

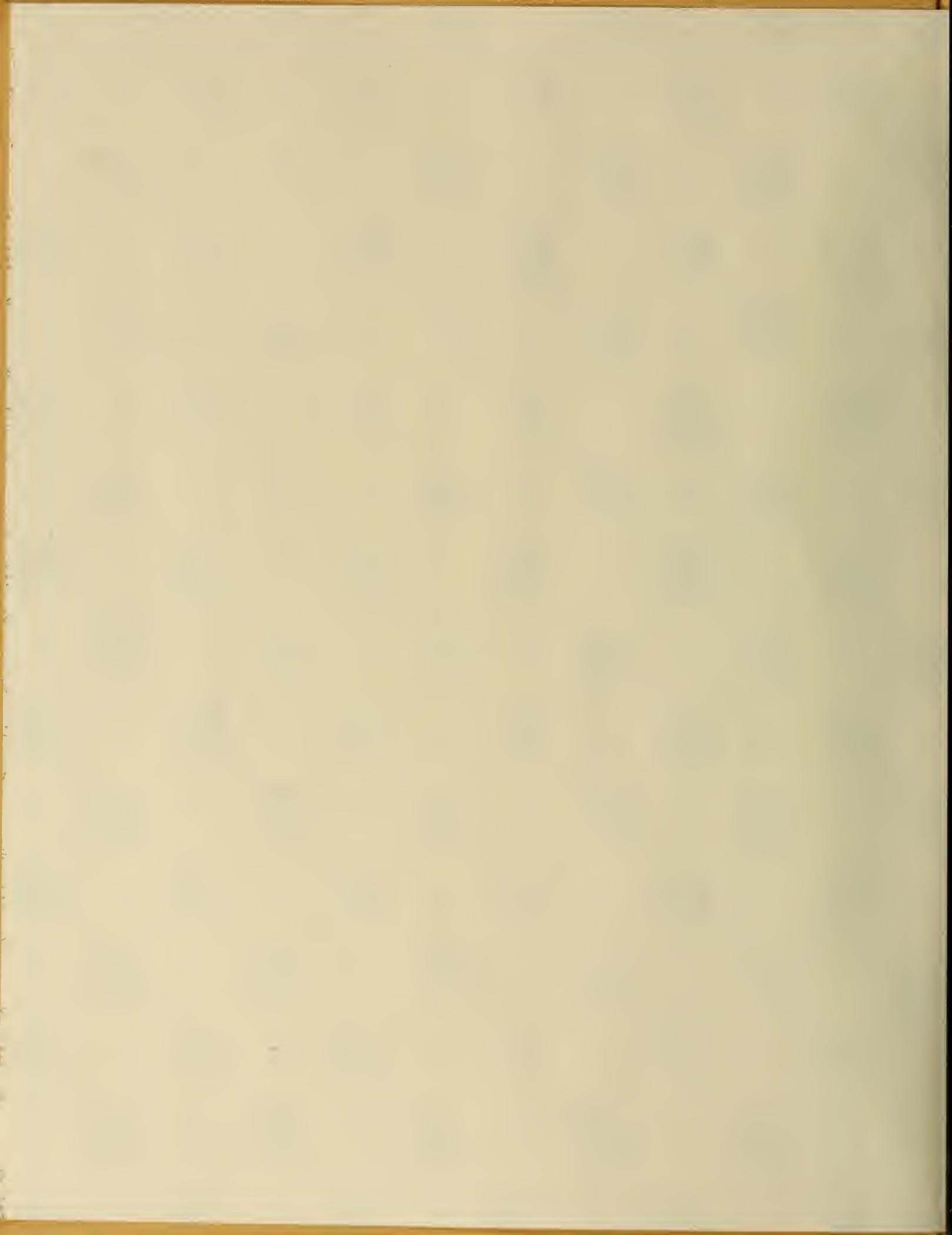
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Dust Reduction Capabilities of Five Commercially Available Bag Valves

By Andrew B. Cecala, Anthony Covelli,
and Edward D. Thimons



UNITED STATES DEPARTMENT OF THE INTERIOR



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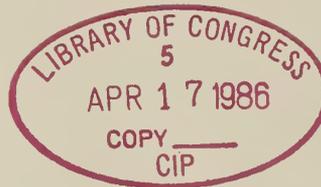
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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cfm	cubic foot per minute	min	minute
in	inch	mm	millimeter
lb	pound	pct	percent
mg/m ³	milligram per cubic meter		

DUST REDUCTION CAPABILITIES OF FIVE COMMERCIALY AVAILABLE BAG VALVES

By Andrew B. Cecala,¹ Anthony Covelli,² and Edward D. Thimons³

ABSTRACT

The dust-reduction capabilities of five commercially available bag valves were evaluated by the Bureau of Mines for use in mineral processing plants. The five valves were made of (1) standard paper, (2) polyethylene, (3) extended polyethylene, (4) double trap (paper), and (5) foam. The valves were evaluated at a mineral processing plant during the bag loading, conveying, and pallet loading process. For the overall process, the extended polyethylene valve was the most effective at reducing product blowback, and resulted in lower dust concentrations for bag-generated dust. When compared to the standard paper, it gave a 62-pct reduction in respirable dust at the bag operator location, and a 66-pct reduction at the bag stacker location. The cost of the extended polyethylene valve is less than 1 cent per bag higher than that of the standard paper valve. The high dust reductions and slight cost increase make it an attractive choice for the mineral processing industry.

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BACKGROUND

The intent of this Bureau of Mines work was to determine the dust reduction capabilities of various bag valves available to the mineral processing industry.

Many different types of ground mineral products are packaged into 50- or 100-lb paper bags. Although bag technology is continually improving, contamination from bags still remains a significant source of dust exposure for workers. Most of the bag contamination comes from the bag valve. The bag valve is simply a means of inserting the fill nozzle into

a bag. When the bag is full and falls to the conveyor, the product within the bag forces the valve closed. The valve usually does not close properly, however, because product is usually trapped inside it during filling and ejection. As a result, the valves leak product, and, therefore, dust is generated during the conveying and pallet-loading process. This dust contaminates the work environment and is a health hazard to persons working in the area.



FIGURE 1. - "Rooster tail" of product discharged from bag valve as bag falls from fill nozzle.

Bag-generated dust contaminates the work area in a number of ways. One source is product blowback during the fill cycle. During filling, the inside of the bag becomes pressurized by the fluidizing air, which is used to carry the product into the bag. This pressure is relieved by air and product blowing out of the bag valve. This produces a considerable amount of airborne dust to which the bag operator is exposed. When the bag has finished filling and falls from the fill station, a "rooster tail" of product is discharged from the valve (fig. 1). As the bag hits the conveyor

belt, additional product is discharged from the valve, further contaminating the work environment and exposing the bag operator.

These dust sources also contribute to the accumulation of product on the outside of the bag (fig. 2). As the bags of product are conveyed to the pallet-loading area, this accumulation is dispersed into the air, exposing workers, especially the bag stackers. In addition, as the bags drop from one conveyor to another or from the conveyor to the bag slinger, dust is again emitted from the valve (fig. 3).



FIGURE 2. - Product accumulation on outside of bags.

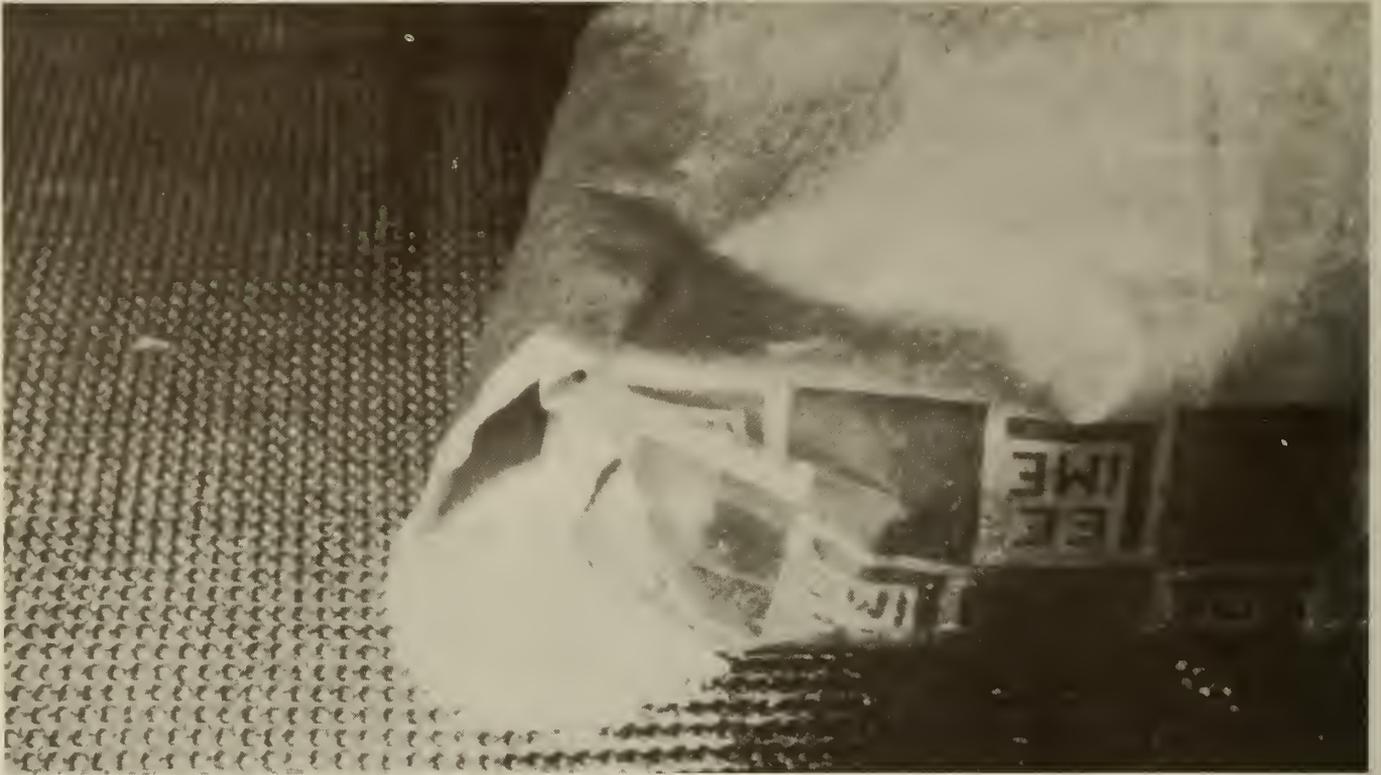


FIGURE 3. - Product that has escaped from bag valve during conveying process.

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Silica Co., for his cooperation and assistance in the actual testing at one of the Central Silica facilities. We would also like to thank Jon C. Volkwein, Bureau of Mines, for helping to establish this project.

TESTING

A 3-week study was performed to evaluate five different bag valves that were considered either to be the most commonly used, or to be potentially the most effective. Initially, 2 weeks of testing were performed to compare the following five bag valves:

1. Standard paper (used as the normal).
2. Polyethylene.
3. Extended polyethylene,
4. Double trap (paper).
5. Foam.

The standard paper and polyethylene valves are the two most common valves

used in the mineral processing industry. The last three valves were believed to have the greatest dust reduction potential.

In preparation for testing, the conveyor and pallet-loading area were enclosed in a tunnel made of wood framing and thick plastic. A 1,300-cfm blowing fan directed air through this enclosure. By knowing the dust concentration coming into the enclosure, the amount of dust generated from bag contamination and valve leakage could be determined. The enclosure and fan provided a controlled atmosphere and reduced contamination from outside sources.

Five real-time aerosol monitors (RAM) were placed at various locations throughout the bagging and pallet-loading area to measure respirable dust concentrations. The RAM-1 monitors, developed by GCA Corp.³ under a Bureau contract, use a light-scattering device to calculate the dust concentration of a sample drawn in from the environment. The monitors can be sensitive to changes in the dust content (size, shape, refractive index), but if calibrated to a specific dust content, their accuracy is within ± 10 pct of gravimetric samplers equipped with the standard 10-mm cyclone to measure respirable dust.⁴ Before the RAM-1 monitors were taken into the field, they were

³Reference to specific manufacturers does not imply endorsement by the Bureau of Mines.

⁴Williams, K. L., and R. J. Timko. Performance Evaluation of a Real-Time Aerosol Monitor. BuMines IC 8968, 1984, 20 pp.

calibrated side by side in a dust box. The RAM-1 dust monitors were used in this study for a comparative evaluation. Since the dust concentration for each valve type was compared to that of each of the other four valves, it was not necessary to use the specific dust type for calibration. The output from these dust monitors were continuously recorded on a data logger and dual-pen strip-chart recorders. The following sampling positions were monitored (fig. 4):

Intake.--Located upstream of the blower to measure intake dust concentrations.

Operator.--Located above the bag operator to measure the dust in the bag pit area.

Transfer.--Located slightly downstream from the conveyor transfer point to measure dust generated at that point.

Right and left stacker.--A cyclone attached to lapel of each bag stacker to give a direct indication of their dust exposure.

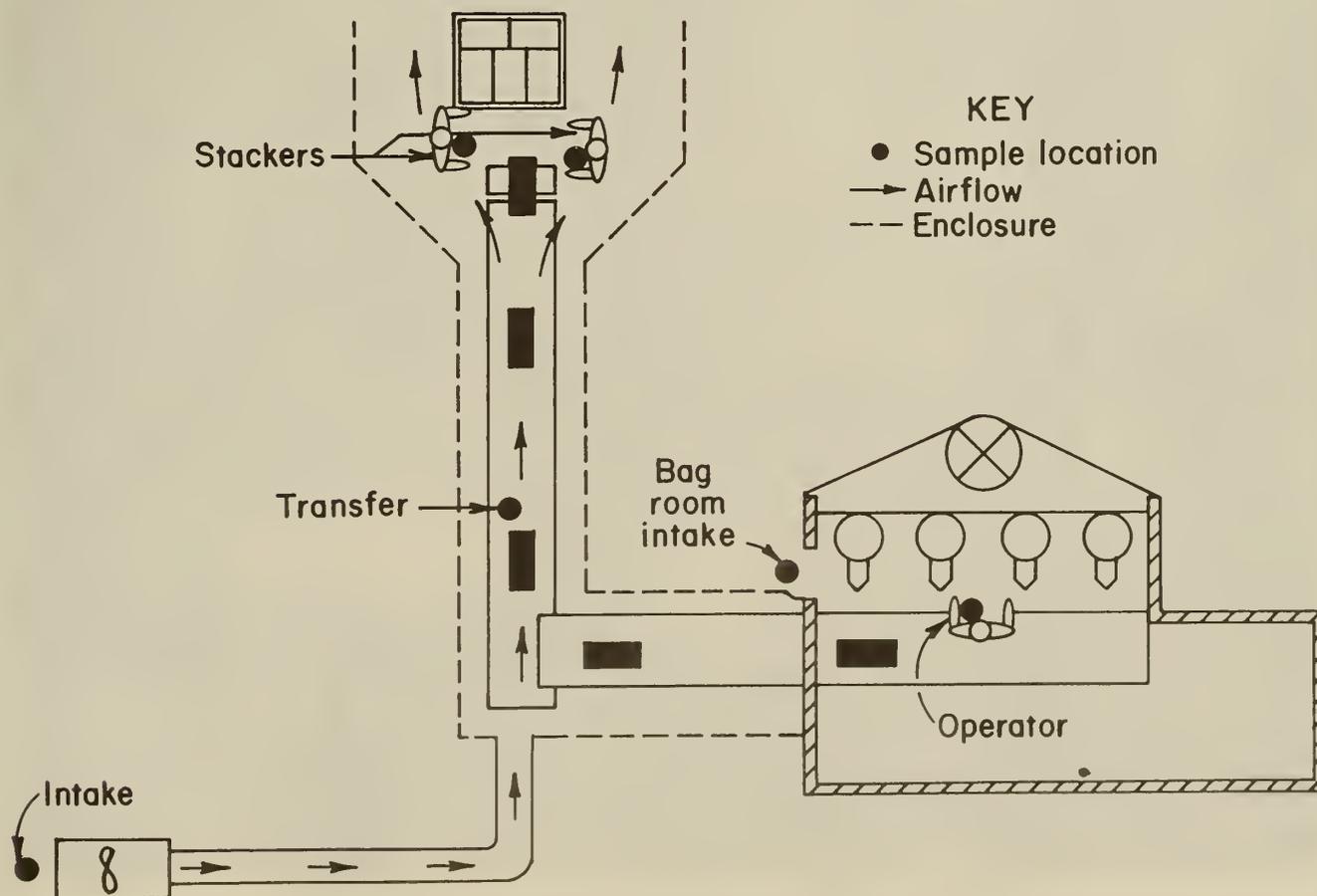


FIGURE 4. - Sampling setup for field testing.

In all cases, the 10-mm cyclone was physically separated from the monitor and connected by Tygon vinyl tubing. To monitor a worker's dust exposure, a cyclone was attached to the worker's lapel, as shown in figure 5. The cyclone was connected to the dust monitor by the vinyl tubing to allow the worker to perform his job function with minimal interference. Since the tubing length at each sample location remained the same, deposition on the inner tubing walls was neglected, especially since the monitors were used for a comparative evaluation in comparing one valve type to another.

Each valve type was tested separately on a truck-by-truck basis (480 bags). After one truck was loaded, the bags were changed to a different valve type, until each valve type had been tested; then the cycle was repeated. At the conclusion of the 2-week test period, the data were analyzed for each valve type.

The results of the 2-week test are shown in table 1 for 325-mesh product. The values in the table represent a time-weighted average concentration for the dust measurements at each location. The measured dust concentration for each truck was multiplied by the run time. The value for each truck was then summed to give the average concentration for each monitoring location. The intake dust concentrations were subtracted for each of the sampling locations. The measured dust concentrations for each position were ranked from one to five (lowest to highest). These ranking values were totaled to indicate an overall comparative rating for each valve. The lower

the number, the more effective the valve was at reducing bag-generated dust. The results from the foam valve were limited to one sampling period because the valve was undersized, which caused difficulty in placing the bag on the nozzle, and would not allow the bag to eject automatically after filling. This undersized valve created production delays and prevented additional testing of the foam valve.

The extended polyethylene valve showed the greatest dust reduction during the conveying and pallet-loading process. The foam valve also gave substantial dust reductions, but it must be remembered that this testing was limited. Dust concentrations with the double trap and the polyethylene valves were higher than with the standard paper valve except at the bag stacker location for the polyethylene valve.

Based on these results, it was decided to perform some additional testing on the standard paper, the extended polyethylene, and the foam valves. Additional foam valve bags were acquired with the correct valve size. Due to financial constraints by the cooperating plant for this study, it was only possible to order 500 bags with foam valves. Therefore, the results of this final analysis are based on one truckload (480 bags) of each valve type (standard paper, extended polyethylene, and foam), which takes approximately 50 min to load. To eliminate fluctuations due to different work patterns and style, each employee at the ground-silica-bagging area was asked to work the same position for the entire

TABLE 1. - Results from initial 2-week test at various locations using 325-mesh product

Valve	Operator		Transfer		Bag stackers		Total of rankings
	Conc, mg/m ³	Rank	Conc, mg/m ³	Rank	Conc, mg/m ³	Rank	
Double trap.....	0.20	4	0.67	5	0.76	5	14
Extended polyethylene	.04	2	.15	1	.32	1	4
Foam.....	.02	1	.25	2	.56	4	7
Polyethylene.....	.24	5	.47	4	.46	2	11
Standard paper.....	.05	3	.41	3	.55	3	9

NOTE.--Intake dust levels have been subtracted from measured dust concentrations.

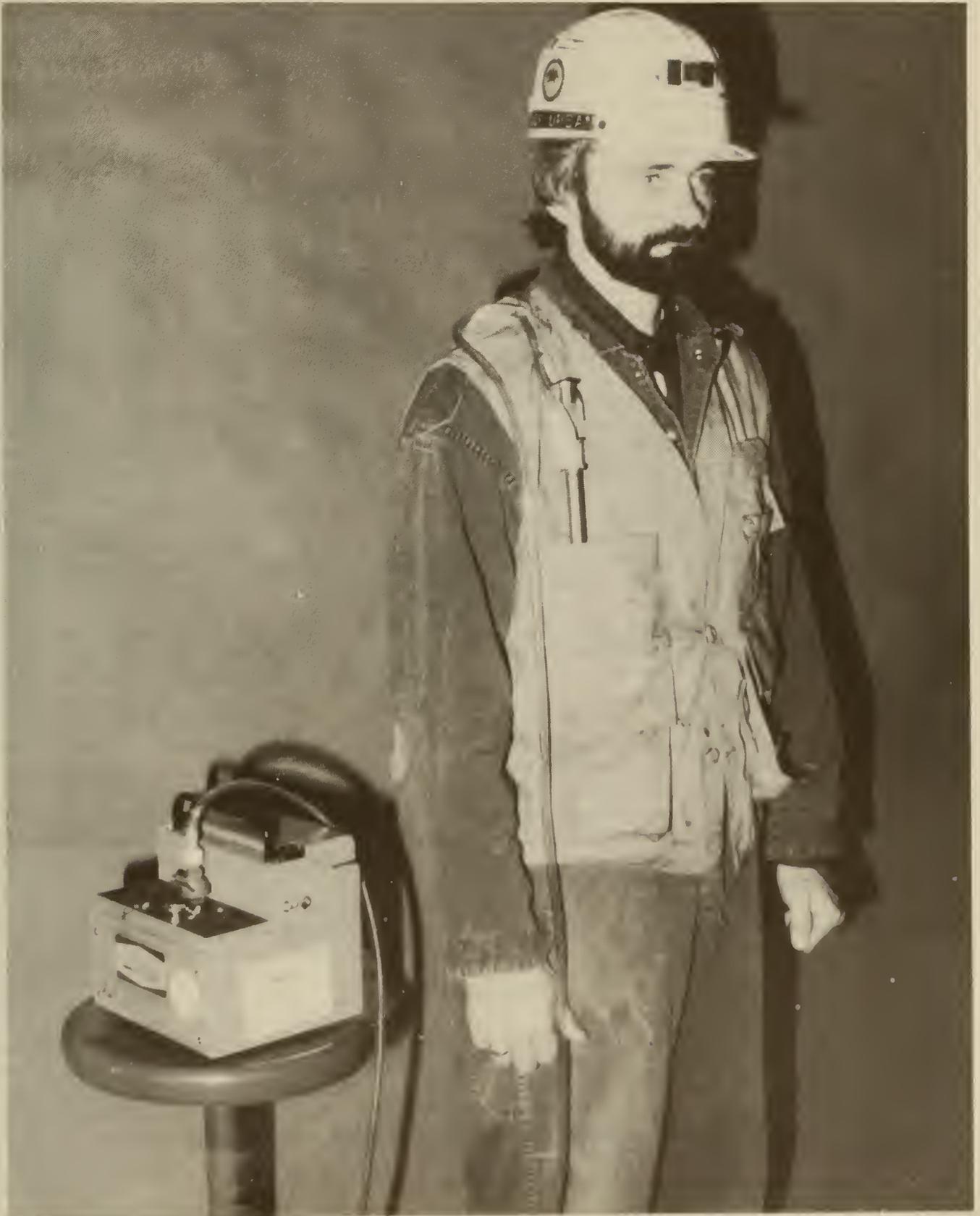


FIGURE 5. - Sampling setup to monitor worker's dust exposure.

test. An additional sample location was included and one sample location was improved, as follows:

Operator.--The cyclone was relocated to the bag operator's lapel to give a direct indication of dust exposure.

Bag room intake.--The cyclone was located at the intake window into the bag room to indirectly measure the amount of dust liberated during the conveying process.

Due to truck schedules the week of testing, it was more advantageous to evaluate the bag valves using 200-mesh product than the 325 mesh used for the 2-week evaluation.

The results of this final analysis are shown in table 2. Because the intake concentrations did not fluctuate significantly during the 2-week evaluation and because of a faulty pump in a RAM-1 dust monitor, the intake sample location was eliminated, and thus the intake concentrations were not subtracted as in the first test; thus, the values are the actual recorded concentrations. The extended polyethylene valve had the lowest dust concentrations at all sample locations, and the foam valve showed an improvement over the standard paper valve at each location. Figure 6 shows the percent dust reduction with these two valves over that of the standard paper valve. The two most critical sample locations, those of the bag operator and the bag stacker, showed a 62-pct and a 66-pct reduction, respectively, using the extended polyethylene, as compared with a 49-pct and a 35-pct reduction, respectively, for the foam valve.

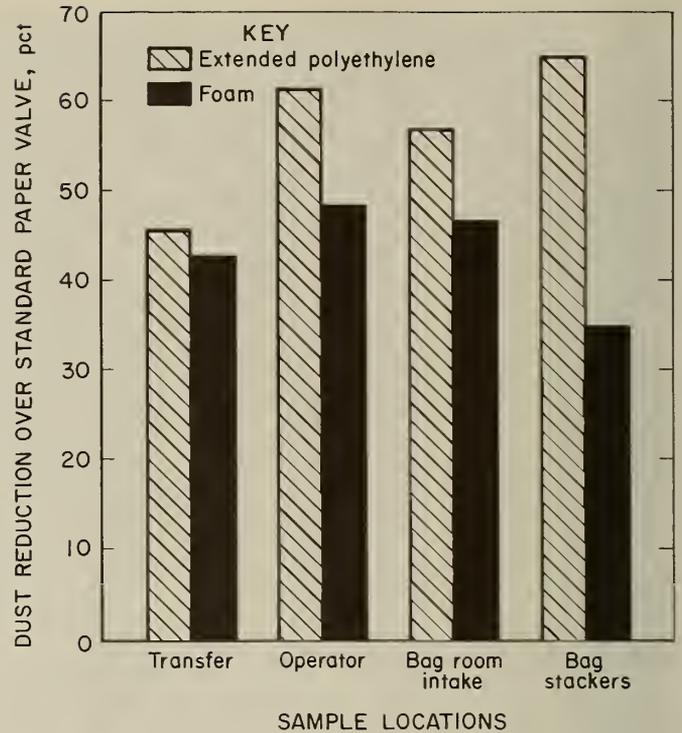


FIGURE 6. - Dust reductions with extended polyethylene and foam valves compared with that of standard paper valve.

TABLE 2. - Results from final test at various locations using 200-mesh product, milligrams per cubic meter

Valve	Operator	Transfer	Bag room intake	Bag stackers
Extended polyethylene.	0.36	0.69	0.28	1.03
Foam.....	.48	.73	.35	1.94
Standard paper	.94	1.28	.66	2.99

NOTE.--Intake dust levels have not been subtracted from measured dust concentrations.

DISCUSSION

The significant portion of bag-generated dust begins in the bag valve area. This leakage from the bag valve either directly contaminates the work environment, or soils the outside of the bag, which contaminates the work

environment later during the conveying and pallet-loading process. The effectiveness of the different bag valves appears to depend on two factors: the valve length and the material.

The first factor that influences the effectiveness of each valve type is the length of the valve. The lengths of the valves used for this study are as follows, in inches:

Double trap.....	4.5
Extended polyethylene...	6.0
Foam.....	4.0
Polyethylene.....	4.5
Standard paper.....	5.5

For the same valve material, the longer the valve, the more effective it is at reducing leakage. This is most clearly demonstrated by the substantial difference between the extended polyethylene and the normal polyethylene valve. The additional 1.5 in of length significantly reduced leakage from the valve, and thus bag-generated dust. However, the valve should never be longer than the fill nozzle because this could substantially increase product blowback.

The second factor that influences the valve effectiveness is the material used in the valve: namely, paper, polyethylene, and foam. Polyethylene is a plastic material, lighter than paper, and thus may provide for a more effective seal. The idea behind the foam valve is that the open cells in the foam allow excess air to exit the bag but retaining the product. If the same bag valve length were tested for each valve material, the speculated ranking of material in this test would be foam, polyethylene, and paper, from the most to the least effective.

The foregoing two factors justify the order of effectiveness in the bag valve testing. For instance, the double trap, which was initially expected to be an effective valve, proved to be the least effective, because it was the second shortest valve and made of what we believe was the least effective material (paper). Another example is the foam valve, which was ranked as the second most effective valve. Foam is believed to be the most effective material, but the valve was the shortest one tested. If the foam valve

were lengthed by an inch or two, it might be more effective than even the extended polyethylene valve.

A major consideration in selecting a specific valve is the increase in cost over that of the paper valve. A number of factors influence the cost of a valve. The first is the inherent cost of the material and the quantity of material required to make the valve. The second factor would be the amount of work necessary to make the valve, such as folding it in a specific way and the difficulty in actually gluing it in place. Table 3 shows the increased cost of the different valves over that of the standard paper valve. These costs represent the average of prices obtained from three different manufacturers, with the exception of the foam valve, which is manufactured by only two companies at the present time.

When a company selects a valve type, it chooses the most cost effective valve possible, which incorporates the effectiveness of the valve in reducing product blowback and bag-generated dust and the cost of the valve. These tests have shown that for the five bag valves tested, the extended polyethylene valve appears to be the most effective valve for reducing product blowback from the bag valve, thus resulting in lower dust concentrations for bag-generated dust for the conveying and pallet-loading process. It also has the lowest cost increase (the same as the normal polyethylene) over that of the standard paper valve. The extended polyethylene, therefore, was the most cost-effective valve tested.

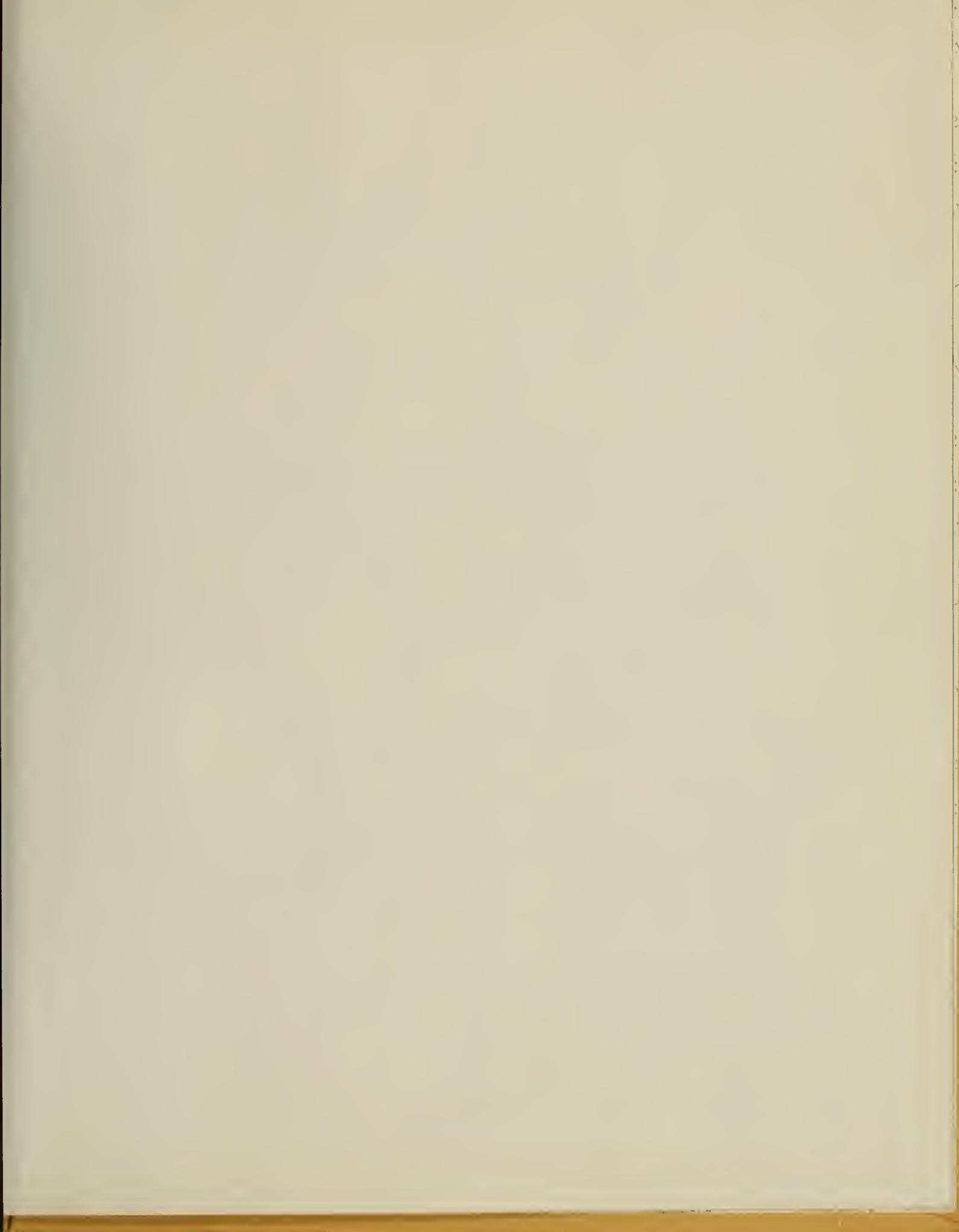
TABLE 3. - Increase in valve cost above the cost of standard paper valve

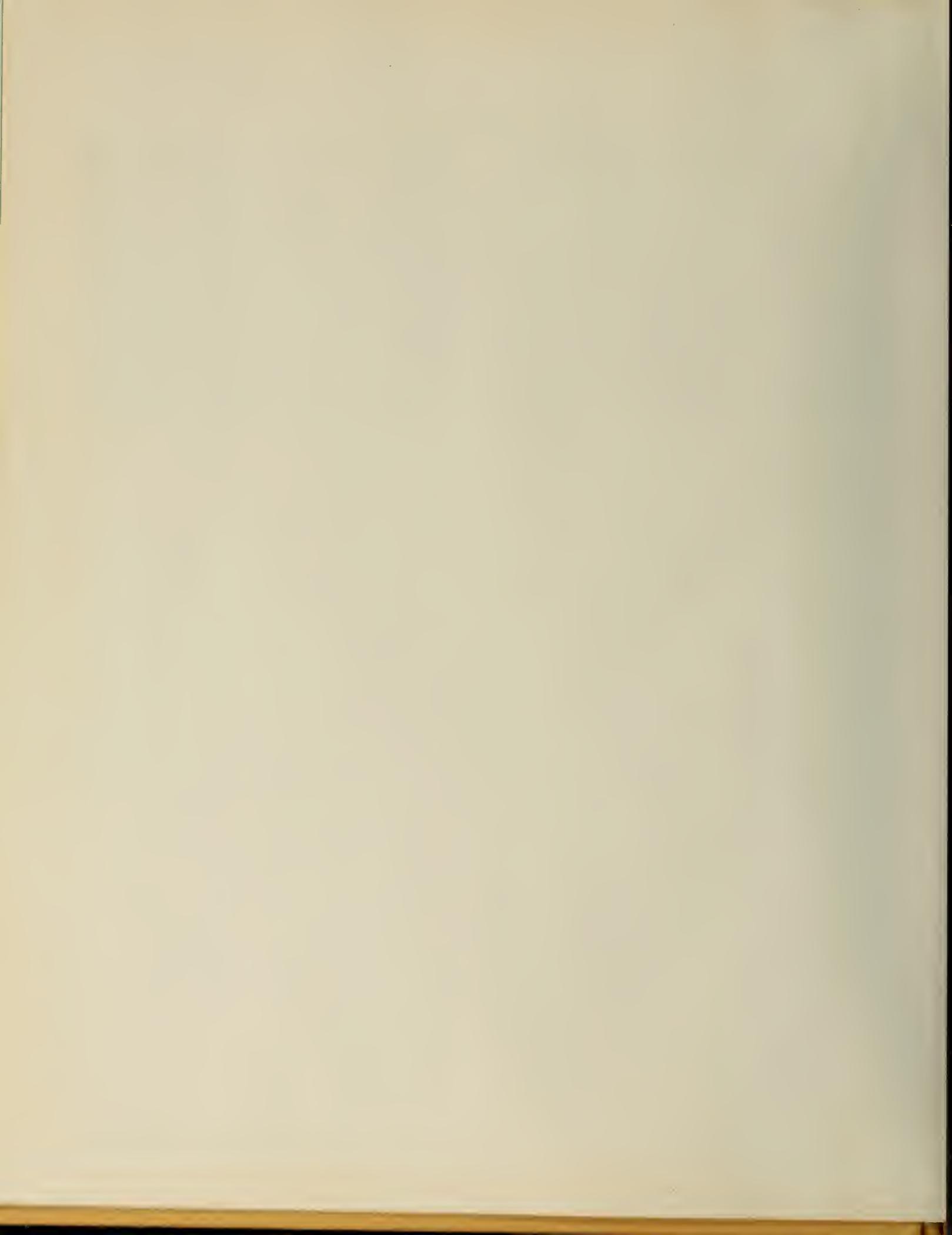
Valve	Price per 1,000 bags, dollars	Price per bag, cents
Polyethylene.....	6.85	0.7
Extended polyethylene.....	6.85	.7
Double trap.....	11.17	1.1
Foam.....	214.98	21.5

CONCLUSION

An evaluation was performed to determine the effectiveness of five commercially available bag valves in reducing dust generated during bag filling, conveying, and pallet loading. The five valves tested included standard paper, polyethylene, extended polyethylene, double trap, and foam. Two factors appeared to determine the effectiveness of these bag valves. The first was valve length, in which the longer the valve, the more effective it was in reducing product blowback and bag-generated dust. The second factor was the valve material. It is speculated that the foam was the most

effective material for reducing dust generation, followed by the polyethylene, and then standard paper. Considering both factors, the extended polyethylene was the most effective valve tested, and resulted in a 62-pct reduction in respirable dust exposure for the bag operator, and a 66-pct reduction for the bag stackers. The extended polyethylene was also the most cost-effective bag valve tested. The increase in cost for the extended polyethylene valve is approximately \$6.85 per thousand bags (0.7 cent per bag) over that of the standard paper valve.





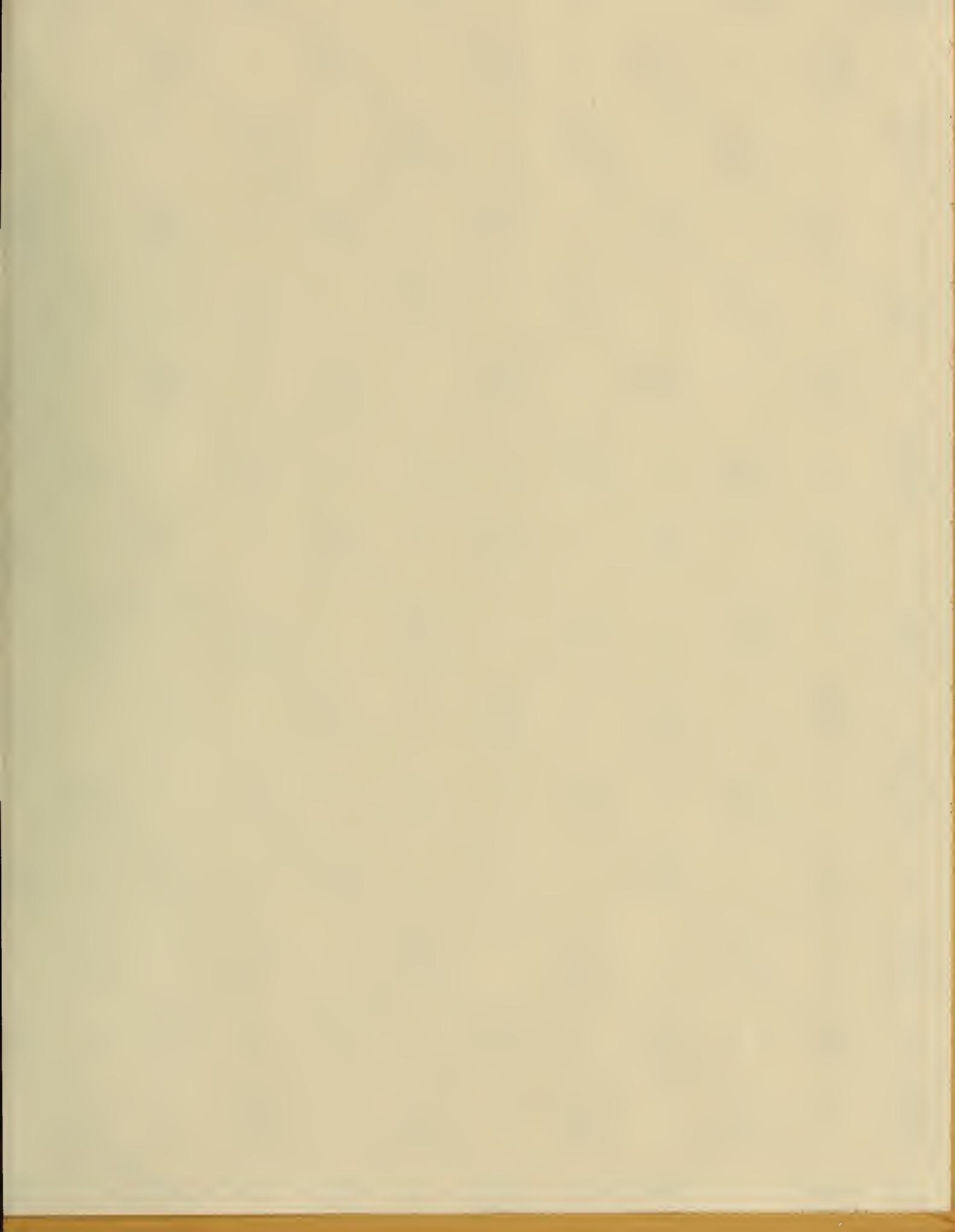


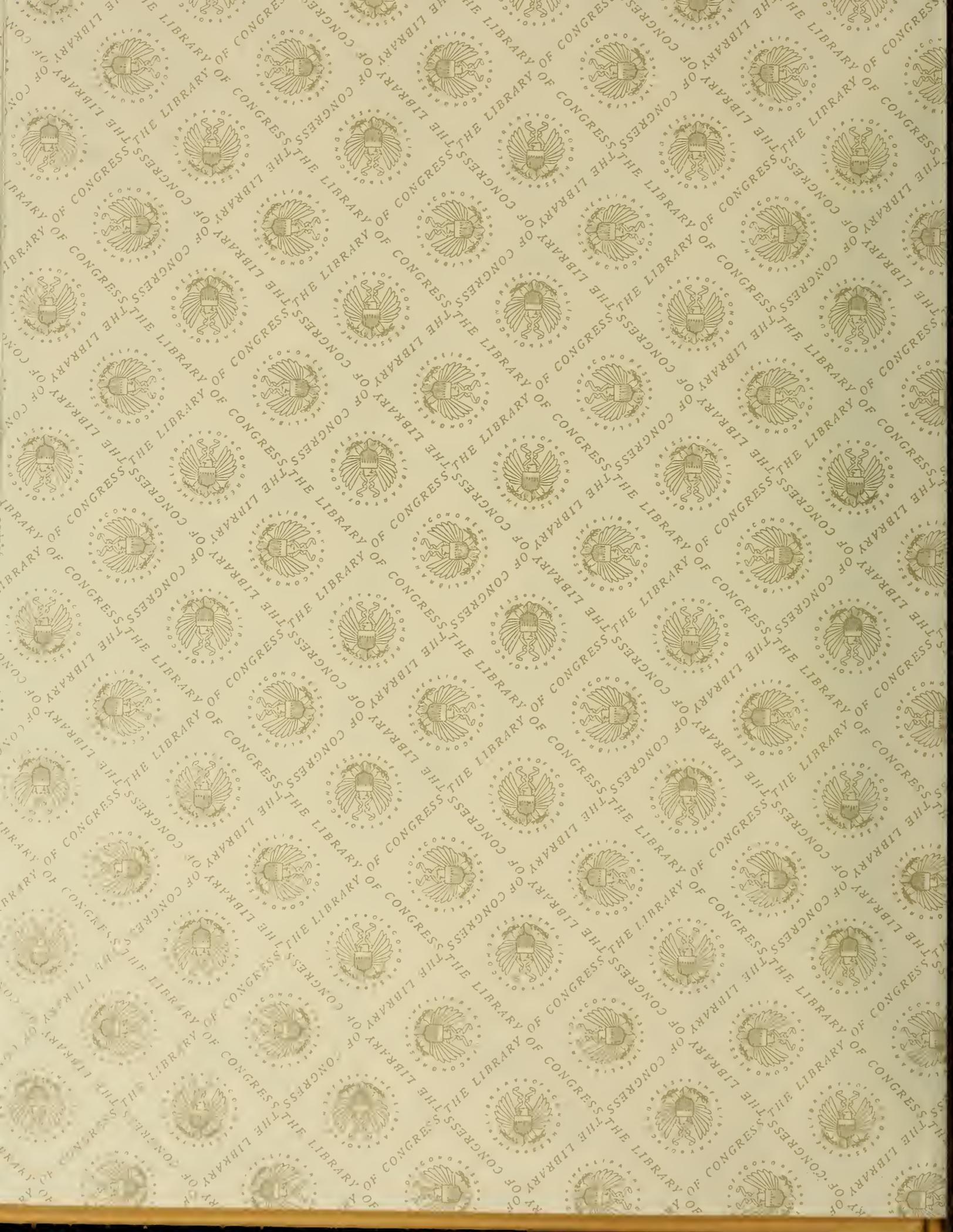
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