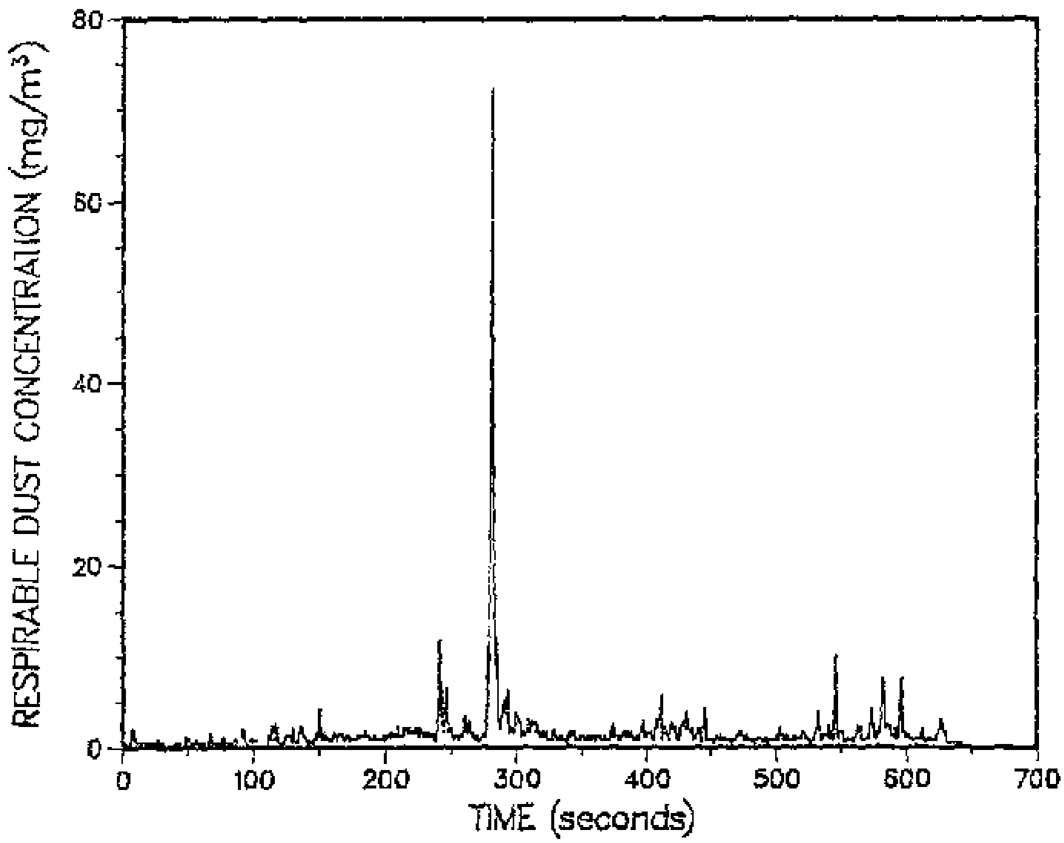

Figure 9. Respirable Dust Concentration Measured by Mini-RAM at the Ten Cubic Foot Booth on October 17, 1985 at 16:50.

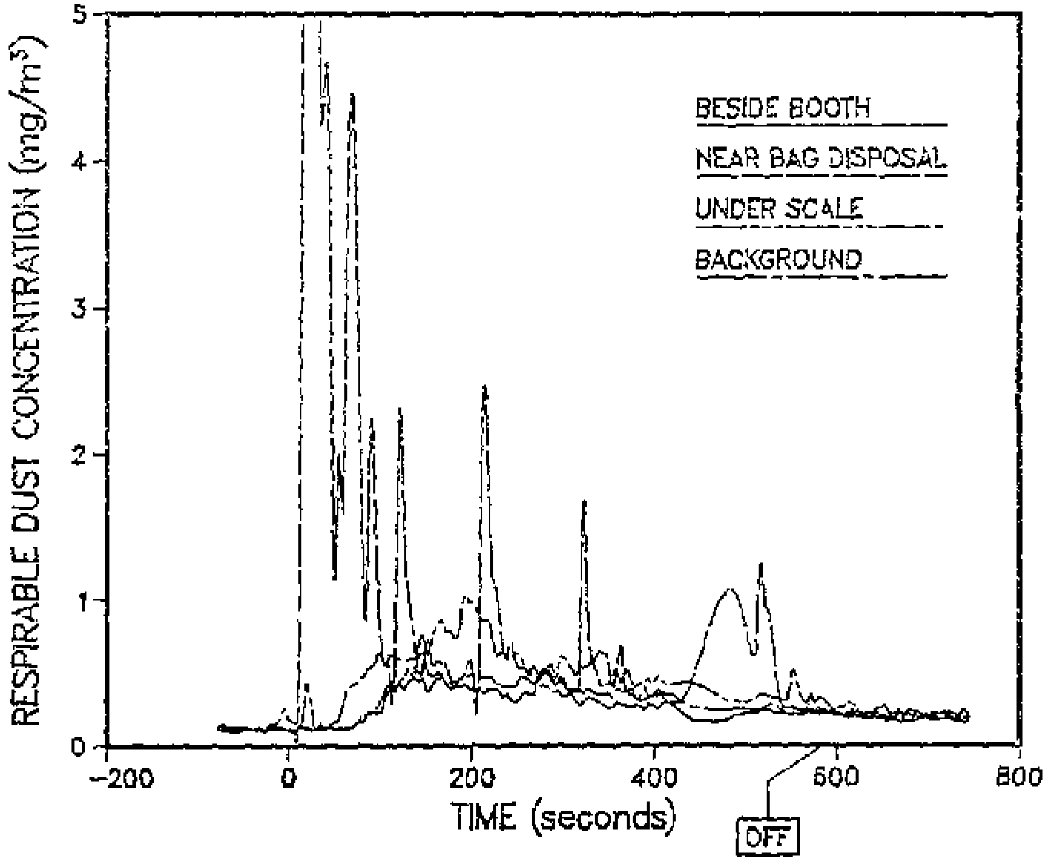

Figure 10. Respirable Dust Concentrations Measured at the Ten Cubic Foot Booth on October 17, 1984 at 16:50.

Figure 11. Photograph of work station and RAMs

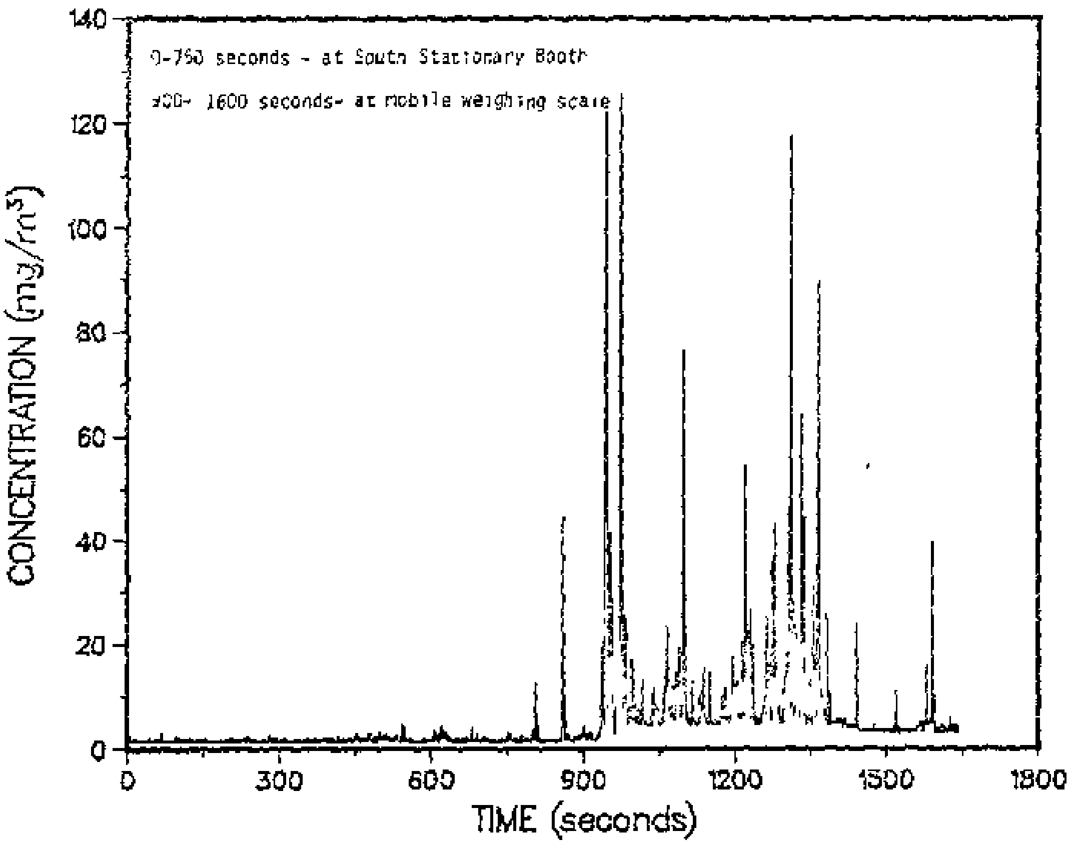

Figure 12. Respirable Dust Concentrations Measured by Mini-RAM at South Stationary Booth Measured at 12:05 on October 18, 1984.

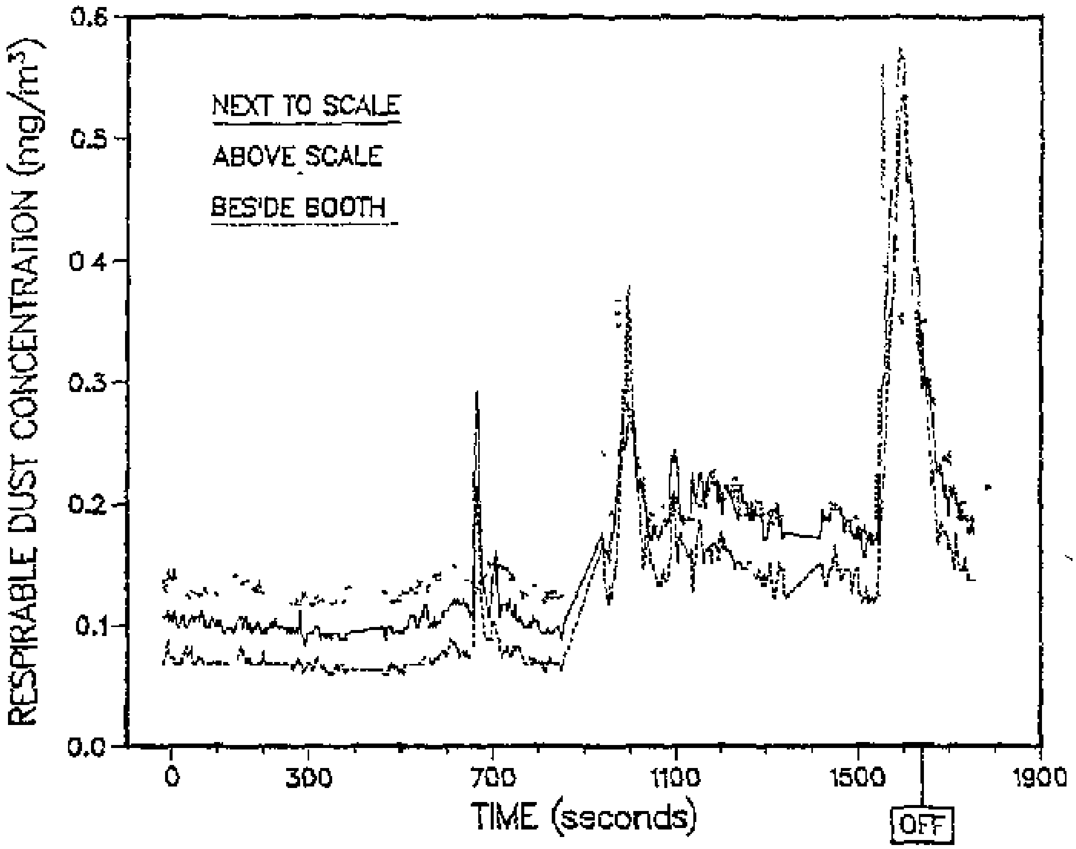

Figure 13. Respirable Dust Concentrations Measured by Mini-RAM at South Stationary Booth at 12:05 on October 18, 1984.

V. CONCLUSIONS

Both the South Stationary Booth and the Ten Cubic Foot Booth control much of the dust generated by weigh-out and transfer operations. The dust exposures are below relevant OSHA PEL's. However, the worker's dust exposures were elevated above background dust concentrations and, as a result, dust control for these weigh-out operations is concluded to be incomplete. Improving or changing the booth's design or ventilation rates probably will not reduce worker dust exposure. Reducing the amount of dust on the bag's exterior surface, keeping the worker's clothing clean, and minimizing the spillage of powdered materials could possibly reduce worker dust exposure.

The survey's purpose was to identify sources of worker exposure associated with weigh-out and transfer of powdered materials. Based upon observation, dirty clothing, dusty bags, spillage of powders, and the workers' need to insert the upper half of his body into the hood could cause the elevation of the worker's exposure above background total dust exposure. Quantitatively evaluating the significance of these exposure sources would require a designed experiment.

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APPENDIX I

Total Dust Concentration Data

Total Dust Concentrations at Ten Cubic Foot Booth

Concentrations (mg/m^3) at booth	at blender	Sampling Locations	Date and Shift
0.67	0.37	I-beam in front of hood	10/16/84, evening shift
0.38	0.16	I-beam in front of hood	10/17/84, day shift
0.41	.	I-beam in front of hood	10/17/84, evening shift
0.14	0.33	I-beam in front of hood	10/18/84, day shift
0.33	0.3	I-beam in front of hood	10/18/84, evening shift
1 4	1.6	worker	10/16/84, evening shift
15.9	15.9	worker	10/17/84, day shift
1.3	.	worker	10/17/84, evening shift
5.6	3.9	worker	10/18/84, day shift
13.8	2.6	worker	10/18/84, evening shift
0.23	0.19	above bag-disposal take-off	10/16/84, evening shift
0.33	.3	above bag-disposal take-off	10/17/84, day shift
0.4	.	above bag-disposal take-off	10/17/84, evening shift
0.76	0.28	above bag disposal take-off	10/18/84, day shift
0.13	0.2	above bag disposal take-off	10/18/84, evening shift
0.24	0.13	next to scale read-out	10/16/84, evening shift
0.19	1.5	next to scale read-out	10/17/84, day shift
0.16	.	next to scale read-out	10/17/84, evening shift
0.24	0.19	next to scale read-out	10/18/84, day shift
0.2	0.23	next to scale read-out	10/18/84, evening shift

Total Dust Concentrations, South Stationary Booth

Concen-tration (mg/m^3)	Sampling Location	Date and Shift
0.9	post near booth	10/16/84, evening shift
0 3	post near booth	10/17/84, day shift
0.3	post near booth	10/17/84, evening shift
0 3	post near booth	10/18/84, day shift
0.4	post near booth	10/18/84, evening shift
2.08	worker	10/16/84, evening shift
0.82	worker	10/17/84, day shift
1.13	worker	10/17/84, evening shift
7.1	worker	10/18/84, day shift
1.6	worker	10/18/84, evening shift
0.54	over scale, booth face	10/16/84, evening shift
0.3	over scale, booth face	10/17/84, day shift
0.35	over scale, booth face	10/17/84, evening shift
0.2	over scale, booth face	10/18/84, day shift
0.4	over scale, booth face	10/18/84, evening shift
0.57	over partially filled bags, booth face	10/16/84, evening shift
0.29	over partially filled bags, booth face	10/17/84, day shift
0.31	over partially filled bags, booth face	10/17/84, evening shift
0.25	over partially filled bags, booth face	10/18/84, day shift
0.25	over partially filled bags, booth face	10/18/84, evening shift