IN-DEPTH SURVEY REPORT

CONTROL TECHNOLOGY FOR A DRY CHEMICA AND FILLING OPERATION AT MONSANTO (MONSANTO AGRICULTURAL PRODUCTS MUSCATINE, IOWA

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PURPOSE OF SURVEY	To perform an in-depth survey of the herbicide bagging operation at the Monsanto Agricultural Products Co.
COMPANY ADDRESS	Monsanto Agricultural Products C P. O. Box 473 Muscatine, Iowa 52761
EMPLOYER REPRESENTATIVES CONTACTED:	Robert C. Fields, Plant Manager Roger Swanson, Industrial Hygienist Don Evans, Environmental Superintendent Jim Hart, Production Superintendent Howard Cole, Superintendent of Personnel Bob Hiti, Production Supervisor Dave Sheridan, Senior Industrial Hygiene Techician Tim Ogdie, Process Engineer
EMPLOYEE REPRESENTATIVES	None
STANDARD INDUSTRIAL CLASSIFICATION CODE:	SIC 2879, 2869, 2819
ANALYTICAL WORK:	Gravimetric for Dust, 89 Samples

ABSTRACT

An in-depth survey of a continuous, open mouth bagging of an herbicide was conducted at Monsanto in Muscatine, Iowa. The herbicide being bagged during the survey was AVADEX BW™. The bagging system consisted of a fully automatic open mouth bagger, the Sackmatic Model 207 manufactured by Ouachita Machine Works and ancillary automated equipment. Controls included an exhaust hood over the bagger, local ventilation, general ventilation, and system automation.

Area and personal samples were taken for total and respirable dust. Samples were also taken inside the hood. Ventilation velocity and flowrate were measured for the bagging system. The relationships between the above were evaluated.

I. INTRODUCTION

A. Purpose of Study

The National Institute for Occupational Safety and Health (NIOSH) works cooperatively with firms in many industries to identify, and more importantly, help solve problems in occupational health. NIOSH's Engineering Control Technology Branch of the Division of Physical Sciences and Engineering conducted Control Technology Assessments (CTA's) on dry chemical/solid material handling operations. The main purpose of these CTA's was to assess and document the strategies used to control airborne dust in such areas as bagging, conveying, and sampling. The results of these CTA's will be described in sufficient detail to allow the information to be used to reduce exposures of workers to toxic or hazardous substances in other industrial operations.

The product of this research will be resource documents/articles containing practical ideas on control methods. Such documents will enhance the design engineer's understanding of industrial hygiene principles and also enable the industrial hygienist to participate more effectively in the design and improvement of control equipment. The results of the assessment will be disseminated in a manner that will maximize the application of demonstrated control technologies in the workplace. The study will have a positive impact on worker health by pin-pointing and stimulating the across-the-board use of good control methods as solutions to occupational health problems.

This report presents the findings, observations, and recommendations for the study at the Monsanto Agricultural Products Company's bagging facility at Muscatine, Iowa. Two visits were made to this plant, in June, 1981 and May, 1982, to conduct a preliminary investigation and an in-depth study of dust control procedures during the bagging of a granular herbicide. At the time of the in-depth study, production schedules were reduced to two shifts per day, however, this had little effect on the study. Outside background dust levels (no samples taken) were considered to be low due to a light rain throughout most of the sampling periods.

B. Scope of Study

The evaluation of atmospheric dust concentrations, ventilation control systems, and other dust control techniques was limited to the bagging operation in the processing/storage building. Environmental dust evaluations were conducted under normal operating conditions without any variations.

II. STUDY PROTOCOL

A. Evaluation Criteria

The principal material investigated in this study was a pesticide considered to be a nuisance dust. The OSHA standard for an 8-hour work shift Time Weighted Average (TWA) for nuisance dust is contained in 30 CFR (Code of Federal Regulations) Section 1910.1000. For the respirable fraction, it is 5 mg/M^3 and 15 mg/M^3 for total dust. The TLV listed by the American Conference of Governmental Industrial Hygienists (ACGIH) for respirable dust is 5 mg/M^3 and 10 mg/M^3 for total dust. In both cases, the respirable dust contains less than 1% quartz. In this study, the OSHA standard is used as the environmental criterion to evaluate the effectiveness of the control techniques under investigation.

B. Process Description

1. General

The Monsanto complex, near Muscatine, Iowa, is a medium size facility consisting of several buildings and surrounding open ground. This facility, in operation since 1962, produces a variety of plastic/polymers and agricultural products. The agricultural products include granular and liquid herbicides. The operation is located in a flat, rural farming area and has a total work force of approximately 550. Average climatic conditions vary between 10 and 85^{o}F and annual percipitation of 31 inches, including 37 inches of snowfall.

This study is limited to the bag filling operation located in the processing/storage building. This building is a three story, steel frame structure with metal sides and concrete floor (no basement) covering a base area of 41,500 square feet. The bagging operation is located in a 20 by 25 foot room within this building, Figure 1. To the north of this processing/storage building is the main warehouse where the bagged product is palletized, stretch wrapped, and stored.

2. Packaging (Bagging) Operation

At the time of this study, AVADEX BW^{TM}, a dry granular herbicide was being packaged. The Registry of Toxic Effects of Chemical Substances gives the following information on this chemical compound:

EZ8575000 CARBAMIC ACID, DIISOPROPYLTHIO-, S-(2,3.3-TRICHLOROALLYL) ESTER
UPDT:8004 CAS: 2303-17-5 MW: 304.68 MOLFM: C10-H16-C13-N-O-S
SYN: AVADEX BW; CP 23426; N-DIISOPROPYLTHIOCARBAMIC ACID S-2,3,3-TRICHLORO-2-PROPENYL ESTER; N,N-DIISOPROPYL-2,3,3-TRICHLORALLYL-THIOLCARBAMAT (German); FAR-GO; 2-PROPENE-1-THIOL, 2,3,3-TRICHLORO-, DIISOPROPYLCARBAMATE; THICARBAMIC ACID, S-2,3,3-TRICHLOROALLYL N, N-DIISOPROPRLTHIOCARBAMATE; 2,3,3-TRICHLOROALLYL DIISOPROPYLTHIOCARBAMATE

MTDS:	mmo-sat 4800 ug/plate	MUREAV 57,277.78
	mma-sat 2800 ug/plate	MUREAV 57,277.78
TXDS:	orl-rat LD50:1471 mg/kg	HYSAAV 33,41.68
	ihl-rat LD50:1471 mg/kg	EQSFAP 3,618.75
	skn-rbt LD50:2225 mg/kg	28ZEAL 5,226.76

The bagging machine is a 1978 commerical Sackmatic Model 207 manufactured under license from Olinkraft Corporation by Ouachita Machine works of West Monroe, Louisiana. This packer is a high volume, automatic machine used to fill open-mouth bags. To close the bags, a heat-sealing unit manufactured by Bemis Co., Inc., Packaging Service Division, Minneapolis, Minnesota folds the tops of the bags, preheats, and seals them in a continuous automatic operation. The bags being filled are open-mouth, multiwall (5 ply, including a plastic liner), pinch bottom, paper bags manufactured by Manville Forest Products Corporation of West Monroe, Louisiana. The bags are designed to hold 50 pounds (22.7 kilograms) of product and excluding faulty bags, have a breakage rate averaging less than 1%.

Several steps take place in the packaging operation. The granular (24 to 40 mesh) product drops by gravity from overhead storage bins into twin weigh hoppers. As one weigh hopper is filling, the second hopper drops its 50 pound charge through the transition unit, packer spout, and into the bag, Figures 2 and 3.

Positioning, filling, tucking and sealing the bags is all automatic. One arm with suction cups takes a bag from the bag caddy and a second arm also with suction cups positions itself opposite the first arm attaching itself to the bag. The bag is opened and positioned beneath the fill spout. The spout lowers into the bag and the clam-shell cover over the spout open while inside the bag. External clamps anchors the bag to the spout during filling. The bag fills, the clam-shell closes, the bag is released allowing it to drop a couple inches onto a conveyor, and the spout is retracted to recieve the next bag.

The filled bag moves along the conveyor (being kept upright by bag guides), through the tucking bridge (open bag tops folded over), and the preheater-sealer unit, Figure 4. The upright bags travel a few feet beyond the sealer, are tipped to lie flat, and travel over a series of conveyors to the main warehouse.

Normally, bagging operates three-shifts-a-day, five-days-a-week with a crew of two operators and a Senior Technician each shift. Two additional helpers can be scheduled as needed. However, during the study, bagging was operating two-shifts-a-day. Actual bagging takes place 7 hours for each 8 hour shift with the operators rotating their job functions very two hours. The operators perform several job functions such as collecting samples from the continuous sampler, rectify bag jams (along the conveyor line) and other malfunctions, removing damaged or improperly sealed bags from the line and emptying (cutting open) them into a recycle bin, and other job functions.

C. Dust Control Systems

The main features of the dust control system are the hood and exhaust ventilation system over the packer area, the internal exhaust system around and through the packer spout, the sources of make-up air, and housekeeping.

1. Packer Hood Exhaust System (Figures 2 and 4)

The canopy-type packer hood is a multi-piece, hinged metal framed structure with plexiglass windows. It covers the packer area from bag filling to the tucking bridge. Six screen covered ports (four 6-inch diameter and two 7-inch by 4-inch oval ducts) exhaust from the top of the hood into two parallel 9-inch exhaust ducts. The exhaust system operates continuously during the packing shift drawing air in from all four sides of the hood.

2. Packer Spout Exhaust Systems (Figures 2 and 3)

Two slot-type exhaust hoods are located on opposite sides of the packer spout. This system operates only during the bag filling cycle, exhausting the dust laden air escaping from the top of the bag. The slot opening, approximately 2 1/2 inches by 10 inches is located along the top of the bag. The ends of the hoods are open to draw air from the ends of the packer spout area. A 2-inch flex-line connects the hoods to the 4-inch line from the transition unit to the baghouse.

In between bag filling cycles, exhaust ventilation is routed up through the packer spout and transition unit to the bag house. A damper in the 4-inch line near the transition unit alternatingly directs the continuous air flow through the spout hood or the spout.

3. Main Ventilation System

The ventilation system for the packaging operation as well as the various other operations located in this processing/storage building is a continuous, bag type, dry dust collector ("roll clean" dynaclone No. 9, Type A) manufactured by W. W. Sly Manufacturing Company of Cleveland, Ohio. Three section filter bags, cotton sateen resist-o-wear (thread count of 104 by 68 with a net filter area of 3366 square feet, air to cloth ratio of 2.38 to 1.0 handling 8000 cfm) are manufactured by Clarage Fan Company of Kalamazoo, Michigan. The bags are automatically cleaned with a reversing airflow, roll-clean device. The roll-cleaner travels across the bag opening, one filter bag at a time, reversing air flow to clean the bag. The air is provided by a blower (1800 rpm, 20 HP with a 36 1/2 inch diameter fan). All ventilation systems are checked quarterly. Also, magnahelic gauges are monitored daily for pressure drops across the filters.

4. Makeup Air (Figure 5)

During the time of our study, approximately one fourth of the makeup air entering the bagging room was the cooled air from the overhead air duct. The remaining air entered through the open doors from the processing/storage building. Very little (if any) air enters the bagging room from outside the processing/storage building.

5. Housekeeping

In the bagging room, dry sweeping is used to clean up spilled product and general dust accumulation. An air hose with shop air is used to remove settled dust from the packer and preheater/sealer unit. At the time of product changeover, wet washing (hosing of the concrete floors and lower three feet of walls, excluding electrical areas) is used to flush and carry away the accumulated dust within the room. Product changeover may occur within a week or up to once in six months.

D. Study Design

A study protocol was developed to evaluate the effectiveness of the dust control procedures in the bagging room. Dust levels were evaluated at seventeen (12 area total, 2 area respirable, 2 personal total, and 1 background area total) sampling locations, Figures 1 and 6.

Atmospheric evaluations were made over four shifts (two shifts per day for two consecutive days), one sample per shift per sample site. Based on these samples and ventilation measurements, the effectiveness of the ventilation system in the bagging room was evaluated.

E. Evaluation Procedures

MSA Model G Pumps (for area) and DuPont Model P-2500 Pumps (for personal) were used to collect integrated air samples of several hours duration. Sixty total dust samples and 8 respirable dust samples were collected and analyzed quantitatively for nuisance dust concentrations (by weight).

Ventilation measurements and air flow patterns were evaluated with a Kurtz Air Velocity Meter, Model 441; a TSI Air Velocity Meter, Model 1650; and Gastic Smoke Tester Tubes.

III. Study Results

A. Atmospheric Dust Concentrations

Table 1 and Figure 7 present the results of atmospheric evaluations during four shifts of packaging operations. Sample sites are shown in Figures 1, 4, 6, and 8. During this study, prevailing winds were out of the west with rain during the second day (shifts 3 and 4).

The ventilation system shut down for approximately 15 minutes during shift 1 to empty the dust collector; the packaging operation was discontinued for a short period of time during this operation. During the six to seven hour sampling periods, packaging operated 5.5 hours (shift 1), 4.0 hours (shift 2), 3.5 hours (shift 3), and 2.9 hours (shift 4).

B. Ventilation Measurements

Figures 4 and 5 show the airflow patterns in the bagging room and at the packer hoods. Figures 9 and 10 present the air velocity measurements around the packer hoods. The resultant ventilation flow patterns are due to the ventilation system exhausting through the six ducts in the packer hood and through the packer spout/hood. Velocities were measured in a vertical plane at the packer hood face and at the face of the six exhaust ducts from the packer hood. It is estimated that without the ventilation system, total dust concentrations would approach 100 mg/M^3 in the bagging room and exceed 400 mg/M^3 at the packer face in a standard 8 hour shift.

IV. Discussion of Results

The following discussions are based on observations and environmental data collected over four shifts of packaging variations. However, during shift 1, the ventilation system was shut down for dust collector emptying (approximately 15 minutes) during which time packaging operations were curtailed. Later, a machine malfunction ocurred which allowed material to inadvertantly drop beneath the conveyor. It is estimated that without the ventilation system, total dust concentrations would approach 100 mg/M^3 in the bagging room and exceed 400 mg/M^3 at the packer face in a standard 8 hour shift.

Shifts 2, 3, and 4 were similar in operation, operating 3 to 4 hours. Actual packaging operations may vary in duration depending on production scheduling demands, formulation sequence, and inventory build up and may be as much as seven (7) hours. In Table 2, it is estimated that if packaging had operated 7 hours, the total dust concentrations would have been slightly higher. This is assuming there are no additional dust sources other than the background (sample site 17) dust during the no-bagging period.

A. Ventilation

The ventilation system consists of a capture hood within a capture hood and makeup air.

1. Packer Spout/Hood

This portion of the system is designed to capture most of the airborne dust at the source. The packer spout/hood continuously exhausts air either through the spout hoods (during bag filling) or through the spout (between bag filling phases). The estimated velocity of the air is from 450 fpm in the spout and 650 fpm at the hood faces. Comparing sample sites inside the packer hood and at the packer hood face, the two areas are nearly the same. This suggests that most of the airborne dust generated during the bag filling cycle is captured at the packer spout/hood.

2. Packer Hood

This canopy type hood captures the fugitive dust not contained by the packer/spout hood and the airborne dust escaping from the open top bags traveling between the packer spout and the tucking bridge. The average velocity of the air inside the hood is estimated at 107 fpm.

The relative effectiveness of this hood within a hood was shown when the ventilation system went down for 15 minutes during packaging on Shift 1. It is estimated that the total dust concentration at the packer hood face would exceed 400 mg/M^3 during a standard shift without ventilation. With the ventilation system, these dust levels, adjusted to a 100% packaging shift (7 hours), exceeded 4 mg/M^3 less than a third of the time.

3. Makeup Air

There are two sources of makeup air to provide general ventilation in the bagging room. Three fourths of the air, approximately 960 cfm, enters through the open doors of the bagging room. During the summer, the remainder is from the overhead air conditioner vents. During the study, the bagging room was under slight negative pressure. (The company states that during normal operations, the bagging room is not under negative pressure.)

B. Dust Sources

Several dust sources were evident both from within and without the bagging room.

1. Leaks

Most of the airborne dust came from the vibrating dribble feeder at the base of the weigh bin. Visible dust could be seen escaping from the dribble feeder as well as material laying on the overhead rafters above the operator's work area.

2. Recycling Damaged Bags

Another dust source is the damaged bag recycling process. Improperly sealed or torn bags are manually removed from the conveyor line, cut open and poured into a recycle bin. The empty bags are then discarded to one side. Since the bagging room was under slight negative pressure during the study, some of the airborne dust generated during bag emptying was drawn back into the bagging operator's work environment. The dust from the discarded bags can become airborne (when tossed or later disposed of) and either be drawn into the bagging room or enter the environment of the processing/storage building, adding to the background dust levels.

3. Spills

Spills or leaks from torn or broken bags adds dust to the environment. If not properly cleaned up, the granules may be crushed under fork truck or foot traffic, further aggravating the situation.

4. Conveying

Bags manually dropped onto the inclined conveyor belt results in airborne dust (from the bag and belt) may be drawn into the bagging room. Air from the overhead air conditioner register in the bagging room does reduce the amount of dust entering the room. However, other dust from this conveyor may enter the processing/storage building, adding to the background dust levels.

5. Sampling

The automatic sampler, discharging through a one inch pipe into an open top paper bag (4" x 7" x 16") located next to the bag caddy, continually generates airborne dust which enters the bagging room.

6. Cleaning Practices

Dry sweeping is used to clean up spills. An air hose and shop air is used to clean parts of the packaging unit. Each of these practices adds dust to the workers environment in the bagging room. The material is reported to be too abrasive for vacuum sweeping and EPA standards for waste water does not permit frequent washing of the floors. (Monsanto has recently field tested and is evaluating a vacuum sweeping system as a control measure for transient material.)

7. Background Sources

The background sources are mostly from other operations (traffic, granulating, product recycling, etc.) located in the processing/storage building. During the study, dust sources from outside of the building were considered to be nil because of the

C. Management has well-established medical and environmental monitoring programs. This was indicated by the following examples:

1. On a regular schedule, environmental monitoring (both personal and area) were conducted.

2. A medical program which includes a preliminary physical for all new employees, biennial physicals for all employees, annual EKG's for employees over 34 years of age, and annual physicals for employees working in certain areas or over 38 years of age. A nurse on the property conducts regular scheduled volumetric and audiometric test and blood test on each employee.

3. The company maintains its own ambulance and has a qualified crew, Emergency Medical Technicians (EMT's), on rotating shifts. Also, the company sponsors Emergency Team Members for EMT and Cardiopulmonary Resuscitation (CPR) training.

D. The heat sealed bags have little apparent leakage from the seams. Leakages from most valve-type bags, observed elsewhere, may be quite pronounced.

E. Automation greatly reduces worker exposures to dry chemicals during packaging. Also, automation reduces other physical ailments such as back strains and tendinitis

Appendix

Description of Air Sampling and Analytical Equipment

1. MSA Model G and DuPont Model P-2500 portable, battery powered, pumps operated at 2.0 liters per minute (standard flow rate for collecting total dust samples). Six of the DuPont pumps were operated at 1.7 liters per minute (standard flow rate for collecting respirable dust samples). Three-piece plastic filter holder cassettes containing a 37 mm PVC filter, No. M5, manufactured by Millipore Corporation were used. For the respirable samples, MSA Gravimetric Dust Samplers, manufactured by Mine Safety Appliances, Inc., consisting of a 10 mm plastic filter holder cassette were used to hold the No. M5 filters.

2. Total weight of each sample were determined by weighing the samples plus the filters on an electrobalance and subtracting the previously determined tare weights of the filters. The tare and gross weights were done in duplicate. The instrumental precision of weighings done at one sitting is 0.01 mg. All weighings, pre-weighed filters (tares) and final total weights, were done by Utah Biomedical Testing Laboratory (UBTL).

TABLE 1: ATMOSPHERIC CONCENTRATIONS OF DUST DURING FOUR PACKAGING SHIFTS

	Day 1		Day 2		Avg.
Shift	1	2	3	4	2, 3, 4
	(Concentrations in mg/M^3)				
Location/Operation					
A. INSIDE HOOD (total dust)					
1) Sample Site 5	36.4	1.4	2.5	1.3	1.7
2) Sample Site 16	43.6	1.5	3.4	7.8	4.2
Average	40.0	1.4	2.9	4.5	2.9
B. HOOD FACE (total dust)					
3) Sample Site 4	14.4	0.7	3.4	0.9	1.7
4) Sample Site 6	26.3	0.9	1.6	0.9	1.1
5) Sample Site 7	12.3	1.3	2.4	1.6	1.8
6) Sample Site 8	19.8	1.2	2.1	1.3	1.5
7) Sample Site 13	18.7	2.9	2.0	3.8	2.9
8) Sample Site 14	24.2	2.2	1.5	2.7	2.1
9) Sample Site 15	16.0	1.4	3.4	1.8	2.2
Average	18.8	1.5	2.3	1.9	1.9
C. BAGGING ROOM (total dust)					
10) Sample Site 9	5.7	1.4	2.1	1.1	1.5
11) Sample Site 11	1.2	3.3	1.6	0.9	1.9
12) Sample Site 12	9.2	0.8	1.5	1.0	1.1
Average	5.4	1.8	1.7	1.0	1.5
D. BAGGING ROOM (respirable dust)					
13) Sample Site 3	1.5	0.1	0.4	0.1	0.2
14) Sample Site 10	0.7	0.2	0.4	0,2	0.3
Average	1.1	0.1	0.4	0.1	0.2
E. OPERATORS (total dust)					
15) Operator 1	2.7	1.0	1.4	0.6	1.0
16) Operator 2	3.8	1.2	1.8	0.7	1.2
Average	3.2	1.1	1.6	0.6	1.1
F. BACKGROUND (total dust)					
17) Sample Site 17	1.0	0.2	0.2	0.3	0.2

See figures 1 and 6 for sample site locations.
Shift 1 omitted from averages due to ventilation system being shutdown for 15 minutes during bag filling operations.

TABLE 2: TOTAL DUST CONCENTRATIONS AT 100% PACKER OPERATING TIME

Shift	1	2	3	4	Average
Meas. Average Sampling Time, (min.)	358	423	389	382	
Meas. Average Sampling Time, (hrs.)	6.0	7.0	6.5	6.4	
Estimated Packer Downtime, (hrs)	0.5	3.0	3.0	3.5	
Packer Operating during Sampling (hrs)		5.5	4.0	3.5	2.9
Measured TDC at Hood Face, (mg/M^3)	13.6	1.5	2.3	1.9	2.0
Estimated TDC at Hood Face, packer Operating 7 Hours (mg/M3)	-	2.5	4.1	4.3	3.6
Measured TDC in Bagging Room, (mg/M^3)	4.3	1.8	1.7	1.0	1.5
Estimated TDC in Bagging Room, Packer Operating 7 Hours (mg/M3)	-	3.0	3.0	1.8	2.6

TDC: Total Dust Concentration

For each 8 hour shift, packaging is scheduled to operate 7 hours.

Calcultation for TDC for a 7 hour shift:

(TDC)(7 hr shift) = (TDC)(time pkg.)
+ (background dust)(time nonpackaging)

Assume no other dust sources during nonpackaging.

TABLE 3: VENTILATION CONTROL SYSTEMS IN PACKAGING ROOM

LOCATION OF HOOD FACE	DESCRIPTION OF SYSTEM	VELOCITY MEASUREMENTS	REMARKS
1) Canopy hood, north face, exhaust. (Figures 2 and 9)	1) West half, directly infront of packer slot. Hood opening 1.5ft x 3.5ft. 2) East half, toward bag discharge. Hood opening 1.4' x 3.5'.	1) Average velocity at face = 60fpm. 2) Average velocity at face = 50fpm.	Air velocity fairly uniform. Good control. Greatest velocity between main dust source (bag filling) and operator, averaging 170fpm
2)Canopy hood, south face, exhaust. (Figure 10)	1) West half, directly infront of packer spout. Hood opening 1.25' x 3.5'. 2) East half, toward bag discharge. Slot opening 1.1' x 3.5'.	1) Average velocity at face = 60fpm. 2) Average velocity at face = 40fpm.	Air velocity fairly uniform. Good control. Greatest velocity nearest main dust source (bag, filling), averaging 110fpm.
3) Canopy hood, east face, exhaust. (Figures 2 and 9)	1) Notch in hood measuring 0.9' x 1.0' plus. 2) Area below hood, 2.0' wide by approx'ly 3'.	1) Average velocity at face = 60fpm. 2) Average velocity approximatley 40fpm.	Filled bag discharge end.
4) Canopy hood, west face, exhaust. (Figures 9 and 10)	1) Opening below hood approximately 2' x 3'.	1) Average velocity at face = 50fpm.	Empty bag feed end.
5) Within canopy hood, hoods on sides of packer spout, exhaust. (Figure 3)	1) Two slot hoods above bag lip approximately 0.1' wide by 0.9'.	1) Estimated velocity at face = 650fpm.	Good control. Operates only when bag is on spout.
6) Within canopy hood, spout exhaust. (Figure 3)	1) Packer spout opening approx'ly 0.3' x 1.3'.	1) Estimated velocity inside spout neck = 450fpm.	Good control. Operates only when no bag is on spout. Also, clam-like shell closed over spout opening.

TABLE 3: VENTILATION CONTROL SYSTEMS IN PACKAGING ROOM (CONT'D)

7) Exhaust ports from canopy hood. (Figures 2 and 9)	1) Two oval ports stradling packer spout meas'g 7" x 4". 2) Four 6" diameter ports, two on each side of canopy hood and down stream of packer spout.	1) Average velocity at face of ports = 1750fpm. 2) Average velocity at port face = 160fpm.	Screens over exhaust ports. Some exhaust ports partially plugged.
8) Overhead register, inflow. (Figure 8)	1) Two flow directions, east and west. Openings 11" x 3.25".	1) Average velocity at face = 1920fpm.	Part of makeup air.
9) Open doors, inflow. (Figure 5)	1) Several	1) Inward flow of air.	

ENVIRONMENTAL DATA BASE TABLE 4

RESULTS OF AIR SAMPLES FOR NUSIANCE DUST
MONSANTO
MUSCATINE, IOWA
408

MAY 19-20, 1982

ENVIRONMENTAL DATA BASE TABLE 4 (Cont'd)

LOC. #	SAMPLE CLASSIFICATION	SAMPLE No.	SAMPLE DATE	PERIOD START	PERIOD STOP	TIME (min)	RATE (lpm)	VOL. (l)	TOTAL DUST (mg)	TOTAL DUST (mg/m3)
1	BO 1	9998	19	1045	1529	284	1.96	556.6	1.51	2.7
2	BO 2	01	19	1035	1532	297	2.04	605.9	2.28	3.8
3	AR 3	04	19	1106	1713	367	1.71	727.6	0.93	1.5
4	TD 4	10	19	1125	1713	348	2.08	723.8	10.39	14.4
5	TD 5	11	19	1125	1713	348	2.06	716.9	26.11	36.4
6	TD 6	9993	19	1125	1712	347	1.97	683.6	17.98	26.3
7	TD 7	14	19	1125	1815	410	1.95	799.5	9.83	12.3
8	TD 8	9995	19	1128	1815	407	2.02	822.1	16.31	19.8
9	TD 9	05	19	1124	1712	348	2.06	716.9	4.09	5.7
10	AR 10	9999	19	1050	1711	381	1.74	662.9	0.47	0.7
11	TD 11	9997	19	1125	1711	346	1.96	678.2	2.26	3.3
12	TD 12	08	19	1126	1713	347	2.01	697.5	6.42	9.2
13	TD 13	09	19	1125	1714	349	1.97	687.5	12.89	18.7
13	TD 13(a)	41	19	1850	2206	196	2.04	399.8	2.41	6.0
14	TD 14	9994	19	1126	1716	350	1.96	686.0	16.63	24.2
15	TD 15	15	19	1128	1716	348	2.04	709.9	11.39	16.0
16	TD 16	07	19	1128	1716	348	2.03	706.4	30.82	43.6
17	TD 17	9996	19	1125	1716	351	2.05	719.6	0.72	1.0

LOC.	SAMPLE	SAMPLE		PERIOD		TIME	RATE	VOL.	TOTAL DUST	
#	CLASSIFICATION	No.	DATE	START	STOP	(min)	(lpm)	(l)	(mg)	(mg/m3)
1	BO 1	36	19/20	1749	0140	471	1.98	932.6	0.91	1.0
2	BO 2	30	19/20	1751	0142	471	1.98	932.6	1.16	1.2
3	AR 3	40	19/20	1850	0147	417	1.73	721.4	0.08	0.1
4	TD 4	24	19/20	1850	0152	422	2.02	852.4	0.56	0.7
5	TD 5	35	19/20	1850	0152	422	1.97	831.3	1.17	1.4
6	TD 6	18	19/20	1850	0150	420	1.95	819.0	0.75	0.9
7	TD 7	31	19/20	1850	0155	425	2.02	858.5	1.14	1.3
8	TD 8	34	19/20	1850	0155	425	1.72	731.0	0.91	1.2
9	TD 9	26	19/20	1850	0150	420	1.73	726.6	1.03	1.4
10	AR 10	23	19/20	1850	0155	425	1.71	726.8	0.16	0.2
11	TD 11	32	19/20	1850	0155	425	2.00	850.0	1.03	1.2
12	TD 12	27	19/20	1850	0145	415	1.99	825.9	0.70	0.8
13	TD 13b	20	19/20	2206	0155	229	2.04	467.2	1.36	2.9
14	TD 14	22	19/20	1850	0155	425	1.99	845.8	1.86	2.2
15	TD 15	28	19/20	1850	0155	425	2.07	879.8	1.26	1.4
16	TD 16	29	19/20	1850	0155	425	2.04	867.0	1.28	1.5
17	TD 17	33	19/20	1850	0200	430	1.99	855.7	0.16	0.2
1	BO 1	46	20	0915	1545	390	2.04	795.6	1.12	1.4
2	BO 2	63	20	0915	1544	389	1.96	762.4	1.37	1.8
3	AR 3	60	20	0912	1542	390	1.71	666.9	0.27	0.4
4	TD 4	58	20	0912	1542	390	1.96	764.4	2.60	3.4
5	TD 5	65	20	0912	1542	390	2.06	803.4	1.97	2.5
6	TD 6	64	20	0913	1542	389	2.02	785.8	1.29	1.6
7	TD 7	45	20	0913	1542	389	1.97	766.3	1.84	2.4
8	TD 8	51	20	0912	1542	390	2.07	807.3	1.69	2.1
9	TD 9	57	20	0912	1542	390	2.06	803.4	1.68	2.1
10	AR 10	54	20	0912	1542	390	1.74	678.6	0.30	0.4
11	TD 11	50	20	0913	1542	389	2.04	793.6	1.27	1.6
12	TD 12	62	20	0913	1542	389	2.08	809.1	1.19	1.5
13	TD 13	49	20	0913	1542	389	1.97	766.3	1.51	2.0
14	TD 14	55	20	0913	1542	389	2.05	797.5	1.17	1.5
15	TD 15	42	20	0913	1542	389	2.05	797.5	2.70	3.4
16	TD 16	61	20	0914	1542	388	2.01	779.9	2.68	3.4
17	TD 17	48	20	0914	1542	388	2.06	799.3	0.18	0.2

LOC. #	SAMPLE CLASSIFICATION	SAMPLE No.	DATE	PERIOD START	STOP	TIME (min)	RATE (lpm)	VOL. (l)	TOTAL DUST (mg)	(mg/m3)
1	BO 1	74	20	1635	2252	377	1.95	735.2	0.46	0.6
2	BO 2	80	20	1648	2300	372	2.00	744.0	0.50	0.7
3	AR 3	72	20	1631	2252	381	1.72	655.3	0.06	0.1
4	TD 4	68	20	1631	2255	384	1.99	764.2	0.68	0.9
5	TD 5	79	20	1631	2250	379	2.02	765.6	0.98	1.3
6	TD 6	69	20	1631	2250	379	1.99	754.2	0.65	0.9
7	TD 7	84	20	1631	2253	382	1.98	756.4	1.21	1.6
8	TD 8	81	20	1631	2253	382	1.98	756.4	1.00	1.3
9	TD 9	67	20	1631	2253	382	1.73	660.9	0.70	1.1
10	AR 10	66	20	1631	2253	382	1.71	653.2	0.10	0.2
11	TD 11	73	20	1631	2253	382	1.98	756.4	0.66	0.9
12	TD 12	77	20	1631	2252	381	2.02	769.6	0.74	1.0
13	TD 13	82	20	1631	2258	387	1.96	758.5	2.91	3.8
14	TD 14	83	20	1631	2254	383	1.98	758.3	2.06	2.7
15	TD 15	89	20	1631	2254	383	1.73	662.6	1.20	1.8
16	TD 16	76	20	1631	2254	383	2.01	769.8	6.04	7.8
17	TD 17	87	20	1631	2254	383	1.97	754.5	0.20	0.3

LIMITS OF DETECTION: 0.01

(units per sample) mg/spl

EVALUATION CRITERIA:

ACGIH	-TLV	R 5.0
		T 10.0
OSHA-PEL	-TWA	T 15.0

NOTES:

(a) Contaminated Sample
AR Respirable Fraction Sampled (8 Samples)
TD Total Dust Sampled - Area (52 Samples)
BO Total Dust Sampled - Personnel (8 Samples)

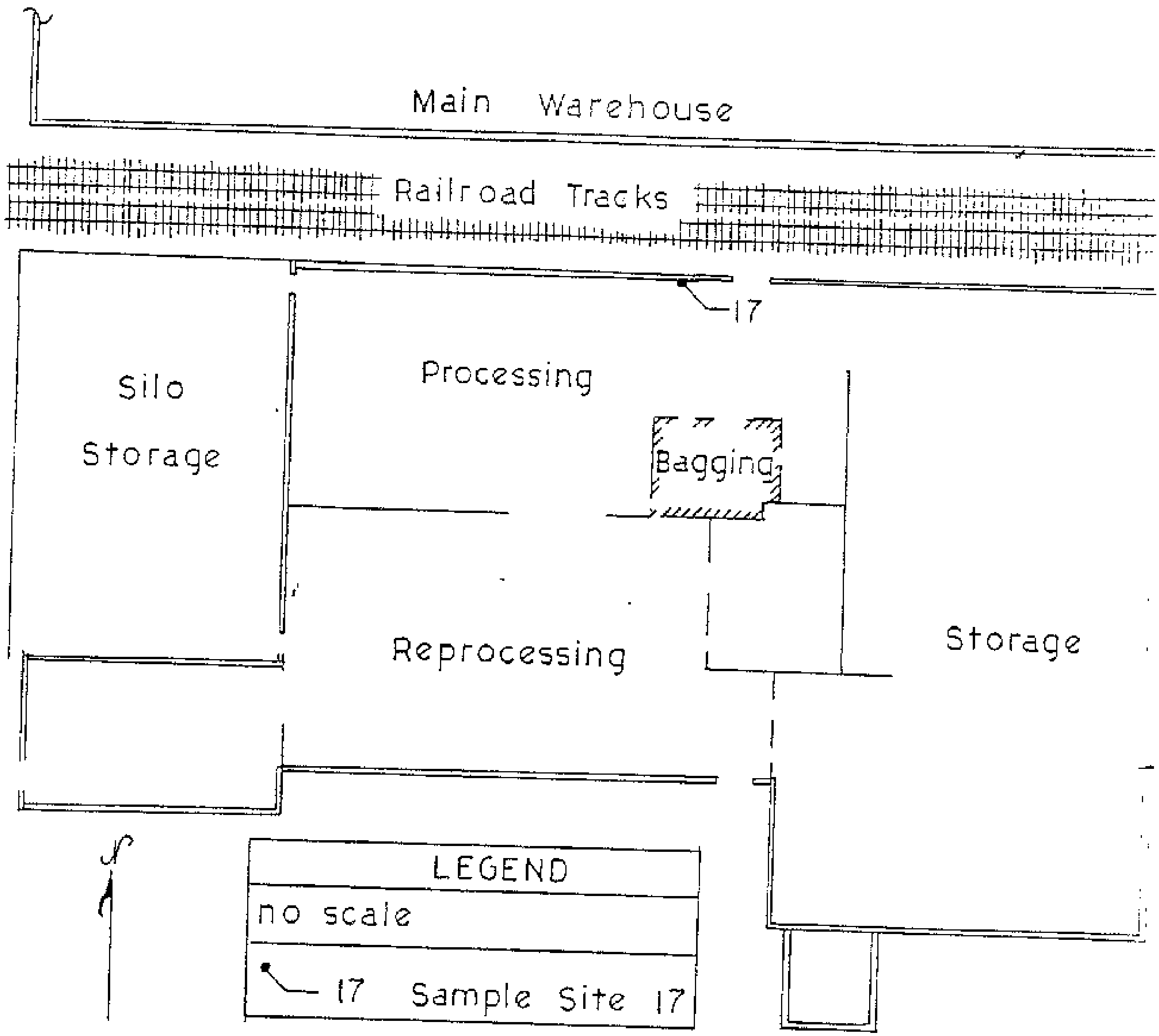


Figure 1. First Floor - General Building Floor Plan

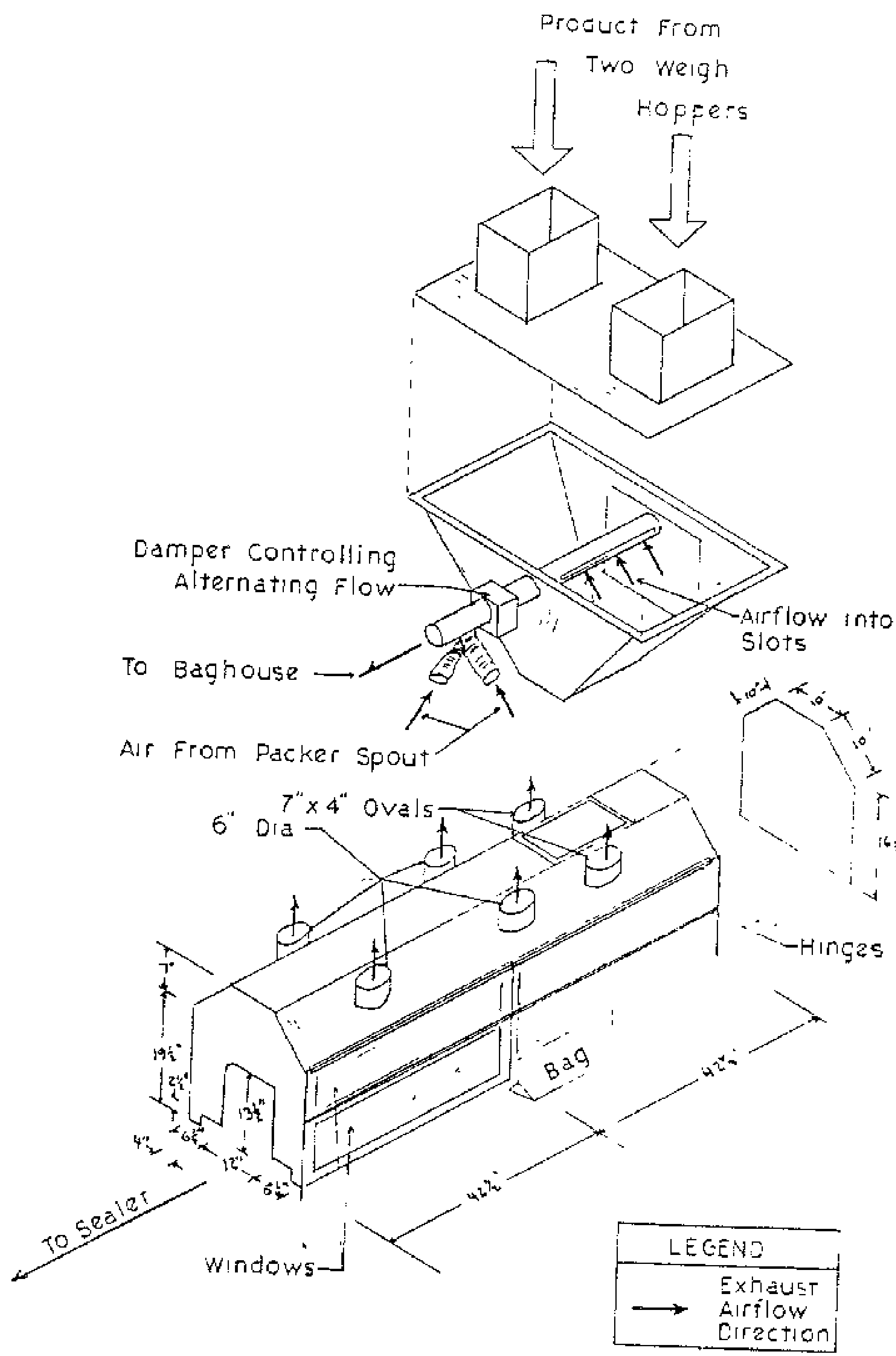
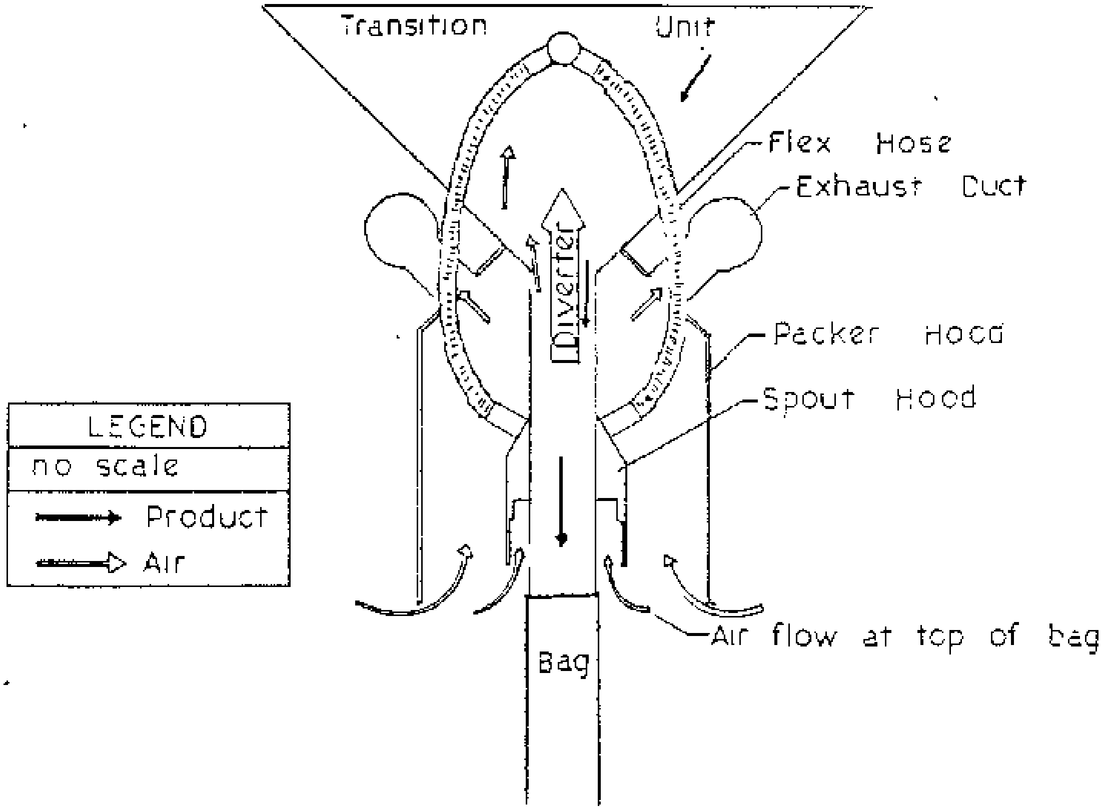
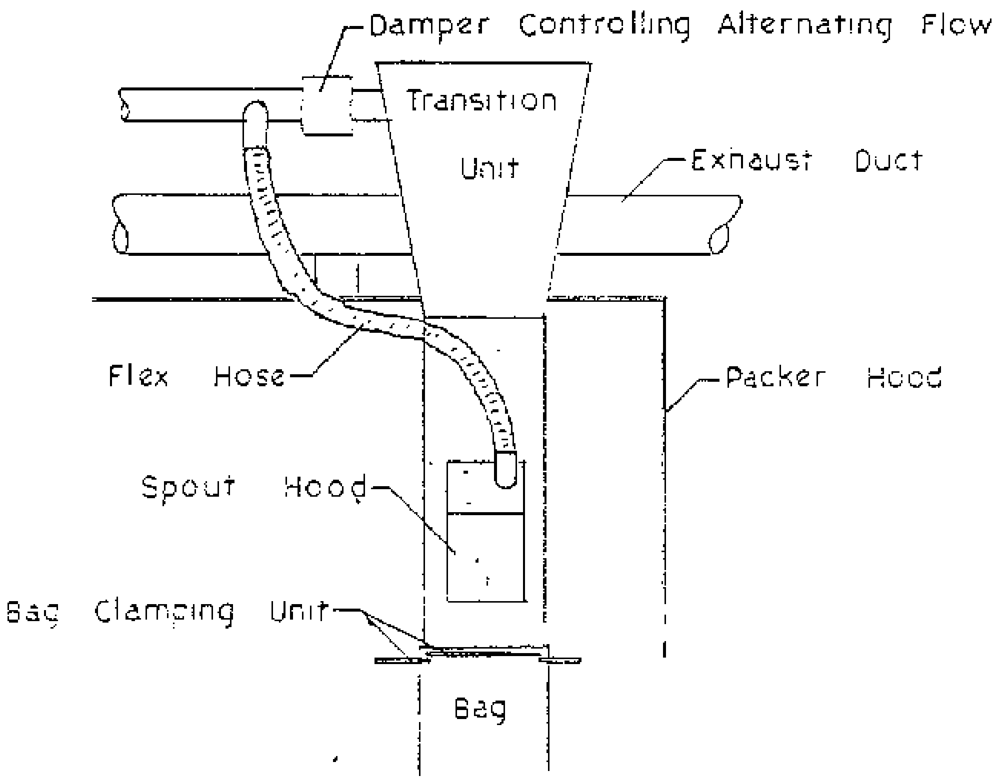


Figure 2. Packer Hood and Transition Unit



END VIEW



SIDE VIEW

Figure 3. Capture Hoods - Canopy and Packer Spout

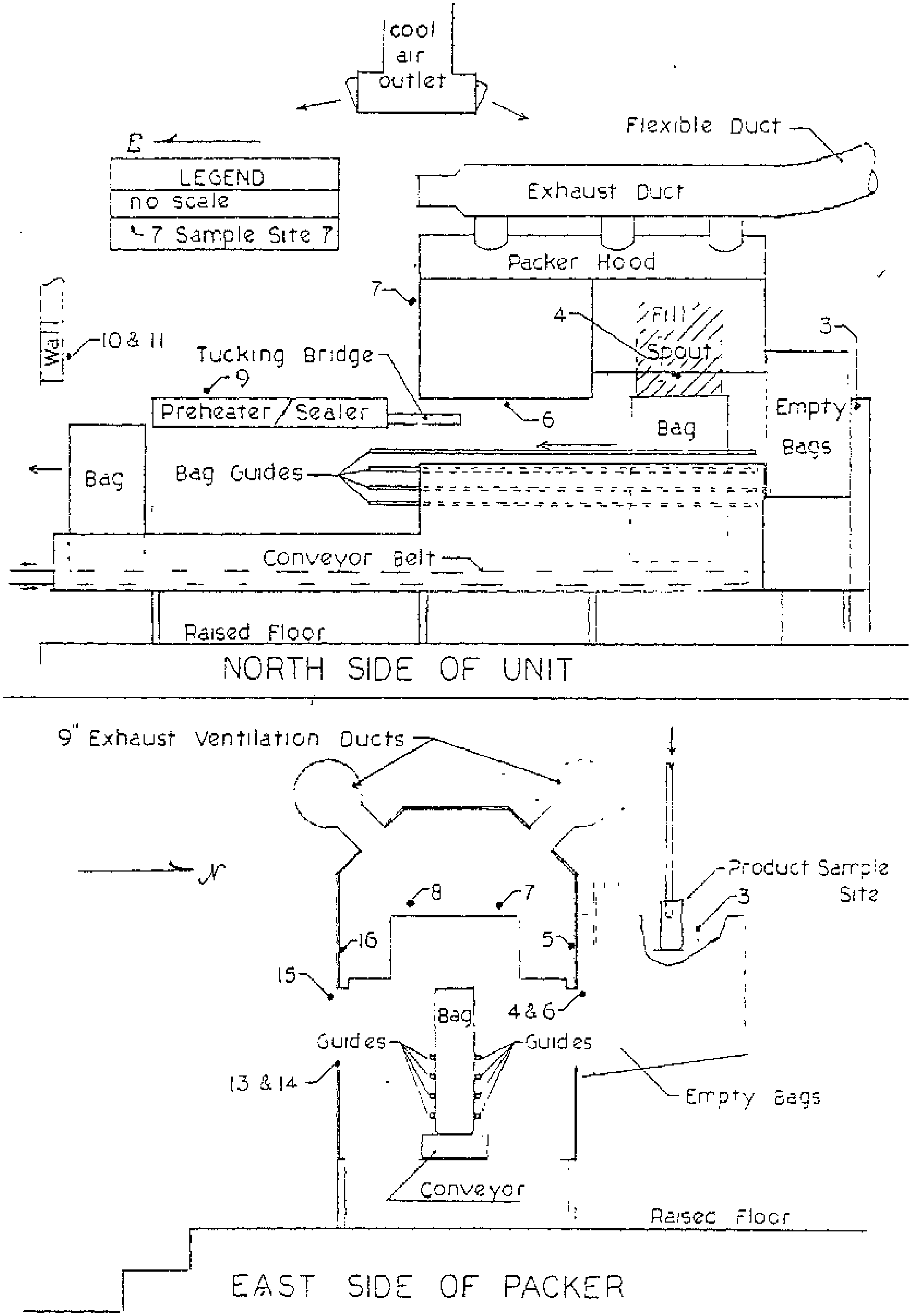


Figure 4. Front and Upstream Views of Packer Unit

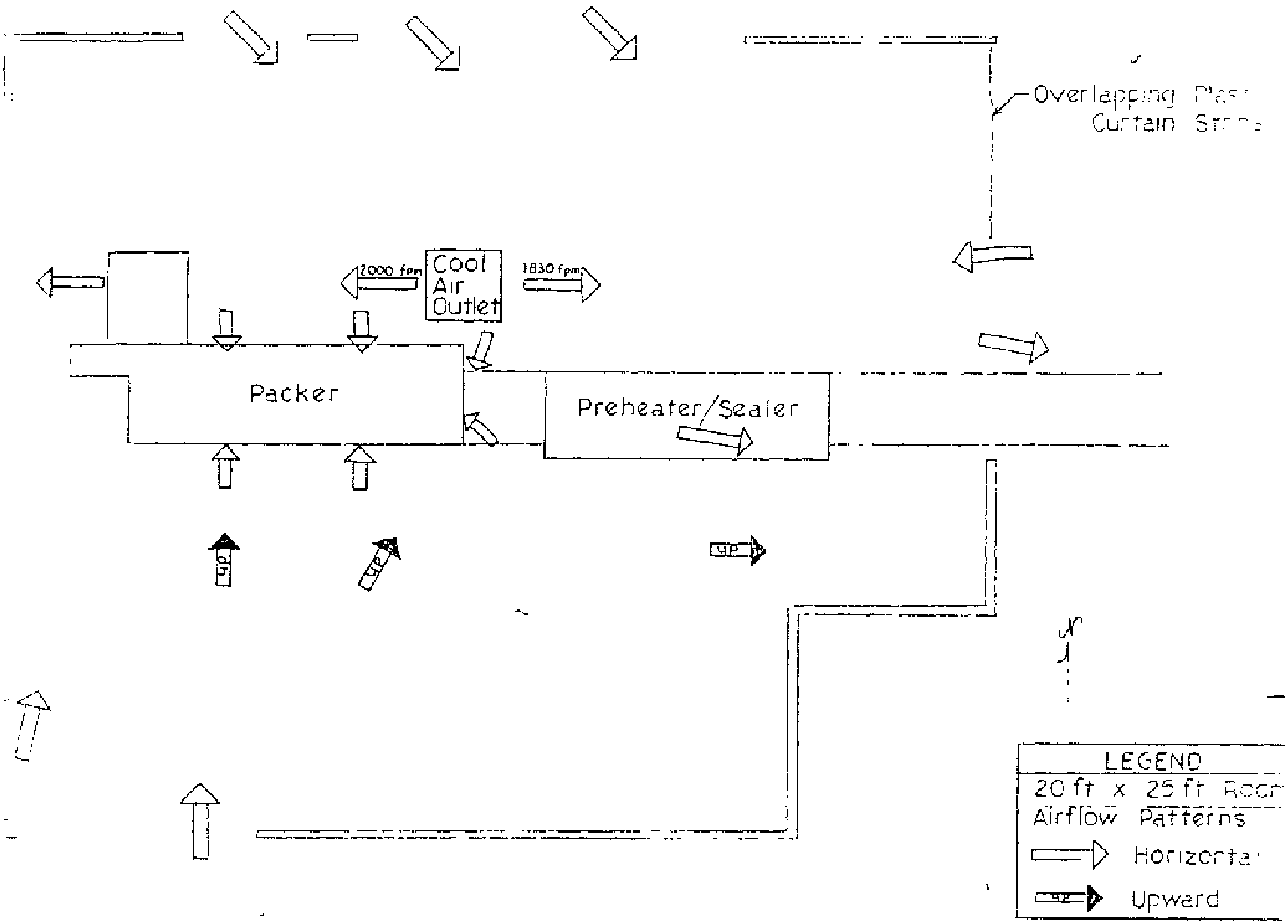


Figure 5. Airflow Patterns at Breathing Zone Level

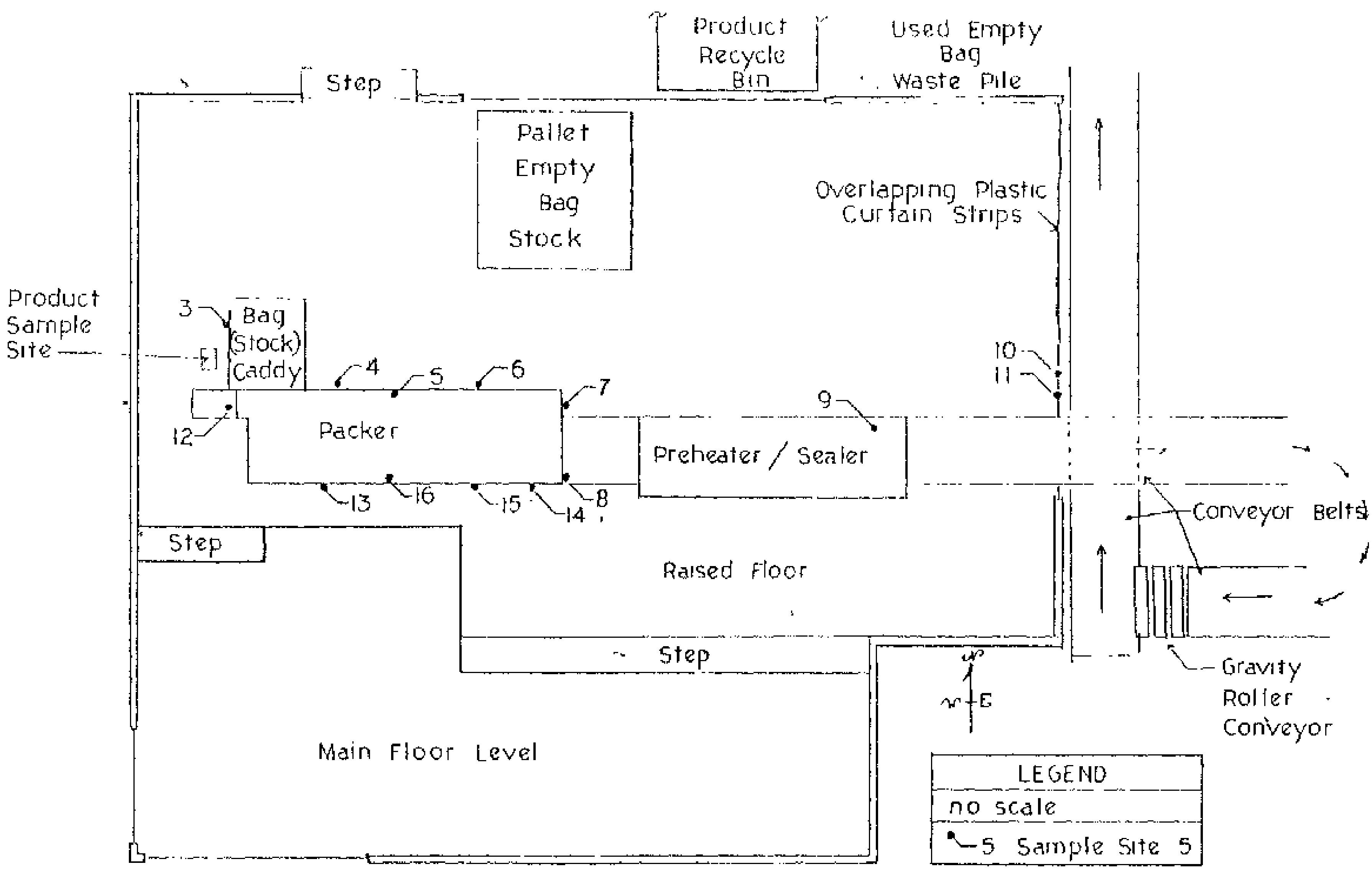


Figure 6. Bagging Area - Packer Unit and Sample Sites

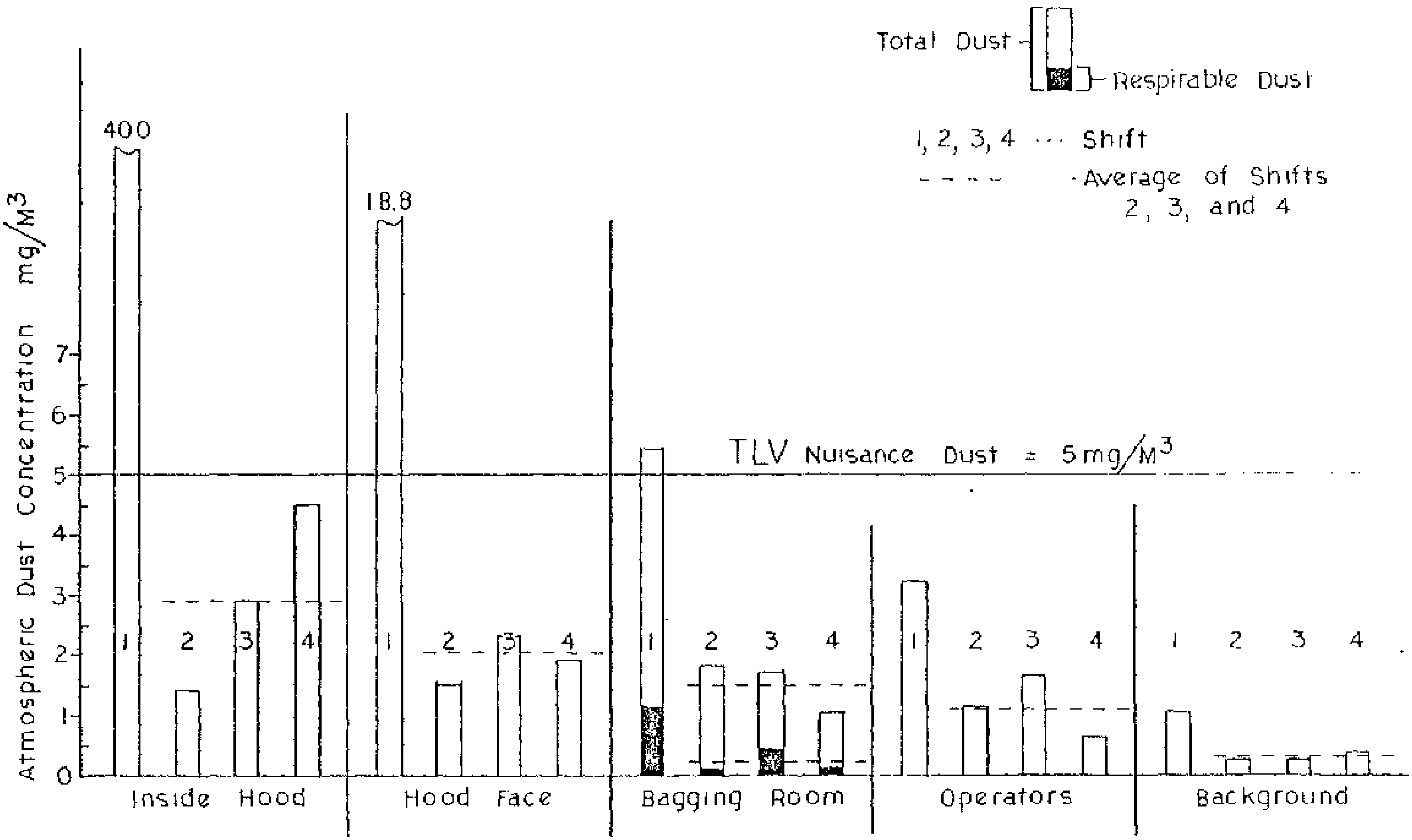


Figure 7. Dust Concentrations in the Bagging Area

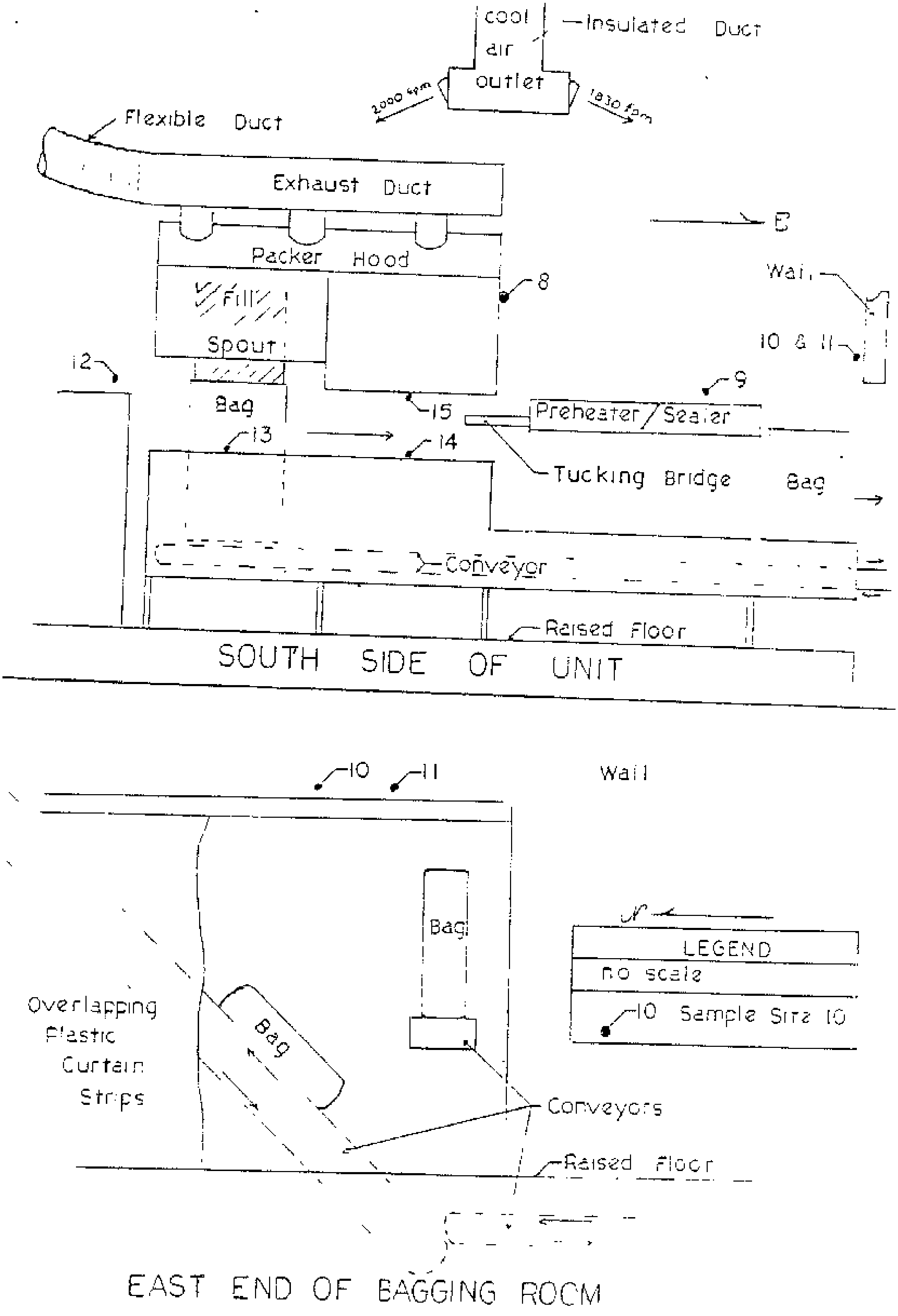


Figure 8. South Side of Packer and East End of Bagging Room

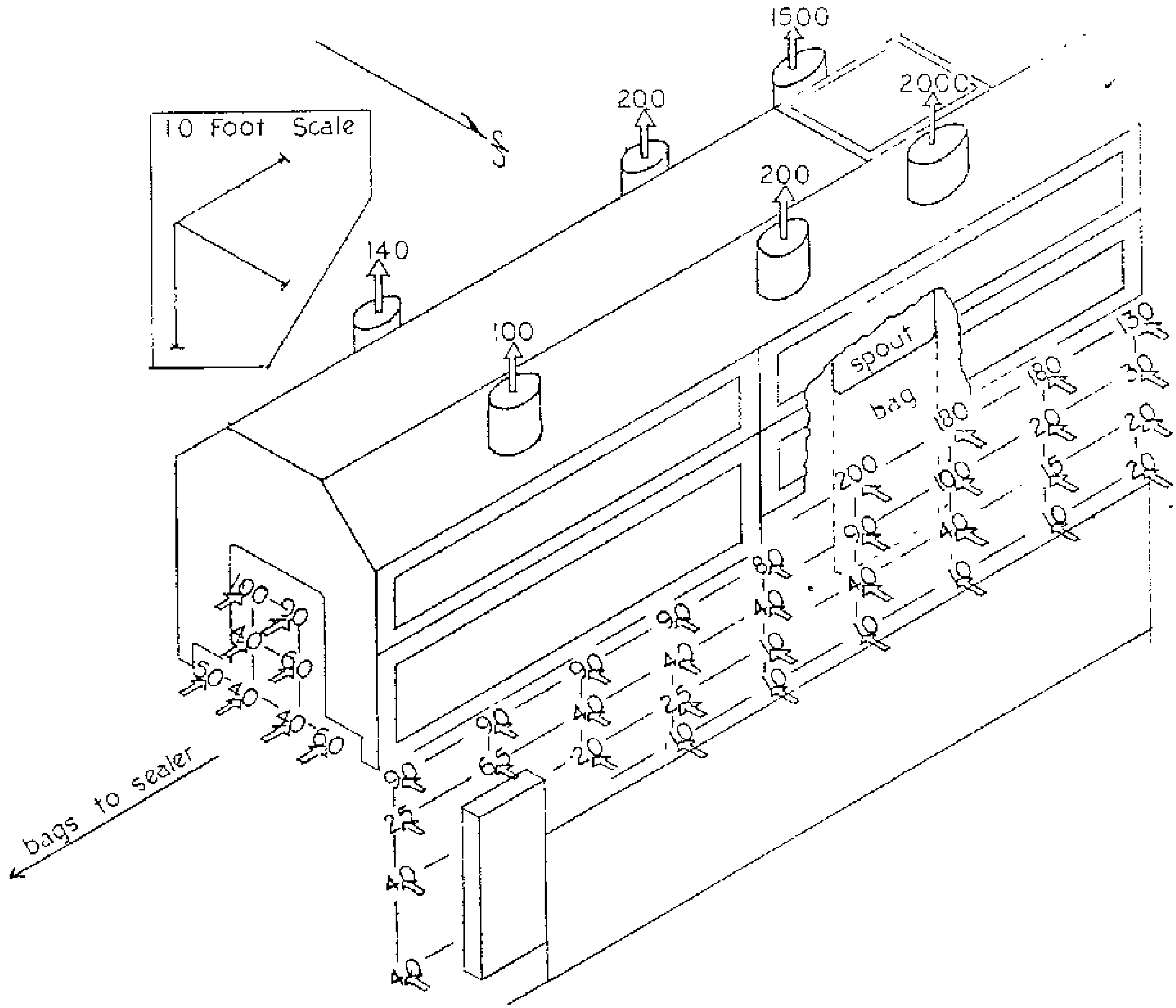


Figure 9. Ventilation (fpm) at North and East Face of Packer Hood and Exhaust Ducts

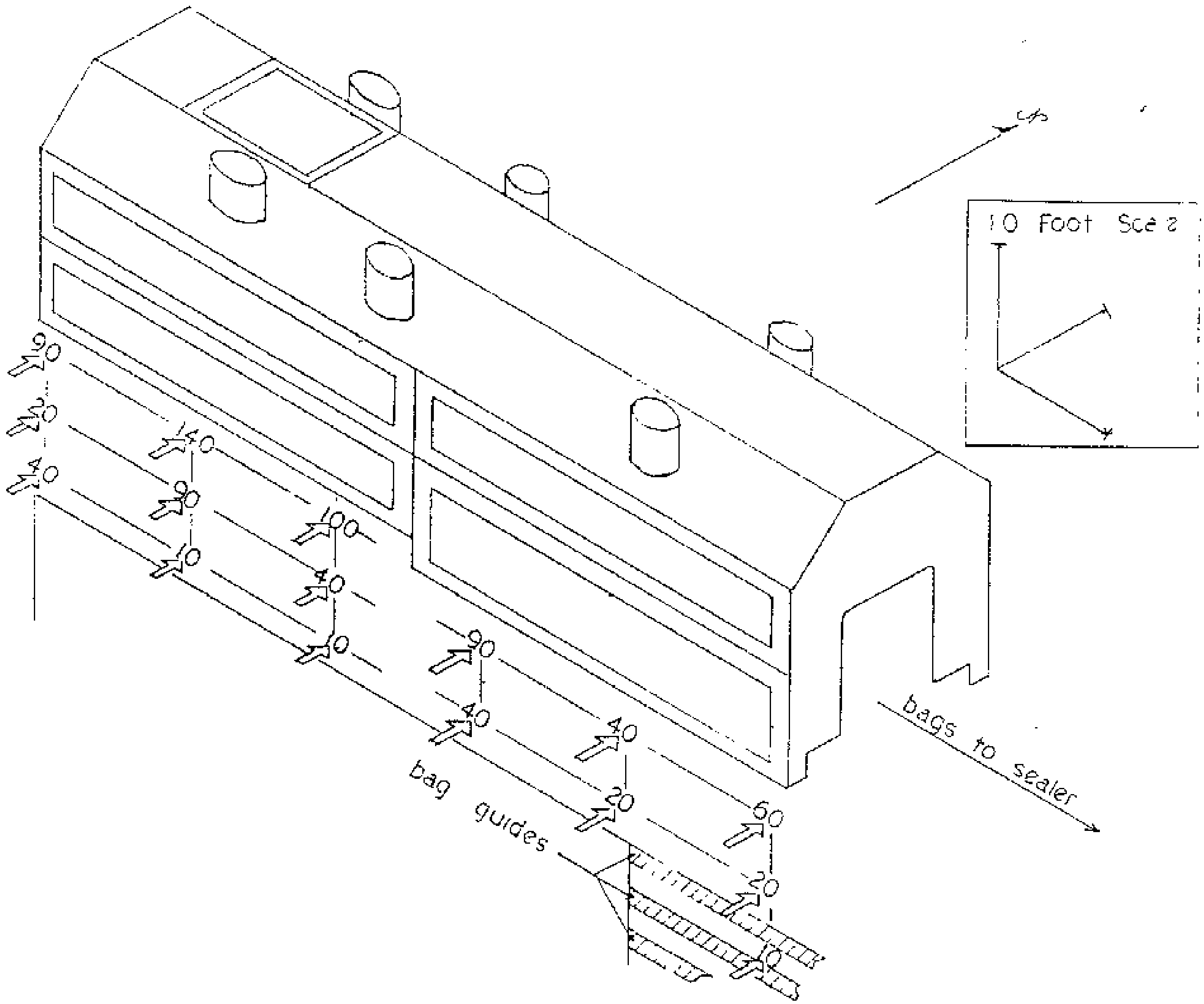


Figure 10. Ventilation (fpm) at South Face of Packer Hood