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SPECIAL ASBESTOS DUST  
&  
PRELIMINARY INDUSTRIAL HYGIENE SURVEY

ABEX CORPORATION  
American Brakeblok Division  
Winchester, Virginia

*Survey Conducted By:*

John Dement  
Patrick Shuler  
Ralph Zumwalde

*Report Prepared By:*

John Dement  
Patrick Shuler

*Environmental Investigations Branch  
Division of Field Studies and Clinical Investigations  
National Institute for Occupational Safety and Health  
1014 Broadway  
Cincinnati, Ohio 45202*

February 7-11, 1972

## *INTRODUCTION*

During the week of February 7-11, 1972, a special asbestos dust survey and a preliminary industrial hygiene were conducted at the American Brakeblok Division of the Abex Corporation, Winchester, Virginia. The main purpose of the asbestos dust survey was to evaluate the asbestos sampling technique used by the U.S. Public Health Service.

To date, the samples which were collected have not been analyzed; however, from past U.S.P.H.S. surveys and the present industrial hygiene survey, several conclusions can be drawn. The following paragraphs discuss plant operations and industrial hygiene practices along with conclusions and recommendations.

## *DESCRIPTION OF THE PLANT*

The plant is located south of the city of Winchester and employs approximately 655 blue collar workers and 119 white collar workers. There is a doctor employed by Abex Corporation but he only visits this facility once or twice a year. A nurse is on duty full time however. A complete pre-employment physical is given and is repeated every two years. Chest X-rays are taken every year. Blood and urine samples are taken twice a year from those in the mixing area to check for lead. Abex employs an industrial hygienist full time. The Personnel Manager acts as the Safety Director and works through the foremen to implement safety programs.

The plant was constructed by Abex in 1947 for the purpose of manufacturing asbestos friction products. The total plant site consists of 44 acres with four main buildings amounting to 440,000 square feet. The buildings are two story structures with the mixing operations and dust collectors being located on the upper level.

Products of the plant include automotive, aircraft and industrial braking materials, ABK industrial bearings, and sintered metallic material for production of metallic friction products. Approximately 50 different braking material mixes are made by the company in order to comply with varying customer needs and specifications.

## *DESCRIPTION OF THE PROCESSES*

Both extruded and dry process brake linings are made along with ABK bearing material. Sintered metallic materials are made in a separate building

and does not involve the use of asbestos. The following paragraphs give a brief description of the operations which make use of asbestos fibers.

#### A. Dry Process Brake Linings

The process by which dry process brake linings are made consists of the following steps:

1. Mixing
2. Preforming and Blending
3. Hot Pressing
4. Cutting and Trimming
5. Curing
6. Final Grinding and Drilling

Raw material mixing is done on the second floor. The various raw materials used in each mixture are dumped into a "Nauta" type mixer which thoroughly mixes the materials and empties to conveying carts on the first floor.

After the materials are mixed they are taken to preform stations where initial forming takes place. Preforming consists of placing a prescribed amount of mix into a mold and pressing with a hydraulic press until the materials cling together as one mass.

Following the preforming operations, the brake blocks are placed in a hot press for a period of approximately two hours. Hot pressing serves the purpose of allowing the resins to further bond the materials into a rigid body.

Finally, the blocks are ground to the proper thickness, drilled with the proper holes, inspected and packaged for shipment. Blocks are labeled with a brander machine.

#### B. Extruded Brake Linings

Extruded brake linings are made in the following steps:

1. Raw Material Mixing & Grinding
2. Extruding
3. Baking
4. Cutting
5. Final Curing
6. Final Grinding and Drilling

Raw material mixing is done in a manner similar to dry process lining productions, the only difference being that oils are added to form a damp paste. After the materials are mixed, they are emptied into conveying carts on the ground floor.

After mixing, the raw materials are extruded in the form of a tape which is wound into a coil. The coil is then placed in an oven for initial curing.

Following the initial curing operation, the coils are surface ground and cut to length on band saws. Depending on customer specifications, the lining may undergo another curing operation.

Finally the linings are drilled with the proper holes, finish ground, inspected, and packaged for shipment.

#### C. ABK Industrial Bearings

ABK industrial bearings are special wear and heat resistant bearing made by the company. The bearings are made by first impregnating a cloth with various resins and then winding this cloth or hot pressing it to form the product. These bearings are used quite extensively in iron and steel foundries.

### *SURVEY PROCEDURES*

The main purpose of the asbestos dust survey conducted at the plant was to evaluate the asbestos sampling technique currently used by the U.S. Public Health Service. To do this, simultaneous samples were taken (85 pairs on the same side of the man and 23 sets on opposite sides) to check the reproducibility of the asbestos sampling under field conditions with relatively low concentrations. The majority of the sampling was conducted at the same machines in the cutting, grinding and drilling of auto linings for three consecutive days on the first and second shift in order to also supply data on variations of concentration of asbestos with the shift and day of week. The remainder of the samples came from the preforming and hot press areas. A special study was done to determine the effect of heavy background on sample results.

A preliminary industrial hygiene survey of the plant was also conducted to try to evaluate general housekeeping and ventilation systems.

### *INSPECTION OF THE PLANT*

Potential Health Hazards: The major potential health hazards encountered were;

1. Exposure to asbestos dust
2. Exposure to lead from mixing operations

Caution needs to be exercised toward some of the raw materials (see Table 1) that are encountered. Indiscriminate use of such things as carbon black, litharge, and hexamethylenetetramine would be hazardous. Also, noise levels could be excessive in some areas.

Personal Protection: The only worker in the plant seen wearing a respirator was in the hot press area. Safety clothing such as rubber aprons and ear protection are provided where appropriate. Safety glasses are required of everyone inside the manufacturing area. There is a program to finance the purchase of safety shoes, but this is voluntary.

Ventilation: Local exhaust ventilation is used quite extensively with ductwork at almost all operations. The contaminated air is vented to 22 American Air Filter "Roto-Clone" type "N" wet dust collectors with a total design capacity of 314,740 cfm. Design specifications are given in Table 3. None of this air is recycled. The sludge from the wet collectors is taken through a series of three settling ponds to clear the water. A pumping station is located at the last pond to recycle some water. The water is evaporated and absorbed so none of it is allowed outside company property. Sludge is cleaned from the ponds about once a year and piled in mounds on company property.

Make-up air is provided, but not enough to prevent a noticeable negative pressure inside the plant. The total capacity of the make-up air is 155,000 cfm from 10 units.

Ventilation layouts of areas sampled during the special survey are shown in diagrams 2 and 3. Table 4 gives the results of the ventilation survey.

The method used to make the mixes is good in that raw materials are not handled by hand. A cart goes down a rail and under a series of hoppers each containing a part of the mix. The mixer stops the cart at the appropriate hopper and puts in that chemical. Each hopper is ventilated individually. The nice part about this system is that the chemicals are loaded by vacuum lines into the hoppers. Unfortunately asbestos cannot be included in this method since it is not a loose powder and is broken into the mix cart at the end by hand.

It appeared that the collection and disposal part of the ventilation system is adequate and performing as designed, but improvements could be made in the duct work and especially the hooding. The duct velocities are quite high, but more emphasis should be placed on using enclosed or flanged hooding as near the source of dust evolution as possible.

Housekeeping: In general the housekeeping was good. There is usually sufficient space in the aiseways. Painting and a general cleanup was in progress during the time of the survey. Brooms and a large vacuum floorsweeper were used for cleaning. The major problem in housekeeping was the frequent use of compressed air to blow off machinery.

#### *CONCLUSIONS AND RECOMMENDATIONS*

From this and past surveys, it appears that the areas of potentially excessive asbestos dust exposures are the mixing and preforming areas. The following are recommendations for some changes which are necessary to improve conditions at the plant:

1. A method needs to be developed for loading asbestos into the mixers which would eliminate hand loading. Until such a method is developed, asbestos mixers should wear Bureau of Mines approved respirators.
2. Ventilation improvements are indicated at the preforming stations. One such improvement would be to place hoods closer to the area of dust generation and use a more enclosing type hood. Another method would be to automate the block preforming operation as has been done for disc brake preforming.
3. More make-up air should be provided to prevent ventilation systems from being starved for air.
4. Once the modifications have been done on the ventilation systems and the systems are balanced, all blast gates should be welded in position to prevent them from being altered.

## A P P E N D I X

### TABLE #

### TITLE

|   |                                            |
|---|--------------------------------------------|
| 1 | Potentially Hazardous Raw Materials        |
| 2 | Abbreviations Used in Ventilation Diagrams |
| 3 | Dust Collector Design Data                 |
| 4 | Results of Ventilation Survey              |
| 5 | Results of Past Surveys                    |

### FIGURE #

### TITLE

|   |                               |
|---|-------------------------------|
| 1 | Diagram of Plant Layout       |
| 2 | Ventilation in Preform Area   |
| 3 | Ventilation in Finishing Area |

*TABLE I*

*POTENTIALLY HAZARDOUS RAW MATERIALS  
USED BY  
ABEX CORPORATION  
AMERICAN BRAKEBLOK DIVISION*

1. Asbestos Fiber
2. Litharge
3. Lead Powder
4. Hexamethylenetetramine
5. Phenolic Resin & Polyrez Resin
6. Paints
7. Carbon Black
8. Coal
9. Zinc Dust & Zinc Powder
10. Nuisance Dusts

TABLE II

ABBREVIATIONS USED IN VENTILATION DIAGRAMS

| <u>Abbreviation</u> | <u>Meaning</u>     |
|---------------------|--------------------|
| DP                  | Drill Press        |
| EG                  | Edge Grinder       |
| MD                  | Multipress Drill   |
| PF                  | Preforming Station |
| R                   | Ripper             |
| S                   | Band Saw           |
| SG                  | Surface Grinder    |

The following ventilation diagrams use the above codes and denote where the sampling was done during the special survey at Winchester in the preforming and finishing area.

TABLE III

## WINGNESIER DUST COLLECTORS

ENGINEERING BULLETIN - #49

APR 15 1971

See PE-W404

| Collector # | Location       | Department Served  | Type & Size | Motor |        |             | Timer Purch for Coll. # | Fan    |        |                     | Interlocked w/ heater # | Pump     |      |        | JRS File # W-10 | Control Drawing # | Blowpipe Drawing # | Blowpipe Installed | Collector Installed | Collector # |
|-------------|----------------|--------------------|-------------|-------|--------|-------------|-------------------------|--------|--------|---------------------|-------------------------|----------|------|--------|-----------------|-------------------|--------------------|--------------------|---------------------|-------------|
|             |                |                    |             | H.P.  | R.P.M. | Oper'g Amps |                         | R.P.M. | C.F.M. | Design Inlet Static |                         | Style    | H.P. | R.P.M. |                 |                   |                    |                    |                     |             |
| 1           | 5FG7 Balcony   | Strip Finishing    | 16N         | 60    | 1200   | 75          | 18                      | 1042   | 16,000 | 6.15                |                         | 2L6-CDQ  | 5    | 1200   | -11B            |                   | W405 Sh 2&3        | '70                | '61                 | 1           |
|             | 5JK6 2nd       | "                  | "           | 60    | 1200   | 70          |                         | 1042   | 16,000 | 6.34                |                         | B-6-6    | 5    | 950    | -11C            |                   | W405 Sh 2          | '70                | '60                 | 2           |
| 3           | 6JK7 2nd       | "                  | "           | 50    | 1800   | 66          |                         | 1039   | 15,000 | 6.0                 | 1                       | 2L6-CDQ  | 5    | 1800   | -11D            |                   | W405 Sh 3          | '70                | '55                 | 3           |
| 4           | 8JK9 2nd       | Wet Compounding    | "           | 50    | 1800   | 60          |                         | 1015   | 15,000 | 3.5                 |                         | B-6-6    | 3    | 1800   | -11             |                   | W214 Sh 1          | '55                | "                   | 4           |
| 5           | 8JK9 2nd       | (Idle)             | 20W         | 40    | 1200   |             |                         | 1430   | 9,200  | 5.4                 |                         | Gravity  |      |        | -11             |                   | W219 Sh 2          | '55                | '55                 | 5           |
| 6           | 8JK9 2nd       | Dry Compounding    | 16N         | 50    | 1200   | 65          |                         | 1074   | 15,000 | 6.0                 |                         | B-6-6    | 5    | 950    | -11             |                   |                    | '55                | '55                 | 6           |
| 7           | 10QR11 Balcony | Block Compounding  | 16N         | 60    | 1200   | 65          | 8                       | 1160   | 15,940 | 5.2                 |                         | K        | 2    | 1200   | -11             | W228 Sh 6         | W405 Sh 19         | '55                | '60                 | 7           |
| 8           | 10QR11 Balcony | Block Preforming   | 16N         | 60    | 1200   | 65          | 8                       | 1008   | 16,500 | 3.6                 | 4                       | B-6-6    | 5    | 1200   | -11F            | "                 | W405 Sh 13         | '67                | '55                 | 8           |
| 9           | 6ZZA7          | Block Finishing    | 16N         | 50    | 1750   | 63          | 17                      | 1060   | 16,000 | 7.2                 | 5                       | Gravity  |      |        | -11E            | W228 Sh 3         | W405 Sh 14         | '67                | '64                 | 9           |
|             | 16KX17         | A.B.K.             | 20N         | 75    | 1750   | 90          |                         | 1121   | 22,000 | 6.17                | 8                       | Drag Out |      |        | -11A            | W228 Sh 4         | W405 Sh 16         | '67                | '66                 | 10          |
| 12          | 13PQ14 2nd     | Pilot Plant        | 12W         | 10    | 1160   | 12          |                         | 2150   | 3,000  | 4.1                 |                         | Gravity  |      |        | -9              |                   | W266 Sh 7          | '55                | '55                 | 12          |
| 13          | 13H14          | Coal Grinding      | 6N          | 15    | 1725   | 14          |                         | 1480   | 5,500  | 6.0                 |                         | 2L6-CDQ  | 5    | 1800   | -10             |                   |                    | '59                | '59                 | 13          |
| 14          | 12ADA13        | Blanket Preforming | 16W         | 50    | 1750   | 65          | 16                      | 1042   | 16,000 | 4.86                | 7                       | 2L6-CDQ  | 5    | 1200   | -14             | W228 Sh 3         | W405 Sh 7          | '67                | '63                 | 14          |
| 15          | 7ZZA8          | Block Finishing    | 16N         | 50    | 865    | 52          | 17                      | 1039   | 16,000 | 3.88                | 9                       | Gravity  |      |        | -15             | "                 | W405 Sh 14         | '67                | '63                 | 15          |
| 16          | 6ZZA7          | Block Finishing    | 20N         | 60    | 1750   | 68          | 17                      | 1071   | 20,000 | 5.84                | 16                      | Gravity  |      |        | -16             | "                 | "                  | '67                | '66                 | 16          |
| 17          | 7ZZA6          | Block Finishing    | 20N         | 60    | 1750   | 58          | 17                      | 1073   | 20,300 | 5.04                | 6                       | Gravity  |      |        | -16A            | W228 Sh 5         | "                  | '67                | '66                 | 17          |
| 18          | 6CD7 Balcony   | Strip Finishing    | 20N         | 60    | 1800   |             | 18                      | 1073   | 20,300 | 6.42                | 1/7                     | 2L6-CDQ  | 5    | 1200   | -16B            | "                 | W405 Sh 2          | '70                | '70                 | 18          |
| 19          | 12ADA13        | Blanket Preforming | 16N         | 50    | 1800   | 55          | 16                      | 1042   | 16,000 | 5.42                | 10                      | 2L6-CDQ  | 5    | 1200   | -16C            | "                 | W405 Sh 7          | '67                | '66                 | 19          |

TABLE III (continued)

| <i>Collector<br/>#</i> | <i>Location</i>             | <i>Type</i> | <i>Motor<br/>H.P.</i> | <i>Fan<br/>C.F.M.</i> | <i>Design Inlet<br/>Static</i> |
|------------------------|-----------------------------|-------------|-----------------------|-----------------------|--------------------------------|
| 20                     | New Addition                | 16 N        | 50                    | 16,000                | 4.69                           |
| 21                     | Metallic Sintering Building | 4 N         |                       | 4,000                 | 2.50                           |
| 22                     | New Addition                | 20 N        | 60                    | 20,000                | 4 - 6                          |

*Total Designed Exhaust Volume - 314,740 cfm*

TABLE IV

## RESULTS OF VENTILATION SURVEY

| <i>Machine</i>      | <i>Machine<br/>Code</i> | <i>Hood Type</i>         | <i>Volume<br/>CFM</i> | <i>Duct<br/>Diameter</i> | <i>Vented to<br/>Collector #</i> |
|---------------------|-------------------------|--------------------------|-----------------------|--------------------------|----------------------------------|
| Multiple Drill #4   | MD- 4                   | Underneath               | 315                   | 5"                       | 2                                |
| Multiple Drill #5   | MD- 5                   | Underneath               | 438                   | 5"                       | 2                                |
| Multiple Drill #6   | MD- 6                   | Underneath               | 411                   | 5"                       | 2                                |
| Drill Press #5      | DP- 5                   | At Drill                 | 151                   | 4"                       | 18                               |
| Drill Press #8      | DP- 8                   | At Drill                 | 151                   | 4"                       | 18                               |
| Surface Grinder #4  | SG- 4                   | Wheel                    | 223                   | 4"                       | 18                               |
|                     |                         | Underneath               | 751                   | 6"                       | 18                               |
| Edge Grinder #1     | EG- 1                   | Underneath               | 771                   | 6"                       | 18                               |
| Surface Grinder #5  | SG- 5                   | At Wheel &<br>Underneath | 680                   | 7"                       | 18                               |
| Surface Grinder #6  | SG- 6                   | At Wheel &<br>Underneath | ---                   | 7"                       | 18                               |
| Lining Ripper #1    | R - 1                   | Underneath               | 813                   | 5"                       | 2                                |
| Cut-Off Saw #1      | S - 1                   | Blade & Underneath       | 1297                  | 5"                       | 3                                |
| Cut-Off Saw #3      | S - 3                   | Blade & Underneath       | 522                   | 5"                       | 3                                |
| Cut-Off Saw #4      | S - 4                   | Blade & Underneath       | 1269                  | 5"                       | 3                                |
| Preform Station #1  | PF- 1                   |                          |                       |                          |                                  |
| Weigh Station       |                         | Slot                     | 166                   | 1 " x 15"                | 19                               |
| Overhead            |                         | Grate                    | 416                   | 10" x 15"                |                                  |
| Preform Station #20 | PF-20                   |                          |                       |                          |                                  |
| Weigh Station       |                         | Slot                     | 250                   | 1 " x 15"                | 19                               |
| Overhead            |                         | Grate                    | 700                   | 10" x 15"                |                                  |

TABLE V

American Brake Shoe Company  
Results of Air Samples of September, 1965  
Winchester, Virginia  
Friction

| Operation             | Ionizing |      | Membrane Filter |       |            |
|-----------------------|----------|------|-----------------|-------|------------|
|                       | Sample # | ppcf | Sample #        | Total | 10 $\mu$ r |
|                       |          |      |                 |       | >5 $\mu$   |
| Mixing & Coating      |          |      |                 |       |            |
| Compounder--BZ        | 116      | 0.7  |                 |       |            |
|                       | 107      | 0.2  | 108             | 0     | 0          |
|                       | 202      | 0.2  | 203             | 0     | 0          |
|                       | 129      | 0.3  | 130             | 1.9   | 0.5        |
| Personal              |          |      | 2               | 0.6   | 0.5 0.4    |
|                       |          |      | 29              | 9.2   | 7.0 3.1    |
|                       |          |      | 30              | 0.6   | 0.5 0.2    |
|                       |          |      | 205             | 1.6   | 1.2 0.5    |
|                       |          |      | 206             | 0.3   | 0.2 0.1    |
|                       |          |      | 209             | 0.2   | 0.1 0.1    |
| Weigher--BZ           | 10       | 0.4  | 11              | 0     | 0          |
|                       | 200      | 0.7  | 201             | 6.8   | 2.5        |
| Personal              |          |      | 1               | 0.7   | 0.7 0.7    |
|                       |          |      | 3               | 1.1   | 1.4 0.6    |
|                       |          |      | 8               | 0.2   | 0.6 0.2    |
|                       |          |      | 207             | 3.0   | 2.5 1.4    |
| Auto Roller Oper.--BZ | 43       | 0.3  | 44              | 11.0  | 0.0        |
|                       | 45       | 0.3  |                 |       |            |
| Personal              |          |      | 22              | 1.5   | 1.2 0.4    |
|                       |          |      | 25              | 1.3   | 1.0 0.5    |
|                       |          |      | 26              | 0.5   | 0.4 0.2    |
|                       |          |      | 27              | 2.9   | 2.4 0.8    |
|                       |          |      | 28              | 0.7   | 0.6 0.4    |

## NOTES ON ABBREVIATIONS

"Personal" refers to personal samples on membrane filters  
 "BZ" refers to breathing zone samples by companion ionizing & membrane filter  
 "Acc." refers to unattended samples taken by a sorbent sampler  
 "Gen." refers to sample of general plant air in the particular department

American Brake Shoe Company

| Operation                                  | Impinger |       | Hardware Filter |       |               |
|--------------------------------------------|----------|-------|-----------------|-------|---------------|
|                                            | Sample # | mppcf | Sample #        | Total | 10 µ +<br>>5µ |
| Mixing & Coating - Continued               |          |       |                 |       |               |
| Auto Roller Oper. -- Personal<br>(Cont'd.) |          |       | 158             | 0.1   | 0.3 0.0       |
|                                            |          |       | 159             | 0     | 0.0 0         |
|                                            |          |       | 210             | 25.0  | 0.9 0.1       |
|                                            |          |       | 211             | 8.9   | 1.6 0.4       |
|                                            |          |       | 212             | 2.4   | 0.5 0.0       |
| Hand Roller--Personal                      |          |       | 213             | 3.7   | 0.5 0.1       |
|                                            |          |       | 214             | 35.0  | 1.1 0.1       |
| Sweeper--Personal                          |          |       | 19              | 0.6   | 0.6 0.2       |
| Service Man--Personal                      |          |       | 20              | 0.7   | 0.6 0.4       |
| Quality Control--Personal                  |          |       | 21              | 1.3   | 1.0 0.3       |
| Proform--Personal                          |          |       | 7               | 1.4   | 1.0 0.6       |
| Forming                                    |          |       |                 |       |               |
| Hand Roll Operator--EZ                     | 139      | 0.4   | 140             | 2.5   | 0.6           |
| Radius Roll--EZ                            | 353      | 0.4   | 354             | 12.9  | 3.3           |
|                                            | 291      | 0.6   | 292             | 3.1   | 0.4           |
| Personal                                   |          |       | 293             | 2.7   | 2.0 1.0       |
|                                            |          |       | 297             | 4.2   | 1.4 0.7       |
|                                            |          |       | 240             | 1.5   | 0.5 0.3       |
| Proform Operator--EZ                       | 51       | 1.3   | 52              | 3.1   | 1.0           |
|                                            | 137      | 1.2   | 138             | 7.6   | 1.6           |

American Drake Shoe Company

| Operation                         | Insulator |       | Membrane Filter |       |         |
|-----------------------------------|-----------|-------|-----------------|-------|---------|
|                                   | Sample #  | mppcf | Sample #        | Total | 10 μ +  |
|                                   |           |       |                 |       | >5μ     |
| Forming (Continued)               |           |       |                 |       |         |
| Preform Operator--EZ<br>(Cont'd.) | 147       | 1.9   | 148             | 11.5  | 4.5     |
|                                   | 162       | 0.4   | 163             | 0     | 0       |
|                                   | 176       | 3.9   | 177             | 3.6   | 1.0     |
|                                   |           |       |                 |       |         |
| Personal                          |           |       | 142             | 16.2  | 9.6 3.9 |
|                                   |           |       | 144             | 7.7   | 5.4 3.2 |
|                                   |           |       | 145             | 4.8   | 3.5 2.5 |
|                                   |           |       | 146             | 4.6   | 3.1 1.6 |
|                                   |           |       | 152             | 8.4   | 7.0 2.9 |
|                                   |           |       | 153             | 6.3   | 5.5 3.0 |
|                                   |           |       | 155             | 7.1   | 6.1 2.7 |
|                                   |           |       | 157             | 1.5   | 1.7 1.0 |
|                                   |           |       | 160             | 10.8  | 9.5 4.6 |
|                                   |           |       | 161             | 7.5   | 6.3 2.9 |
| Hand Roll Operator--EZ            | 139       | 0.4   | 140             | 2.5   | 0.6     |
|                                   |           |       |                 |       |         |
| Radius Roll--EZ                   | 353       | 0.4   | 354             | 12.9  | 3.3     |
|                                   | 291       | 0.6   | 292             | 3.1   | 0.4     |
| Personal                          |           |       | 293             | 2.7   | 2.0 1.0 |
|                                   |           |       | 297             | 4.2   | 1.4 0.7 |
|                                   |           |       | 343             | 1.5   | 0.5 0.3 |
| Preform Operator--EZ              | 51        | 1.3   | 52              | 3.1   | 1.0     |
|                                   | 137       | 1.2   | 138             | 7.6   | 1.6     |
|                                   | 147       | 1.9   | 148             | 11.5  | 4.5     |
|                                   | 162       | 0.4   | 163             | 0     | 0       |
|                                   | 176       | 3.9   | 177             | 3.6   | 1.0     |
|                                   |           |       |                 |       |         |

American Brake Shoe Company

| Operation                                 | Impinger |       | Nephelometer Filter |       |            |
|-------------------------------------------|----------|-------|---------------------|-------|------------|
|                                           | Sample # | mppcf | Sample #            | Total | 10 $\mu$ + |
|                                           |          |       |                     |       | >5 $\mu$   |
| Forming (Continued)                       |          |       |                     |       |            |
| Preform Operator--Personal                |          |       | 142                 | 16.9  | 9.6 3.9    |
|                                           |          |       | 144                 | 7.7   | 5.4 3.2    |
|                                           |          |       | 145                 | 4.8   | 3.5 2.5    |
|                                           |          |       | 146                 | 4.8   | 3.1 2.3    |
|                                           |          |       | 153                 | 8.4   | 7.0 2.9    |
|                                           |          |       | 154                 | 6.3   | 5.5 3.0    |
|                                           |          |       | 155                 | 7.1   | 6.1 2.7    |
|                                           |          |       | 157                 | 1.5   | 1.7 1.0    |
|                                           |          |       | 160                 | 10.8  | 9.5 4.6    |
|                                           |          |       | 161                 | 7.5   | 6.3 2.9    |
| Hot Pressing                              |          |       |                     |       |            |
| Sweeper--Personal                         |          |       | 60                  | 0     | 0.1 0.0    |
| Serviceman--Personal                      |          |       | 89                  | 2.5   | 1.0 0.7    |
|                                           |          |       | 180                 | 2.8   | 1.0        |
| Cinching Forms--Personal<br>(Form Fitter) |          |       | 402                 | 1.4   | 1.2 0.7    |
| ABK & Press Oper.--BZ                     | 84       | 0.1   | 83                  | 0     | 0          |
| Book Press Oper.--BZ<br>(Hot).            | 185      | 1.1   | 186                 | 1.6   | 0.9        |
|                                           |          |       | 181                 | 5.3   | 4.0 1.5    |
| Service Man, Hot Press                    |          |       | 141                 | 2.7   | 1.4 0.6    |
|                                           |          |       | 143                 | 3.9   | 1.4 0.5    |

American Brake Shoe Company

| Operation                   | Impinger |      | Membrane Filter |       |            |
|-----------------------------|----------|------|-----------------|-------|------------|
|                             | Sample # | mpcf | Sample #        | Total | 10 $\mu$ + |
|                             |          |      |                 |       | >5 $\mu$   |
| Hot Pressing; ( Continued ) |          |      |                 |       |            |
| Hot Press Oper.--BE         | 63       | 1.0  | 64              | 0     | 0          |
|                             | 73       | 0.1  | 74              | 0.6   | 0.4        |
| Personal                    |          |      | 58              | 1.8   | 1.5        |
|                             |          |      | 59              | 3.4   | 2.5        |
|                             |          |      | 61              | 2.5   | 1.8        |
|                             |          |      | 62              | 0     | 0.1        |
|                             |          |      | 65              | 7.9   | 5.0        |
|                             |          |      | 66              | 2.9   | 2.1        |
|                             |          |      | 68              | 1.8   | 1.3        |
|                             |          |      | 70              | 2.5   | 2.2        |
|                             |          |      | 71              | 1.6   | 0.7        |
|                             |          |      | 72              | 3.3   | 1.6        |
|                             |          |      | 79              | 4.4   | 3.8        |
|                             |          |      | 80              | 4.3   | 3.6        |
|                             |          |      | 81              | 1.8   | 1.4        |
|                             |          |      | 82              | 0.2   | 0.1        |
|                             |          |      | 183             | 3.1   | 2.2        |
| Baking                      |          |      |                 |       |            |
| Oven Oper.--BE              | 221      | 0.4  | 220             | 0.4   | 0.0        |
| Conveyor                    |          |      |                 |       |            |
| Personal                    |          |      | 193             | 1.4   | 1.2        |
| Oven Oper.--Personal        |          |      | 194             | 1.9   | 1.4        |
|                             |          |      | 403             | 5.4   | 3.1        |
|                             |          |      | 414             | 0.5   | 0.3        |

American Brake Shoe Company

| Operation                           | Production |      | Standard Time |      |         |
|-------------------------------------|------------|------|---------------|------|---------|
|                                     | Sample #   | Time | Sample #      | Time | Time    |
|                                     |            |      |               |      | >5p     |
| Grinding & Sanding                  |            |      |               |      |         |
| Radius Roll--37                     | 215        | 0.5  | 227           | 0.0  | 0       |
|                                     |            |      | 228           | 3.5  | 1.4     |
| Back Grinder--37                    | 341        | 0.3  | 362           | 1.3  | 0.2     |
|                                     | 343        | 0.1  | 363           | 0.2  | 4.3     |
| Strip Grinder--37                   | 352        | 0.3  | 365           | 1.6  | 0.2     |
| Auto Grinder--37                    | 401        | 1.9  | 402           | 5.5  | 1.4     |
| Stock Grinder--37                   | 310        | 0.6  | 410           | 2.1  | 0.0     |
| Double Flank Break<br>Grinder -- 37 | 409        | 1.7  | 490           | 0.5  | 0.2     |
| Rough Grind--37                     | 611        | 1.2  | 610           | 1.5  | 0.2     |
| Radius Grind--37                    | 612        | 1.9  | 613           | 3.9  | 0.3     |
| Ball Grinder                        | 703        | 3.7  | 705           | 9.0  | 3.4     |
| Auto Grinder<br>DR Block            | 705        | 0.8  | 706           | 5.0  | 1.9     |
| Cool Grinder--37                    | 351        | 0.4  | 352           | 3.1  | 0.3     |
| Personal                            |            |      | 268           | 1.3  | 0.9 0.7 |
| Strip Finish--Personal              |            |      | 299           | 6.9  | 3.5 1.3 |
| Turner Oper.--Personal              |            |      | 321           | 12.9 | 3.5 2.1 |
|                                     |            |      | 356           | 3.0  | 1.0 0.3 |

American Brake Shoe Company

| Operation                         | Dewatering |       | Membrane Filter |       |            |
|-----------------------------------|------------|-------|-----------------|-------|------------|
|                                   | Sample #   | mppcf | Sample #        | Total | 10 $\mu$ + |
|                                   |            |       |                 |       | >5 $\mu$   |
| Grinding & Sanding<br>(Continued) |            |       |                 |       |            |
| Coil Grinder                      |            | 296   |                 | 3.7   | 2.5 1.2    |
| Double Disk Grinder--Personal     |            | 334   |                 | 5.4   | 3.7 2.5    |
| Sweeper--Personal                 |            | 409   |                 | 5.0   | 4.2 2.3    |
| Auto Burr. Mach.--Personal        |            | 393   |                 | 19.7  | 15.2 7.3   |
| Printer--Personal                 |            | 242   |                 | 7.6   | 5.3 2.7    |
|                                   |            | 267   |                 | 23.1  | 2.9 0.5    |
|                                   |            | 335   |                 | 3.0   | 1.2 0.8    |
| Back Grinder--Personal            |            | 249   |                 | 7.9   | 3.6 1.4    |
|                                   |            | 254   |                 | 0.7   | 0.5 0.2    |
|                                   |            | 255   |                 | 2.3   | 0.6 0.2    |
|                                   |            | 298   |                 | 1.2   | 0.5 0.5    |
|                                   |            | 338   |                 | 4.4   | 2.7 2.2    |
|                                   |            | 345   |                 | 18.5  | 4.9 2.0    |
| Finish Grind Block--Personal      |            | 497   |                 | 3.9   | 6.6 2.8    |
|                                   |            | 498   |                 | 7.8   | 6.1 2.5    |
| Strip Grind.--Personal            |            | 256   |                 | 15.6  | 1.5 0.9    |
|                                   |            | 257   |                 | 0     | 0.0 0      |
|                                   |            | 264   |                 | 7.4   | 5.5 2.5    |
| Chamfer. Oper.--Personal          |            | 243   |                 | 1.7   | 0.7 0.3    |
|                                   |            | 247   |                 | 0.1   | 0.0 0.1    |
|                                   |            | 261   |                 | 14.3  | 2.5 1.2    |
|                                   |            | 391   |                 | 4.1   | 3.1 1.4    |
|                                   |            | 270   |                 | 5.6   | 1.2 0.8    |
|                                   |            | 346   |                 | 13.9  | 3.1 1.3    |

American Brake Shoe Company

| Operation | Laminar  |      | Membrane Filter |                          |
|-----------|----------|------|-----------------|--------------------------|
|           | Sample # | mpcf | Sample #        | Total 10 ft <sup>4</sup> |

>5μ

Cutting & Drilling  
(Continued)

Drill. Oper.---Personal  
(Cont'd.)

|     |      |      |     |
|-----|------|------|-----|
| 251 | 0.0  | 0.0  | 0   |
| 252 | 1.5  | 0.9  | 0.4 |
| 259 | 1.4  | 0.1  | 0   |
| 260 | 48.4 | 1.7  | 0.2 |
| 265 | 6.1  | 1.1  | 0.4 |
| 269 | 4.4  | 2.0  | 1.1 |
| 277 | 0.5  | 0.2  | 0.0 |
| 280 | 3.1  | 2.2  | 1.5 |
| 282 | 2.5  | 0.6  | 0.6 |
| 376 | 13.0 | 10.2 | 3.1 |
| 397 | 3.5  | 2.2  | 0.8 |
| 700 | 6.7  | 4.9  | 1.7 |

Tafton --- Personal  
Lathe Oper.

|     |     |     |     |
|-----|-----|-----|-----|
| 197 | 0.9 | 0.7 | 0.3 |
| 198 | 2.1 | 1.4 | 0.6 |

Ball Joint Punch

|     |     |     |     |
|-----|-----|-----|-----|
| 385 | 3.2 | 2.1 | 0.7 |
| 67  | 1.0 | 0.8 | 0.3 |

Cutter

|     |     |     |     |
|-----|-----|-----|-----|
| 401 | 3.7 | 2.6 | 0.7 |
|-----|-----|-----|-----|

Pexco Press

|     |     |     |     |
|-----|-----|-----|-----|
| 376 | 1.9 | 1.1 | 0.6 |
|-----|-----|-----|-----|

AMK Oven

|     |     |     |     |
|-----|-----|-----|-----|
| 199 | 3.5 | 1.2 | 0.6 |
|-----|-----|-----|-----|

Inspection & Packing

Grouping---JM

|     |     |  |     |
|-----|-----|--|-----|
| 368 | 0.3 |  |     |
| 369 | 4.7 |  | 1.0 |

American Brake Shoe Company

| Operation                           | Impinger |      | Membrane Filter |       |          |
|-------------------------------------|----------|------|-----------------|-------|----------|
|                                     | Sample # | mpcf | Sample #        | Total | 10 µ +   |
|                                     |          |      |                 |       | >5µ      |
| Inspection & Packing<br>(Continued) |          |      |                 |       |          |
| Box Segments --Personal             |          |      |                 |       |          |
| Printer, Loader                     |          |      | 377             | 1.6   | 1.0 0.5  |
|                                     |          |      | 378             | 1.7   | 1.2 0.7  |
|                                     |          |      | 380             | 1.4   | 1.2 0.6  |
| Packer--Personal                    |          |      | 382             | 1.8   | 0.9 0.3  |
|                                     |          |      | 383             | 0.9   | 0.7 0.5  |
|                                     |          |      | 386             | 1.8   | 1.4 0.5  |
|                                     |          |      | 371             | 4.2   | 3.1 1.2  |
|                                     |          |      | 372             | 2.6   | 2.1 0.9  |
|                                     |          |      | 363             | 2.6   | 2.1 0.7  |
| Inspection Dry -- RI                | 459      | 0.6  | 460             | 1.2   | 0.2      |
|                                     | 474      | 0.7  | 475             | 0.0   | 0.0      |
| Personal                            |          |      | 278             | 2.6   | 0.5      |
|                                     |          |      | 308             | 19.1  | 14.3 5.0 |
|                                     |          |      | 341             | 8.2   | 6.4 2.3  |
|                                     |          |      | 347             | 7.1   | 5.1 2.2  |
|                                     |          |      | 348             | 4.2   | 3.2 1.1  |
|                                     |          |      | 370             | 5.3   | 4.0 1.3  |
|                                     |          |      | 399             | 9.9   | 7.8 3.1  |
| Net--32                             | 366      | 0.3  | 367             | 0.6   | 0.0      |
|                                     | 445      | 0.1  | 446             | 0     | 0.0      |
|                                     | 487      | 0.2  | 488             | 1.6   | 0.0      |
| Personal                            |          |      | 439             | 1.9   | 1.3 0.6  |
|                                     |          |      | 443             | 1.4   | 1.2 0.7  |
|                                     |          |      | 444             | 1.4   | 1.0 0.5  |
|                                     |          |      | 449             | 7.5   | 5.7 2.5  |
|                                     |          |      | 451             | 3.1   | 2.2 0.6  |

American Drake Shoe Company

| Operation                           | Inspection |      | Radiation Filter |             |         |
|-------------------------------------|------------|------|------------------|-------------|---------|
|                                     | Sample #   | Type | Sample #         | Total       | 10 p. + |
|                                     |            |      |                  |             | >5u     |
| Inspection & Packing<br>(Continued) |            |      |                  |             |         |
| Net--Personal<br>(Cont'd.)          |            |      | 452              | 5.0 3.3 1.3 |         |
|                                     |            |      | 453              | 3.1 1.7 0.3 |         |
|                                     |            |      | 461              | 5.4 1.7     |         |
|                                     |            |      | 472              | 0.7 0.6 0.3 |         |
|                                     |            |      | 474              | 4.3 3.5 1.3 |         |
| Leader--Personal                    |            |      | 442              | 1.7 0.6     |         |
| Miscellaneous                       |            |      |                  |             |         |
| Shipping Checker--Personal          |            |      | 379              | 0 0 0       |         |
| Wire Splitter--Personal             |            |      | 204              | 2.7 1.0 0.8 |         |
| Printer--Personal                   |            |      | 500              | 2.1 1.0 0.6 |         |
| PC Room--Personal                   |            |      | 411              | 2.9 2.4 1.3 |         |
| Electrician--Personal               |            |      | 405              | 1.4 1.3 0.8 |         |
|                                     |            |      | 408              | 1.1 1.2 0.4 |         |
|                                     |            |      | 410              | 2.0 0.9 0.4 |         |
| Maint. Crew--Personal               |            |      | 400              | 0.6 0.4 0.1 |         |
|                                     |            |      | 404              | 3.3 1.5 1.1 |         |
|                                     |            |      | 412              | 1.7 0.9 0.5 |         |
|                                     |            |      | 413              | 1.8 1.2 0.4 |         |