Background Report Reference

AP-42 Section Number: 9.7

Background Chapter: 2

Reference Number: 2

Title: Control Technology Assessment of Raw Cotton Processing Operations

Enviro Control Inc.

June 1980

24

PB82-186685

AP-42 Section 9.7
Reference
Report Sect. 2
Reference 2

FINAL REPORT

Control Technology Assessment Of Raw Cotton Processing Operations

(16)

Contract No. 210-78-0001

June 15, 1980

Page 37-74

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ABSTRACT

Cotton dust has required implementation of control technology to reach permissible exposure levels of 200 μg/m^3 in yarn manufacturing, 500 μg/m^3 in cottonseed processing, knitting and waste processing and 750 μg/m^3 in slashing and weaving. A control technology assessment was made by conducting preliminary and detailed surveys in cotton ginning, cottonseed processing, yarn manufacturing, knitting, weaving, and waste processing operations that utilize raw cotton. Plants were selected that were utilizing control technology, as follows:

- Local and general exhaust ventilation
- Air filtration equipment
- Work practices
- Process enclosure and isolation
- Personal protective equipment
- Liquid oversprays

The results of the study are usable as a reference by both government and industry personnel concerned with cotton dust control. A number of areas in which applications of engineering control equipment for dust emission control can be improved or are likely candidates for research were also identified.

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APPENDIX A.1 COTTON GINNING

A.1.0 Overview - Process Flow and Exposure Patterns

The information contained in this summary is divided into five functional process areas in cotton ginning in which exposure to cotton dust exists. These functional process areas are at seed cotton feeding, seed cotton cleaning, gin stands, lint cleaning, and the bale press.

The index of control techniques and processing variables (Figure A.1-1) provides the reader with a convenient reference to appropriate sections of interest. The control techniques surveyed are listed above the appropriate functional blocks, along with the processing variables that must be considered when estimating the effectiveness of the controls in any particular cotton gin. The sections of this report in which the controls are discussed in detail are referenced.

The modern cotton gin utilizes automatic processing to remove trash matter (hulls, leaf, dirt, stems, etc.) from the seed cotton and to separate cotton lint fiber from the cottonseed. The U.S. ginning industry is located throughout the sun belt, stretching from Virginia and North Carolina south through the Mississippi Delta and Texas to the San Joaquin Valley in California. The four main production regions can be classified as follows:

- Southeast - Virginia south to Alabama.
- Mid-South - Kentucky and Missouri south to Mississippi and Louisiana.
- Southwest - Texas and Oklahoma.
- West - New Mexico, Arizona, Nevada and California.

Preliminary surveys were conducted in California, West Texas, and Mid-South gins in an effort to cover the major differences in climate, type cotton, and harvesting methods. Detailed surveys were completed in one Mississippi Delta gin and two West Texas gins.

FIGURE A.1-1. INDEX OF CONTROL TECHNIQUES AND PROCESSING VARIABLES

Control Techniques	1.1.1 Module Feeding 1.1.2 Personal Protective Devices	1.5.3 Location of Material Handling Fans	1.2.1 Exhaust Ventilation at Feeders 1.2.2 Application of Liquid Overspray 1.5.6 Automatic Overflow Recycling	1.5.7 Process Air Flow	1.3.1 Humid Air at Lint Slide 1.3.2 Exhaust Ventilation at Lint Slide 1.3.3 Fixed Box Bale Press 1.5.8 Automatic Bale Handling 1.4.1 Local Exhaust Ventilation at Seed Scale	1.5.1 Make-up Air Intakes 1.5.2 Cyclone Locations 1.5.3 Location of Material Handling Fans 1.5.4 Partitioning Capability 1.5.5 Work Station Isolation
Functional Block Diagram	Seed Cotton Feeding →	Seed Cotton Drying and Trash Removal "Overhead" →	Ginning →	Lint Cleaning →	Baling and Seed Weighing	All Plant Processes
Common Variables 1. Type Cotton 2. Growing Region 3. Harvest Method 4. Trash Content 5. Ambient Weather and Climate 6. Production Rates and gin capacity 7. Gin Plant Design		1. Type Machines Used 2. Number of Cleaning Stations	1. Brush or Air Type 2. Size and Number of Saws 3. Production Rate per Stand 4. Saw or Roller Gin	1. Number of Stages 2. Air Flow	1. Type Press 2. Production Rate	

Considering there are approximately 2700 active U.S. cotton gins, this assessment included a very small portion of the industry. However, through contacts and discussions with the industry associations and USDA representatives, gins were visited that offered the greatest opportunity to evaluate control technology. As this report explains in the descriptions of control techniques, conditions vary throughout the large growing region. This includes type of harvesting, trash content in the seed cotton, moisture level, and ambient conditions. Due to the limitations of this assessment it is not possible to determine the effectiveness of the control techniques if they were applied in all gins.

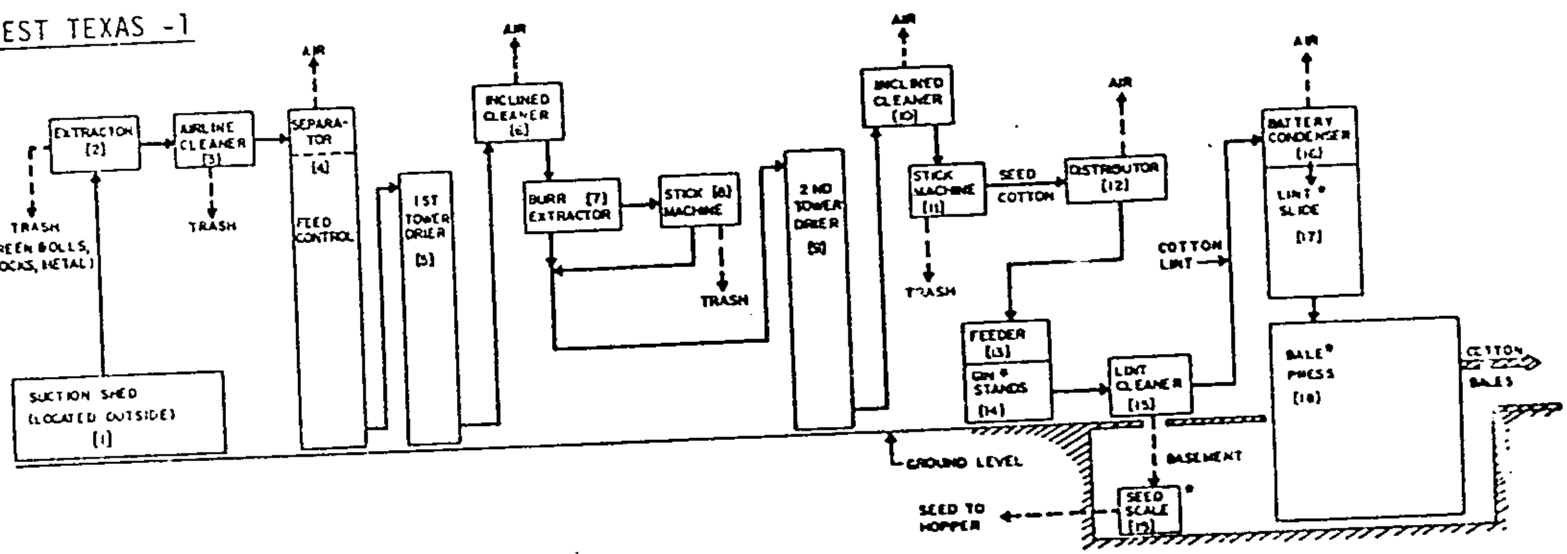
The functional operations in cotton ginning can be described as follows:

- Feeding Seed Cotton - Seed cotton is normally delivered to the gin in trailers, from which it is fed pneumatically to the processing operations. Generally, one to three workers operate the suction pipes which take the seed cotton from the trailers to the cleaning line. Module feeding is a relatively new technology which eliminates the manual suction feeding function.

- Drying and Cleaning Seed Cotton - Cleaning machines are used to remove rocks, dirt, stems, leaf and other foreign particles. This "overhead" line usually includes two tower dryers which condition the seed cotton to a moisture content of approximately 6-8 percent. The combinations of type and number of cleaning machines used in different gins vary according to growing regions, types of cotton produced, and operator preference. Figure A.1-2 illustrates the combinations of ginning machinery for the plants in Mississippi and West Texas that were included in this project. The Texas gins process stripper harvested cotton

FIGURE A.1-2. PROCESS FLOW DIAGRAMS - COTTON GINS

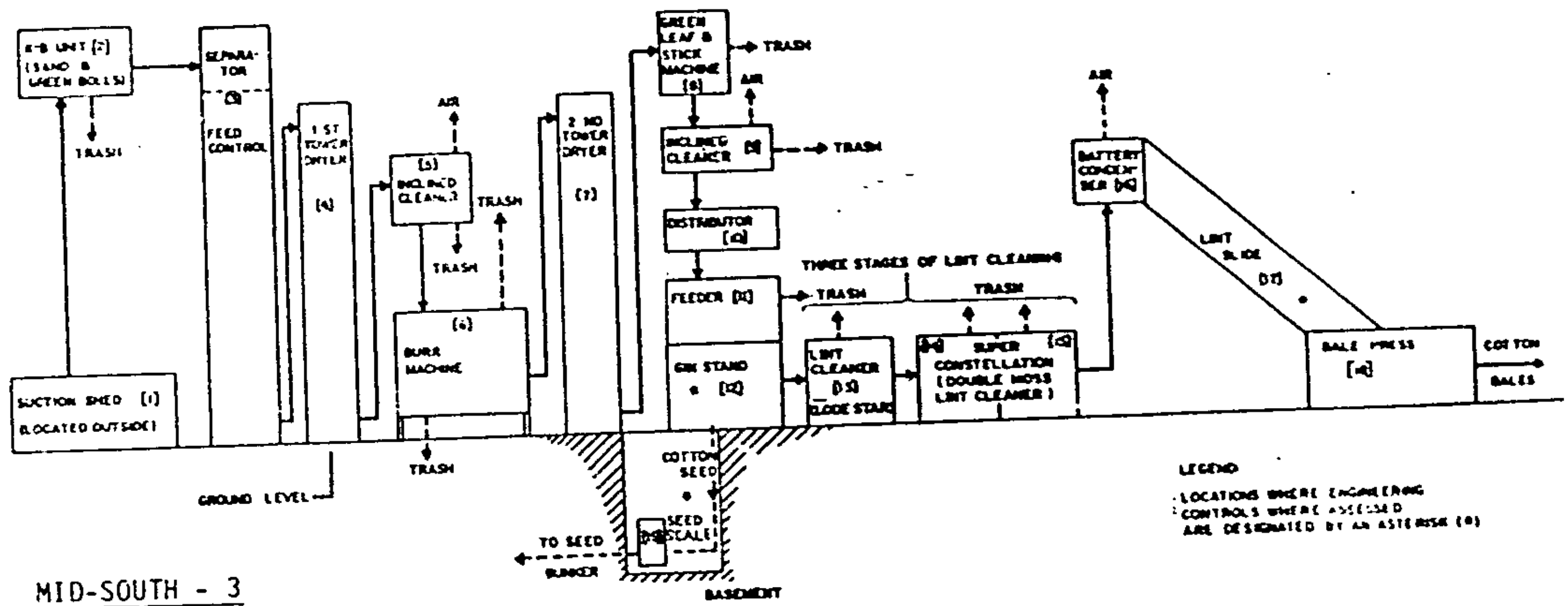
WEST TEXAS -1



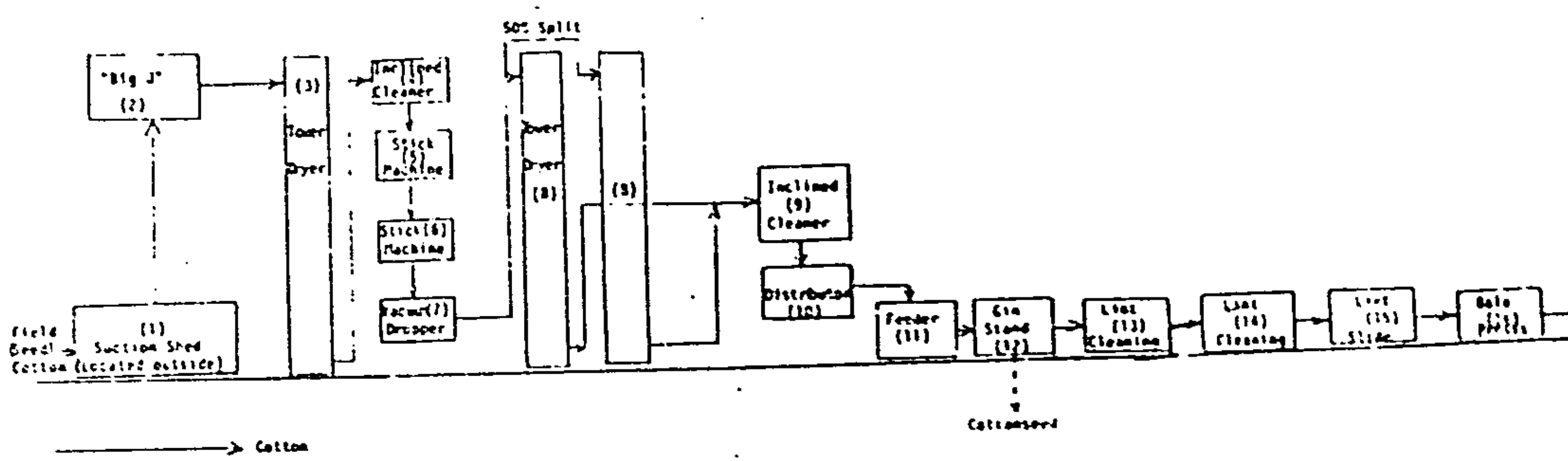
LEGEND
LOCATIONS WHERE ENGINEERING CONTROLS WHERE ASSESSED ARE DESIGNATED BY AN ASTERISK (*)

FIGURE A.1-2. PROCESS FLOW DIAGRAMS - COTTON GINS (Continued)

WEST TEXAS - 2



MID-SOUTH - 3



which contain 4 to 5 times as much foreign matter as the machine picked cottons processed by the Mid-South gin.

- Ginning - After the seed cotton is cleaned, the lint fibers are separated from the seed either by saw-type or roller-type gin stand equipment. Since only about 1% of U.S. plants use roller ginning, only saw gins were surveyed. The gin saws project between a series of metal ribs, with just enough clearance to permit cotton fibers to be drawn through without allowing seed to pass. The lint fibers are actually pulled from the seed whereas the linters must be cut from the seed (Section A.2.0 - Cottonseed Processing). The cottonseed is mechanically and pneumatically transported to storage bins, for eventual transport to a cottonseed oil mill.

- Lint Cleaning - The lint fibers are pneumatically conveyed through lint cleaners which remove more trash and a portion of short staple length fiber. From one to three lint cleaning stages are used, depending upon the type cotton and the quality requirements of the local market.

- Baling - After lint cleaning the lint fiber is pneumatically conveyed to a condenser/separator where it is formed into a bat. Doffer rolls remove the bat from the condenser drum, allowing the cotton to fall down a lint slide into the bale press. The bale press hydraulically presses the cotton into bales weighing approximately 480-500 pounds. The packaged bale is then removed from the press and conveyed to the storage location.

Based on the information obtained in the plants surveyed during this project and from other available sources, the potential for exposure of workers in ginning is characterized below. This data is indicative of the possible benefits of control technology in reducing the dust exposure of the worker population in cotton ginning.

Work Area	Workers Exposed Average per/Shift per gin surveyed	Estimated Industry Total @ 2700 gin plants
Feeder Operator	3.33	16,200
Gin Stand Operator	1.67	5,400
Lint Cleaner Operator/Sweeper	1.00	--
Bale Press Operator*	2.00	16,200
Sample Man**	.67	--
Totals	8.67	37,800

Cotton harvesting and ginning is a seasonal function which lasts 6 to 12 weeks each year. Also, since the major portion of the crop is ginned in 4-6 weeks, the second 12 hour shift is normally needed only during this period. Some gins operate only one shift throughout the season. Since the turnover rate is also high, several additional employees are usually kept on standby and used when needed.

A.1.1 Seed Cotton Feeding

A.1.1.1 Module Feeding (Process Control)

In a conventional cotton gin, field cotton is fed pneumatically to the gin processes at the suction shed. This job function requires two to four employees to move the trailers into position and to operate the large suction pipes that transport the seed cotton to the cleaning line. The module feeding system (Figure A.1-3) eliminates the manual feeding of field cotton at the suction shed and provides a constant flow to the ginning process. Monitoring of the feeding area can be done with a closed circuit T.V. screen located at the gin stand console. This enables the worker to be removed from the suction feed operation and the time weighted average exposure at this location to be reduced.

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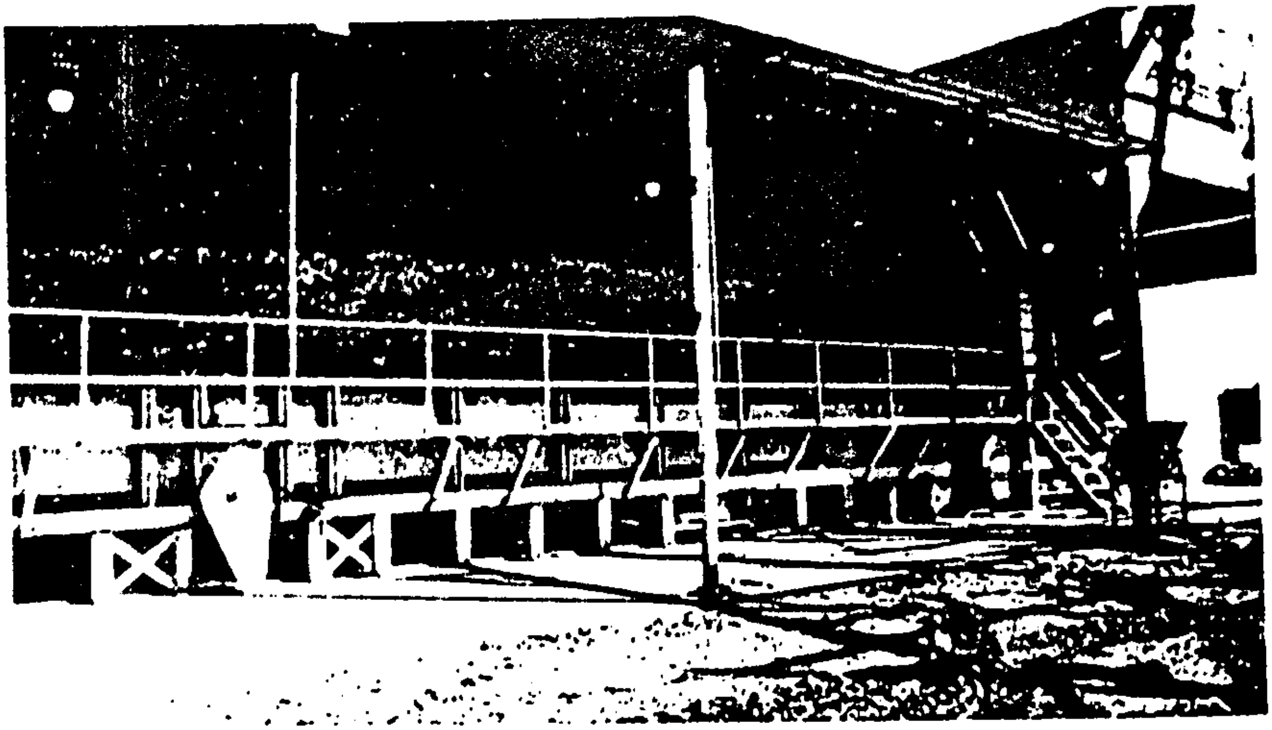
* Two gins had automatic presses with one operator, one gin had a manual press with four operators.

** One of the gins did not do sampling.

FIGURE A.1-3. MODULE FEEDING SYSTEM



However, implementation of this process requires capital investment in new module feed harvesting and feeding equipment. This change could completely phase out the use of conventional seed cotton trailers and manual suction shed feeding.

A.1.1.2 Suction Shed Feeding - Personal Protection Devices

The feeding of field cotton at a suction shed process requires the worker to stand inside a wagon and operate a suction pipe which picks up the seed cotton and transports it to the cleaning machines. The nature of this equipment makes the use of engineering controls impractical. Since engineering controls cannot be utilized, respirators must be used if it is necessary to provide workers with personal protection against potential exposure to cotton dust emissions.

A.1.2 Ginning

Control assessed: A.1.2.1 Exhaust Ventilation at Feeders (Engineering Control)

The effectiveners of control with this ventilation system was evaluated simultaneously with the application of an overspray (X-78), described in Section A.1.2.2. Vertical elutriators were positioned approximately three feet from the feeders to obtain samples at the emission source. The resulting data listed below indicate a reduction in dust levels with the ventilation system operating.

Sample Date - 12/14/78

Vertical Elutriator Sample Set	Vertical Elutriator Cotton Dust Levels ($\mu g/m^3$)					
	No. Samples N	Mean $\bar{X}$	Std. Dev. σ	Range Low	Range High	Range Median
1. With all controls operating	3	1147	—	960	1360	1120
2. With local exhaust ventilation turned off and other controls operating	3	1940	—	1780	2200	1840

The processing variables particular to this operation are as follows:

Variables Influencing Control Effectiveness	December, 1978	
1. Type of Cotton:		
Geographic Region	West Texas	
Harvest Method	Stripper	
Trash Content	34-41%	
2. Ambient Conditions:	12/14/78	12/15/78
Wind Speed and Direction	8 mph SW	10.4 mph NW
Relative Humidity	37%	39.2%
Ambient Air Dust Levels - Upwind	230 $\mu g/m^3$	
- Downwind	850 $\mu g/m^3$	
3. Production Variables:		
Production Rate	4.6 - 10.8 bales/hr	
Adjacent Process Dust Sources	Lint slide, lint cleaners	
Exterior Cyclones	Downwind of gin building	

The use of exhaust ventilation at the bottom rear panel of the Super Mitchell feeders (Figure A.1-4) reduces the emission of dust to the workplace air. Originally this feeder was designed to introduce humidified air at the top of the feeder to reduce static charges and moisten the cotton fiber to improve the separation of lint from seed at the gin stand. Part of the system is the exhaust duct that was connected to the base of the feeder to assist in more thoroughly applying the humid air.

The humid air system is not now being used since the plant started using the overspray (Section A.1.2.2) to improve ginning. However, since the gin operators observed improved dust levels with the ventilation system operating, it is still being used to exhaust air through the feeder.

The ventilation system is designed with a 6" exhaust take off mounted flush to the lower rear panel of the feeder. This 6" duct is then connected to a tapered duct system sized for proper balance at each branch. The air flow at the feeders ranged from 680-741 CFM through the four 6" exhaust ducts. This volume of air had a positive effect on removing dust, based on the measurements made during this survey.

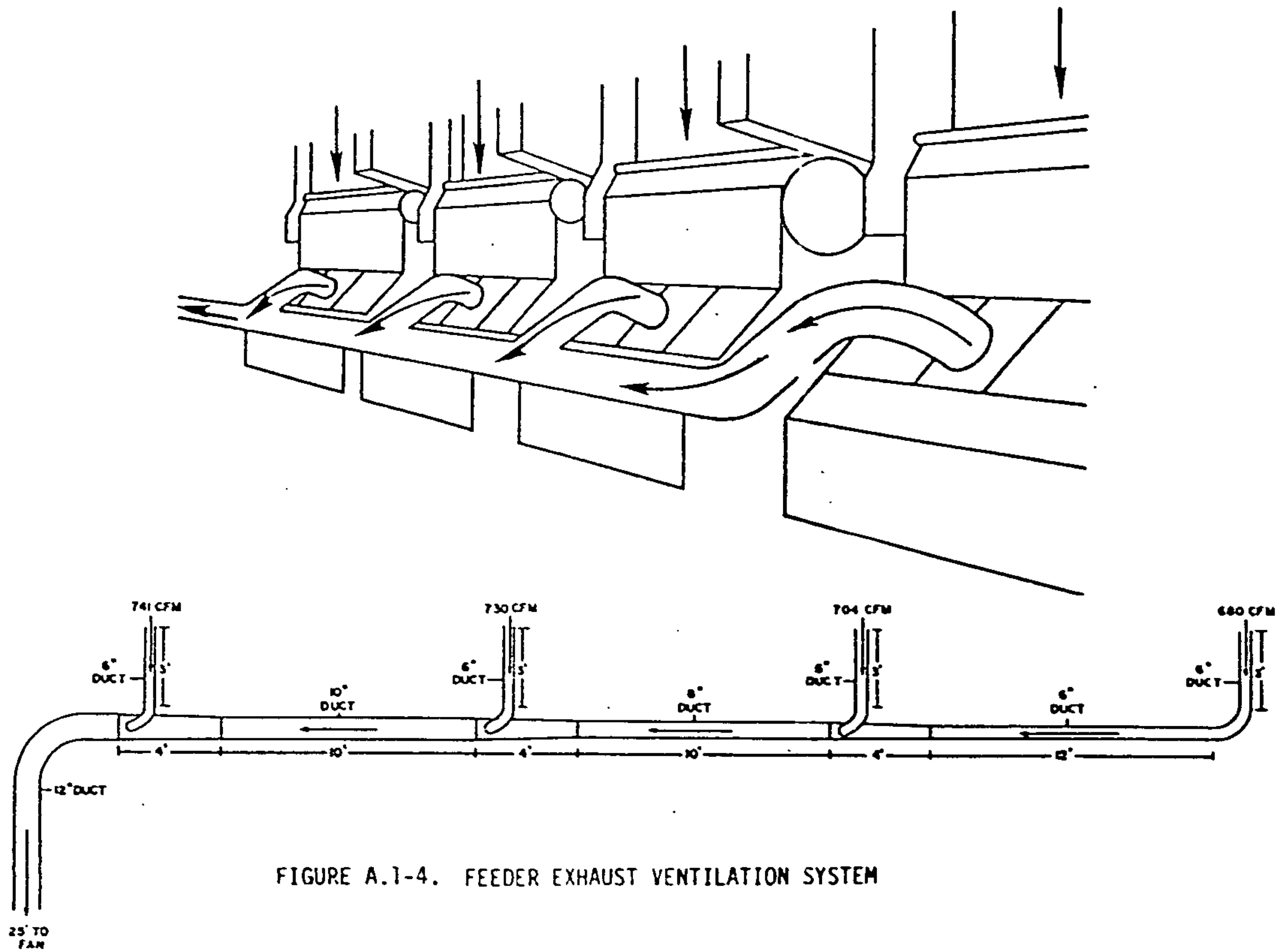


FIGURE A.1-4. FEEDER EXHAUST VENTILATION SYSTEM

Control assessed A.1.2.2 Application of Liquid Overspray (X-78) (Engineering Control)

During the assessment of this control technique the following dust levels were observed in the gin stand, bale press, and seed scale areas:

Vertical Elutriator Samples (μg/m³)

Sample Date - 12/14/78

Sample Set	No. Samples N	Mean $\bar{X}$	Std. Dev. σ	Range Low	Range High	Range Median	% Reduction
1. With X-78	6	952	460	293	1457	1037	45
2. Without X-78	6	1723	832	817	3217	1559	

The dust data obtained with this control technique demonstrates a reduction in dust levels with the additive. The processing variables particular to this operation are as follows:

Variables Influencing Control Effectiveness	Description	
1. Type of Cotton:		
Geographic Region	West Texas	
Harvest Method	Stripper	
Trash Content	34-41%	
2. Ambient Conditions:	12/14/78	12/15/78
Wind Speed and Direction	8 mph SW	10.4 mph NW
Relative Humidity	37%	39.2%
Ambient Air Dust Levels - Upwind	230 μg/m³	
- Downwind	850 μg/m³	
3. Production Variables:		
Production Rate	4.6 - 10.8 bales/hr	
Adjacent Process Dust Sources	Lint slide, lint cleaners	
Exterior Cyclones	Downwind of gin building	

The description of this engineering control is as follows:

A liquid additive (X-78) is sprayed on the seed cotton before ginning to reduce static electricity and to improve the separation of lint from the seed at the gin stands. Another reason for using the additive was to improve dust levels in the gin work areas. The results of this study showed a reduction in dust emission based on the vertical elutriator measurements.

The system sprayed approximately 4 ounces of additive per bale of cotton after the second tower drier. This helped the additive to be as uniformly distributed as possible on the seed cotton before ginning and reduces emissions from ginning, lint cleaning, baling, and seed scale operations.

A possible effect of using the additive to control dust emissions in ginning could be increased emissions in downstream processes. This has not been evaluated previously and is included in the recommendations for research.

A.1.3 Baling.

Control assessed: A.1.3.1 Application of Humid Air at Lint Slide (Process Control)

Cotton grown in the drier climates such as West Texas has excessively low moisture levels, and after ginning moisture is added to the lint fiber. The technique of forcing humid air into the lint cotton underneath the lint slide was evaluated to estimate the contribution toward dust control in the gin. The vertical elutriators were positioned approximately two feet from the lint slide to obtain samples at the emission source.

Vertical Elutriator Samples ($\mu g/m^3$)

Sample Date - 12/12/78

Vertical Elutriator Sample Set	No. Samples N	Mean $\bar{X}$	Std. Dev. σ	Range Low	Range High	Median
Without Moisture	3	1743	—	1440	2010	1780
With Moisture	3	983	—	560	1320	1070

The dust levels observed show a reduction in cotton dust emission when this method of applying humidified air is used, compared to when no humid air is being applied. The processing variables particular to this operation are as follows:

Variables Influencing Control Effectiveness	December, 1978	
1. Type of Cotton:		
Geographic Region	West Texas	
Harvest Method	Stripper	
Trash Content	12-44%	
2. Ambient Conditions:	12/12/78	12/13/78
Wind Speed and Direction	9.6 mph SW	12 mph NW
Relative Humidity	40%	32%
Ambient Air Dust Levels - Upwind	84 $\mu g/m^3$	
- Downwind	890 $\mu g/m^3$	
3. Production Variables:		
Production Rate	12.2 - 15.4 bales/hr	
Adjacent Process Dust Sources	Gin stands and lint cleaners	
Exterior Cyclones	Downwind	

A description of the control technique is as follows:

Besides conveying the cotton to the bale press, the lint slide is used to re-condition the lint fibers with moisture. The high proportion of foreign plant matter in the field cotton also contains a greater amount of moisture (up to 20-25%) than does the cotton lint. While the tower dryers reduce the overall moisture content in the field cotton to less than 10%, it also reduces the moisture content of the lint to 4-5%. Moisture is added to the cleaned seed cotton at the feeders and at the lint slide to get the desired 6-8% moisture content in the finished bale. It is realized that this addition of moisture at the lint slide is a processing technology not applied directly to control cotton dust; however, moisture does have a direct effect on the handling of cotton fiber and the amount of matter that becomes airborne.

The lint slide at this plant was approximately 18 feet in length by 54" wide. The bottom of the lint slide (Figure A.1-5) has a 15 foot louvered grid system where humid air is blown into the bat of cotton. Included in this design is a duct to slide attachment, 10" diameter duct work, a gas-fired humid air unit and water supply. The 10" main duct feeds humid air into the bottom of the lint slide. The volume of air moving into the lint slide grid measured 210 cubic feet per minute. This

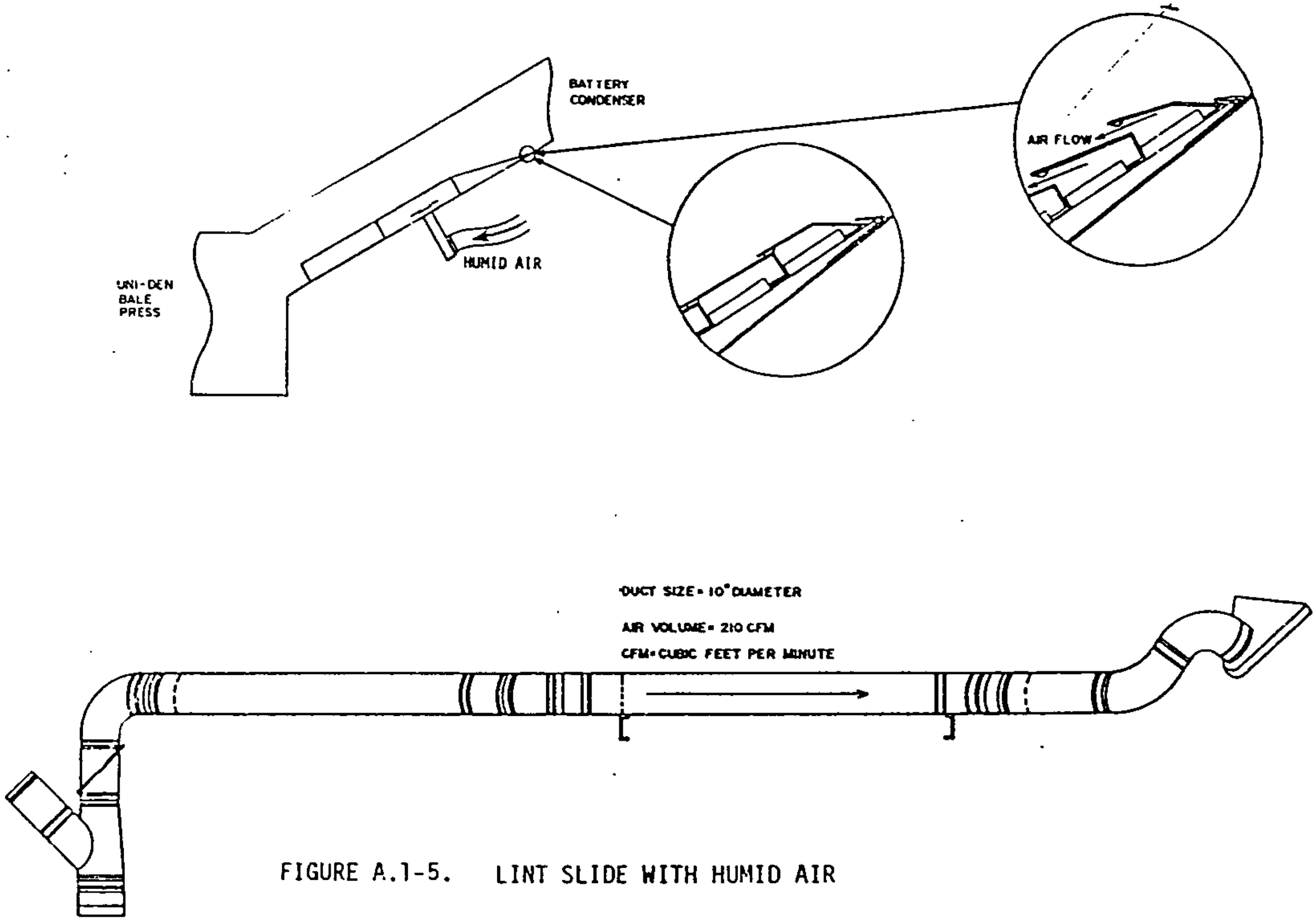


FIGURE A.1-5. LINT SLIDE WITH HUMID AIR

relatively low quantity of humidified air controls the amount of moisture added. Also, since it is introduced at a slow velocity, emissions from the lint slide are prevented. The air also provides a cushion on which the lint travels while falling down the slide. The final moisture content is 6-8% in the cotton lint. Approximately 30 lbs of of water per bale is needed for this system.

Control assessed: A.1.3.2 Local Exhaust Ventilation at Lint Slide (Engineering Control)

When this system was evaluated a chemical conditioner (X-78) was applied as an overspray to the seed cotton (Section A.1.2.2). During this assessment all control techniques, including the use of chemical conditioner, the humid air system and the ventilation system were in operation. The ventilation system was the only control turned off during this assessment. The vertical elutriators were positioned approximately two feet from the lint slide. The sampling data is listed below:

Sample Date - 12/15/78

Vertical Elutriator Sample Set	Vertical Elutriator Cotton Dust Levels ($\mu g/m^3$) No. Samples N	Mean $\bar{X}$	Std. Dev. σ	Range Low	Range High
1. With all controls operating	2	413	—	293	533
2. With local exhaust ventilation turned off	2	1295	—	1004	1585

The results show a significant reduction in dust levels with the local exhaust ventilation equipment. The processing variables particular to this operation are as follows:

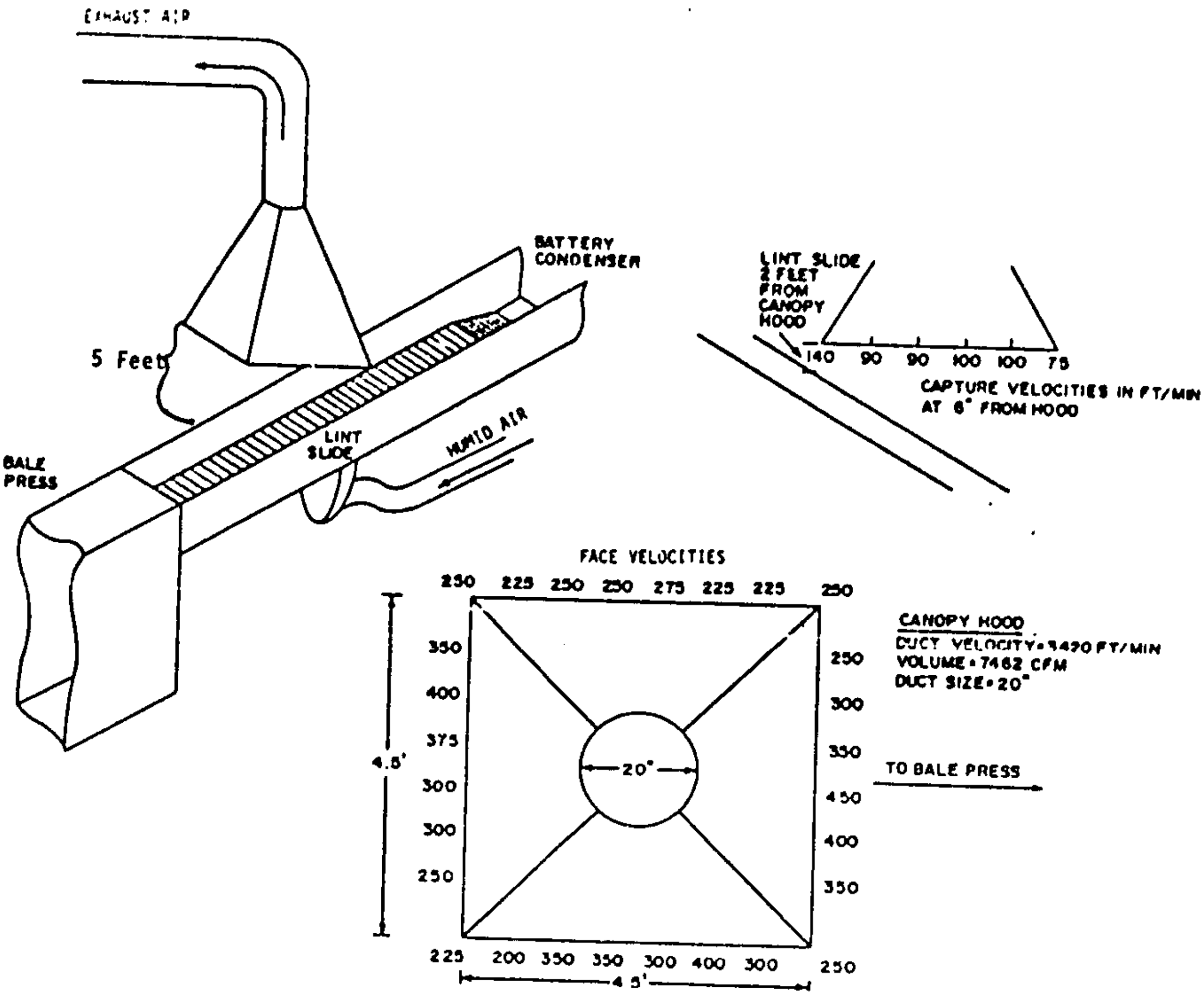
Variables Influencing Control Effectiveness	Description	
1. Type of Cotton:		
Geographic Region	West Texas	
Harvest Method	Stripper	
Trash Content	34-41%	
2. Ambient Conditions:	12/14/78	12/15/78
Wind Speed and Direction	8 mph SW	10.4 mph NW
Relative Humidity	37%	39.2%
Ambient Air Dust Levels - Upwind	230 $\mu g/m^3$	
- Downwind	850 $\mu g/m^3$	
3. Production Variables:		
Production Rate	4.6 - 10.8 bales/hr	
Adjacent Process Dust Sources	Lint slide, lint cleaners	
Exterior Cyclones	Downwind of gin building	
4. Additional Control Techniques:		
Application of Humid Air at Lint Slide	Described in Section 1.3.1	
Application of Liquid Overspray	Described in Section 1.2.2	

This control technique is described below:

While the cotton lint slides down the lint slide to the bale press, humidified air is introduced through a louvered grid system on the bottom of the lint slide. This gin was experiencing a problem with this air blowing lint into the air and collecting on the ceiling and rafters. In order to correct this problem and eliminate the need to clean overhead frequently, a canopy hood (Figure A.1-6) was installed over the lint slide. This ventilation hood is suspended two feet above the 45^0 angled lint slide approximately three feet from the bale press and exhausts lint and cotton dust to exterior cyclones.

The dimensions of the tapered canopy hood are 4.5' x 4.5' and the duct work was 20" in diameter. Velocity readings were taken to record air flow at the time of the sampling. The duct velocity measured by pitot traverse was 3420 feet/minute with a volume of 7462 CFM of air. Face velocity readings taken around the perimeter of the hood ranged from 200

FIGURE A.1-6. EXHAUST VENTILATION AT LINT SLIDE



to 450 ft./min. Capture velocities ranged from 76-140 ft./min. at 6" from the hood system, and were below 50 ft./min. at the lint slide.

However, during this assessment, the hood connection to the main exhaust duct was partially dislodged and the effective capture velocity was decreased. Repairing the hood would further reduce dust levels at this lint slide. Also, lowering the hood as close as possible to the lint slide without picking up cotton fiber would improve control over emissions.

Control assessed: A.1.3.3 Process Isolation for Fixed Box Bale Press (Process Equipment)

This modern automatic bale press was included in the assessments described in Sections A.1.3.1, Application of Humid Air at Lint Slide and Section A.1.4.1, Local Exhaust Ventilation at Seed Scale (Site #1). The vertical elutriators were positioned three to four feet from the bale press. The cotton dust measurements observed indicate the level of control achieved in the bale press area.

Vertical Elutriator Samples ($\mu g/m^3$)

Sample Date - 12/13/78

Sample Location	Without Seed Scale Exhaust Ventilation	With Seed Scale Exhaust Ventilation
Underneath main floor at seed scale and bale press	5070	1457
	With Moisture	Without Moisture
Main floor at lint slide-bale press	983	1743

The processing variables encountered during the survey are as follows:

Variables Influencing Control Effectiveness	December, 1978	
1. Type of Cotton:		
Geographic Region	West Texas	
Harvest Method	Stripper	
Trash Content	12-44%	
2. Ambient Conditions:	12/12/78	12/13/78
Wind Speed and Direction	9.6 mph SW	12 mph NW
Relative Humidity	40%	32%
Ambient Air Dust Levels - Upwind	84 $\mu g/m^3$	
- Downwind	890 $\mu g/m^3$	
3. Production Variables:		
Production Rate	12.2 - 15.4 bales/hr	
Adjacent Process Dust Sources	Gin stands and lint cleaners	
Exterior Cyclones	Downwind	

The purpose of this process equipment being installed is to improve productivity through automation of the different steps in forming a bale of cotton. The pressing of the cotton is accomplished under the main floor level, thus isolating this part of the press. As a result, dust particles emitted when the ram presses the cotton (Figure A.1-7) are not discharged directly into the workplace air. In addition, the automatic strapping, bale removal and bagging operations make it possible to reduce the number of workers exposed to cotton dust.

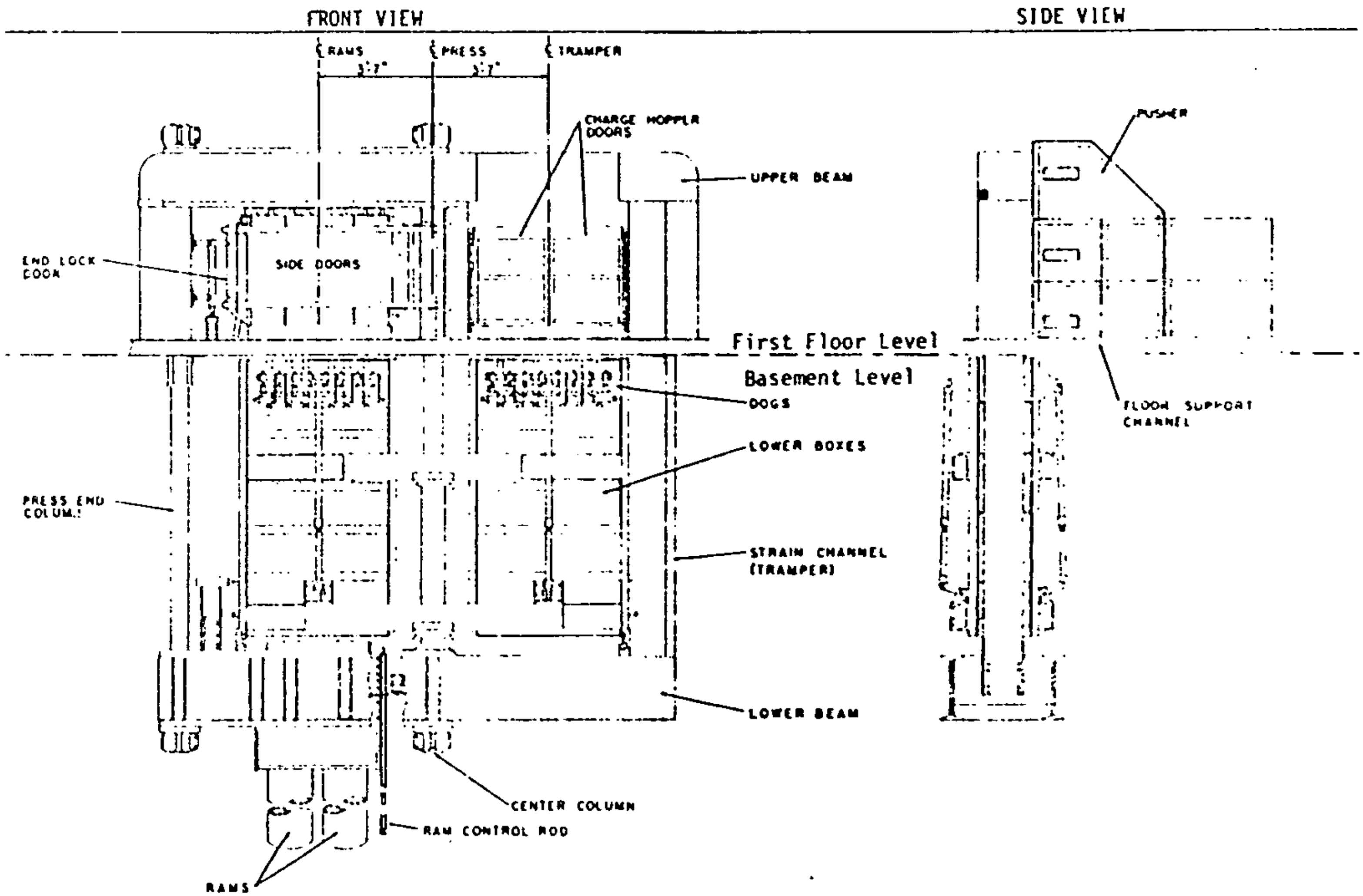


FIGURE A.1-7. UNI-DEN FIXED BOX BALE PRESS

A.1.4 Seed Scale

Control assessed: A.1.4.1 Local Exhaust Ventilation at Seed Scale (Engineering Control)

The evaluations of this engineering control technique at two cotton gins showed the following levels of cotton dust control:

Vertical Elutriator Samples ($\mu g/m^3$)

Samples	With Exhaust Ventilation	Without Exhaust Ventilation
Site #1	5,070	17,270
Site #2	1,457	1,861

The vertical elutriator samples were taken two feet from the seed scales and showed reductions in cotton dust emissions at both gin sites with the ventilation systems. The seed scales at both sites were positioned below the main floor level to isolate them from the remaining ginning processes. As a result, the use of local exhaust ventilation in these gins had no effect on reducing dust concentrations in the main workplace. However, in gins where a seed scale is located on the main floor level, improvement in this dust level can be made with the local exhaust ventilation.

The processing variables particular to each operation are as follows:

Variables Influencing Control Effectiveness	Site #1		Site #2	
1. Type of Cotton:				
Geographic Region	West Texas		West Texas	
Harvest Method	Stripper		Stripper	
Trash Content	34-41%		12-44%	
2. Ambient Conditions:	12/14/78	12/15/78	12/12/78	12/13/78
Wind Speed and Direction	8 mph SW	10.4 mph NW	9.6 mph SW	12 mph NE
Relative Humidity	37%	39.2%	40%	33%
Ambient Air Dust Levels - Upwind	230 $\mu g/m^3$		84 $\mu g/m^3$	
- Downwind	850 $\mu g/m^3$		890 $\mu g/m^3$	
3. Production Variables:				
Production Rate	4.6-10.8 bales/hr		12.2-15.4 bales/hr	
Adjacent Process Dust Sources	Bale press		--	
Exterior Cyclones	Downwind		Downwind	

A description of each control follows:

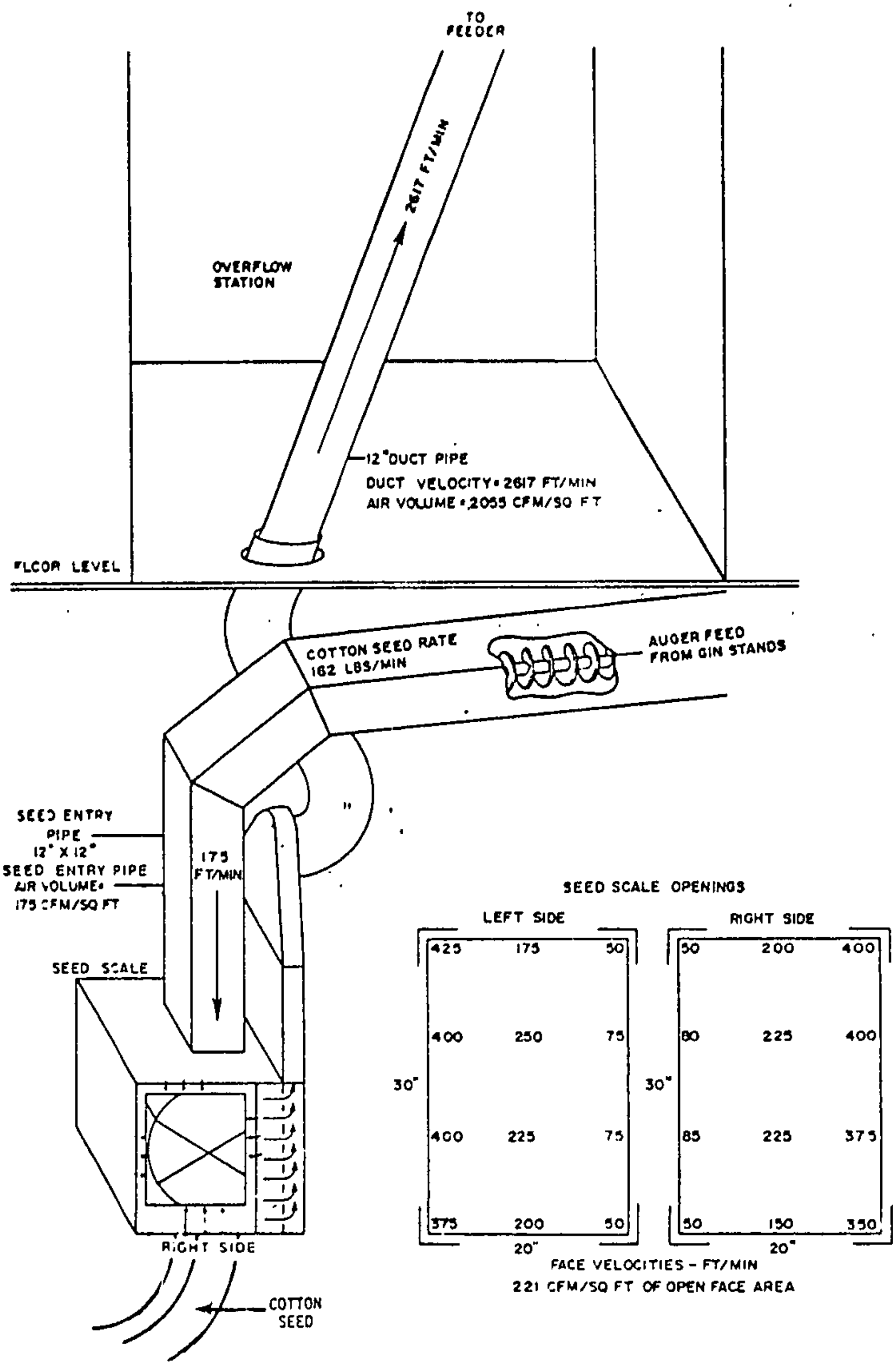
Site #1

The seed scale is a major source of cotton dust emissions for two reasons. The cotton seed is transported from each gin stand by a mechanical auger feed, as opposed to a pneumatic system, and the seed is dropped from the conveyor on an open seed scale. This action of dropping the seed onto the scale causes dust to be discharged from the scale.

At Site #1, two techniques were used to reduce the amount of cotton dust emitted by the seed scale into the workplace air. First, the scale was moved underneath the main floor level in a room with the bale press to isolate the dust source from the areas where workers spend their time. Secondly, a local exhaust ventilation system (Figure A.1-8) was installed to exhaust cotton dust generated by the mechanical transport of seed and dropping it onto the scale.

A 25" x 30" opening was cut in the back of the seed scale to accommodate the 9" x 30.5" x 33.5" hood system. A 12" duct was connected to the top of the taper to exhaust air. Both side panels of the seed scale were removed to allow adequate make up air to the system. When necessary to recycle seed cotton that collects in the overflow bin, the 12" duct

FIGURE A.1-8. LOCAL EXHAUST VENTILATION AT SEED SCALE - SITE #1



would be removed from the connections to the seed scale hood. However, this occurred only 7% of the time sampling was done.

The air volume exhausted through the 12" main duct was 2055 CFM and the air velocity was 2617 ft./min. The face velocity readings ranged from 50 to 425 ft./min. around the 20" x 30" side panel openings of the seed scale housing. Also, the opening to the auger conveyor is a third source of make up air for the suction hood. The area of this opening is 10.5% of the total open face area of the seed scale housing. Air flow measurements taken at this point showed a face velocity of 175 ft./min. Although the system was not designed to specifically control dust generated in the auger conveyor, a negative pressure is maintained in the conveyor. As a result, dust generated inside the conveyor is exhausted through the seed scale to the hood. The plenum design is illustrated in Figure A.1-8, along with corresponding air flow measurements.

The installation of this seed scale in a room below the first floor isolates it from the main work area and is unique. Few cotton gins have a basement since the common construction is poured concrete on grade. Although dust exposure is improved there are some drawbacks with this underfloor installation. Maintenance is increased due to visual inaccessibility and energy requirements are increased to raise the seed from the basement floor to the seed hopper.

The excessive dust levels in the room with the bottom of the bale press and the seed scale helps illustrate the excessive amounts of cotton dust particles that are entrained in stripper harvested cottons. The results do indicate that a very sizable amount of fine dust is being eliminated from the first floor workplace air with the isolated locations and the application of exhaust ventilation.

Site #2

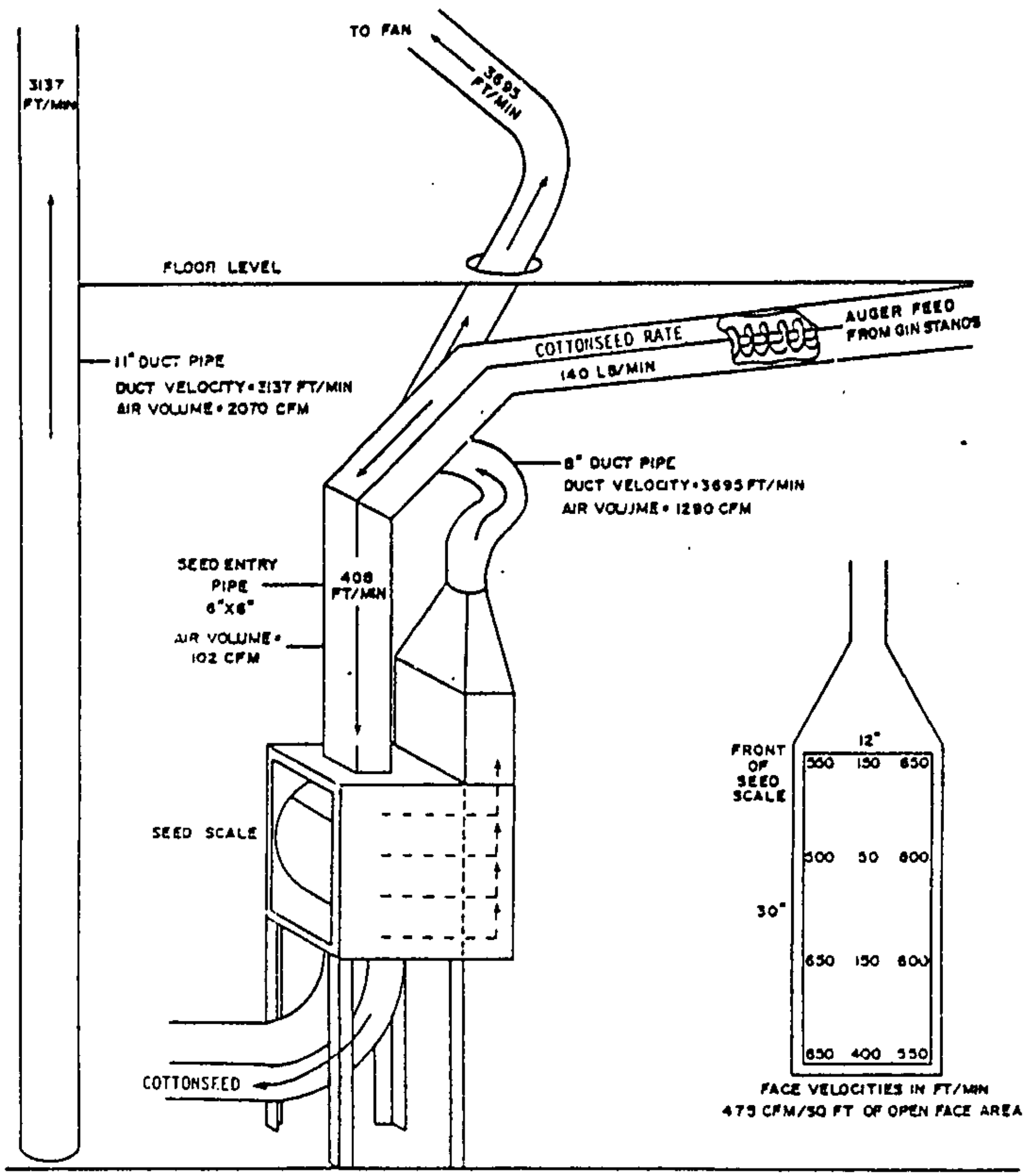
The scale for automatic weighing at this gin plant was also positioned in a room underneath the main floor of the gin. The duct for transport of cottonseed to the scale was installed at the top of the seed scale enclosure (Figure A.1-9) and an exhaust hood was mounted on the back side. This local exhaust system maintained an air flow of 102 CFM through the top duct where seed enters and 475 CFM/sq. ft. of face area at the open front panel. Make up air was provided to this enclosed space through a 2' x 3' opening in the first floor. This system controlled dust generated from the auger transport system as well as when the seed was deposited on the scale. Also, the location of the seed scale isolates the process from employees working on the main floor level and reduces dust exposure.

The dimensions of the seed scale hood were 17" width x 9" depth x 34" height. The dimensions of the exhaust hood centered at the back of the seed scale were 12" x 30" x 5". The hood is connected to a taper and exhausted through an 8" duct. Air velocity measurements showed an average face velocity of 475 ft./min. The duct velocity was 3695 ft./min. with an air volume of 1290 CFM. The system could be modified to include a blast gate in the main duct prior to the fan for adjustment of air flow at the seed scale enclosure. A provision should be made for locking the damper after the balancing has been performed.

Additional ventilation in the room is provided by an 11" duct, positioned approximately 2" above floor level to capture dust and fly that falls to the floor. The air velocity in the duct was 3137 ft./min. and the exhaust air volume was 2070 CFM (Figure A.1-9).

Improvements could be made to this ventilation system in two ways. The restriction of make-up air reduces the efficiency of ventilation at the seed scale. Disconnecting the floor exhaust duct will permit more air flow into the seed scale enclosure and improve control at the emission source. Observations at the seed scale indicated excessive dust emissions still come from this operation.

FIGURE A.1-9. LOCAL EXHAUST VENTILATION AT SEED SCALE - SITE #2



A.1.5 Gin Plant Design

Process Systems assessed:

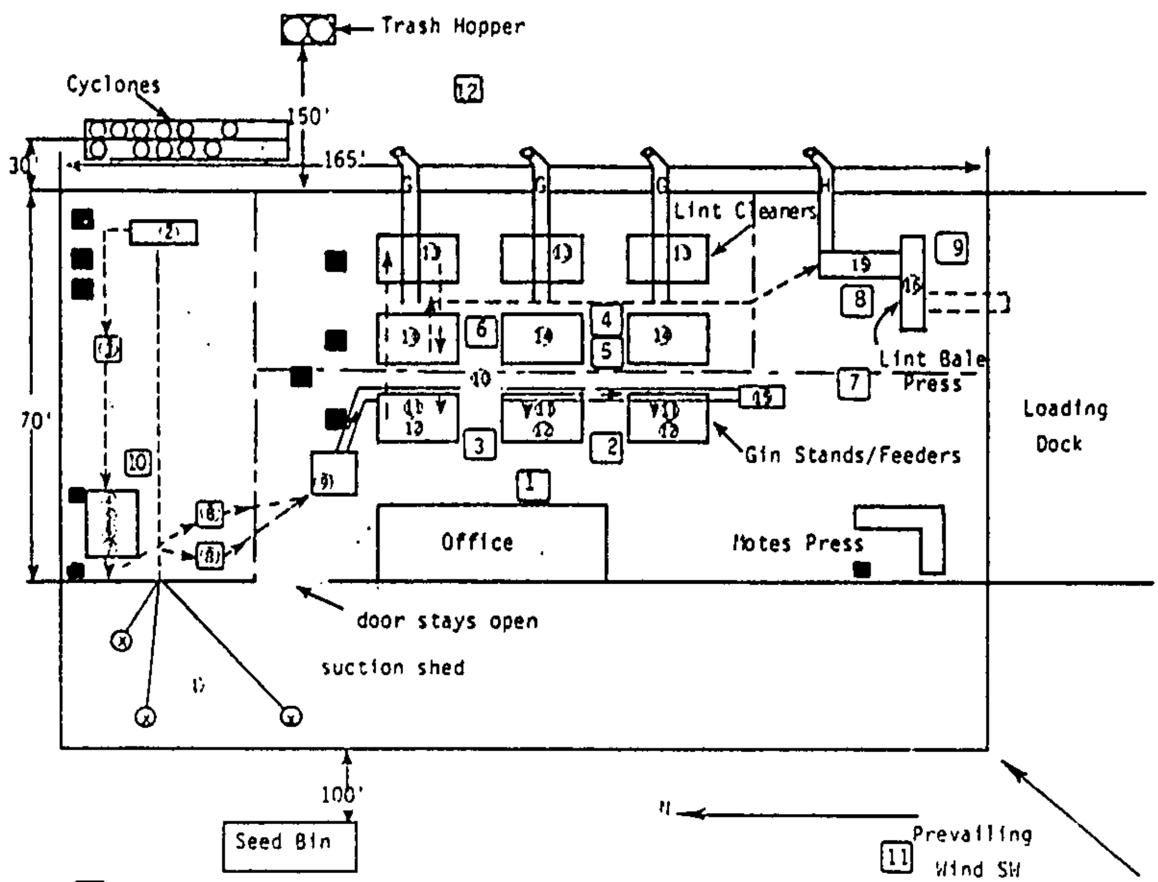
- A.1.5.1 Make-Up Air Intakes
- A.1.5.2 Cyclone Locations
- A.1.5.3 Locations of Material Handling Fan
- A.1.5.4 Partitioning
- A.1.5.5 Work-Station Isolation
- A.1.5.6 Automatic Overflow Recycling
- A.1.5.7 Lint Cleaning Process Air Flow
- A.1.5.8 Automatic Bale Handling Equipment

The construction of the gin building and the plot plan for placing machines and fans were designed to provide for control of dust exposure. The gin takes advantage of inherent operating parameters to provide control over dust emissions in the work areas. Figure A.1-10 is a plot plan which can be referenced to during the discussion on this gin. The vertical elutriators were positioned to obtain samples that would be representative of worker exposure. The resulting cotton dust sampling data is outlined below:

COTTON DUST SAMPLING ($\mu g/m^3$)

Sample Date - 11/7/79	Elutriated Samples ($\mu g/m^3$)						Total Dust Samples ($\mu g/m^3$)					
	No. Samples	Mean	Std. Dev.	Range			No. Samples	Mean	Std. Dev.	Range		
Sampling Location	N	$\bar{X}$	σ	Low	High	Median	N	$\bar{X}$	σ	Low	High	Median
Gin Stands/Lint Cleaners	9	282	68	175	349	319	3	500	49	446	542	513
Bale Press	9	289	52	217	390	275	3	480	139	381	639	419
Overall Gin	30	304	76	175	515	304	9	594	253	381	1227	542

FIGURE A.1-10. PLOT PAN OF NEW GIN



▢ = V.E. Sample Sites
■ = Material Handling Fans
⊙ = Processing Equipment
— · — = Future Partition Locations

Processing Equipment Key:

1. Suction Shed	9. Inclined Cleaner
2. "Big J" Machine	10. Distributor
3. Tower Dryer	11. Feeder
4. Inclined Cleaners	12. Gin Stand
5. Stick Machine	13. 1st Stage Lint Cleaner
6. Stick Machine	14. 2nd Stage Lint Cleaner
7. Vacuum Dropper	15. Lint Slide
8. Tower Dryer	16. Bale Press

These cotton dust data indicate that a substantial level of control can be achieved in a gin properly laid out and operated under the conditions found in this cotton growing region. The processing variables particular to this plant were as follows:

Variables Influencing Control Effectiveness	Description
1. Type of Cotton:	
Geographic Region	Mississippi Delta
Harvest Method	Spindle Picked
Trash Content	32%
2. Ambient Conditions:	11/7/79
Wind Speed and Direction	5 mph SW
Relative Humidity	57%
Ambient Air Dust Levels - Upwind	53 $\mu g/m^3$
- Downwind	791 $\mu g/m^3$
3. Production Variables:	
Production Rate	15 bales/hr
Adjacent Process Dust Sources	Gin stands
Exterior Cyclones	Downwind
4. Additional Control Techniques:	Process Air Exhaust - Battery Condenser Material Transport Fan Layout

The processing parameters used in designing the gin to provide control over dust emissions are described below:

A.1.5.1 Make-Up Air Intakes

The gin building is constructed with the front facing the prevailing southwest winds. This allows air to enter through the front of the gin and be exhausted through duct work to the exterior cyclones downwind (Northeast) of the building. The front suction shed employs a canopy roof to shelter the pneumatic suction operation and concentrate makeup air through one wall opening on this side of the building.

This design allows makeup air to enter the plant through the top of the front wall. The doors are kept closed and cross drafts and turbulence are reduced.

A.1.5.2 *Cyclone Positioning*

Thirteen fans are located in the gin for transporting seed cotton and expelling trash to the exterior cyclones at the rear of the building. The effect of designing the gin to exhaust trash to the NE side takes advantage of the prevailing wind to minimize reentrainment by allowing fine dust to be blown away from the building. During the survey two vertical elutriators were positioned outside the gin to sample ambient air. The upwind sampler recorded dust levels of 53 $\mu g/m^3$ for air being supplied to the plant. The V.E. sample obtained downwind of the gin was positioned at the base of the cyclones and lint cleaner exhaust and recorded ambient dust levels of 791 $\mu g/m^3$.

This range of particles sampled demonstrates the importance of cyclone placement to minimize reentrainment of dust and trash material exhausted from the gin. This gin uses approximately 104,700 CFM of air for pneumatic transport systems. Ambient air concentrations can have a significant effect on raising workplace dust levels.

A.1.5.3 Location of Material Handling Fans

All precleaning equipment and a majority of the material conveying fans (Figure A.1-10) are located in the northwest corner of the building. The inclined cleaners and stick machines remove the heavy dirt and trash and can be major contributors to dust emission. The material transport fans in this process area use approximately 20,000 CFM of air taken from inside the gin. Airborne dust from the cleaning equipment is exhausted in this air supplied to the fans. This process space occupies a volume of 37,200 cubic feet and receives 32 air exchanges per hour. Vertical elutriator samples taken in this area during three sample sets showed an average dust level of 255 $\mu g/m^3$.

In more conventional gins, material handling fans are usually more scattered throughout the plant. The air supplied to each fan is taken from the surrounding workplace in each unit process. Airborne dust emitted at the cleaning stages migrates to the other worksites in the gin and causes an increase in worker exposure.

A.1.5.4 Partitioning

This gin was constructed with a provision for installing partitions in the various process areas to isolate sources of dust emission. The layout of the gin stands and 1st and 2nd stages of lint cleaning allows for isolation of the two process areas. The duct work that transports cotton lint fiber from the gin stands to the lint cleaners was lengthened to permit the installation of a partition that would contain the lint cleaning operation and isolate it from the gin stands and bale press work sites. The average vertical elutriator dust level recorded in the lint cleaning process area was 354 $\mu g/m^3$.

A.1.5.5 Exposure Isolation

In addition to the isolation of process areas, an enclosed office area has windows for observing the entire ginning operation. Although the gin stand and bale press control console is not installed in the office enclosure, workers can spend time in this area and be isolated from the ginning operation. This reduces their time weighted average exposure to cotton dust during the eight hour work shift.

A.1.5.6 Automatic Overflow Recycling

An automatic overflow "live feed" recycles excess seed cotton supplied to the three gin stands. This open end suction hopper collects the overflow for pneumatic transport to a separator above the conveyor distributor. This system eliminates manual recycling of seed cotton with a suction pipe and encloses this operation. A fan delivering 800 CFM of exhaust air from this process transports seed cotton from the "live feed" to the conveyor distributor. As a result of this air being exhausted from the automatic seed overflow airborne dust and trash emitted by the processing equipment is controlled.

A.1.5.7 Lint Cleaner Process Air

The layout of the lint cleaners and gin stands make optimum use of pneumatic transport to reduce dust emissions. The gin stands and lint cleaners are positioned in a direct line (Figure A.1-10) to permit a sequential flow of material from the front to the rear of the gin building. Motes and trash removed by the lint cleaners are pneumatically transported to the exterior cyclones. Each of the three 1st stage lint cleaners exhausts 12,900 CFM of air. A total of 38,700 CFM of dust laden air is exhausted from the 1st stage lint cleaner condensers to the outside air.

At the 2nd stage lint cleaners, cleaned cotton fiber is transported through a lint flue to a battery condenser. A total of 33,000 CFM of air is exhausted from the three 2nd stage lint cleaners to the outside air.

A total of 84,700 CFM of air is exhausted from the six lint cleaners. Make up air is supplied to each cleaner through four 7' by 4" openings. Air flow measurements taken at the face of each of the six openings showed capture velocities ranging from 95-220 CFM. This provided control over dust and trash material being emitted from the equipment by inducing a negative pressure inside the enclosure. There is additional air supplied to the lint cleaners through openings and gaps in the enclosure of each machine.

A.1.5.8 Automatic Banding and Bale Removal (Process Equipment)

The bale press at this cotton gin was completely automatic with all functions, including compacting the cotton lint, strapping the full bales, doffing, and transport for the bales on a conveyor to the outside. All functions are controlled by one worker at a central console who also monitors the operation. A conventional bale press would need 3-4 employees for operation.