

IN-DEPTH SURVEY REPORT:
CONTROL TECHNOLOGY FOR SOLIDS MATERIAL HANDLING

AT

GENERAL MOTORS CORPORATION
INLAND DIVISION
VANDALIA OHIO

REPORT WRITTEN BY:

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PLANT SURVEYED: General Motors Corporation, Inland Division, Vandalia Ohio

SIC CODE: 3714 Motor Vehicle Parts and Accessories

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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 complete 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 Project

This plant was visited as part of a study of dust control during bag opening, dumping, and disposal. Significant dust exposures can occur during these operations. Although dust can be controlled during bag opening and dumping, bag disposal is a significant source of worker dust exposure. Ultimately this project will result in a concise 10-15 page report describing dust control techniques during bag opening, emptying, and disposal. This report should provide valuable information for those who are responsible for controlling workers' dust exposure.

Background for this Survey

The purpose of this survey is to evaluate the control of airborne asbestos generated by bag opening, emptying, and disposal. To open bags which contain bales of pressure packed asbestos, Inland Division has obtained a machine which opens and empties these bags in an enclosure. The empty bags are fed into a ventilated trash hopper. Observation of these machines during a walk-through survey suggested that the bag opening machines do their tasks without elevating asbestos concentrations in this plant. Data collected during this survey was used to quantitatively evaluate this observation.

PLANT AND PROCESS DESCRIPTION

Plant Description

The plant is over 20 years old and typically employs 1,800 people. This plant is part of General Motors' Mechanical Components Group. One of the major components manufactured at this plant are brake shoes and asbestos is their primary ingredient.

The area where bags of asbestos are opened, emptied, and discarded is the subject of this study. These operations are carried out in a room with concrete floors which is separate from the rest of the plant. The bag opening machines are located on a mezzanine and have metal plates under them. The remainder of the mezzanine's floor is a metal grate. One full-time operator and two workers are employed in this part of the plant. The operator runs the equipment and the two workers clean the asbestos from the floors and equipment.

Process Description

At this plant, three bag opening machines are part of an unspecified process to manufacture brake linings. Each bag opening machine is used to feed asbestos into a mixer which is located below the bag opening machine. Figure 1 schematically describes this area. The operator of the bag opening machine is responsible for the following: a) feeding the bags of compressed asbestos into the bag opening machines, b) the operation of the bag opening machines and the associated mixers, and c) moving the output of the mixers to the next processing step.

The bags of asbestos, sometimes called asbestos bales, are transported into the compounding room by battery-powered, hand-lift trucks. These bags, which contain 45-kilograms of compressed asbestos, are stacked on wooden pallets. Sometimes cardboard is used to protect the bags from nail heads which protrude from the pallet. Before shipment, these pallets of asbestos bales are shrink-wrapped with plastic as shown in Figure 2. In this area of the plant, the amount of asbestos is restricted to the production needs of no more than one or two days.

To feed the asbestos into the process, the worker picks up the bags of asbestos from the pallet and drops them on the conveyor which carries the bags to the opener. This area is shown in Figure 3. The bags of asbestos fall from the conveyor and into the charge chute of the bag splitter as shown in Figure 4. A saw inside of the bag splitter cuts the bale in half. Spiked rollers separate the bag from the asbestos and discharges the emptied bags into trash hoppers which are shown in Figure 5. The asbestos is discharged through a trap door into a mixer. Between 10 and 15 bags of asbestos are fed into the mixer per batch. These bag opening machines are used every time a batch is mixed. Generally, 6 to 10 batches are mixed per shift.

Once a shift, the operator empties the bins in which the empty bags are collected. Each bag opening machine has two trash hoppers. The procedure is:

1. Wear a respirator.

2. Use a vacuum line to suck the air out of the plastic bag which is used to line the trash hopper. The vacuum line is part of a centralized vacuum cleaning system for this part of the plant.
3. Pull the hopper out from under the bag opening machine.
4. Tie the bag off and drop it down a special chute into a trash receptacle for hazardous materials pictured in Figure 6.
5. Vacuum the inside of the hopper and the floor around the trash hopper.
6. Line the the hopper with a clean plastic bag.
7. Place the hopper back under the machine.

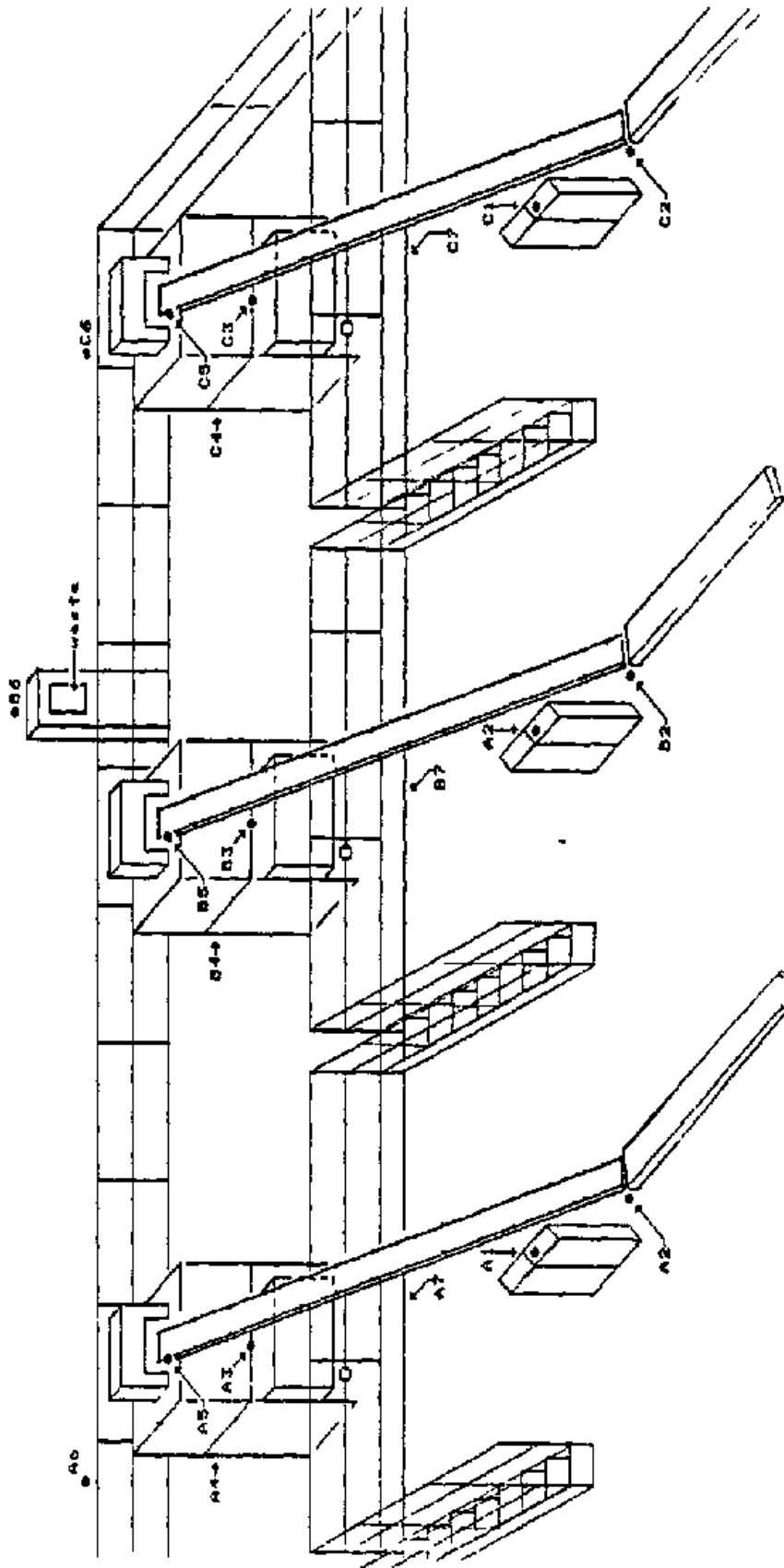


Figure 1. Sketch of debugging area.



Figure 2. Pallet with cardboard between pallet and bags of asbestos. The cardboard protects the bag from potential tears caused by nail heads in the pallets.



Figure 3. Picture of conveyor which moves the bags of asbestos from the ground floor level to the mezzanine floor where bag slitter is located. Note the respirator use.

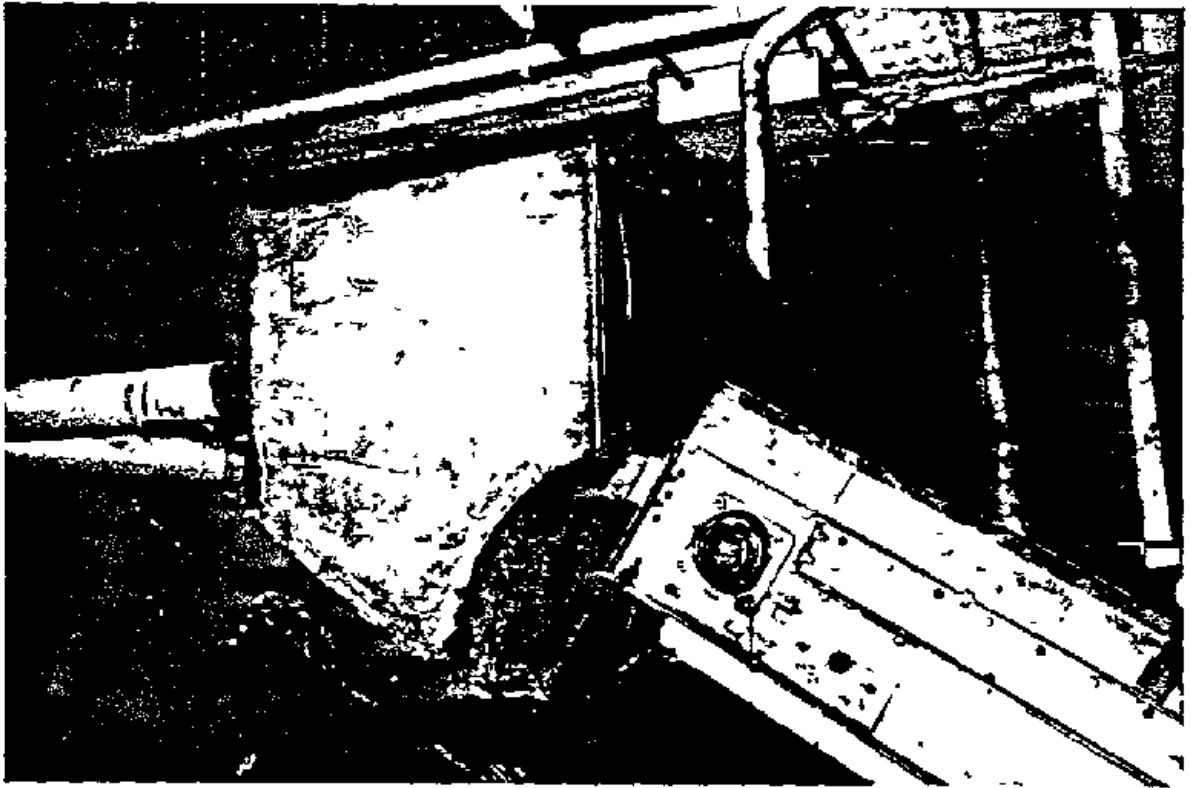


Figure 4. Entry into bag opening machine.

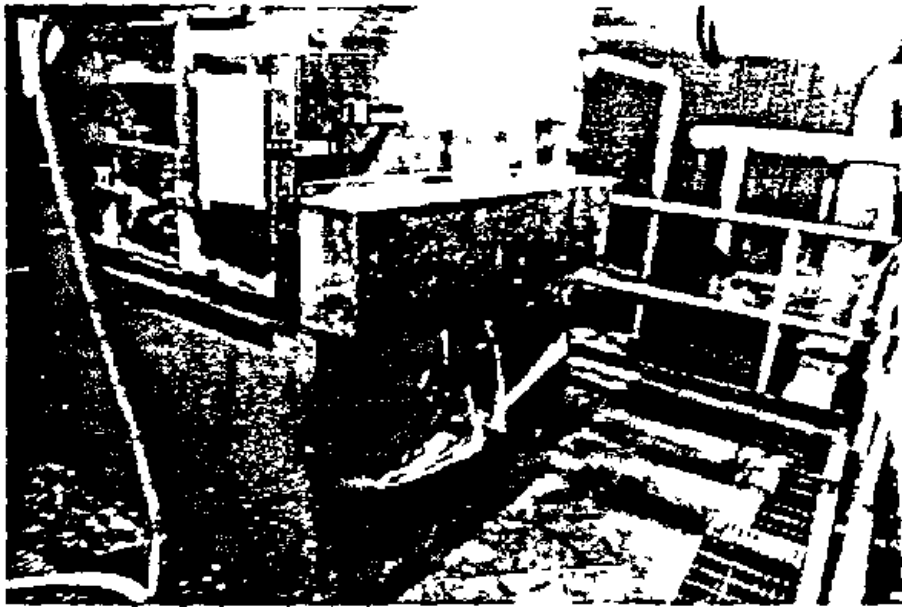


Figure 5. View of back of bag opening machine. The trash hopper (shown with plastic sticking out) is used for collecting empty wrappings. It rolls out of the enclosure for emptying.



Figure 6. The chute for discarding plastic bags which contain the bag wrappings from the bag opening machine.

POTENTIAL HAZARDS

Asbestos exposure is the primary hazard associated with this operation. Asbestos is a well known human carcinogen. OSHA regulates asbestos to prevent a lung fibrosis called asbestosis. This fibrosis impairs the transport of oxygen between the lung and the blood. The NIOSH recommended standard considers asbestosis but also considers excess cancer among asbestos workers. Such cancers include lung cancer, gastro-intestinal cancer and mesothelioma. 1,2,3 Table 1 presents a summary of health standards for asbestos.

The room in which the bag opening machines are located have numerous potential sources of asbestos exposure. These are:

1. Holes in the asbestos bags.

This happens for the following reasons: 1. Quality control workers cut holes in these bags to obtain samples. 2. The blades from lift trucks occasionally lance the bags. 3. Nail heads which protrude from the pallet into the asbestos bale can tear the bag. Generally, when the operators observe holes in bags, they promptly patch them and then remove spilled asbestos by vacuuming. (Figures 6, 7)

2. Resuspension of asbestos on the floor.

Any activity on the floor could resuspend settled asbestos. The floors in this area of the plant are vacuumed once a day to minimize the generation of airborne asbestos. As noted above, the operator of the bag opening machine frequently vacuums the floor to remove asbestos spills.

3. The conveyors are an emission source of asbestos.

Dropping bags on the conveyor can generate airborne asbestos. Because some asbestos (from holes in the bags) is spilled on the conveyor, the conveyor is observed to dump asbestos on the floor where it can be resuspended. In addition, the motion of the conveyor belt can resuspend asbestos left on the belt.

4. Exposed bolts on inclined conveyors.

Inclined conveyors have hard rubber strips which keep the the bags from sliding down the conveyor. Some of these rubber strips are missing and this exposes the bolts. When the bags slide over these exposed bolts, the bags could tear. This could cause contamination of the belt.

5. The operation of the bag slitter.

This equipment is designed to contain the asbestos generated by bag opening, emptying, and disposal.

6. Emptying, the bag slitter's trash hopper.
7. Maintenance on the bag slitter.

During repair operations, the housing for the bag slitter's apparatus may be removed. This exposes contaminated parts to the work room air. Handling these parts could create a serious asbestos exposure. During such activities, the worker's wore NIOSH-approved respirators.

Table 1. Summary of Health Standards for Asbestos

Materials or Agents	PEL ¹ fibers/cc	TLV ² fibers/cc	NIOSH ³ Recommended level fibers/cc	Major Health Effects
Asbestos for fibers longer than 5 micro- meters 8-hour TWA	2.0		0.1	Major health effects include asbestosis, lung cancer, gastro- intestinal cancer, mesothelioma.
Amosite		0.5		
Chrysotile		0.5		
Crocidolite		0.2		
All other forms of asbestos		2.0		

NOTE: The PEL levels are enforced by the Occupational Safety and Health Administration. The TLV and NIOSH Recommended level are suggested exposure limits and are not enforced by OSHA.



Figure 6. Damaged bag.

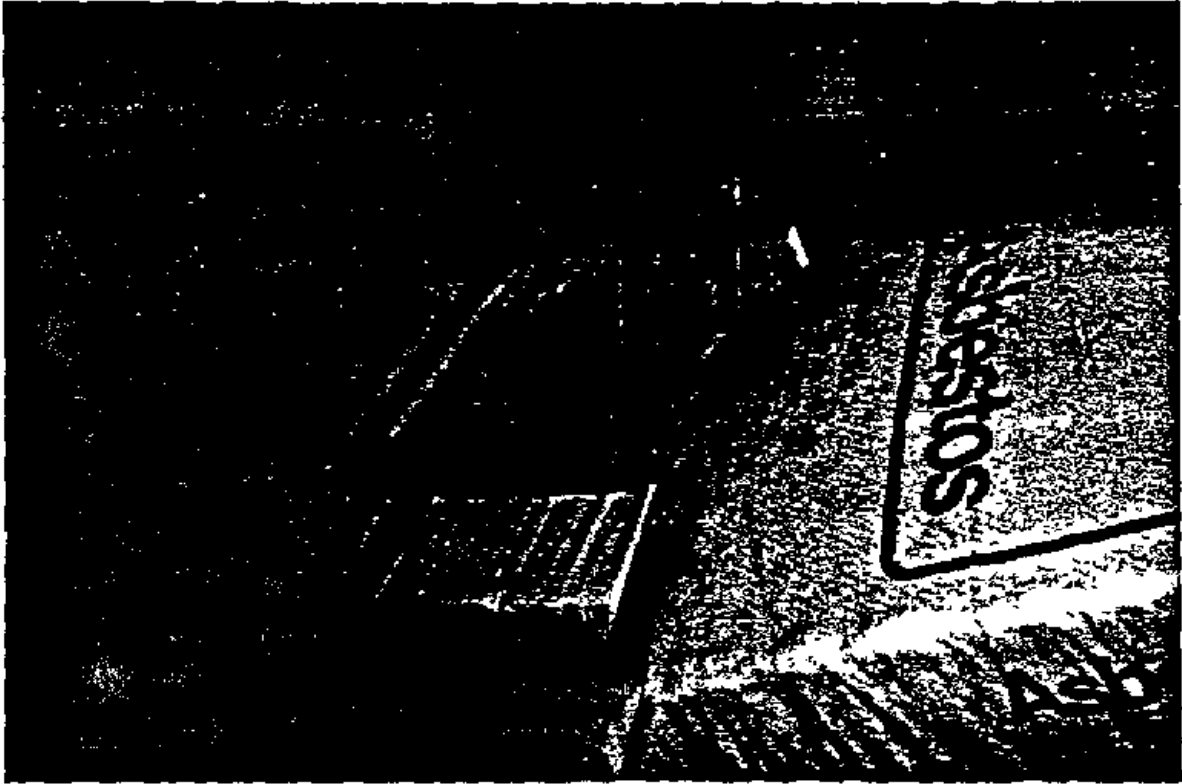


Figure 7. Bag patched with tape.

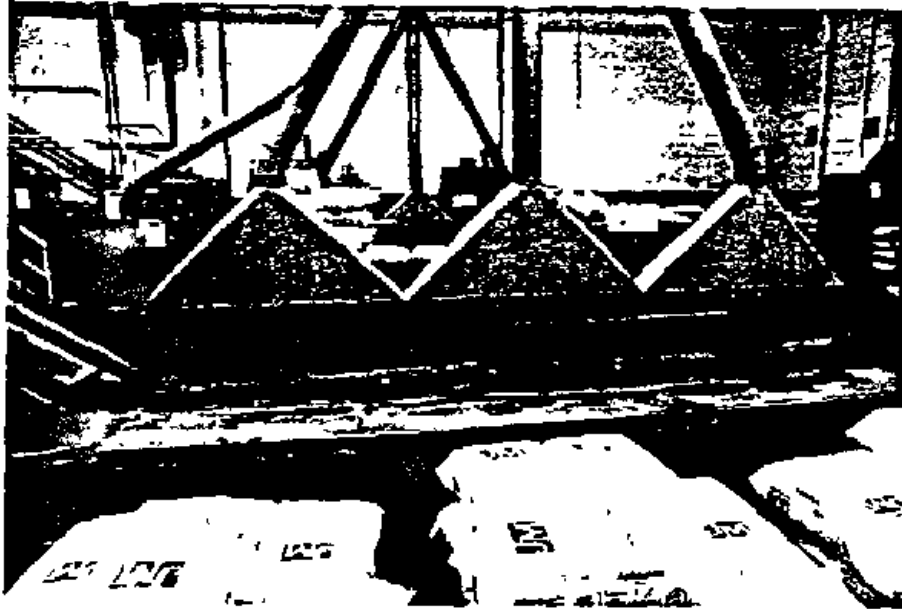


Figure 8. Slot hood next to loading Conveyor. There is a slot hood beneath the transfer point for the loading conveyor and the inclined conveyor which transports the bags to the bag opening machine.

CONTROL OF ASBESTOS EXPOSURES

At this plant, asbestos control during bag opening, emptying, and disposal is a comprehensive program of engineering control, personal protective equipment, work practices, and education. Although this study is focused on the automatic bag opening equipment, all of these activities are needed to control asbestos exposures in the workplace.

Engineering controls

According to Soule⁴, industrial hygiene engineering controls involve substitution, isolation, and ventilation. The use of an automatic bag opening machine involves all three of these components. Initially, the bag slitter was installed to replace a less well controlled operation. This is an example of substitution. The design of the equipment is such that the operations which generate the airborne asbestos are isolated from the worker. Local exhaust ventilation is applied to the machine to contain asbestos emissions from the inlet (Figure 4) and at the bottom of the machine where asbestos is discharged into trash hoppers (Figure 5). Additional ventilation is applied where the material is placed on the loading conveyor and under the transfer point between the inclined conveyor and the loading conveyor.

Housekeeping

Vacuum cleaners are used in this area of the plant to keep the floors clean. This is done to prevent the floor from becoming a source of asbestos emissions. One worker thoroughly vacuums the floors in this area once every 24 hours.

Work Practices

Work practices play an important role in minimizing asbestos emissions into the workplace. Damaged bags of asbestos are repaired and the spilled asbestos is removed by vacuuming. The procedure for discarding of emptied bag halves (wrappers) was developed to minimize the asbestos exposure while the worker empties the trash hoppers beneath the bag opening machine. The practice of using a vacuum cleaner to suck the air out of the plastic bags used to line the trash hopper is noteworthy. This practice compresses the bags without dispersing asbestos into the air.

Education

Twice a year, the workers in this area of the plant get one-on-one training with an industrial hygienist. The safety program is reviewed and sampling results are discussed with the workers.

Personal Protection

Respirators are worn during jobs which have potential for asbestos exposure. The usual respirator is a 3M 8710 disposable respirator. These respirators are worn:

1. When the worker empties the the bag slitter's trash hopper.
2. When the worker places bales of asbestos on the loading conveyors.
3. When the bag slitting machine is being repaired.
4. At other times when the operator suspects there might be relatively high asbestos concentrations.

STUDY METHODOLOGY

The control of asbestos in the bag opening area of the plant was studied by making ventilation system measurements and measuring the asbestos concentration in the air. The equipment used in this study is listed in Table 2. The ventilation measurements are summarized in Table 3. The slot hood shown in Figure 8 did provide a gentle drift of air toward the slots. However, the air velocities where the workers dropped the bags of asbestos onto the conveyor seemed to be too low to contain whatever asbestos is being emitted into the air. Based upon smoke tube traces, all of the other local exhaust ventilation listed in Table 3 seemed to contain whatever airborne asbestos is being emitted.

Table 2. Equipment used in this Study

Item	Used for
DuPont P4000 Pumps	Air sampling at 3.5 liters per minute
MSA model G Pumps	Air samples collected at 2.0 lpm.
Smoke tubes	traces of air flow
Kurz velometer	measuring hood face and capture velocities.

Table 3. Summary of ventilation measurements.

Measurement	Quantity
Conveyor hood:	
Slot velocity	1,100-1700 feet per minute (fpm)
Slot Dimensions	about 1"X15' (There are two slots located 4" and 15" above the conveyor)
Air velocities at conveyor edge about 2 feet from slot and 8" above conveyor	0-40 fpm
smoke tube traces at conveyor edge	smoke slowly drifts into slots
Transfer point hood:	
Slot Dimensions	about 1"X26" located beneath transfer point
Slot Velocity	300-1200 fpm
Air velocity at level of conveyor	30-100 fpm
Smoke tube traces	smoke released at conveyor height goes into slot
Entry Hood on Bag Slitter:	
Hood face velocities:	100-300 fpm
smoke tube traces	smoke goes into hood
Trash hopper ventilation on bag slitter	
air velocities in space between trash hopper and side of enclosure	50-100 fpm at top of bins 10-50 fpm between side of trash hoppers and side of enclosure
smoke tube traces	Smoke released along the top of the hoppers just outside of the enclosure flowed into the enclosure

Air Monitoring

Air Samples for asbestos were taken on the worker, near potential emission sources, and away from immediate sources of asbestos emissions. This air sampling was done to address two issues. The first issue is stated:

"Is the worker's environment acceptable?"

This question is answered by computing the worker's time-weighted average concentration and comparing the result to the values listed in Table 1.

The second issue can be stated:

"Is the operation of the bag opening equipment associated with increased asbestos concentrations?"

To address this issue, asbestos concentrations were measured in the worker's breathing zone and on each machine at the locations listed in Table 4. Area samples were collected on each machine while the machine was off. These samples were collected at flow rate of 2.0 liters per minute. These "off" samples were to be compared to concentrations measured while the bag opening machines were in use. Because the bag opening machines were only operated about 30 minutes per shift and because low asbestos concentrations were expected, it was not feasible to take distinct "on" samples for each machine and maintain the detection limit below 0.01 fibers/mL. For each location in Table 4, an average "on" concentration was measured. This involved moving the set of "on" samplers to the machine which is "on". This was done every time one of the three bag openers was in use. Fortunately, only one bag opening machine was in use at a time. As a result, the second issue can be addressed by comparing the "on" concentration measured at a location in Table 4 to an average of the "off" concentrations which has been weighted according to the operating time of the bag opening machines.

Asbestos concentrations were measured as described by NIOSH Method 239.⁵ The "off" samples were collected at a known flow rate of 2.0 liters per minute. However, the worker's "off" sample and all of the "on" samples were collected at a nominal flow rate of 3.5 liters per minute. The worker's off sample was turned off when he manually weighed out batches of powdered material. This was necessary to prevent the filters from becoming overloaded with dust which would obscure the asbestos fibers.

Table 4. Description of sampling locations on each machine.

Location Number	Description
1.	On top of Control Panel. Taken to reflect background contamination
2.	Under conveyor transfer point. This location is under the point where bags of asbestos are transferred from the loading conveyor to the inclined conveyor. Small pieces of asbestos were observed to accumulate on the floor under this transfer point. Possibly, asbestos is emitted into the air here.
3,4	Just above the trash hoppers on the exterior surface of the bag slitting machine. At this location, the emptied bags are being discharged into a trash hopper. If the air flow into the hood is too low, asbestos could be emitted into the air.
5.	Under entry conveyor at inlet to the bag slitting machine. Elevated asbestos concentrations here might reflect leakage from the bag slitter inlet or spillage from the conveyor.
6.	Back railing of the the platform on which the bag slitter is mounted. This sample was taken to estimate background asbestos concentrations in the area of the bag slitter.
7.	Underneath bag slitter on platform for the mixer. Asbestos concentrations at this location might be elevated because people walk on the grated floor above the mixer.

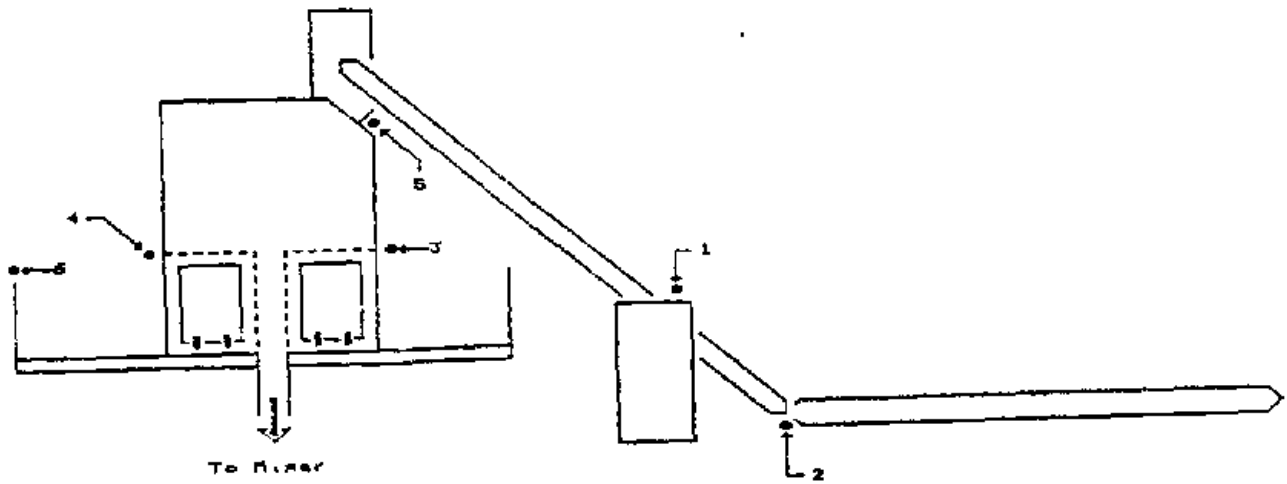


Figure 9. Schematic describing sampling locations.

Sampling Results and Discussion of Sampling Results

Sampling results are listed in the attached appendix. Generally, the area samples collected during the off conditions were just at or below the detection limit of about 0.01 fibers/mL. Table 5 summarizes the worker's asbestos exposures and the sampling results obtained from the samples which were collected during "on" conditions. The "on" samples collected at locations 3 and 5 and on the worker were consistently above background. The results from these locations suggest that there is some asbestos generated when the conveyor belt wraps around a roller at the inlet to the bag slitting machine. In addition, the airborne asbestos generated within the bag disposal bin is a possible source of emissions into the workplace. Because the ventilation for the disposal bin appears to be adequate, the conveyor belt appears to be the source of the increased asbestos concentrations at locations 3 and 5.

Table 5 Summary of sampling results for samples collected while the bag opening machine is on

Location	Number of samples below lod*	Number of samples above lod*	Range fibers/mL
1	4	2	0.01, 0.02
2	3	3	0.01-0.13
3	1	5	0.01- 0.85
4	4	2	0.01, 0.04
5	1	5	0.01- 0.53
6	5	1	0.01
worker			
loading conveyor	1	4	0.03 - 0.74
"off" sample	0	5	0.01 - 0.10
emptying hopper	1	3	0.14 - 1.2

*- limit of detection which is 5000 fibers per filter or about 0.01 fibers per cubic centimeter

The air samples collected in the worker's breathing zone suggest that the worker's asbestos exposure could be elevated above 0.1 fibers/cc as a time weighted average concentration. Placing bags of asbestos on the conveyor and emptying the trash hopper under the bag slitting machine can cause increases in the personal sampling results for the worker. The data in the Appendix shows that these activities increased the asbestos exposure of the operator on the first shift. However, these activities did not appear to increase the asbestos exposure of the evening shift operator.

Table 6 lists time weighted average asbestos exposures for the two operators. These time weighted average concentrations were computed on the basis of the time that the operator wore the personal sampling pumps. Based upon these calculations, the evening shift worker's exposure was below the NIOSH recommended standard of 0.1 fibers/cc. The day shift operator's exposure exceeded the NIOSH recommended standard during two out of the three shifts sampled. During these two shifts, the worker's background asbestos exposure was above 0.1 fibers/cc. However, these results are below the current OSHA PEL of 2.0 fibers/mL. On November 30, there was some asbestos fibers spilled on the floor from the previous shift. The spill occurred around the loading conveyor for Little Ford Mixer Number 3. On December 1, the bag opening machine for Little Ford Mixer Number 2 was disassembled and repaired. The operator did observe this operation at the stairwell going to the bag slitting machine. Both of these events could have increased the worker's exposure to asbestos concentrations while the "off" samples were being taken. As a result of these activities, increased background concentrations during the "off" sampling period could have occurred.

Table 6. Time weighted average asbestos exposures (fibers/mL) for the operator of the bag slitting machine

Date	Operator	
	Day Shift	Evening Shift
November 29	0.04	0.02
November 30	0.16	0.03
December 1	0.39	---

CONCLUSIONS

This plant uses a comprehensive program to control worker asbestos exposure during bag opening, emptying, and disposal. Housekeeping, equipment design, worker education, and work practices are designed to minimize asbestos exposure. The bag opening equipment is designed to contain the asbestos generated by bag opening, emptying, and disposal. Promptly removing spilled asbestos from the floor and repairing damaged bags which contain asbestos does maintain low asbestos concentrations. In spite of these competent efforts, the worker's exposure to asbestos increases when he places bags of asbestos on the conveyor. This suggests that the exterior surfaces of the asbestos bags or the conveyor belt are sources of worker asbestos exposure.

When the operation is proceeding normally, the worker's TWA asbestos exposure does remain below 0.1 fibers/cc. However, abnormal activity such as spilled asbestos or equipment repair could cause worker exposure which exceeds 0.1 fibers/cc. Two routine activities, placing bags of asbestos on the loading conveyor and emptying the trash hoppers under the bag opening machine, can increase asbestos exposures above 0.1 fibers/cc. Because these activities involve less than 40 minutes per shift, the use of respirators to control the worker's asbestos exposure seems acceptable for the time being. However, more work may be needed to prevent the elevation of worker asbestos exposure while loading the conveyor.

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ASBESTOS CONCENTRATION DATA

Codes Used in Appendix

- C - Concentration of asbestos fibers greater than 5 micrometers in length with a length to width ratio greater than 3
- lod - asbestos loading on filter below 5,000 fibers.
- V - sample volume in liters

Location codes:

a,b,c-bag opening machines for Little Ford Mixer 3, 2, and 1 respectively

1, 2, 3 , 4, 5, 6, 7 -location description from Table 4

The location codes which start with a letter are the "off" samples - they were not moved. The location codes which are simply numbers are the "on" samples - they were moved to the bag opening machine in use.

Asbestos Fiber Concentration Data Day Shift

Location Code	November 29		November 30		December 1	
	C #/mL	vol liters	C #/ml	Vol liters	C #/ml	Vol liters
a-1	0.01	734	0.01	725	lod	645
a-2	lod	781	lod	728	lod	651
a-3	d		0.01	699	lod	509
a-4	lod	700	0.01	692	0.01	507
a-5	lod	725	0.01	703	0.03	514
a-6	lod	715	0.01	693	0.02	506
a-7	lod	410	lod	786	0.01	771
b-1	0.01	714	0.02	630	0.03	169
b-2	lod	700	0.02	598	lod	156
b-3	lod	682	0.02	542	0.06	158
b-4	0.02	678	lod	549	lod	157
b-5	lod	690	lod	540	lod	156
b-6	lod	700	lod	542	lod	156
b-7	0.01	732	0.01	852	0.01	761
c-1	lod	675	lod	559	lod	646
c-2	lod	682	0.01	550	lod	548
c-3	0.01	707	lod	612	0.01	612
c-4	lod	707	0.01	570	lod	489
c-5	0.01	715	lod	585	0.02	495
c-6	0.01	700	0.01	558	lod	601
1	lod	119	lod	347	0.02	261
2	lod	119	0.14	383	0.06	261
3	0.85	76	0.07	308	0.22	270
4	lod	73	lod	286	0.04	258
5	0.53	75	0.04	268	0.08	265
6	lod	75	0.03	292	lod	257
worker:						
on	0.1	132	0.34	122	0.74	86
off	0.03	996	0.11	552	0.22	399
bag changing			0.58	29	1.22	47
floor sweeper			0.03	327	0.23	748

Asbestos Fiber Concentration Data Evening Shift

Location Code	November 29		November 30		December 1	
	C #/mL	vol liters	C #/ml	Vol liters	C #/ml	Vol liters
a-1	lod	754	lod	557	lod	726
a-2	lod	747	lod	571	lod	719
a-3	lod	743	lod	569	0.02	715
a-4	lod	736	lod	563	0.01	708
a-5	lod	744	lod	568	lod	715
a-6	lod	751	lod	574	lod	712
a-7	lod	747	lod	636	lod	719
b-1	0.04	644	lod	536	lod	818
b-2	0.01	641	lod	534	lod	809
b-3	lod	635	0.1	529		
b-4	0.01	644	0.06	536		
b-5	0.01	635	lod	528		
b-6	0.01	644	lod	536		
b-7			0.01	642	lod	813
c-1	lod	647	lod	588	lod	702
c-2		644	lod	586	lod	702
c-3	lod	656	lod	597	0.01	716
c-4	0.01	660	lod	597		
c-5	0.01	660	lod	600	lod	720
c-6	0.01	656	lod	597	lod	720
1	0.01	347	lod	385	lod	321
2	lod	322	0.01	368	lod	307
3	0.01	340	0.17	390	lod	325
4	lod	320	0.01	396	lod	307
5	0.01	338	0.05	397	lod	318
6	lod		lod	387	lod	317
worker:						
on	0.03	131	lod	118		
off	0.01	445	0.02	472	0.05	582
bag changing			0.13	44	lod	36