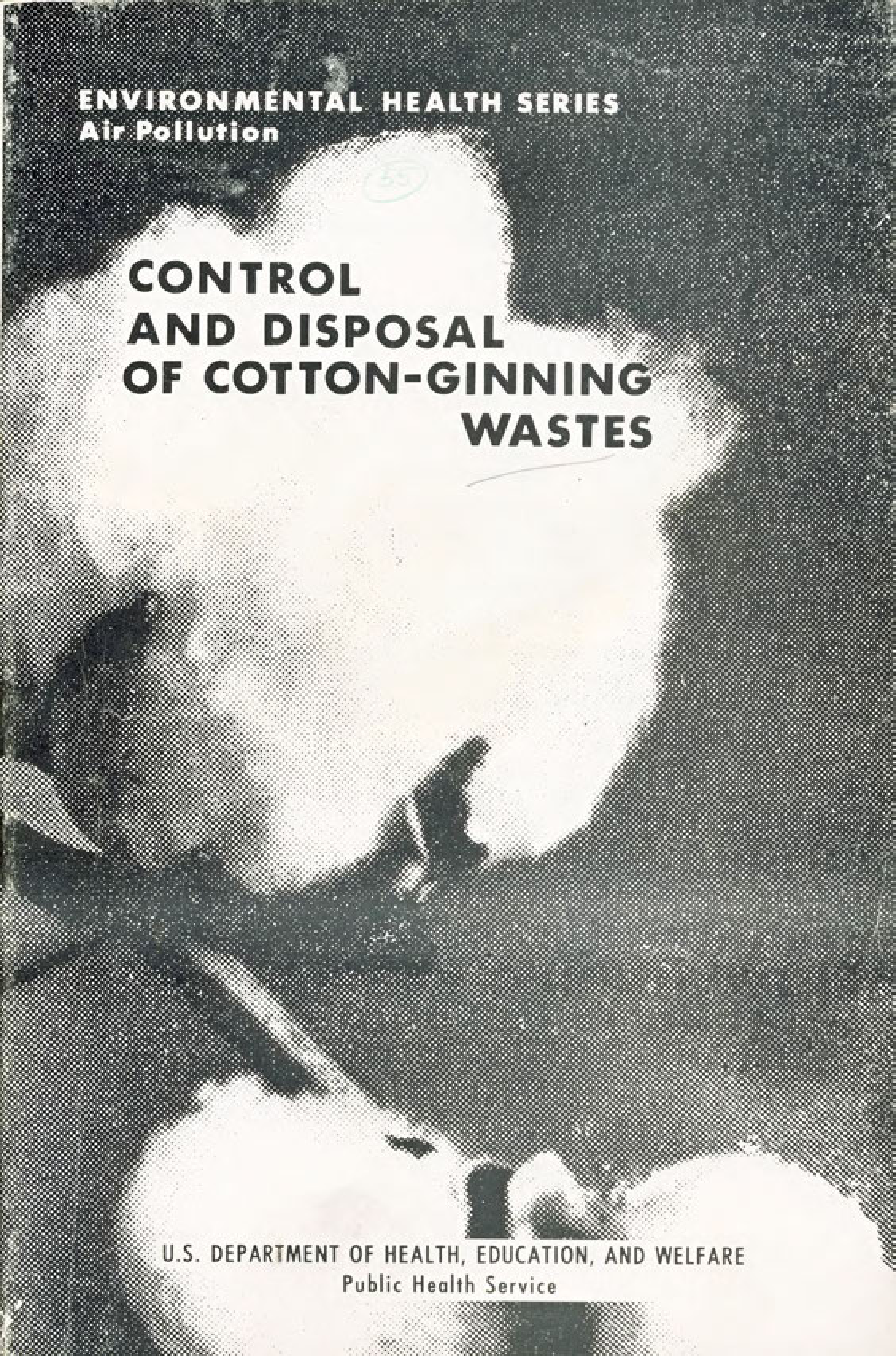
ENVIRONMENTAL HEALTH SERIES
Air Pollution

CONTROL AND DISPOSAL OF COTTON-GINNING WASTES



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

CONTROL AND DISPOSAL OF COTTON-GINNING WASTES

A Symposium
Sponsored by
National Center for Air Pollution Control
Public Health Service
U. S. Department of Health, Education, and Welfare

and

Agricultural Engineering Research Division
Agricultural Research Service
U. S. Department of Agriculture

Dallas, Texas
May 3 and 4, 1966

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Disease Prevention and Environmental Control
Cincinnati, Ohio
1967

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Public Health Service Publication No. 999-AP-31

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WELCOME ADDRESS

Richard E. Boyd
Regional Health Director
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I am pleased to have the opportunity to welcome each of you, both to Dallas and to this important technical symposium on the Control and Disposal of Cotton-Ginning Wastes. The Dallas Regional Office of the U. S. Public Health Service, which I represent, is most privileged to be your host.

The U. S. Department of Agriculture, cosponsors of the symposium and a major contributor to your program, has asked me to add their welcome to mine.

I understand also that the National Cotton Ginners' Association has been kept informed of the planning for this symposium and has indicated its wishes to cooperate toward the symposium's success.

You are gathered together, today and tomorrow, to work toward the resolution of technical problems associated with the control of air pollution from cotton-ginning operations. Some of you were among those who attended a similar meeting on this same subject held in Greenville, Mississippi, in 1955. It was the recommendation of this first meeting that a second meeting be held on these problems, after certain field studies had been completed. This is the second meeting, some 11 years later.

Technological changes in cotton-harvesting and cotton-ginning operations over the past decade, and wider use of pesticides, desiccants, and defoliant chemicals in cotton production suggested the need for a second technical seminar of this type to reevaluate the problem of air pollution.

In addition, a social change in this country further supports the need for a second meeting. As the people of this country have increasingly gained access to scientific facts about the nature and magnitude of air pollution and about the capability that exists for dealing with it more effectively, they have called for greater control efforts by the agencies that serve them at all levels of governmnt. This insistence upon better air pollution control is reflected most pointedly in the development and passage of the Federal Clean Air Act of 1963. Many states and local agencies have responded to this same demand by the passage of new state laws and local ordinances governing air pollution.

New air pollution control agencies are being established each year. These agencies are being staffed with personnel not always experienced or trained in the field of air pollution control.

Your symposium will serve, not only as a means of reviewing technical problems associated with the control of air pollution from cotton gins, but also as an orientation for these new personnel.

With a better understanding of these problems, reasonable approaches to their solution should result.

OPENING REMARKS

William E. Holy
Regional Program Director

First, I would like to add my welcome to that of Dr. Boyd's; secondly, if you will allow me a few minutes of your time, there are a few things that need to be said before we start our formal meeting.

The symposium you are attending has been designed to serve as a means of exchange of technical information related to the interests of the representatives of Federal, state, and local governmental agencies, universities, schools, and the cotton-ginning industry here in attendance.

You have been provided with a handout that sets forth the primary objectives of the symposium. These objectives can be achieved if we concentrate our efforts toward their achievement.

The agenda includes items that may be elementary to some attendees. Your patience and indulgence during these presentations will be appreciated.

We hope by the afternoon session of the second day of the symposium, sufficient background information will have been presented to set the stage for an open and free discussion of the problems that have been covered. Out of these discussions should come guidelines for future approaches to these problems.

I would like to take this opportunity to acknowledge the important parts the U. S. Department of Agriculture and the Cotton Ginners' Association have played in support of this symposium. The U. S. Department of Agriculture is a co-sponsor of the symposium and a major contributor to the program. The research carried out at their cotton-ginning laboratories on control of ginning wastes represents the best available technical information on this subject. It would have been impossible to have held the symposium without their cooperation.

The National Cotton Ginners' Association has been kept informed of every step taken in the planning of this symposium. Their secretary has advised me of their interest in the symposium and their willingness to cooperate in any way that will help accomplish its objectives.

The Texas Cotton Ginners' Association participated in the planning of the symposium and are contributors to the program. Their assistance is most appreciated. I would like to mention that the Texas Cotton Ginners' Association has published their own "Manual on Control of Air Pollution from Cotton Gins," for use of ginners in their association. They have also taken a leadership role in working toward solving gin waste disposal problems.

I would also like to express my appreciation to Mr. Pendleton, Cotton Ginning Engineer, Agriculture Extension Service, and others in Extension field work for their valuable assistance and support of our symposium.

My colleagues at the Federal, state, and local level of air pollution control are most interested in the conclusions or recommendations that will result from this symposium. We feel sure reasonable solutions can be achieved for the problems that will be discussed.

THE ROLES OF LOCAL, STATE, AND FEDERAL AGENCIES IN CONTROLLING AIR POLLUTION

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Air pollution is not new. Natural sources such as windblown dust, smoke, and fly ash have been with us since the beginning of time. Manmade air pollution probably started about the time that man began to use fire for beneficial purposes such as cooking and warmth. Industrial development in the United States during the late 1800's led to many new and different types of air pollution. Most of this new pollution was due primarily to the use of coal and other materials to produce consumer goods and provide transportation. Thus the air pollution problem was first recognized as being primarily due to smoke, dust, and dirt.

About 1948 a new type of air pollution problem was noted in Los Angeles. This air pollution had a different appearance from that of the usual smoke, dust, and dirt. The Los Angeles area used oil and gas rather than coal, and many other things were different, and yet they had an air pollution problem. This type of air pollution caused irritation to eyes, damage to plants, and other effects that had not been evident from the other type of air pollution. Later it was given the name of photochemical smog because it was produced by a photochemical reaction of the gaseous pollutants in the atmosphere.

At about the same time and shortly thereafter, a number of acute episodes occurred during which many people died and large numbers became acutely ill. The most dramatic episodes were those in Donora, Pennsylvania, in 1948, and in London, England, in 1952 and 1962. In Donora, 20 deaths occurred and approximately 5,000 people became ill. In London, in 1952, approximately 4,000 deaths above normal occurred, and thousands became ill. Just 10 years later, in 1962, London experienced its second episode when approximately 300 deaths above normal occurred and thousands of people became ill.

At present, practically all major urban areas have an air pollution problem of one type or another. Some of these problems are due primarily to automobiles, some are due primarily to industry, and some are due to a combination of sources such as the automobile, industry, and commercial and residential activities. Air pollution is not a problem that affects only the large cities; some smaller communities also have significant air pollution problems. These are usually due to the presence of one large industry or a group of small activities associated with one industry. Cotton ginning is a good example of one activity that can contribute to a significant air pollution problem in small communities.

Three things are usually required for the creation of an air pollution problem: (1) There must be a source of pollution; (2) there must be a method of transportation; and (3) there must be a receptor affected by the pollution. We cannot change the weather conditions such as wind speed and direction that provide the method of transportation of air pollution. We cannot remove all the people, animals, or vegetation from the area affected by the air pollution, and we cannot purify the air after it has been polluted. This leaves only one choice: The control or prevention of air pollution must be undertaken at its source.

As indicated previously, industrial developments in the United States in the late 1800's created large quantities of air pollutants primarily as a result of using coal and other raw materials to produce consumer goods and provide transportation. In 1881, Chicago adopted a smoke control ordinance and started the first program to control air pollution. Shortly thereafter, St. Louis, Cincinnati, and other cities also established smoke abatement programs. These early efforts established the often repeated concept that responsibility for air pollution control rests solely with the local and state governments. From 1930 to about 1950, dramatic improvements were made in the control of smoke by some local programs operating strictly within the confines of this concept. We are familiar with the past success of Chicago, Pittsburgh, St. Louis, Cleveland, and other cities that suffered from a pall of smoke pollution and a dirty atmosphere. This was such an obviously dirty and undesirable nuisance that we are amazed that the population tolerated it so long.

When the Los Angeles photochemical air pollution problem emerged, a different type of local program was established. First, it covered an entire county; second, it received more money, resources, and authority than any program had ever had before; and third, it established probably the most ambitious and stringent air pollution control program in the world. Even so, the very difficult and more complex air pollution problems that faced Los Angeles obviously would not yield to local efforts alone, no matter how vigorously and relentlessly these were applied. This problem, along with the acute episodes previously mentioned and more public concern about the air pollution problem, led to the development and establishment of state air pollution programs.

Additional problems along with still more public concern about air pollution led to the establishment of the first identifiable Federal air pollution program. In 1955 the Federal Government was authorized to aid local and state air pollution programs in the field of research and technical assistance. The continued growth of the national air pollution problem coupled with the improved documentation of its subtle as well as obvious effects on the public health and welfare demonstrated that local and state efforts, even when backed by Federal research and technical assistance, were not adequate to cope with the challenge posed by the air pollution problem. Recognition of this fact was reflected in the development and passage of the Clean Air Act of 1963 and in the subsequent amendments thereto in 1965. This added new dimensions to the Federal role in air pollution problems. It also marked an important shift in the national policy and recognized that a combination of efforts by the local, state, and Federal agencies was necessary to control air pollution. The Clean Air Act of 1963 reaffirmed the position that Congress took in 1955: The prevention and control of air pollution is primarily the responsibility of state and local governments.

For about the last 80 to 85 years, the roles of local, state, and Federal air pollution agencies have been and still are in a phase of development and evolution. As new air pollution problems emerge in the future, we can expect the respective roles to be changed and modified. At present, local, state, and Federal agencies have fairly definite roles in controlling air pollution.

Local agencies are primarily directed toward regulatory control of air pollution. The role of the local agency largely depends upon the nature and extent of the problem, the funds and personnel available to operate the program, the nature of the state laws that establish the powers and duties of the local agencies, and the activities and policies of the state agencies. Local-agency activities may range from a one-man smoke abatement effort up to attempts by a staff of over 200 people to control a multitude of air pollution sources, conduct research, and develop new approaches. The local program budgets presently range from 2 cents per capita per year up to 80 cents per capita per year. In 1965 the median budget for local agencies was about 15 cents per capita per year. Although the local air pollution control agency may engage in a variety of activities, it has three general roles: (1) Defining the nature and extent of the air pollution problems, (2) controlling and preventing air pollution (correcting the problem), and (3) operating the program.

Since state agencies have not been widely and extensively involved in air pollution control activities, their role is primarily in the phase of development and evolution. Wide variations in their approaches are very evident, owing to differences in their problems and in the laws or authority for a program. In 1965, 19 states had established some form of regulatory activity consisting of 10 active regulatory programs, and 8 with authority and budget but not extensive involvement in regulatory activities, and 1, the State of California's, with regulatory powers for only motor vehicles. In 1961, only five states were engaged in regulatory activities, and these were modestly funded and their regulatory role was limited. In 1965, 34 states had air pollution programs with budgets of $5,000 or more. Thirteen of these were created during 1965 partly because of the stimulatory effect of the Federal grants program. For 1965 the average per capita budget in the states having programs was less than 2 cents per capita per year. The U.S. Constitution places the right and responsibility with the states for the exercise of policy powers to protect the public health and safety. Since most states have delegated some of this police power to cities and counties, air pollution can be controlled at the local level. This does not mean that the state agency can remain aloof from air pollution problems and leave them entirely to the local governments. The states still have a basic responsibility to look after the needs of their citizens and the needs of those cities or counties they have created or authorized. In the air pollution field, as in others, the state agency's roles can be placed in five general categories: (1) Leadership, (2) coordination, (3) evaluation, (4) services, and (5) operations. Leadership is a primary role of the state agencies. Coordination must be accomplished with local agencies, other state agencies, and in some cases, agencies within another state. Evaluation may be accomplished by monitoring air quality, studying the effects, determining the effectiveness of the local agencies, and establishing priorities for the allocation of financial and personnel resources. Services, which probably represent the most important role of the state agencies, may include training, technical assistance, technical information, and specialized laboratory analyses. In their role of operations, the state agencies may have to assume the responsibilities for air pollution emergencies, conduct some research, conduct a public information program, and in some cases, actually do the regulatory control work because they have the specific authority or a local agency is not present in a particular problem area. If the state agency engages in the regulatory control of air pollution, then it also has the three general roles previously outlined for local agencies.

The roles of the Federal agencies are a little more specific. The Department of Health, Education, and Welfare, and the Public Health Service have their roles fairly well defined by the Clean Air Act. These roles can be summarized as: (1) Research and development; (2) technical and financial assistance to state and local programs; (3) abatement of air pollution in international, interstate, and under certain conditions, intrastate areas; (4) development of air quality criteria; and (5) establishment of standards for the control of air pollution from new motor vehicles. The Clean Air Act also specifies that the role of other Federal agencies should be one of cooperation with the Department of Health, Education, and Welfare, and any other air pollution control agency in preventing and controlling air pollution from their respective facilities.

That the responsibility for the control of air pollution should be at the lowest level of government capable of dealing effectively with the problem in its entirety is a generally accepted concept. This has been amplified by Section 101 of the Clean Air Act, which specifically states that the prevention and control of air pollution at its source is the primary responsibility of state and local governments and that Federal financial assistance and leadership are essential to the development of cooperative Federal, state, regional, and local programs to prevent and control air pollution. If we accept either or both of these statements, then the roles of the local, state, and Federal agencies in air pollution control are fairly well defined. In simplest terms, the local agencies control air pollution. The state agencies assist the local agencies and do the control work where there is no local agency or when the problem is beyond the capability of the local agency. Federal agencies assist the state and local agencies in the prevention and control of air pollution, support research, and engage in activities that are beyond the resources and capabilities of the state and local agencies.

Air pollution control cannot be accomplished without close cooperation among all levels of government, industry, and the general public. The air resource of any area, whether it is a city, a county, a state, or an entire nation, will be controlled or neglected in proportion to the extent of the citizens' desire and demand. Certainly, everyone has a role in the control of air pollution.

THE ROLES OF THE STATE EXTENSION'S GIN AND MECHANIZATION SPECIALISTS

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Because techniques for accurately measuring the lint and seed value of mechanically harvested, unginned cotton have not been perfected, the first sale that places these products in the market channels normally occurs after ginning. This makes ginning the last step in cotton production and points up the importance of producers' understanding the ginning process. If quality of the lint and seed is to be preserved during ginning, then harvesting practices should be geared to the capabilities of the local ginning facility.

The major objectives during the ginning process are to obtain maximum dollar returns for the producer from each bale and maintain fiber properties for the manufacturer and ultimate consumer. Success in achieving these aims is determined primarily by: (1) The type of harvesting job done, or the condition of seed cotton arriving on the gin yard; (2) the capabilities of the equipment in the gin; and (3) the judiciousness of the selection and use of ginning equipment by ginners as determined by the condition of the cotton and the status of current market premiums and discounts.

Although ginning research has shown that the sequence of machinery used and the skill of the gin operator displayed in ginning have a marked effect on bale value, the condition of the seed cotton arriving on the gin yard has a greater effect. Growing conditions and resulting inherent qualities of lint and seed vary from year to year, but techniques and practices controlled by producers have much to do with the conditions of harvested seed cotton. Thus, the type of harvesting job done largely determines the results obtained from the ginning process.

RECOMMENDATIONS FOR GIN MACHINERY SEQUENCE

The local ginner is in a position to exercise good judgment in the selection and settings of gin machinery for a given set of seed cotton conditions. In so doing, he can make use of the machinery recommendations established through extensive programs of the U. S. Department of Agriculture's Ginning Research Laboratories and of the Extension Service. These recommendations are designed to serve the best interests of producers, ginners, and spinners. The basic machinery components for a cotton gin processing mechanically harvested cotton are listed in recommended sequence:

1. Suction unloading telescope,
2. green-boll trap,
3. air line cleaner (recommended only in sandy areas to protect the machinery from abrasion),
4. bulk feed control unit,
5. dryer (24-shelf tower or equivalent) with 3-million Btu burner with modulating or automatic moisture-sensitive control,
6. a 6- or 7-cylinder inclined cleaner with grid selection,
7. bur machine,
8. green leaf and stick machine,
9. dryer (24-shelf tower or equivalent) with 3-million Btu burner with modulating or automatic moisture-sensitive control,
10. a 6- or 7-cylinder inclined cleaner with grid section,*
11. extractor feeders,
12. gin stands,†
13. tandem saw-type cleaning with complete bypass system,‡
14. press.

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*Six additional cylinders of second-stage cleaning are recommended on high-capacity gin stands. This additional cleaning is to offset the loss of cleaning efficiency in feeder and huller fronts of stands. If the gin is equipped with less than this amount of machinery, grades on the damper, trashier cotton will be such that full value will probably not be realized from the lint. Machinery bypasses play an important part in a modern gin. They allow the gin operator to fit machinery selection to the condition of the cotton to be ginned. In this way the gin plant is made flexible, excessive machining of clean or high-grade white cotton can be avoided and trashy low-grade, light-spotted, or spotted cotton can also be processed properly.

†Research tests and the experience of commercial ginners have shown that cotton should enter the gin stands with a fiber moisture content of 6.5 to 8 percent. This is a desirable goal in that fiber length can be preserved and other fiber qualities such as neps and short fibers can be maintained within desirable limits when the lint and seed are separated at this moisture level. Weather conditions in some areas are such that fiber moisture will often be at the 4 to 5 percent level in the field. This fact alone plays a major role in the Texas High Plains cotton production for it makes stripper harvesting feasible. Dry burs do not cause damage to seed cotton held in storage before ginning and can be easily removed during ginning. This also means that dryers are not always needed to facilitate proper seed cotton cleaning, ginning, and lint cleaning, but that moisture should be added to the fiber in the overhead cleaning equipment to protect the qualities of the fiber from the action of the gin stand and lint cleaners. Moist-air-type fiber moisture restoration equipment can be used for this purpose to approach the desirable goal of 6.5 to 8 percent fiber moisture in the gin stands. Moisture-air-type fiber moisture restoration equipment is also useful to eliminate the problems caused by static electricity during ginning of extremely dry cotton.

CAPABILITIES OF THE GIN COMPONENTS

Green-Boll Trap. Since green bolls, rocks, and other, similar types of objects should be removed from cotton before it enters the ginning machinery, all gins should be equipped with a green-boll trap. These units are sometimes referred to as rock traps. Rocks and tramp iron can damage gin machinery severely, and the wet fibers of green bolls are likely to stick to gin machinery saws and cause a considerable reduction in the gin plant's efficiency. Sometimes shutdown periods are required for picking the gin stand saws. At times the sap from green bolls may cause dust and trash to build up inside fan scrolls, and this can also cause shutdown periods for cleaning.

Boll traps for gins are available in various models. Many are efficient at green-boll removal; however, in high-capacity gin plants, some green bolls enter the gin machinery if a relatively high percentage of green bolls is present in the cotton. For this and other reasons to be discussed, green or unopened bolls should be separated from the mature cotton during stripper harvesting. Highly efficient green-boll separators have been developed for use on strippers. When green bolls are efficiently removed during harvest, the performance of gins and the quality of the lint and seed of most stripped cotton are greatly improved.

The relatively high percentage of moisture present in green bolls can cause deterioration in lint and seed quality during seed cotton storage before ginning. Unopened bolls, either green or dry, normally contain relatively immature fiber. If this fiber is not separated from the mature fiber either as a whole opened boll or as waste in the lint cleaners, the micronaire of the bale can be lowered. In either case, bale value is reduced, and producers should, therefore, make every feasible effort to separate green or unopened bolls from the mature cotton during the stripping process.

Bulk Feed Control. Gin plants should be equipped with a bulk uniform-feed control unit. The unit should be located in the machinery sequence in such a way as to ensure that each machine is fed cotton at the proper uniform rate for peak efficiency. The bulk feed control unit should not be used as an overflow bin, for this results

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‡Lint cleaning normally pays the producer a dividend in bale value on cotton that grades below Middling White without lint cleaning. If the cotton grades below Middling White after one stage of lint cleaning, the second stage of lint cleaning may further increase bale value provided the moisture content of the cotton is at the percent level as it enters the press box. Bale value is the prime factor for consideration. Lint cleaning improves lint grade by removing trash and smoothing the sample — both involve a reduction in bale weight. If the premium for the higher grade obtained by cleaning is great enough to offset the resulting differences in bale weight, then lint cleaning pays the producer. Spinning qualities of the lint can be preserved during two stages of lint cleaning provided the fiber moisture is within the range of 6.5 to 8 percent. For these reasons, the lint-cleaning system should be maintained within the recommended range.

in a recirculation of the overflow cotton through the overhead clean and drying equipment.

Dryers and Moisture Regulation. The amount of moisture in seed cotton during cleaning and ginning is the most important factor affecting cotton quality. Temperatures of the dryer should be adjusted on the basis of the moisture in the wagon sample and in the lint at the lint slide. Temperatures of the dryer should be regulated so that cotton is presented to the gin saw within the 6.5 to 8 percent lint moisture range. The amount of moisture removed from the cotton should be increased or decreased by increasing or decreasing the temperature in the dryers, or the time that cotton is exposed to hot air in the dryer, or both. Wet cotton passes through the cleaning equipment in wads that may cause chokages and inefficient cleaning. When cotton is ginned, damp samples are not as clean or as smooth, and lower grades result. If cotton is ginned while excessively dry, the fibers are brittle. Cotton cleans easily at the 3 to 5 percent moisture level, but the fibers are weakened or broken. This results in increased "short fiber" content. In extreme cases excessively dry cotton suffers a staple length reduction during ginning owing to fiber breakage. These facts emphasize the importance of fiber moisture during ginning, and the part controlled drying and moisture restoration play in efficient ginning.

Cleaners and Extractors. Stripped cotton contains burs, bracts, sticks, stems, dead leaves, and sometimes green leaves. Each type of trash involves a special type of cleaning job. Cylinder-type cleaners fluff the cotton and remove sand, fine leaf, and bract particles; bur machines extract sticks and burs; green leaf and stick machines extract burs, sticks, stems, and green leaves. Since the bur machine is an efficient, high-capacity, dry-bur extractor, good results are obtained by using a bur machine in combination with a green-leaf and stick machine. This allows the bur machine to remove the bulk of bur trash and prepare the cotton for the specialized action of the green-leaf and stick machine. The slingoff principle of the stick machine makes it especially efficient in green-leaf and stem removal. If the bulk of the bur trash has been removed when the cotton enters the green-leaf and stick machine, the benefits of the slingoff principle are fully used in the specialized removal of green leaves and stems. Research has shown that the best cleaning results are accomplished when two-stage drying, cylinder cleaning, and extraction are used alternately in the overhead cleaning sequence. In other words, the machinery sequence should be such that the two stages of drying are split with cleaning and extracting machinery.

Gin Stands. The gin stand is the heart of the gin plant and should be maintained in top condition to perform efficiently. Saws and ribs should be inspected frequently and necessary replacements made. Saws should be kept sharp and replaced when the diameter has been reduced by as much as 1/16 inch. Rib and saw clearance should be checked and maintained according to factory recommendations to avoid fiber damage and maintain ginning capacity.

Lint Cleaners. Tandem lint cleaning has been proved profitable to producers on spotted, light-spotted, or low-grade cotton. Spinning quality can be maintained during lint cleaning when the fiber moisture is maintained within the 6.5 to 8 percent range. Adjustment and operation of the lint cleaner are important in preserving quality, and factory recommendations should be followed closely.

MAINTAINING THE MERCHANDISABILITY OF COTTON IN THE GINNING PROCESS

After ginning, both sides of bales are sampled for fiber evaluation. Both sides are sampled because trade rules stipulate that bale value be based upon the low-grade side of the bale if there is a difference in the halves of the composite sample. To improve the merchandisability, producers of cotton should cooperate with ginners in grouping loads of similar-quality seed cotton for block ginning. By ginning cotton with similar-quality moisture and trash content in blocks of several bales, the occurrence of two-sided bales can be minimized. Wet and dry cotton should not be placed on the same trailer since this will likely result in two-sided bales.

Gin operators should exercise diligence in their efforts to eliminate two-sided bales through proper operation of gin machinery. Gin stand breasts should be pulled when trailers are changed to avoid getting linters in the sample as a result of the saws' running in a dry seed roll. When remnants are married, caution should be exercised to see that the grade and staple of the remnants are the same or very similar to avoid widely different two-sided bales. Good housekeeping should be practiced by pressroom crews to ensure that only clean cotton goes into the press box.

The gin plant should be equipped with a live overflow suction system so that overflow cotton can be placed directly on the distributor. Overflow cotton should not be dropped in the bulk feed control bin and recirculated through the dryers and overhead cleaning. The drying and overhead cleaning equipment should be bypassed with the overflow cotton; otherwise, excessive drying and cleaning results in a two-sided bale and the producer is penalized by the reduction in bale weight.

HANDLING GIN TRASH

Handling the trash and dirt removed from machine-stripped cotton is a part of the ginning process that can become a nuisance if the gin plant is not equipped with an efficient disposal system. Tremendous progress has been made during recent years in the development of gin trash-handling equipment. At present, a combination of trash collection devices can be used to collect and handle gin trash efficiently with a minimum of hand labor. The basic components of a gin trash-collecting facility are:

1. High-efficiency cyclones. High-efficiency cyclones are small-diameter, long-barrel cyclones developed by the Atomic En-

ergy Commission and adapted to the collection of gin trash. They give satisfactory performance on the small, lightweight trash particles encountered in ginning operations. These units work well on high-volume, high-velocity air systems such as the suction unloading system, the drying cleaning system, and trash conveying systems with high-velocity fans that are operated against fairly high resistance pressure.

2. Lint fly catchers. On condenser exhausts the air-trash separating problem involves a small amount of fine lint fly in a large volume of air produced by fans that operate against very low resistance pressure. This situation is not adaptable to centrifugal-type catchers. A screen wire cage is desirable for this trash-collecting job. The screen cage is constructed of 14- to 18-mesh-per-inch galvanized screen wire on a cylindrical frame, approximately 3 feet x 4 feet. It is used to collect the lint fly from condenser exhausts. The lint fly builds up in a layer on the screen and sluffs off when the mass becomes too heavy to be held in place by the exhausting air. If the screen is damp, the lint fly sticks to the screen and inhibits air exhaust, which causes backpressure on the condenser and an eventual chokedown of the gin plant. For this reason, the screen must be kept dry for the screen cage collector to perform satisfactorily. Louvers can be placed around the cages or under a roof for efficiency. Cyclones and screen cage lint fly catchers are available in Agriculture Handbook No. 260, *Handbook for Cotton Ginners*, ARS, USDA.

3. In-line filter. The in-line air filter is a recent development of the USDA ginning laboratory, Mesilla Park, New Mexico. It involves a stainless steel, bolting cloth (40- to 150-mesh-per-inch) collecting action and a pressure-differential, automatically operated wiping brush mechanism. This unit has displayed desirable performance in the laboratory and in field trials. Additional information on this type equipment is in ARS 42-103, September 1964, USDA Southwestern Cotton Ginning Research Laboratory, Mesilla Park, New Mexico. This filter is adaptable to the trash-collecting problem encountered on lint cleaner and press condenser exhaust fans and was designed as a replacement for the screen cage lint fly catcher. The design is such that protection from moisture is achieved satisfactorily without elaborate housing or louvering.

BUR HOPPERS

Bur hoppers are used to collect trash after it has been separated from the air used to exhaust it from the gin plant. They play a vital role in the mechanization of gin trash handling. These units are normally of sufficient capacity for collecting the trash from 30 to 50 bales. When equipped with a screw conveyor to distribute the trash over the length of the bin, they are self-loading. Bur hoppers are elevated bottom-dump bins that dump directly into hauling equipment.

TRASH DISTRIBUTORS

Distributor trucks are used to transport the trash to farms and distribute it at a uniform rate of 2 to 4 tons per acre. Commercial trash-distributing equipment is also adaptable to four-wheel-type trailers. Trash distributors are of two types, low-flight screw conveyors and dragchains with flail-type spreaders. Both types are power takeoff operated and play an important part in trash handling. This equipment is fully mechanized and spreads the trash uniformly.

PRECLEANING MACHINERY INSTALLATIONS FOR COTTON GINS

Precleaning facilities have proved beneficial to several ginners of the state. This type facility offers the advantages that follow.

1. *It protects the gin plant.*

   When the facility is used to preclean ground-salvaged or stripped cotton, the sand tramp metal and other trash that might damage the machinery of the gin plant can be removed in the less complicated, less expensive precleaning setup. Maintenance costs on the gin plant can thus be held to a minimum.

2. *It increases the capacity of the gin plant.*

   The capacity of the gin plant is increased by minimizing the amount of material handled per bale and improving the condition of the seed cotton when stripped or ground-salvaged cotton is handled.

3. *It evens out grade differences.*

   According to the experience of precleaner users, grades of stripped cotton run even as a result of the blending effect of the precleaning operation.

The sequence of machinery recommended for a precleaning facility:

1. Suction unloading system;
2. green-boll and rock trap;
3. cylinder cleaner—5 to 7 cylinders, grid section;
4. bur machine or stick machine.

Precleaning and storage in baskets increases some costs but reduces others:

Extra handling requires additional labor and equipment. The added cost ranges from $4.80 to $6.75 per bale, but the ginning cost is reduced significantly. Tests have shown that the cost of precleaning and storage in baskets compares favorably with ginning in the usual way. By adjusting gin capacity closely to ginning volume and using basket storage, gin cost can be reduced by as much as $5.00 per bale.

Summary of Open Discussion

The question was raised as to what constitutes a marginal gin in regard to the number of bales ginned per year. Mr. Reeves cited a study by the University of Texas in 1965 that revealed a breakeven point of 2,108 bales per year for Texas. This survey also showed that the average gin handles about 3,233 bales per year and has an investment of $163,000.

Another question concerned the reasons for wide variations in yearly ginning rates (yearly bales per gin) from state to state. Citing the fact that though Texas has more gins than any other state its average ginning rate is 3,233 bales per gin compared with 5,300 and 6,000 bales per gin for Arizona and California respectively, Mr. Reeves stated that ginning rates mainly depend upon whether the region is a high- or low-yield cotton-growing area. Relatively low-yield areas, i.e., a half bale per acre, usually have corresponding ginning rates of 1,000 to 1,700 bales per gin. There are exceptions, but as a general rule, this is true. The average size of farm in the gin territory and the type of gin ownership also have a bearing on volume of ginning.

METHODS EMPLOYED IN HARVESTING COTTON

B. G. Reeves
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The mechanical cotton-harvesting machines of today are a credit to the inventive and productive genius of American industry. They provide a means of harvesting more cotton of desirable quality in less time and at less cost than ever before. More than 80,000 of these machines helped harvest better than 75 percent of the 1965 U.S. cotton crop. They are in use in every cotton-producing state in ever-increasing numbers. Their use by producers is highly important to cotton's future. Let us examine how they may best be used to the advantage of the entire cotton industry.

The development of modern mechanical cotton pickers and strippers began about 100 years ago. The early models were crude and, in many cases, inefficient, but the machines of today are well designed and capable of doing a good job of harvesting cotton. The factors that determine the kind of harvesting job any machine can do in any given situation are: (1) Field conditions at harvest time, (2) machine condition and adjustment, and (3) skill of the machine operator.

Since American cotton producers seek both efficiency and quality preservation during the mechanical harvesting process, each of these factors must be given its due considerations so that it will supplement and balance the others.

The capabilities of any mechanical cotton harvester were established by the features incorporated into the machine by the design engineers. Although the performance range of each machine is reasonably broad, no one machine can handle all harvesting situations equally well. This is primarily due to differences in field conditions at harvest time.

Many practices contribute to field conditions at harvest time, beginning with the selection and preparation of land. For best harvesting results with spindle-type cotton pickers and mechanical cotton strippers, the goal is to have a uniformly mature crop in which weeds, insects, and diseases have been controlled. Uniform plant spacing, stalk size, row spacing, and row profile all play an important role in mechanical cotton harvesting. Of all the field condition factors at harvest time, probably the most important is the moisture content of the lint. Lint moisture during harvest affects efficiency of the machine, the techniques employed to protect cotton quality before ginning, and, to a large degree, the quality of the cotton in the bale.

The moisture content of lint varies with the relative humidity of the atmosphere. In early morning, around 6 a.m., the moisture content of lint in the field may be extremely high—possibly as much as 17 percent at 80 to 90 percent relative humidity. By midmorning—sometimes earlier under dry, windy conditions—the relative humidity should be near 60 per cent at boll height, and the lint moisture content should most likely be 8 percent or less. Through research and practice, this is the moisture range that has been found satisfactory for machine harvesting.

Normally seed cotton remains in trailers or storage for several hours, sometimes several days, before it is ginned. The spinning quality of cotton can be preserved during storage when the moisture level of the composite mass is 12 percent or less. A lint moisture of not more than 8 percent and a seed moisture of not more than 10 percent are used by producers and ginners as desirable goals in seed cotton storage. In this moisture range, the temperature in the stored seed cotton remains low. The transfer of moisture from the trash to the lint is slow, and the luster and whiteness of the fiber are maintained. Seed quality is also preserved in terms of germination and vigor. This condition is usually attained when harvesting is done in a relative humidity of 60 percent or less from mature fields.

The moisture content of green leaves, stems, and bolls is extremely high—possibly 60 to 75 percent by weight. For this reason, every practical effort should be employed to minimize the accumulation of these materials in the harvested cotton. To reduce the amount of green leaves and stems on the stalk, a chemical defoliant may be applied to cotton fields where harvesting is to be done with a spindle picker. This application is made when 60 per cent or more of the bolls are open. When stripper harvesting is to be done before frost, a chemical desiccant is applied to the field when 75 percent or more of the bolls are open.

GUIDELINES FOR MECHANICAL STRIPPERS

Mechanical strippers generally operate most efficiently in cotton that is less than 3 feet tall. Since mechanical stripping is a once over operation, early maturing bolls must remain on the stalk until the late-maturing bolls are open. Storm-resistant varieties should, therefore, be planted, for the bulk of the crop is left in the field longer when harvesting is done by this method. Owing to the principle of operation of the stripper, green-leaf staining of the lint can occur when only 5 percent of the plant leaf cover is green during stripping. Best grades are obtained with the stripper when the only trash present is dry leaves, burs, and stems. Stripping cotton a week or 10 days after an efficient application of a chemical desiccant or after the occurrence of killing frost when the relative humidity is 60 percent or less at boll height generally gives desirable results in terms of grade.

The mechanical stripping method of harvesting is a dry-weather practice, primarily because of the necessity for desiccation and good weather in order that dry leaves be taken to the gin in brittle condition. This has been true in many observations in whatever state and with whatever machine stripping is practiced. Before entering the field with the stripper, dead leaves and leaves and stems should be checked; they should be crisp and brittle for satisfactory harvesting results.

Although the adjustments are reasonably simple on the stripper, they are very important. The owner should be sure that his operator understands how to make these adjustments: (1) Tension on stripping mechanism, (2) elevation of stripping mechanism, (3) adjustment of plant lifters or guides, and (4) travel speed.

In addition, since it is important to leave as much foreign matter in the field as possible, the green-boll separators should be kept in perfect operating condition, properly adjusted, and cleaned. Every device on the stripper, such as grid bars and screens, that takes out dry leaf should be kept clean and maintained in top working condition. Good operation of the stripper also requires careful driving in the row at speeds to fit field conditions. This minimizes bark and excessive foreign matter in the sample. Reasonable care taken to prevent mixing of different-quality cottons in the trailer, to avoid excessive tramping on the trailer, and to bring about proper handling between harvesting and ginning helps good seed cotton become good lint cotton.

GUIDELINES FOR SPINDLE PICKING

The spindle picker can generally handle cotton over 3 feet tall more efficiently than the mechanical stripper can. Provided insects have been controlled efficiently, this type picker can normally be expected to carry a yield in excess of a bale per acre. The spindle picker is best adapted to the harvesting of river bottom or irrigated cotton in areas with a sufficiently long growing season to allow full maturity of the crop before frost occurs. Since the lint must be exposed from the burs for the machine spindles to remove it, open-boll varieties are best adapted to spindle picking. The spindle picker cannot separate a large volume of dry trash from cotton as it is harvested, and the presence of excessive amounts of green leaves reduces the efficiency of the picking operation. Green trash also results in the development of green-leaf stain on the lint. Grades can be lowered in either case, owing to the addition of trash and leaf stain. Efficient defoliation is, therefore, vitally important if desirable grades are to be obtained in spindle picking.

If the mechanical picking method of harvesting is used, the owner should be particularly sensitive to the importance of the following: (1) Drum evaluation, (2) drum tilt, (3) relationship of spindle to doffer and spindle to a moistening pad, (4) adjustment of pressure plates, (5) proper speeds, (6) moisture adjustments, and (7) operation techniques—driving on row, entering field at full throttle. There are others, but these affect the quality of every pound and the efficiency of every horsepower.

SUPERVISION OF OPERATOR

Many owners may have been careful to provide all safeguards to good stripper and picker operation down to this point and failed to evaluate the operator or his job through strong supervision. Every owner ought to write the County Agent or National Cotton Council and obtain a copy of the *Owner's Outline for Checking Pickers' Performance* and *Field Method of Determining Cotton-Harvesting Losses*. There are solid, proved methods of evaluating field losses in terms of pounds, quality, and time. This evaluation is only one step ahead of the bank account evaluation that shows up later.

GUIDELINES FOR BETTER HARVESTING RESULTS

Selection of the harvest method is not a simple choice. Two good yardsticks for evaluating either method are harvesting efficiency and fiber quality. Once a choice has been made, care should be given to selection of the best practices that make the choice a good one and the results economically sound. A few important practices pay good dividends in improved efficiency in either harvesting method.

1. *Field layouts*—short rows make all mechanical operations inefficient and should be avoided whenever possible.

2. *Good turning rows*—should be 1½ to 2 times the machine's length and should be firm, smooth, and level.

3. *Uniform row profile*—the drill should be slightly higher than the middle and as uniform as possible. Beds should be prepared to fit the mechanization plan; however, row profile is important to efficient harvesting with either machine. Equipment used and type beds prepared vary with local weather and soil conditions. Recommendations of the State Extension Service and the Experiment Station should be followed.

4. *Three to four plants per foot of row*—this plant population results in better stalk confirmation and means more efficient harvesting for the producer. A thick, uniform stand helps the ginner because a cleaner load of cotton is generally harvested from fields with the recommended plant population.

5. The amount of trash and moisture in cotton is largely dependent upon the condition of the field when the machine enters it. The key question is this: Is the field condition right for the practices used?

6. Does the machine operator know how to adjust the machine properly? Does he care? The differences means a good or bad situation at the gin, good or bad quality for the mill, and more or less profit for the producer. It pays the owner to see that the operator *does know* and *does care.*

7. Is the machine itself properly prepared before harvest season? This is necessary both for efficiency of operation and preservation of quality. Adjustment of the machine and proper operation on an hour-by-hour, field-by-field basis are of equal importance. A fine stripper or a fine cotton picker requires accurate adjustment and intelligent handling in the field. These simple suggestions along with the careful personal use of the machine operator's manual pay good dividends through better mechanical harvesting.

Cooperation and exchange of information between the producer and the ginner ensure:

1. The ginning of excessively damp cotton as quickly as possible and storage of the dryer cotton if necessary.

2. a knowledge of moisture in the cotton waiting at the gin through measurement of moisture with electronic moisture meters,

3. proper handling of both lint and seed,

4. and, finally, a more profitable product for both the producer and the spinner.

The future of American cotton depends upon how well the industry promotes its use, protects its quality, and competes in price. Today there is a need for reduced costs, but cotton quality is not being sacrificed as a part of cost cutting. Mechanical harvesting offers important cost-cutting possibilities that will benefit every segment of the cotton industry from producer to consumer. It will play an increasingly important role in the future of U.S. cotton.

Summary of Open Discussion

In regard to the prospects for development of field extraction equipment, it was revealed that attempts at this development have been made during the past 20 to 25 years and that currently four or five companies are working on the problem. This research has two major obstacles to overcome in developing a marketable device: (1) Control over cotton moisture and (2) high initial investment by the cotton ginner.

OPERATIONS AND CHARACTERISTICS OF THE COTTON GIN

Edward H. Bush
Executive Vice President
Texas Cotton Ginners' Association

Gentlemen, it is my pleasure to speak this morning on the broad subject of operations and characteristics of the cotton gin. Perhaps a more suitable title would be "What a Cotton Ginner Does and How He Goes About It." In discussing the program that will be presented to you in the next 2 days, we felt that this presentation should vary somewhat from the technical and attempt to give you the background of the people in the ginning industry and their operations.

Twenty years ago, cotton gins were the hub of the cotton-farming community. They still are today, though this is about the only resemblance that remains. Twenty years ago, cotton gins of the most modern type cost approximately $75,000 to $80,000. This was for land, buildings, equipment, offices—in fact, the total investment. Today the total investment approaches in many instances $400,000. The $80,000 plant I spoke of required probably something less than 1,000 bales' volume per year in order to break even before beginning to show a profit. Today our figures indicate that the modern plant requires 3,500 to 3,600 bales' volume before any profit can be realized. The earlier plants ginned at a rate of about 3 to perhaps a maximum of 4 bales per hour. Plants today often exceed 15 bales per hour. In terms of trash and dirt, plants over 20 years ago were handling relatively clean handpicked or handsnapped cotton containing perhaps a maximum of 400 pounds of all types of waste material per bale. At 4 bales per hour, this would be 1,600 pounds of waste per hour. Contrast that with today's plant ginning at 15 bales per hour—handling trash at a maximum rate of about 1,500 pounds per bale—you can readily see that the volume of waste material has jumped to 22,500 pounds per hour.

Now what has brought all this about? Perhaps the simplest explanation is mechanization. Because of the need to cut costs and eliminate harvest labor, which was not only difficult to obtain but also expensive to manage and use, the cotton farmer has been forced to mechanize to the maximum. This mechanization with cotton pickers and cotton strippers has brought tremendous tonnages of trash to the gin, which must be removed and disposed.

Now, just what does a cotton gin do? Primarily its job is to take raw seed cotton and separate the seed and the lint. But it does other things. It packages the lint into approximately 500-pound bales and it provides for disposal of the seed either to an oil mill for crushing or back to the farmer if he wants to save them for planting purposes. Cotton gins have always done some cleaning, but the need for removing trash has accelerated so rapidly over the past few years that this is a prime function of the gin today and has resulted in the addition of many and varied types of specialized cleaning equipment.

If this were all that a cotton ginner does, my talk could end here; but as I pointed out, the cotton gin is the hub of the cotton-farming community around him. It is a service organization dedicated to helping the cotton farmer in any way it can to be more productive and do a better job with reduced costs. As a result, the demand for ginners' services has broadened drastically. Many ginners now help farmers obtain good planting seed, fertilizers, insecticides, weed control chemicals, defoliants and desiccants, airplanes and ground equipment for applying these various chemicals, harvest labor, and even trailers and other necessary transportation for moving the crop from the field to the gin. Perhaps the greatest impact on this industry since the rapid development of full mechanization has been the speed with which the crop must now be processed. Twenty years ago the harvest season probably lasted 4½ to 5 months in most areas and sometimes longer. Today the peak season is approximately 2 months. This then has meant that ginners are more conscious than ever before of having a tremendous investment to be used only a very small portion of the year and of having had it sit idle the rest of the time. Consequently, ginners think in terms of 24-hour operations during the peak season. They are forced by economics to operate uninterruptedly if possible throughout this period. They know that, if for some reason they must shut down during their peak season, their customers will go elsewhere for service. A lost customer means lost volume, and in many instances, instead of reduced profit, a loss. Just one customer may sometimes make the difference. Ginners as a consequence are extremely sensitive to any interruption in their operations.

They are usually community leaders. They are anxious to be good citizens and provide the utmost in service to their customers and their communities. This is traditional in the ginning industry.

For this reason it is extremely important to understand that ginners are equally as concerned with trash and waste disposal as the general public is. The problem here lies then not with an appreciation of the problem nor with a desire to correct it but with the know-how and economic resources that can be brought to bear to solve the problem. The added investments that have been necessary and the shortening of the season have narrowed ginners' margins of profit to such an extent that in the last 3 years nearly all gins have merely managed to exist. To complicate the situation further and to look to the future, we now have a cotton program known as the Food and Agriculture Act of 1965 that will reduce acreage and cotton planted approximately 30 percent this year and for the next 3 years following. This obviously means for more ginners an across-the-board cut of one-third of their volume. This confronts them now when they are already operating at or near the break-even point. Most ginners view this as a fight for survival. They see no opportunity for profit and thus they are reluctant to consider any expenditure that is not of the direst need. Add to this the fact that, even though for the past 15 years our Association, together with the United States Department of Agriculture's Cotton Ginning Laboratories, and private industry, have been trying to develop cheap, acceptable ways of collecting and disposing of gin wastes, we are still in need of improved techniques, equipment, and methods in this area. Vast strides have, however, been made. Rather than discuss these in detail as they will be discussed by others during the next 2 days, I will merely say that it is now possible in most instances, I think, for a gin to control dust and waste emissions adequately within limits acceptable to its surrounding neighbors and community. We have many individual cases in our largest cities and in our smallest ginning communities that prove this point. These gins have met this problem, have availed themselves of the existing technology, and have applied these techniques to the mutual benefit of their own business as well as their neighbors. None of these gins have the same emission control problems nor the same system of control.

The technology is here. The main problem now and for the forseeable future is economic. Newer, cheaper, and more efficient collection, disposal, and control systems must be devised. If this is done, I know that most ginners will rapidly adopt the new equipment and procedures.

Like most other businesses we have experienced an increase in our average income during the past 10 years. The average income for the gin averaging 6,000 bales increased by 23 percent in that period. Nevertheless, our cost of processing these 6,000 bales jumped 36.6 percent in that same period. This does not include a sharp increase in the amount of investment in machinery. Our labor costs increased from 87 cents per hour in 1955 to over $1.25 an hour in 1965. The actual horsepower necessary for the ginning process increased from 352 to 404 with a resulting increase in kilowatt-hour costs to gin cotton.

All good gin management sets aside a certain amount of profits for improvement of equipment and addition of new systems. But the amount of profits to be set aside decreases as operational costs rise and the income decreases.

I must reemphasize that new equipment will be added and new procedures adopted if they are economically sound and the equipment is priced within reach of the ginners' budget.

I shall be happy to discuss in detail any of the operating procedure, equipment, and problems that ginners face if you will but ask.

Summary of Open Discussion

Mr. Bush emphasized that the title "ginner" may be applied to the owner of the gin or to the gin supervisor or foreman and that the distinction between the two should be maintained.

In response to an inquiry on gin ownership, Mr. Bush gave the following breakdown:

30% are cooperatively owned,
53% are independently owned (including corporations),
17% have multiple ownership (more than 5 to the owner—usually oil mills).

METHODS OF COLLECTING SEED COTTON TRASH

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For purposes of this discussion we shall loosely define seed cotton trash as the material that is removed from the gin building by the high-pressure fans. The material is primarily from the seed cotton cleaners. There are dust and dirt, of course, which must be dealt with, but for the most part, the gin's seed cotton-cleaning equipment removes relatively heavy plant parts consisting principally of leaf, burs, sticks, and stems. The lighter materials or trash containing a preponderance of fibrous materials handled by the high-pressure fans are from the gin's moting system and lint cleaners.

Machine harvesting was begun in earnest after World War II, and last year, 77 percent of the crop was harvested by machine—58 percent with pickers and 19 percent with strippers. Of the remaining 23 percent of the crop, 16 percent is handpicked, 6 percent handsnapped, and 1 percent machine scrapped. For all practical purposes, clean handpicking no longer exists. Most of the handpicked cotton contains as much foreign matter or more than machine-picked cotton does and is rapidly decreasing in volume so that it warrants no special consideration. Handsnapped cotton, in terms of trash, can roughly be put into the same category with machine-stripped cotton. Therefore, if, the gin's trash system can handle machine-picked or machine-stripped cotton, depending upon in what area of the Cotton Belt the plant is located, it can cope with almost any cotton brought to it, the exception, if any, being the 1 percent machine-scrapped material.

Machine-picked cotton usually contains about 80 pounds of foreign matter per bale consisting of 29 pounds of hulls, 43 pounds of leaf trash and dirt, and 9 pounds of sticks and stems (Table 1). An average bale of machine-stripped cotton contains 525 pounds of foreign matter consisting of 397 pounds of hulls, 50 pounds of sticks and stems, and 78 pounds of leaf trash and dirt.

At a ginning rate of 15 bales per hour, the quantity of foreign matter that must be handled is impressive, amounting to over 1,200 pounds for machine-picked cotton, 7,700 pounds for machine-stripped cotton, and 13,000 pounds for machine-scrapped cotton. Machine scrapping is a relatively new practice but is becoming rather widespread. An analysis of the foreign matter content of machine-scrapped cotton in the Mississippi Valley shows that it contains 329 pounds of hulls, 143 pounds of sticks and stems, and 398 pounds of leaf and dirt, making a total of 870 pounds of foreign matter per bale to be dealt with.

TABLE 1 — AVERAGE AMOUNT AND TYPE OF TRASH IN SEED COTTON HARVESTED BY VARIOUS METHODS, lb/bale

Types	Machine picked	Machine stripped	Machine scrapped
Hulls	29	397	329
Sticks and stems	9	50	143
Leaf and dirt	43	78	398
Total	81	525	870

This mass of material must be collected from a total of over 43,000 cubic feet of air per minute (Table 2). The fans removing the trash from the lint cleaners also airwash the grid bars to keep them clean. The material removed from the lint cleaners consists primarily of fine-leaf trash and short fiber.

TABLE 2 — SIZE OF FAN AND AIR VOLUME REQUIRED FOR VARIOUS SEED COTTON TRASH-HANDLING SYSTEMS (BASED UPON 12 TO 15 bales/hr)

Systems	Fan sizes		Volume, cfm
	Push	Pull	
Trailer-unloading system		2 No. 50 IN SERIES	8,500
No. 1 drying and cleaning system	No. 45	No. 50	9,000
No. 2 drying and cleaning system	No. 45	No. 50	9,000
Live overflow		No. 35	4,000
Trash fan		No. 30	3,000
Lint cleaner trash fan		2 No. 40	10,000
Total			43,500

The emissions from the trailer-unloading system consist primarily of dust, fine-leaf trash, and some fibers (Figure 1). The exhausts from the drying and cleaning systems pick up leaf trash and dust from the cylinder cleaners, and burs, sticks, and stems from the stick and green-leaf machines (Figure 2). The exhaust from the live overflow contains a small quantity of lint fly and dust. This system is similar to the trailer-unloading system. The function of the so-called trash fan is to remove the trash from the feeders and gin stands (Figure 3). This material consists of every type of foreign matter in cotton, including burs, sticks, and leaf trash from the feeders; burs and sticks from the gin stand huller fronts; and fibrous material, leaf particles, immature seeds, and grass from the gin stand's moting system.

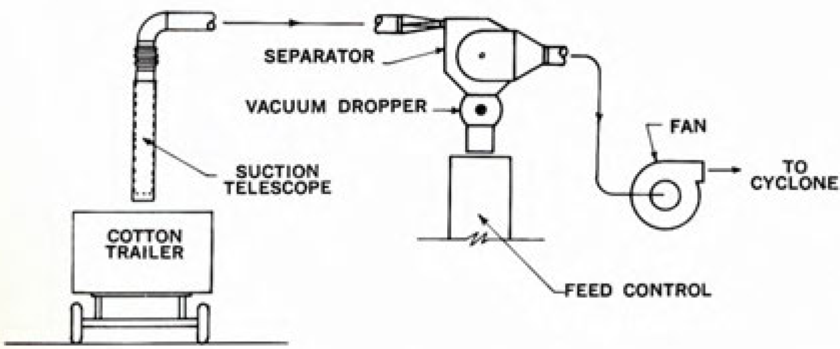


Figure 1 — Typical seed cotton-unloading system.

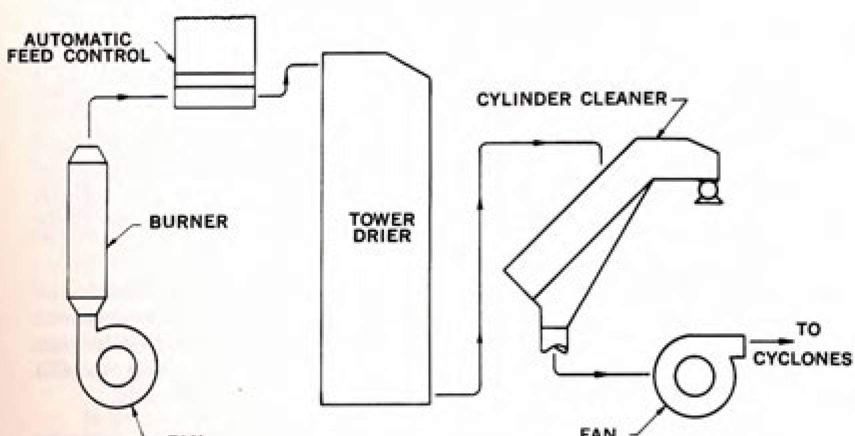


Figure 2 — Typical seed cotton drier-cleaner installation.

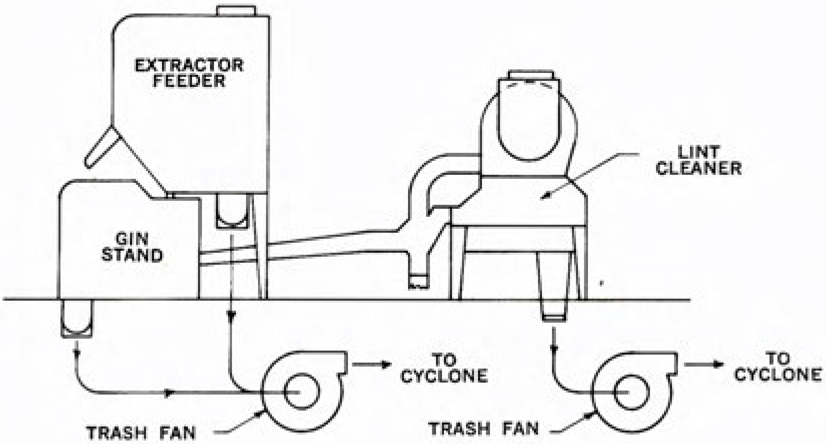


Figure 3 — Typical gin stand feeder's and lint cleaner's trash-handling system.

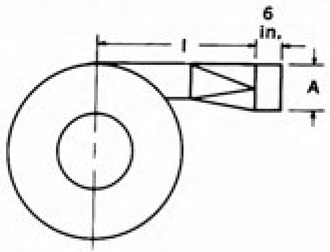
There are no up-to-date data on the volume of material emitted by the various systems or on the analysis of material by particle size. With expected new personnel it is anticipated that some of this work will be done next season.

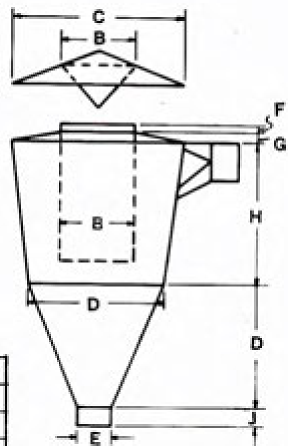
The small-diameter cyclone has virtually eliminated the old conventional large-diameter cyclone for gin use. It has proved less expensive, easier to install, and more efficient. One marked disadvantage of the smaller unit, however, is that its tolerance in sizing is much less than that of the large-diameter cyclone.

For proper operation of the system, the cyclone must be sized correctly. If the cyclone is too small for the air volume, the static pressure on the system is too great for proper operation. In extreme cases an excess of foreign matter blows out of the top and bottom of the cyclone. If the cyclone is too large for the amount of air, then the centrifugal force created is not sufficient to provide effective separation between air and foreign matter. Thus an excessive amount of foreign matter is carried out of the cyclone with the air. When properly sized, a small-diameter cyclone has a working static pressure of about 5 inches of water.

The measurement of air volumes is a subject unto itself and will not be discussed here, but a working knowledge of air measurement is basic to the design of pneumatic materials-handling and collection systems for cotton gins. A simplified explanation is given in the *Handbook for Cotton Ginners,* Agricultural Handbook No. 260.

When new gins are constructed or new trash-handling systems installed, the fan and piping should be installed and air measurements should be taken to determine the proper size of the cyclone. The stack velocity of cyclones should not exceed 500 to 600 feet per minute (fpm). Within limits, the smaller the cyclone for a given amount of air, the more efficient the separation of air from trash. This is why the small-diameter cyclone is rapidly replacing the old conventional type (Figure 4). In fact, the old-type cyclone was never meant for handling the type of material emitted from cotton gins. For most cotton gin trash, the barrel of the cyclone should have straight sides or should be tapered from top to bottom rather than from bottom to top. This type cyclone is no longer recommended for use in gins except possibly for the collection of cottonseed.





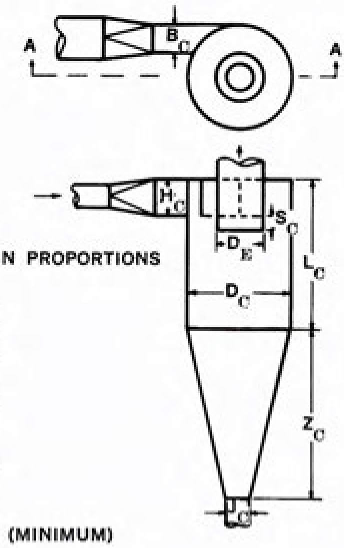
AIR, cfm	CYCLONE DIMENSIONS, in.									
	A	B	C	D	E	F	G	H	I	J
3,000	16	32	64	56	8	7/8	4	36	40	4
6,000	22	44	88	77	11	1	5½	49½	55	6
12,000	30	60	120	105	15	1⅛	7½	67½	75	6

Figure 4 — Dimensions of a large-diameter cyclone.

The small-diameter cyclone that came into widespread use several years ago has proved effective (Figure 5). It creates more static pressure than the old conventional unit does but its higher efficiency makes up for this increased cost of operation. For best efficiency, an effort should be made to keep cyclones to a maximum of 34 inches in diameter. For example, one 18-gauge, 34-inch cyclone handles 3,000 cubic feet of air per minute; two 34-inch cyclones handle 6,000 cubic feet of air per minute. Four of them are needed to handle 12,000 cubic feet per minute (cfm). If for some reason cyclones larger than 34 inches are required, they should be made from 16-gauge metal as opposed to 18-gauge metal for sizes up to 34 inches in diameter. Standard practice for splitting the air into two or four cyclones requires rectangular transitions that are one-half the diameter of the cyclone in height and one-fourth the diameter in width (Figure 6). These clusters have proved satisfactory.

It is standard practice to place all but one of the cyclones in a battery beside the gin building (Figure 7). They all discharge into a screw conveyor that has a dust-tight cover. The conveyor in turn discharges trash through a conventional dropper into an air line that conveys it to a bur house or incinerator. The air from one of the gin's fans, preferably the fan handling the lint cleaner's trash, is used for this purpose, because this fibrous material has a tendency to choke a conveyor (Figure 8). This is especially true if this material must be conveyed past a bearing hanger.

CYCLONE DIMENSIONS, in.			
AIR ENTERING CYCLONE, cfm	SINGLE	DOUBLE	QUADRUPLE
	DIA — Dc	DIA — Dc	DIA — Dc
3,000	34.0	24.0	17.0
6,000	48.0	34.0	24.0
12,000	68.0	48.0	34.0



CYCLONE DESIGN PROPORTIONS

$B_C = D_C/4$

$H_C = D_C/2$

$D_E = D_C/2$

$L_C = 2D_C$

$S_C = D_C/8$

$Z_C = 2D_C$

J_C = 12 in. (MINIMUM)

Figure 5 — Dimensions of a small-diameter cyclone.

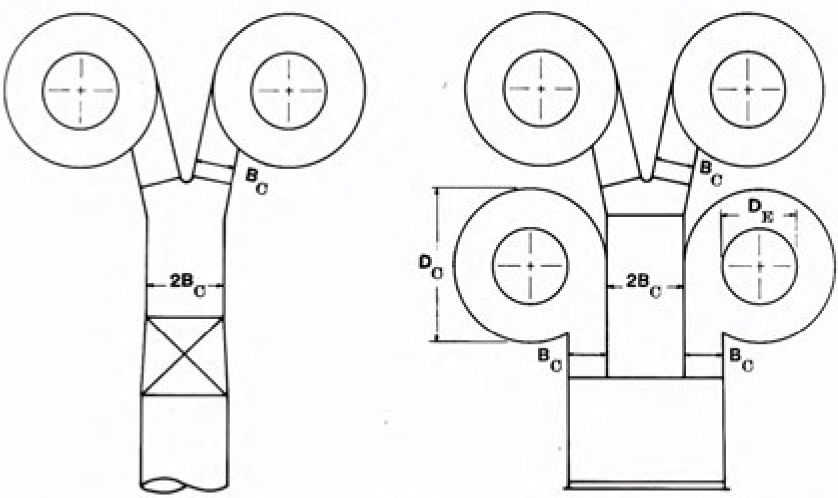


Figure 6 — Inlet transition proportions for multiple small-diameter-cyclone mounting.

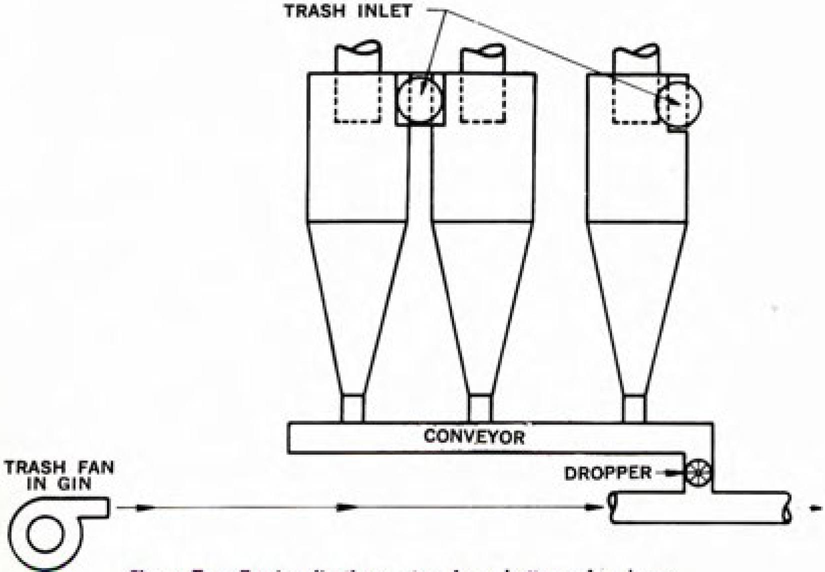


Figure 7 — Trash collection system for a battery of cyclones.

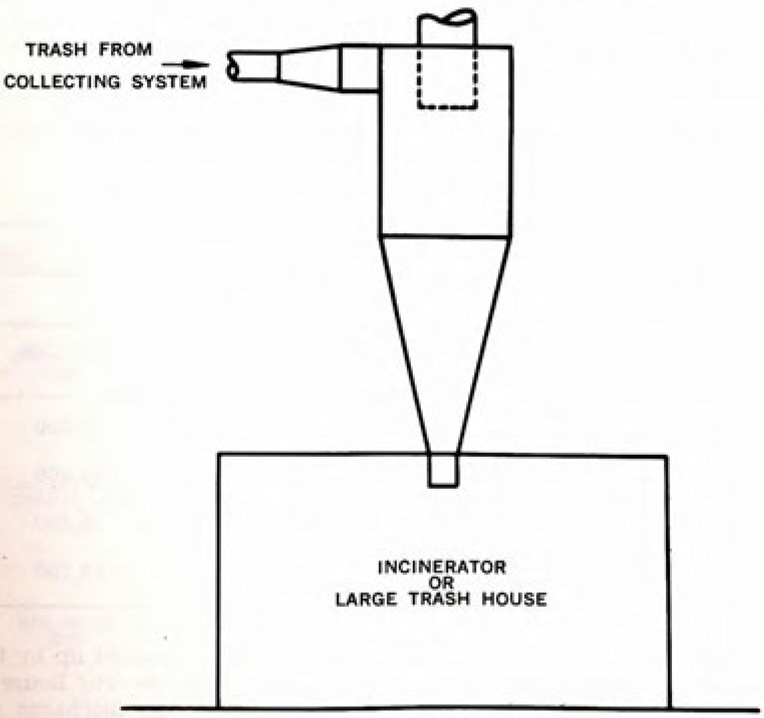


Figure 8 — Collecting trash from a battery of cyclones for disposal.

This system offers several advantages. An incinerator must be 100 feet from any building. By placing the battery of cyclones beside the gin and collecting all the trash into a single line, several hundred feet of pipe are saved as well as the power cost to move the large volume of air the greater distance. Moreover, this system requires one less cyclone and fan since the trash fan picking up under the battery of cyclones, and the cyclone over the incinerator are performing a double function by carrying trash from one point in the gin and by handling the remaining material from the battery of cyclones.

In some areas the dust coming from the exhaust of the cyclones may be objectionable. In this event further filtering is necessary. This can be done several ways. Probably the best would be to use an in-line filter or a commercial unit employing somewhat the same principle (Figure 9). Because the in-line filter will be described in a companion paper (McLain), no details will be given here. Commercial units come in two general types, those that use a fine-mesh screen as a permanent filter and those that have a roll of disposable filter media. Both of these types use a differential-pressure switch to activate the cleaning or roll-turning mechanism. These filters handle a relatively large volume of air for a given size at less than ½ inch of water static-pressure demand (Table 3). For example, all the high-pressure air from a 12- to 15-bale-per-hour gin could be filtered through a 7- x 15- or 10 x 10-foot filter unit costing about $6,000. An installation for the rain-grown area would probably be somewhat as shown in Figure 10. The filter media would have to be kept dry.

TABLE 3 — FILTER SIZE REQUIREMENTS FOR HANDLING VARIOUS AIR VOLUMES (BASED UPON 600 fpm DISCHARGE VELOCITY)

	Height, ft		
	4	7	10
Width, ft	Capacity, cfm	Capacity, cfm	Capacity, cfm
5	7,600	15,300	22,900
10	15,300	30,600	45,900
15	22,900	45,900	68,800
20	28,900	57,800	86,700

When the trash from the battery of cyclones is picked up by the lint cleaner's trash fan and carried to a cyclone on the bur house, a second automatic air filter may be used to clean the discharge air from the cyclone if desirable (Figure 11). An air volume of 4,000 cfm being assumed, a 39-inch cyclone and a 4- x 5-foot filter would be required. A cyclone filter installation such as this would cost an estimated $2,000 for the 4- x 5-foot filter and $575 for the cyclone. The vacuum dropper under the cyclone and filter could be driven by the same motor that drives the distributor conveyor in the house.

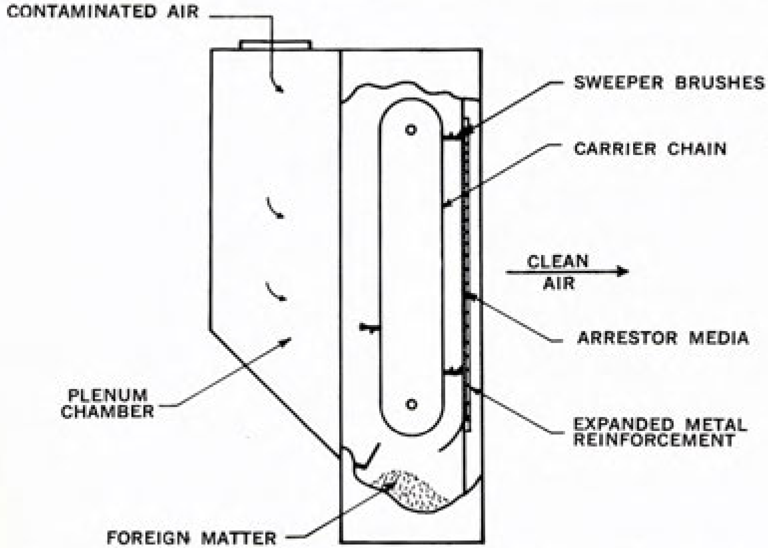


Figure 9 — One type of filter for removing foreign matter from cyclone exhaust.

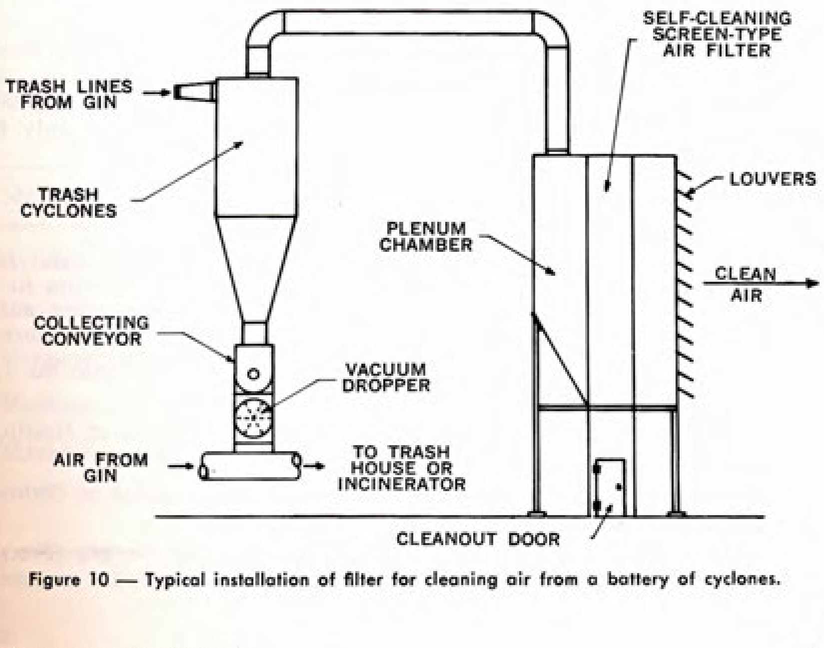


Figure 10 — Typical installation of filter for cleaning air from a battery of cyclones.

It has been found that, by using a cyclone filter unit such as just described along with an airwash or second filtering, the air is cleaned sufficiently to be returned to the gin building. This was demonstrated on a pilot model basis at Mesilla Park last season and in limited trials with lint cleaner trash in connection with a packaging research project at Stoneville.

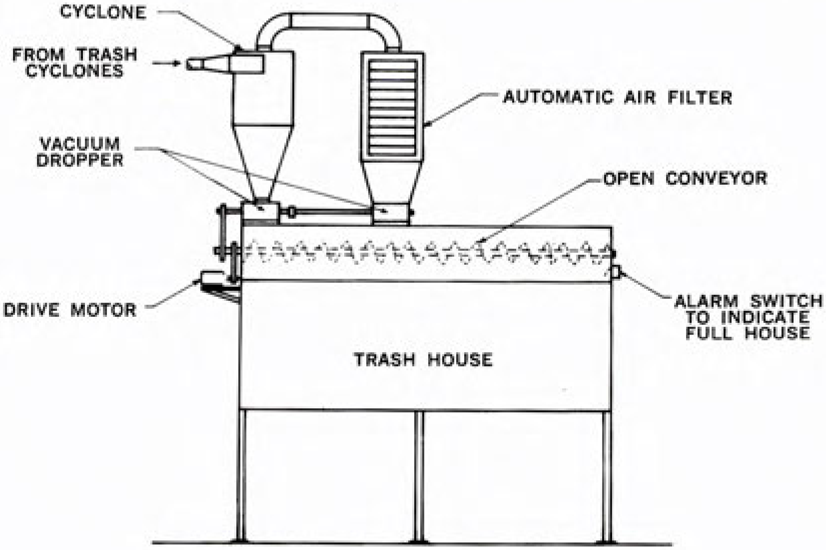


Figure 11 — Cyclone filter installation for trash or bur house.

The gin can be cleaned by using equipment and techniques now available. The question of simple economics remains. It is doubtful that half the gins in the United States can afford $20,000 to $30,000 for an elaborate trash collection system that would operate only 6 weeks out of the year.

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CURRENT GIN TRASH DISPOSAL PRACTICES

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Five harvesting methods, two manual and three mechanical, are used to gather the U. S. cotton crop. Table 4 shows the percent of cotton harvested by each method for the U. S. and for a few selected states. With 58 percent gathered by spindle pickers and 19 percent by mechanical strippers in 1964, hand harvesting of cotton is obviously a fast-disappearing practice.

Table 5 shows that the total pounds of weight of the seed cotton mass required to make a 500-pound bale of cotton varied in 1964 from 1,383 pounds to 2,473 pounds. Since most of the U. S. crop is now harvested by the spindle picker or stripper, U. S. gins obviously must be geared to handle the volume of trash gathered by these two predominant harvesting methods. Table 6 shows that machine-picked cotton in 1964 carried about 89 pounds more trash and moisture than handpicked cotton did. It also shows that the average machine-stripped bale carried an estimated 1,090 pounds more trash than the handpicked bale did. This means then that a gin with a volume of 3,000 bales of machine-picked cotton in 1964 handled 267,000 pounds more trash and moisture than it would have if it had ginned all handpicked cotton. The total load of trash and moisture removed from seed cotton probably amounted to about 366,000 pounds. Since the ginning season grows ever shorter with mechanized harvesting, about 80 percent of this disposal problem takes place each year during a 6-week period.

TABLE 4 — METHODS OF HARVESTING COTTON, CROP OF 1964[a]

Method, %	U. S. A.	Ark.	Calif.	Miss.	S. C.	Tex.
Handpicked	16	20	3	31	37	2
Handsnapped	6	5	—	1	—	13
Machine picked	58	93	94	68	63	20
Machine stripped	19	2	—	—	—	64
Machine scrapped	1	—	3	—	—	1
	100%	100%	100%	100%	100%	100%

[a]Source: U. S. Department of Agriculture.

TABLE 5 — WEIGHT OF SEED COTTON/500-lb bale. AVERAGE U. S. BALE, CROP OF 1964[a]

Method, lb	
Handpicked	1,383
Handsnapped	2,049
Machine picked	1,472
Machine stripped	2,159
Machine scrapped	2,473

[a]Source: U. S. Department of Agriculture.

TABLE 6 — APPROXIMATE EXCESS OF TRASH AND MOISTURE/500-lb bale ABOVE THAT CONTAINED IN HANDPICKED COTTON, CROP OF 1964

Method, lb	
Handsnapped	666
Machine picked	89
Machine stripped	776
Machine scrapped	1,090

The trash problem is much more difficult where machine stripping is practiced—particularly in Texas and Oklahoma. A plant that ginned 3,000 bales of machine-stripped cotton in 1964 handled 2,328,-000 pounds more trash and moisture than a handpicked gin did with a total volume of probably 2,500,000 pounds. Again, about 80 percent of this volume was handled in a 6-week to 2-month period. This brief picture indicates that the size of the gin trash-handling problem at an average cotton gin depends upon the harvesting practice employed. It also points out that the problem changes instantly with a change in harvesting practice.

Three principal pieces of equipment are commonly used in cotton gins to collect the trash: (1) The cyclone, including both the very efficient small-diameter type and the larger commercial type; (2) the lint fly catcher or screen cage; and (3) the in-line filter. Mr. Moore, Mr. McCaskill, and Mr. Stedronsky of the U. S. Cotton-Ginning Laboratories discuss the operation of these in detail. I shall point out only that these are used in groups to form the more elaborate systems capable of trapping the large amounts of air currently used in cotton gins.

To prepare for this conference, I consulted with engineers of two leading manufacturers of cotton gins to determine the range of air volumes used in a current-model cotton gin where air is fully used for lifting and propelling materials as well as for aiding in drying, cleaning, extracting, lint cleaning, separating, and actual ginning. The range of air volume employed for an 8-bale-per-hour gin was calculated at 50,000 to 75,000 cfm. The range for a 12-bale-per-hour gin was from 65,000 to 80,000 cfm. This means that, with the use of the three methods of trapping air previously mentioned, installations are engineered to capture this large amount of air if they are attempting to do the total job. This will be discussed later. For doing this job well, a complicated and costly set of installations is required.

In calculating the cost of incinerating burs with a complete collection system, as we understand it today, I have worked with a prominent supplier of trash-handling equipment to estimate the cost of complete dust control and incineration equipment for a 12-bale-per-hour cotton gin handling stripped cotton. The estimate amounts to $29,049.50 for installation of a complete cyclone system, an in-line filter trap system, and a commercial incinerating system, including power and auxiliary equipment (see Table 7 for more detail).

The same system was priced with dust collection house and one complete spreader truck. This arrangement is designed for returning the gin trash to the soil. The complete cost of this installation was $26,252.50, or slightly less than that of the incineration system (Table 8).

TABLE 7 — ESTIMATED COST OF TRASH-COLLECTING AND TRASH-INCINERATING SYSTEM FOR 12-bale/hr GIN[a]

Three in-line filter traps—to specifications (screen cages may be substituted for price of $1,405.00)	$ 4,125.00
Six sets twin cyclones—to specifications	1,966.00
One set quad cyclones—to specifications	639.00
One suction manifold for three lint traps	395.00
Cyclone stand for bank of cyclones on ground. Conveyor, drives, motor, blowbox, tail pipes, etc	2,674.50
One 45-foot-diameter trash burner with cyclone mount and cleanout doors—erected (est)	13,500.00
One complete set pipe elbows, etc, to connect pipe from gin wall to incinerator (est)	3,150.00
Delivery and erection—trash collection system	2,600.00
Total cost trash-collecting and trash-incinerating system	$29,049.50

[a]Capable of handling stripped-cotton trash.

Ginners vary in trash-handling methods from community to community, based upon outside pressures for dust control, the economic situation of the gin, and the prospects for continuation of a profitable enterprise. As an aid to better understanding of the problem, the Cotton Division of the U. S. Department of Agriculture has specially prepared for this conference a table showing how gins dispose of the gin trash. The fieldmen of the Cotton-Classing offices have personally visited all the gins in the course of their cotton-classing and cotton-marketing duties, and these figures are derived from their visits. They indicate that approximately 37 percent of the gins incinerate the trash, 58 percent return it to the land, and 5 percent handle it in some other manner (see Table 9). The differences among neighboring states in the handling of gin trash are interesting.

TABLE 8 — ESTIMATED COST OF TRASH COLLECTING, HAULING, AND SPREADING SYSTEM FOR 12-bale/hr GIN[a]

Three in-line filter traps—to specifications	$ 4,125.00
Six sets twin cyclones—to specifications	1,966.00
One set quad cyclones—to specifications	639.00
One suction manifold for lint traps	395.00
Cyclone stand for bank of cyclones, etc	2,674.50
Trash hopper, cyclone, and auxiliaries	3,103.00
One complete truck spreader	7,000.00
Complete pipe from gin wall to system parts	3,150.00
Delivery and erection—trash system	3,200.00
	$26,252.50

[a]Capable of handling stripped-cotton trash.

In looking at the gin trash and air pollution problems today, every well-informed person must be impressed with the improvements this industry has made in the last 20 years. Twenty years ago many gins blew the trash on the ground for the entire harvest season, then disposed of it as best they could by hauling or burning. Others burned the burs and leaf trash in open pits or homemade, galvanized-iron enclosures. There was no attempt, to my knowledge, to control the dust and smoke nuisance, with but a few special exceptions. Later, and particularly as cotton mechanization progressed, many ginners built expensive incinerators in an attempt to deal with the problem. And finally, the movement to return the trash to the land—whether for agricultural purposes or for disposal—caught on with the cotton ginners of West Texas. The Texas Agricultural Extension Service and the Texas Cotton Ginners' Association deserve strong commendation for leading this movement. The U. S. Cotton-Ginning Laboratories deserve much credit for seeking out and adapting for the ginners' needs the high-efficiency cyclone and the screen cage, and especially for developing the in-line filter for the use of all the people.

This paper does not intend to imply that all gins today contain the trash disposal equipment discussed. A trip through the Cotton Belt at harvest time will show that some gins have no dust control

TABLE 9 — METHODS OF TRASH DISPOSAL AT COTTON GINS, 1965-66 SEASON[a]

State and United States	Incinerate		Return to land		Other		Total (100%)
	No.	%	No.	%	No.	%	No.
Georgia	18	7	246	92	4	1	268
Alabama	74	20	224	62	64	18	362
South Carolina	—	—	256	100	—	—	256
North Carolina	9	4	189	91	11	5	209
Virginia	—	—	6	100	—	—	6
Florida	1	17	5	83	—	—	6
Louisiana	156	73	59	27	—	—	215
Arkansas	359	69	142	28	14	3	515
Mississippi	244	40	280	45	89	15	613
Tennessee	83	32	176	68	—	—	259
Missouri	150	99	—	—	1	1	151
Illinois	—	—	2	100	—	—	2
Kentucky	2	67	1	33	—	—	3
Texas	573[b]	43	719	55	33	2	1,325
Oklahoma	56[c]	37	77	50	19	13	152
Arizona	28	19	117	79	3	2	148
California	14	5	285	94	3	1	302
New Mexico	27	38	44	61	1	1	72
Nevada	—	—	1	100	—	—	1
United States	1,794	37	2,829	58	242	5	4,865

[a]Source: Cotton Division, Consumer and Marketing Service, U. S. Department of Agriculture.

[b]Includes 70 gins that use both methods—incinerate and return to land.

[c]Includes 19 gins that use both methods—incinerate and return to land.

equipment. A careful study, however, will show that most gins have made some improvements, and hundreds of gins have spent large sums and have achieved an admirable degree of control. Many western area gins can be so described.

In summation, the methods of controlling gin trash and air pollution at gins are known and widely used today. These methods were nonexistent a few years ago. They are expensive. Better and less expensive methods are needed. I recommend that the vast experience and the controlled ginning facilities of the U. S. Cotton-Ginning Laboratories be employed in an expanded program to seek solutions to these problems. I also recommend that demonstration setups be built at each regional ginning laboratory so that the state extension services, the ginners' organizations, and health agencies can conduct tours and educational clinics at these points and show the ginners and others interested the latest and most efficient method of controlling gin dust. I am certain more rapid progress can thus be made in handling the age-old, expensive problem of air pollution at cotton gins.

Summary of Open Discussion

Mr. R. J. Lewis of the State of Georgia remarked that ginners are reluctant to return trash to the land because of its grass and weed seed content.

In reply, Mr. F. Elliot suggested that conveying cotton trash over a sand screen before spreading it can be effective in separating seeds; composting before spreading might also be considered. In Texas, composted cotton trash has a fertilizer value of $7.50 per ton and results in increased lint yields of 25 percent for 2- to 4-ton-per-acre applications. Larger applications of 6 tons or more per acre are usually avoided because of increased handling problems and adverse carbon-to-nitrogen ratios in the soil.

METHODS OF COLLECTING LINT COTTON TRASH

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Traditionally, cotton gins are dirty, dusty, smoky, and noisy. That is why they are generally built in the country or far enough away from communities to avoid creating a public nuisance. Cotton gin businesses perform many services other than simply separating the fiber from the seed. They may sell seed, fertilizers, and supplies; act as the clearing house for exchange of implements, tools, machinery, and labor; and become a voting place and the center of transacting all kinds of business. The gin owner or manager soon finds himself in the center of these activities and becomes a leader and a central figure for his customers. Naturally, therefore, gins become the center of agricultural activity for their areas. This tends to cause people to migrate to the gin's location and results in a buildup of homes and stores. These people move into these surroundings willingly, well aware of existing conditions. They may participate in the profits or otherwise benefit materially from the gin or associated activities. These people are not often the source of public complaints. More often, the complaints come from residents who have moved into the area for other reasons, particularly since World War II, owing to the expansion of urban communities. These new residents are mostly concerned with the nuisance rather than the health hazard aspects of their complaints.

The problem of collecting and disposing of gin trash generally falls into two main areas. The first consists of dealing with the coarse, heavier trash such as burs, sticks, stems, leaves, sand, and dirt, the bulk of which is removed in the seed cotton-cleaning stages of ginning. (Seed cotton means cotton with fibers still attached to the seed as it comes from the field.) The collection of this material lends itself to the use of cyclones because centrifugal fans have the necessary pressure characteristics and are adaptable to cyclone use. The collection of this type of foreign matter is not a part of this discussion. The second problem area is more difficult—that of collecting the finer dust, small leaf particles, and fly lint that are discharged from the lint after the fibers are removed from the seed.

Since 1952 the Mesilla Park Ginning Laboratory has been engaged in a research program on the collection and disposal of gin wastes. The problem of the disposal of the heavier trash was undertaken first. This consisted of work on incineration, then on composting, and finally, with the cooperation of private industry and the

Texas State Department of Health, on the introduction of the small-diameter cyclones to the industry.

Work on the second phase was begun about 1956, that is, the collection of the finer types of foreign matter such as dust and fly. The collection of this material is more difficult because it is emitted into the atmosphere by large volumes of air under very low pressure. The increasing use of two or more stages of lint cleaning, together with the use of more suction condensers, has necessitated employing many of these high-volume, low-pressure, propeller-type, vane-axial fans. These fans have the needed characteristics for adequately performing the required function in the ginning process. Modern gins can have four, five, or more low-pressure fans in the lint-handling systems, each discharging from 2,000 to 20,000 cfm air. They normally operate under total resistance requirements ranging from 3 to 6 inches of water pressure.

One of our first attempts at collecting gin waste was by use of a settling chamber. One was designed and installed at a local gin. This house was designed to receive approximately 28,000 cfm air from a combination of high-pressure centrifugal fans and low-pressure tube fans. It was 30 feet long by 24 feet wide by 16 feet high. It had one partition baffle and a discharge area of 360 feet or a discharge velocity of approximately 80 fpm. It performed very well, but outlet velocities of less than 75 fpm are more satisfactory.

Generally, unsatisfactory performance of settling chambers results from their being too small, and very often, sufficient space for the proper size of chamber is not available. One satisfactory installation was at the Hatch Co-op Gin. This gin got into trouble when the town built a new grammar school on the edge of the gin yard, even though the gin had been there for years. The difficulty was overcome by converting the old seed house into a settling chamber and discharging all the condenser vents into it. The gin manager reported that it did a good job but was rather difficult to clean and also was a fire hazard.

Concurrently with our efforts, other people in the industry were trying to find a solution to collecting fine trash. The screen wire lint cage first appeared at California gins about 1957. To the best of our knowledge these cages were designed and introduced to the industry by Mission Cotton Equipment and Engineering, Inc., of Fresno, California. California has for some time been more strict than other states about safety and air pollution law enforcement. These cages were a big step toward the control of lint fly emitted by lint cleaner condensers and battery condensers. The use of these cages soon spread from California to other areas and is now very common. Nevertheless, the use of relatively coarse, ordinary window screen wire of 14, 16, or 18 mesh coupled with the constant agitation of lint fly, dust, and so forth permits considerable amounts of dust and fly to escape through the screen wire. Another undesirable feature of these cages is that they must be kept dry at all times. In areas where rains, showers, or heavy dews occur, these cages must be protected with louvered skirts, or better yet, housed under a solid roof. Most California gins now provide a screen-walled enclosure with solid roof. This second screen outside the cages acts as a secondary collection agent, and the screen walls accumulate additional fly and dust that escaped through the cages. The walls are periodically brushed and cleaned by the yard man. This is done perhaps once or twice a day, or as needed. Apparently, some installations are more effective than others.

Even though the lint cages were increasing in popularity, they did not satisfy the requirement at all gins. Progressive ginners were attacking the problem by other methods. One fine example of an attempt to correct an individual problem will be described to you here by Mr. Andrew O'Neal of the Community Gin Company of Glendale, Arizona. Another pioneer is Mr. Jack Francis, owner of the Valley Gin Company, Peoria, Arizona. He installed a very elaborate system of cyclones and filter bags at one of his gins. The results of this installation seem to be reasonably satisfactory, but the system is expensive, and maintenance costs are high. These and other efforts by various individuals are making a big contribution toward helping to solve the air pollution problem at gins. Their efforts are even more admirable when we consider that they were done voluntarily and at an expense of thousands of dollars with no motive other than a conscientious effort to eliminate a nuisance in their communities. In spite of all these efforts, however, these devices were evidently not a complete solution to the problem.

In 1962 the Mesilla Park Ginning Laboratory began developing a lint collection device that was efficient, economical, and generally satisfactory for use at commercial cotton gins. Preliminary review of dust collection principles revealed that a filtering device was desirable and also that the potential for adapting commercially available bat-type filters did not appear encouraging. As the investigation progressed, the idea of the in-line filter materialized. The objective was to use a fine-mesh screen to stop the flow of foreign matter in the airstream, and as it accumulated, have it become its own filtering medium for collecting finer particles and dust. Woven-wire screens were investigated. Brass and bronze screen wire strainer cloth of 14 x 18, 80, and 100 mesh were tried. They were found unsuitable for practical use with low-pressure fans because the initial pressure drop is too great. The next step was to find a fine screen with resistance-to-airflow characteristics low enough not to interfere with condenser operation. The best material found to date is a stainless steel, bolting-grade wire cloth. This woven-wire screen has the remarkable properties of low resistance to the flow of air, a high percentage of open area, strength, and durability. The main components of the in-line filter are a sheet metal housing, screen, a wiping brush, a small electric motor, and a diaphragm pressure-differential switch. The operation of the filter is simple; it can be installed in a horizontal position in any air line at almost any location. The filter operates on a collecting-cleaning cycle. Fly lint, leaf trash, and dust are caught on the screen. The fly that accumulates on the screen acts as a filter to catch smaller leaf particles and dust. As the collected material increases on the screen, backpressure is built up in the air system. The amount of backpressure allowable depends upon the performance characteristics of the fan, and the resistance of the equipment in the gin system. When the backpressure across the filter reaches some preset level, say 0.75 inch water pressure, the pressure-differential switch closes the electric circuit, which starts the motor that drives the wiping brush. A plain gin brush stick sweeps downward across the surface of the screen, wiping away the collected material. The material can be caught in sacks or conveyed away by other means. The backpressure drops as the screen is wiped clean, and when it is lowered to another preset pressure of, say, 0.3 inch water pressure, the brush stops, and the collecting cycle starts over again. The collecting process continues with intermittent starting and stopping of the brush automatically, depending upon the degree of contamination of the discharging air. The design and construction of the filter are not difficult, and the sizing of screen areas is not too critical. The sizes are determined by the volumes of air handled by the vane-axial fans. Although the measurement of air volumes is not difficult, few operators have developed the skill and ability to perform this task satisfactorily. Manufacturer's performance tables for these fans are usually sufficient to determine the air volumes handled by vane-axial fans. Two important factors are to be considered in designing these filters: First, the proper selection of bolting cloth mesh; second, the proper shape of the housing, in order to minimize the pressure drop due to shock loss of the incoming air. Our filters have been designed for a pressure drop of 0.1 inch water pressure through a clean screen and 0.2-inch pressure drop caused by the housing, making a total pressure drop of 0.3 inch through the unit. Most of our filters have 70-mesh screens because these seem to be the most practical and have been satisfactory to date. We have also tried screens of 40, 60, 80, 105, and 230 mesh. A 70-mesh screen has a free area of 54.9 percent, with screen openings of 0.0106 inch or 269 microns. The resistance is less than 0.1 inch with an air entrance velocity of 1,000 fpm. Filters can also be designed for finer mesh screens and for face velocities of from 750 to 1,280 fpm.

Complete design details are given in *An In-line Air Filter for Collecting Cotton Gin Condenser Air Pollutants.* U. S. Department of Agriculture Report No. ARS 42-103.

The in-line filter is very efficient. Tests have shown that, with our testing procedure, a filter with 105-mesh screen collected, for all practical purposes, over 99 percent of all lint fly and all foreign matter particles larger than 165 microns, and 70 percent of all the particles smaller than 165 microns, resulting in an overall efficiency of 87 percent for the unit. This same relationship holds for 70-mesh screens, but slightly larger particles are emitted at the beginning of the collection cycle. Hence, wiping cycles should be kept to a minimum, consistent with pressure losses allowable for any given system, because the longer material is allowed to accumulate and the thicker the filter mat becomes, the more and the finer the dust filtered from the discharging air. Our tests have shown that one-half (0.51) pound of pollutants per bale is caught from machine-picked cotton in the Mesilla Valley and 2¼ pounds from stripped cotton in the Lubbock area. The in-line filter is the most practicable, economical, and efficient device available to date for collecting these fine pollutants in cotton gins. Research at the Mesilla Park Ginning Laboratory continues toward developing still other practical and adaptable devices.

Many gins have installed lint cages that can be modified and covered with bolting cloth, equipped with a vertical shaft and wiping brush, motor, and pressure switch, and thus be converted into a vertical version of an in-line filter. We have one at Mesilla Park that is installed on a condenser discharge. It has performed well this past season. We feel that some minor changes need to be made in our installation. Stoneville has covered gin condenser drums with bolting cloth, and we have one at Mesilla Park. This is also a great aid in reducing the emission of pollutants into outside air. We have another experimental installation at a local gin. This is a centrally located sheet metal dust house that receives the discharging air from all the condensers. One wall is open but covered with bolting cloth screen and equipped with mechanical wiping brushes. This system worked well for a short time, but difficulties have been encountered owing to flimsy construction and clogging of the link chains to which the wiping brushes are attached. It seems feasible that these difficulties can be overcome if necessary. Since, however, the individual in-line filters are performing so satisfactorily, we shall probably not devote much effort in the future to the further development of this centralized collection system.

We are also experimenting with the use of large-propeller ventilating fans that are installed in the side of the gin house and exhaust air from the inside. The fan discharges into an in-line filter, which collects the dust and fly that normally float around inside the building. Our objective is to provide cleaner and cooler working conditions for the gin crew. We are not yet able to report much progress on this work.

Research on other phases of ginning investigations indicates good possibilities of materially contributing to the solution of the air pollution problem. The small-diameter-pipe trash-handling system reported in ARS Bulletn 42-59 (U. S. Department of Agriculture) can reduce outside air pollution. The use of pressure blowers instead of centrifugal fans for conveying trash can reduce air volumes discharged to the outside from approximately 5,000 to 600 cfm. Materials-handling research for conveying seed cotton, cottonseed, and trash is underway at Mesilla Park. The air flotation principle of conveying in open or closed troughs will reduce the need for high-pressure, centrifugal fans that emit high-pressure, turbulent air into the atmosphere. Seed and trash conveyed by this method will reduce power and air requirements, and could in many cases eliminate the need for small-diameter cyclones.

Perhaps the most promising research is our experimental Monoflow ginning system, which has only one fan exhausting into the atmosphere where conventional gins now have as many as five or six. In the Monoflow system, the seed cotton-conveying air is drawn into the system at the unloading telescope and follows the cotton through the entire drying, conditioning, and cleaning process. The air is cleaned by means of small-diameter cyclones and in-line filters, reused, and finally cleaned before discharging into the outside atmosphere.

The lint-conveying air from gin stands, lint cleaners, and condensers is also cleaned, washed, and returned to the inside of the gin house. With this system, dust and fly inside the building are practically eliminated, and only clean air is discharged to the outside. Since this new concept of the ginning process is still experimental, there are no commercial installations yet, but very good dust control was achieved this past season at the Mesilla Park Ginning Laboratory.

In summary, the problem of collecting air pollutants from cotton gins is not new. Voluntary efforts by private industry, state and Federal agencies, and ginning laboratory research have contributed materially to improving the dusty and dirty conditions around cotton gins and to reducing the gin nuisance to surrounding communities.

Devices and equipment for control of these emissions are now available. They were not available 15 years ago, or even 5 years ago. Progress has been made, and the prospects are good for even better control in the future.

Summary of Open Discussion

Referring to the secondary bag collectors used in Texas, Mr. Paganini stated that maintenance proved a problem and the bags were never replaced. Although collection efficiencies can be high on this type of collector, a properly designed bag-sock installation will not exceed a filter ratio of 4 cubic feet of air per square foot of cloth. Moreover, at a cost of $1.75 per cubic foot of air handled, bag-sock collectors are expensive to install.

Mr. Stedronsky attributed the low-pressure-drop characteristics of the stainless steel bolting cloth to the large free area (54.9%) of the 70-mesh cloth that results from wire diameters of 37/10,000 inch.

PROGRESS REPORT — AIR POLLUTION STUDY OF COTTON GINS IN TEXAS

Otto Paganini
Chief, Air Pollution Control Program
Division of Occupational Health and Radiation Control
Environmental Sanitation Section
Texas State Department of Health

The day of the harvesting by handpickers of just the seed cotton with a slight amount of trash is becoming a thing of the past in Texas. The cost of and shortage of manual labor have contributed to the disappearance of handpickers of cotton from the scene in most areas of this state. In their stead are the faster machines—the spindle pickers and the stripper units. Machine-harvested cotton contains from 150 to 1,000 pounds or more of trash. If the cotton ginner is to compete, he must not only provide the means of separating the seed from the lint but must also clean the trash, both plant and dirt, from the lint fibers. In addition, he must provide the haulage units to enable the grower to bring the cotton to the gin. He must perform this ginning service in the relatively short time of 6 to 12 weeks. Further, he must dispose of the voluminous waste removed from the cotton. In a modern, high-speed gin, the processing of from 12 to 20 bales per hour can result in from 1 to 10 tons of waste. The ginning operators usually employ pneumatic conveying systems. These systems, without properly designed and adequately sized collection devices, can release every minute to the community atmosphere thousands of cubic feet of air containing large quantities of entrained dust, lint, trash, and some pesticide residues. These pollutants have on or in them pesticides that may be harmful to humans and other organisms in the areas surrounding the gins. Some of these pesticides are also corrosive and may cause damage not only to living matter but to physical objects. In addition, bacteria and fungi have been found to a greater degree in the dust samples collected downwind from a gin that is ginning cotton than have been found in the dust normally present in the atmosphere over the community upwind from the gin.

Citizens are becoming more concerned about these large dust concentrations and are objecting to them. In this state, some court cases have been filed and won in which the plaintiff obtained relief through an injunction stopping operations until adequate provisions could be made to prevent the emission of the offending dust, trash, and lint. In addition, one doctor, an allergist, has stated that the dust, trash, and lint are harmful to his patients who have respiratory diseases. The doctor, who practices in Abilene, definitely stated this to be the case during cotton-ginning season in eight or more towns in his area where cotton gins are operated. He has more asthmatic patients during cotton-ginning season and he attributes this to the dust, lint, and fine trash they are exposed to when the gins are ginning cotton.

Most of the people who complain are not interested in putting a gin out of business but in getting relief that will permit them to enjoy life and their surroundings without the fear of serious injury to their health, or destruction of their possessions. In addition, the industry, through the Texas Cotton Ginners' Association, the state and Federal Agricultural Departments, and Agricultural Extension Services, have encouraged ginners to make improvements to abate the emission of dust, lint, and fine trash from the gin operations. The gin machinery manufacturers have not, however, expressed much interest in providing equipment to prevent these emissions.

The Texas State Department of Health, through its Air Pollution Control Program of the Division of Occupational Health and Radiation Control, recognized the problem in the late 1940's, and in 1957, published its first bulletin on the methods by which waste emissions from cotton gins could be abated. This bulletin was revised in 1964.

In the summer of 1964, the Department of Health initiated a study of the problem to determine the amount of cotton gin waste in the form of dust, lint, and pesticide residues that may be present in the community atmosphere of the areas around gins. This was done with the cooperation and assistance of local health departments. In 1964, four gin locations were selected: Robstown, West, Big Spring, and Lubbock. In addition, one sample was collected downwind from a cotton gin at Van Court that incinerated its trash.

This presentation summarizes what was done and found in the first year of this study and presents some suggestions in connection with the abatement of emissions from cotton-ginning operations. With employment by the Division of additional personnel in the summer of 1964, the study was begun, and with funds made available through the Air Pollution Control Grant from the Division of Air Pollution, Public Health Service, U. S. Department of Health, Education and Welfare, in December 1964, the study was continued in 1965. These funds permitted the purchase of additional air-sampling equipment and made greater sampling depth possible.

The objectives of the study were to:

1. Determine the nature and extent of air pollution in the affected areas;

2. relate air pollution to its effects, such as harm to humans, damage to vegetation and property, and other economic and aesthetic losses;

3. determine the need for and feasibility of a control program;

4. determine the degree of reduction of pollutant emissions needed;

5. conclude whether problems are of sufficient magnitude to warrant study and research.

High-volume, electrostatic precipitator, millipore, grab, and bacterial air samples were collected upwind and downwind from the gins. These methods were employed to examine the samples for dust and lint to determine: (1) The amounts emitted, (2) the distance from the gins of the areas affected by them, and (3) the types of chemicals and bacteria present in the dust. Controls or baselines were established by the collection of samples upwind from the gin.

In 1964 only four high-volume air samplers were available for sampling the air for suspended particulate matter and arsenic. Two samplers were placed downwind, while one was situated upwind and one was used as a mobile unit. A total of 70 air samples of 2- to 8-hours' duration at all locations were collected. In addition, 130 samples of 1- to 2-hours' duration were collected. These samples were collected over a 2- to 5-day period, and the samplers were moved at times so that they would be in the downwind direction from the gin at the time the samples were collected. Other samples were collected with electrostatic precipitators and millipore filters, and particle counts and sizes were determined; bacteria samples were collected on nutrient and blood agar plates by means of a General Electric Electrostatic bacterial air sampler. These were incubated and bacteria colony counts were made. Sterile millipore filters were used to collect samples that were then placed in sterile buffered-water solution, transferred to selective media, and incubated. *Aerobacter aerogenes* was isolated from these air samples. These bacteria are said to cause the acute illness that sometimes occurs among cotton mattress makers. The samples were analyzed also for fungi. Air samples were collected upwind and downwind with all these methods.

The dust count and size determination were made by the Spencer Bright Line Hemocytometer Counting Cell Method. In addition, the samples were further analyzed for arsenic content. Samples were taken from cotton in the wagons, from debris found on vegetation in the general area of the gin, and from rafters.

In 1965, 8 additional units were made available, bringing the total to 11. Nine were placed at fixed locations, one upwind and eight downwind. The other two were used as mobile units. This permitted greater coverage to determine how far downwind from the gin cotton gin dust and trash could be found. Arsenic determinations were again made as well as determinations of total suspended particulate matter.

The samples of suspended particulate matter collected downwind in 1964 contained from 39 to 76,000 micrograms of particulate matter per cubic meter of air sampled, and from 0.01 to 141 micrograms of arsenic per cubic meter of air sampled. The largest concentrations were found close in to the gin (1 to 8 blocks). Concentrations in samples taken at distances greater than 2,500 feet from the gin were nearly equal to background concentrations. Upwind samples varied from 67 to 783 micrograms of particulate matter per cubic meter of air. In general the upwind samples had less than 128 micrograms per cubic meter of air. In 1965, over 450 high-volume air samples and 50 grab samples were collected. The results of this phase of the study will appear in a final report.

The bacteria and fungi counts in samples taken upwind were 88 to 100 and 33 to 70 per cubic meter of air, respectively, when collected on nutrient agar. The counts in samples taken downwind ranged from 172 to 1,752 and 19 to 129 per cubic meter of air, respectively.

Blood agar bacteria and fungi counts in samples taken upwind were 82 and 87, and 24 and 26 per cubic meter of air, respectively; bacteria and fungi counts in samples taken downwind were 285 and 248, and 22 and 57 per cubic meter of air, respectively. Two samples of *Aerobacter aerogenes* taken upwind, were negative while two taken downwind were positive.

In the 1964 phase, a review was made of the number and location of deaths that occurred in West. Deaths for the period 1961 through 1963 were analyzed by our Vital Statistics Section. There was a definite increase in deaths in the winter months, which could be expected; however, this same increase showed itself in the summer months and could be in part due to hot weather. Our Vital Statistics Division informs us, however, that more deaths occur in the winter than in the summer. Of the 120 people who died in West during this period, 47 were residents of the area downwind (prevailing) from the gin and represented 39 percent of the total deaths, and this area contained only about 25 percent of the population. The death rate in this community (age-adjusted rate) is 894.2 per 100,000 as compared with a state rate of 846.8 per 100,000 for the period 1961 through 1963.

The air-sampling period during the 1964 phase varied with the gin operation and ranged from ½ to 24 hours over a 3-day period. In 1965 the sampling period was extended to 24 hours over a 5- to 6-day period, with mobile sampling for periods of ½ to 2 hours. In addition, in 1964, air sampling included analysis for suspended particulate matter, dust particle size and counts, bacteria and fungi, and pesticides. In 1965, samples were analyzed only for suspended particulate matter and arsenic.

This study was begun in the last part of August 1964 at Robstown, Texas, through the cooperation of the Corpus Christi-Nueces County Health Department. Other areas studied were West, Van Court, Big Spring, and Lubbock. In 1965, the areas studied were Lazona and San Benito in the lower Rio Grande Valley, and again, West, McKinney, and Ellinger.

In 1965, except for the mobile samplers, the fixed sampler sites operated 24 hours. The gins did not operate continuously throughout the 24 hours during which most of the samples were collected. Therefore, the loadings would be less on a microgram-per-cubic-meter basis.

Six conclusions were reached from the study.

1. Smoke emitted from incineration of cotton gin waste was found to contain significant amounts of benzene-soluble organic matter and arsenic, and to reduce visibility to such an extent at times in some locations that driving was hazardous on the highway. In addition, these smokes are acrid, and reports have been received that they and the dust and lint are a hazard to the health of individuals, particularly of those who have respiratory involvements. Texas A&M University Report MP 771, June 1965, *Study of Arsenic Acid Residues on Cotton* states: "The amount of arsenic which would be expected to escape in fumes from burning of such trash would be essentially three pounds of arsenic per ton of trash burned . . . The release of arsenic in the fumes during combustion of leaf trash implies that burning of gin trash with high arsenic content poses one of the potentially most hazardous situations encountered in the study."

2. Dust and lint concentrations in the air have been found to be excessively large and much greater than the ambient air standards set by some states.

3. The areas affected downwind reached about ½ mile.

4. Bacteria and fungi are present in greater amounts in the air sampled downwind from gins than in those sampled upwind. One type isolated was *Aerobacter aerogenes.*

5. Concentrations of arsenic, pesticides, and defoliant exceeded many times the concentrations found in the natural ambient air.

6. Abatement of dust and lint to a safe concentration at many gins is still a desire and not fact. A concentration of 125 micrograms or less per cubic meter of air sampled at the property line of a gin is recommended at present, based upon this and other similar studies. A smaller concentration may be advisable as more information becomes available, especially on pesticides other than arsenic.

There appears to be a definite need for better control of emissions at gins. High-efficiency cyclone collectors appear to be required to handle more material than is normally expected of these units. These were originally intended for use when trash per bale was around 150 pounds maximum and 4 to 7 bales of seed cotton was being ginned per hour.

The remarks that follow are no reflection on any group associated with the cotton production and ginning industries; however, since I have long been on the scene with the problem at hand, I wish to make these comments. Again, before I do, let me point out that the U. S. Department of Agriculture has contributed in part to the solution of the problem by their work and their ideas. Even though their prime missions are to improve and obtain maximum yields of cotton from the soil and seed, and produce a good quality of cotton, they have devoted time that could have been spent on their major missions to help abate the problem of emissions from gins and we are grateful.

The Texas Cotton Ginners' Association has made considerable effort to recognize the problem by pointing it out to its members and to others and encouraging them to do something about it. Their bulletin *What We Know About Air Pollution* is one of their contributions to the solution of the problem.

Then there is our own contribution, the Texas State Department of Health OH-2 Bulletin No. 2 *Control of Cotton Gin Waste Emissions,* first issued in 1957 and revised in 1964. Copies may be had by writing the Texas State Department of Health, Austin, Texas. This bulletin needs, however, to be revised again because of the information we have gathered.

One group that, in my opinion, has done little to control emissions created in the operation of equipment consists of the manufacturers of ginning equipment. These people know well, or should know, air- and trash-handling capacities of their equipment and could develop adequate control devices from information at hand on methods that may be employed to prevent emissions of dust, lint, and gas. In their stead, this has been left to the manufacturers of auxiliary equipment who do not have the benefit of this information. Some of this latter group have done some fine work toward abating emissions.

If at all possible, and many ginners would prefer and welcome it, I believe, the trash should be left in the field. We and the Texas Cotton Ginners' Association prefer this, because of the benefits the trash returns to the land.

We understand that the cleaning of cotton in the field poses a problem, which has been cited previously by others. One manufacturer hopes, however, to develop in the near future a unit that will pick and clean the seed cotton in the field.

We think that we can eliminate the problem of dust and lint emission at the gin. Our close association with the problem leads us to think that efforts to eliminate it must be given greater emphasis. Today seed cotton brought to gins contains an average of 700 pounds of trash per bale, and the gins have capacities of ginning 7 to 25 bales per hour with an average of perhaps 12. These efforts must begin with the coming ginning season. Already, in Texas, persons are bringing this matter before the Texas Air Control Board for hearing, and out of this may result development of rules and regulations to require gins to abate the emissions of these pollutants.

In closing, let me philosophize a bit. The ginner, who must manage the gin and pay the bills, is in a competitive business, and like all of us, wishes to obtain a profit from the services he performs. We must, therefore, treat ginners as individuals. We in the governmental service and enforcement groups can, by proper persuasion and education in our contact with ginners, go a long way toward abatement of this air pollution problem.

Summary of Open Discussion

Mr. Paganini first discussed some problems of dust emission from a cyclone collector at a gin in the Lubbock, Texas, area. He speculated that perhaps the screw conveyor serving the cyclone's trash exit may not be removing accumulated trash fast enough and thus may be causing flow disruptions in the cyclone itself. One possible solution to this problem might be to install a surge box between the cyclone exit and the auger feed to handle periods of overload or unusually dirty cotton.

Mr. T. Wimberly, confirming these remarks, stated that he could forecast the extent of fine-dust emissions from cyclone dust collectors by merely estimating the trash content of incoming trailer cotton. Trash contents of as much as 1,800 pounds per bale are usually adequately handled so that no visual emissions occur. Trash loadings, however, of 2,000 pounds per bale or greater seem to exceed the capacity of the cyclone, and it emits great quantities of dust.

In answer to another question concerning the state of arsenious acid emitted from cotton gins, the speaker expressed the opinion that the arsenious acid crystal is present on the cotton trash particles. Vegetation damage from this heavy metal acid occurs when the acid crystal contacts moisture in the air or on the plant. In the preceding report, arsenic was reported as arsenic trioxide.

The following letter was read by the speaker in answer to a question from the floor on whether cotton gin emissions constitute a health hazard:

April 20, 1966

Air Control Board
Texas State Department of Health
1100 W. 49th Street
Austin, Texas

Attn: Mr. Wimberly

To Whom It May Concern:

This is to confirm in writing the conversation, which I had on April 18, 1966, with Mr. Wimberly of your Department concerning the extremely harmful effects produced particularly against children with asthma by cotton gins in our area. I see patients from all over West Texas, as far north as Crosbytown and as far west as Clovis, New Mexico, and Odessa, and as far south as Pecos and Fort Stockton. It would be easy to go through the files and find literally dozens of cases that are easily controlled with minimum amounts of medication and regular hypersensitization injections for pollen dust, molds, and spores etc., *until* the cotton gins begin operating in the fall. It is impossible to put into an injection everything to protect them against the extremely irritating effects of lint, dust, and smoke from cotton gins. *Anything* which can be done to minimize the air pollution from this source will be of real service to the asthmatic patients in this area. I would be happy to cooperate in any way in furthering this objective.

Signed,

David F. Pugh, M.D.
Diplomate, American Board of Pediatrics
Associate Fellow, American Academy
of American College of Biology

THE OUTLOOK FOR DEFOLIANTS AND PESTICIDES

Fred C. Elliott
Extension Cotton Specialist
Texas A&M University

There is more interest in mechanical stripper harvest of cotton in Texas and Oklahoma than in the other cotton-producing states, which are concerned first with spindle packing.

Almost three-fourths of the 1965 Texas cotton crop was stripper harvested, desiccants being the preferred harvest aid chemical. This leaves nearly one-fourth to be harvested by spindle picking, the main interest being in the true defoliants. The leaflet L-145, *Cotton Defoliation Guide for Texas,* is supplied to growers by the Agricultural Extension Service through the County Agricultural Agents. Their 1965 annual reports showed that 56,465 farms used desiccants or defoliants in 167 counties.

Table 10 shows the extent of use of defoliants and desiccants in cotton harvesting in Texas.

TABLE 10 — EXTENT OF USE OF DEFOLIANTS AND DESICCANTS IN COTTON HARVESTING IN TEXAS, 1962 THROUGH 1965

Year	No. of farms	No. of counties
1962	82,219	164
1963	56,967	174
1964	60,879	166
1965	56,465	167

Table 11 gives the number of pickers and strippers in use in Texas from 1947 through 1965.

These machines harvested about 94 percent of the Texas crop. In the near future, as we approach total machine harvesting, the division will likely be as follows: About three-fourths to be stripped will require a desiccant or frost, and one-fourth to be machine picked will require true defoliants when a harvest aid chemical is used.

In 1966 the total acreage allotment is 6,520,211 acres, on 125,914 farms. As of March 25, 1966, a total of 99,189 farms had signed to divert 1,736,236 acres from their allotted 5,456,027 acres. The final signing shows 1,996,042 acres to be diverted from the 6,326,733 acres allotted to those signing.

TABLE 11 — NUMBER OF PICKERS AND STRIPPERS USED IN TEXAS, 1947 THROUGH 1965

Year	Spindle pickers	% machine picked	No. of counties	Stripper harvesters	% machine stripped	No. of counties	Total % machine harvested
1947	19		13	3,443		58	
1948	92		23	4,523		61	
1949	335		69	7,003		84	
1950	255		63	7,138		72	
1951	767		72	14,127		109	
1952	1,122		74	14,270		119	
1953	1,557	3	83	15,088	21	130	24
1954	1,532	3	78	18,877	18	133	21
1955	1,547	3	70	19,524	21	130	24
1956	1,618	3	68	20,698	22	117	25
1957	1,587	2	57	23,132	35	123	37
1958	1,831	4	78	26,692	31	133	38
1959	3,280	10	100	29,236	34	143	44
1960	4,505	14	110	32,042	44	152	58
1961	4,782	14	106	33,089	51	151	65
1962	6,777	19	103	37,540	58	159	77
1963	5,381	18	92	40,921	62	168	80
1964	5,864	20	86	41,512	70	167	90
1965	6,498	22	88	45,232	72	173	94

In addition, most of the crop in Oklahoma is likely to be machine stripped. Parts of New Mexico and Arkansas are also interested in stripper harvesting.

Currently there is a need for approximately enough desiccating material to prepare about 3 million acres of Texas cotton crop for stripper harvesting.

The spindle picker is operated in the lower Rio Grande Valley, along the gulf coast, up through the river bottoms of central Texas, and in the western irrigated areas in the Pecos and El Paso Valleys. The maximum acreage requiring the use of true defoliants would be about 1 million acres.

Stripper harvesting machines are used on the high plains and rolling plains, the uplands of central Texas, and the Blackland area, and into the nonirrigated areas of south Texas. Formerly, stalk size was one of the main points determining whether or not growers desired to use stripping machines rather than the spindle picker. This has partially changed, however, because of the brush stripper. The brush machine strips a larger stalk. It also permits stripping under slightly damper weather conditions.

Furthermore, the stripper is more efficient in regard to the percent of crop harvested. In Texas we can easily attain a 98 percent efficiency with the stripper harvester. Moreover, further developments of the stripper are underway.

We urgently need, therefore, a desiccant that will prepare the cotton for the stripping machine. It should have a regrowth inhibitor and, further, it should be as nontoxic and noncorrosive as possible if the price is right. At present, arsenic acid is approved. Chlorates can be used at the upper limits for desiccation. Still other materials are in the developmental stage.

Often, on the high plains, cotton can be planted early and can reach maturity early enough so that it can be desiccated and stripped, even in the latter part of September. Certainly, large acreages can be desiccated in October—as much as 1 month ahead of the annual first-frost date. This prevents cotton from staying in the field and taking weather damage, which reduces the fiber qualities.

Desiccation and early stripping also greatly reduce cotton insect populations the following year. In the central Texas Blacklands, the bollweevil is being drastically reduced by a program of desiccation and machine stripping.

Practically all the manufacturers of cotton-stripping machines have added a green-boll separator and are building excellent machines. The basket has been added to the stripper. This reduces the harvest labor about 50 percent. Under the best operating conditions, a green-boll separator can take out most of the green bolls and immature bolls that may be killed by frost or injured by insects.

Moreover, a number of companies have a very active research and development program underway to remove burs in the field. Since the green bolls can be separated out, this opens up a new possibility of bur extraction in the field. The experimental models of these machines look very promising indeed.

The green-boll-separating devices have been adapted from the USDA research models. This work was started at the Agricultural Experiment Station at Lubbock, Texas. These green-boll separation devices take fully 96 percent of the green bolls that might be in the cotton.

The need for a suitable desiccant is evidenced by the fact that growers are stripping about three-fourths of the Texas cotton crop with over 45,000 machines operating in 173 counties. A stripper is more efficient and economical than the spindle picker. Two row spindle pickers sell for about $20,000. A stripper sells for $3,000 to $9,000, depending upon the model and whether it is self-propelled. Currently, machines to strip cotton handle larger stalks than formerly. The brush stripper also handles cotton under somewhat damper conditions than the steel roll machine. At present this would mean a potential of approximately 3 million acres that could be stripped in the state of Texas. The acreage in Oklahoma, New Mexico, and Arkansas could be added to this. Two companies sold 1,200,000 gallons of arsenic acid for preparation of the 1965 crop for stripping.

Where cotton can be stripped before frost, the use of a desiccant is an absolute must. There is no other way. True defoliants cannot be used. At the McGregor Experiment Station it has been shown that not more than 4 percent green leaf can be permitted if full-quality potential is to be obtained.

Other pesticides necessary for profitable cotton production are fungicides, insecticides, herbicides, and fumigants for nematode control.

Fungicides are used to control seedling diseases such as damping off and reduce bacterial blight. These materials are used to treat the planting seed or as in-the-furrow application at planting time.

Insecticides are needed to control a large number of insects in cotton, from soil insects at planting to bollworms or leafworms shortly before harvest.

In 1964 the economic loss to Texas cotton growers from weeds was $58,715,781. The cost of controlling weeds in Texas cotton fields was more than $25 million. The sale of herbicides for this purpose exceeded $8 million. The ever-increasing scarcity of farm labor, and the progressive demand for higher efficiency on fewer acres is expected to stimulate almost universal use of herbicides for controlling weeds in this crop within the next few years.

THE COMMUNITY GIN COMPANY'S TRASH COLLECTION AND DISPOSAL SYSTEM

Andrew O'Neal
Superintendent
Community Gin Company
Phoenix, Arizona

Four or five years ago we were faced with the problem of cleaning up the dust emitted from a gin in Scottsdale, Arizona; the system that we designed at that time has been operating ever since. You can imagine our dismay when we found that a housing development was being built within 150 feet of our gin plant. Since the land we occupied was very expensive, we probably could have sold the real estate for enough money to move the gin, but the only way we could move was east—into an Indian reservation. We talked to those people about a site, but found this alternative unattractive. Hence, we preferred to eliminate the dust, thinking it would be cheaper than moving the gin and finding new customers.

We first made simple tests upon the amount of dust or lint that we would have to handle and dispose of. We made these tests with a standard high-efficiency cyclone and found that, under severe conditions, we might have to trap and dispose of 250 pounds of dust per hour. This represents trash loadings of ground pickup cotton under very rough conditions. About 90 percent of our ginning is spindle-picked cotton, and we estimated that we might have to collect about 75 pounds of dust per hour from that type of ginning. This total discharge includes the motes, handling system, and the condenser discharges as well as the main trash line. The gin stand has 490 saws with a capacity of 6 to 11 bales an hour, depending upon the condition of the cotton.

A local sheet metal fabricator explained to us that an enclosed cyclone would do a better job on the fines. His experiences were with hay and oil mills; we ran a simple test on this type of cyclone and found an appreciable reduction in the emissions. We estimated about half the emission figures that I have quoted earlier, or 125 pounds per hour for trashy cotton and 30 to 35 pounds per hour on good machine-picked cotton.

We decided to use a water injection system for two reasons: (1) We discovered how to inject the water before the second cyclones; (2) disposal would be more practical when the dust was wet than when it was dry. I have two or three thoughts about disposal; I thought it would be easier to plow under a truckload of slurry or slush than a truckload of dust. One could also dump the slurry in an irrigation ditch or on the desert and it would dry up to a sort of cake. In our particular case we were using the old type of bale yard storage with 2,500 to 5,000 stored in a yard; I thought that we could hold the dust down on the roadway by using this dust slurry. I say slurry because we do trap this dust in water and have to change the water often. The only problem with this technique was the odor, which we were able to control economically with moderate amounts of DK powder. Since then, we have abandoned the bale yard storage system and have found that the slurry is of definite advantage in trash compost piles; it seems to accelerate the decomposition of the gin trash.

Bur and trash disposal in our area is becoming an expensive problem. In most cases, our growers are just not interested in going to the expense of spreading gin trash back on the land, even though they understand the fertilizer and humus value. Probably hay and grain crop rotation along with other crop rotations is more valuable to them since these are cash crops. The farmer also feels that weed seed would be expensive to control, especially the morning glory. We are exploring compost for the retail market; I shall explain that later in more detail.

The following equipment has been constructed in series: (1) A large-diameter cyclone with vacuum dropper box at the trash outlet to allow operation of the cyclone under negative pressure; (2) an 8,000-cfm paddle blade with a 19-inch water pressure drop across the fan, and a 2-inch water pressure after the fan; (3) a ⅜-inch water pipe inserted into each of the inlet lines; and (4) a pair of high-velocity cyclones for collection of the fines. I think you can imagine the scrubbing action that the dirt gets in this wet cyclone.

We find it necessary to use 5 gallons of water per minute (gpm). This water is recirculated until it becomes too dirty as a cleaning agent and then we pump it out of the sump and replace it with clean water. We find that a ⅜-inch pipe, inserted in the galvanized water pipe, is a satisfactory device for water injection. We even tried nozzles at that point, hoping to get a better spray, but these were not as successful as the simple injection system.

I should like to answer Mr. Paganini's question about the particle sizes emitted: The only measurement we have is the number of phone calls we get. We simply do not have a method yet; I should also like to find what is coming out of that cyclone. This system might be expanded to industry. It could possibly be compounded and two wet-type cyclones used under really severe conditions, and we could probably pull through both of them with one fan. As the engineers know, we are probably reaching the limits of paddle blade fans at these pressures. There is, however, one fan manufactured that, I believe, will go to 45 to 50 inches of static water pressure. A liquid could be used that is compatible with some other reclaimed material, and perhaps a centrifuge could be used to reclaim valuable materials from the slurry.

Our lint condenser systems are equipped with the lint cages described on the first day of the symposium; the first condenser after the gin stand is double screened—the lint cage being one screen and the wire-enclosed house the second screen. We have had very good results with these lint cages and we are sold on them entirely; the maintenance is very low, and the lint coming out seems to settle in 45 to 50 feet on the ground, as a result of the low screen velocities.

Summary of Open Discussion

In elaborating upon the details of his wet-cyclone dust collectors, Mr. O'Neal explained that the pipe is injected into the inlet line about 10 feet from the high-efficiency cyclone entrance. The dust-water slurry discharges directly into a sump tank, where settlement of the suspended dust occurs; the water is then recirculated for further use. Because of sludge buildup in the sump, the water must be replaced with 900 gallons of fresh water after 500 bales of machine-picked cotton have been ginned. In states such as Texas and Oklahoma, there would admittedly be an icing problem during the cold winter months, but this could probably be overcome by use of an underground sump and heating element.

When questioned about mud caking problems in the cyclone, Mr. O'Neal stated that, as long as an adequate water flow of 5 gpm or more was maintained, no caking problems were encountered, even with very trashy cotton.

For the large-diameter cyclone that collects most of the bur sticks and coarse particulates, a screw conveyor serves the cyclone trash outlets. From the screw conveyor, the trash is conveyed to an inclined chain drag elevator for loading onto the trash trailers. Just above the trailer, two hanging canvas flaps help to prevent fine dust from dispersing during loading operations. These flaps are weighted to ensure stability even during strong winds.

While this system costs $20,000, it was felt that a new dust collection system could be built at a much lower cost.

In elaborating upon the composting system he employes, Mr. O'Neal explained that the cotton trash is piled in 100-foot-long by 10-foot-wide by 4-foot-high piles and watered for 24 to 36 hours to initiate the composting process. Trenches along each side of the pile return drainoff water to a central sump from which it is recirculated. Occasionally, turning of the piles dissipates the heat of decomposition and prevents temperatures from exceeding 130°F. The purpose of the composting studies has been to produce a marketable compost that has a decent shelf life.

PRACTICAL CONSIDERATIONS IN THE DESIGN AND OPERATION OF THE IN-LINE FILTER

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INTRODUCTION

The in-line filters that are the object of this report are located at the Honey Island Gin Company in Kruger, Mississippi, and at the Experimental Department of Continental/Moss-Gordin, Inc., Prattville, Alabama. There are three filters at Honey Island Gin Company, each filtering the discharge air from one 26-inch vane-axial fan. Each fan supplies the suction for two lint cleaner condensers mounted behind a 16-inch-diameter, 119-saw brush gin (Figure 12). The volume of air cleaned by each filter is approximately 8,500 cfm. The single in-line filter at the Continental/Moss-Gordin Experimental Plant cleans the air from one 21-inch vane-axial fan. This fan supplies the suction for a one lint cleaner located behind a 16-inch diameter, 79-saw brush gin (Figure 13). The volume of air cleaned by this filter is approximately 2,200 cfm. The three filters at Honey Island Gin Company have been in operation for two full seasons, while the filter at the Continental/Moss-Gordin Experimental Department was installed for test purposes only. All the experimental data contained herein were obtained from one or both of these two installations.

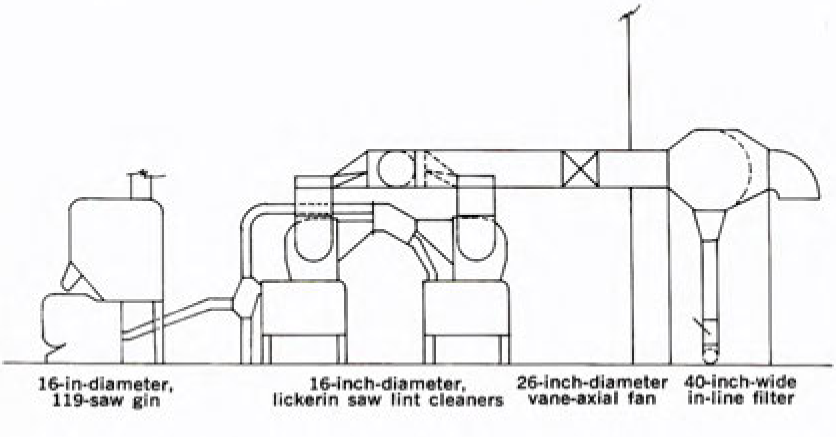

Figure 12 — Continental/Moss-Gordin, Inc., in-line filter installation, Honey Island Gin Co., Kruger, Miss.

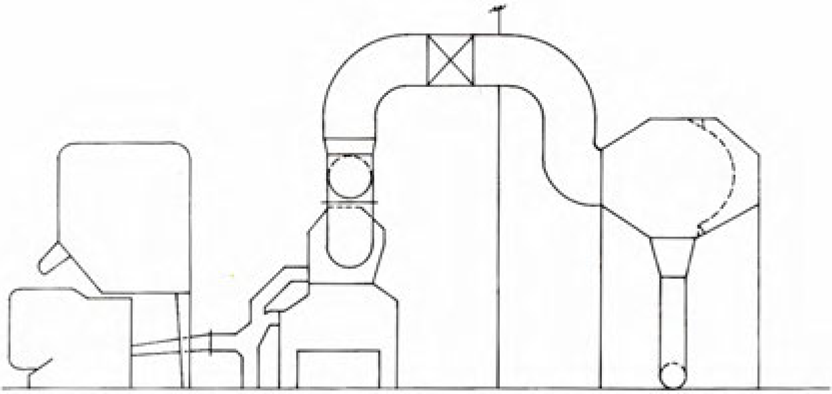

Figure 13 — Continental/Moss-Gordin, Inc., in-line filter installation, Continental/Moss-Gordin Experimental Plant, Prattville, Ala.

DESIGN CRITERIA

The in-line filter, designed and built by Continental/Moss-Gordin, Inc., was constructed with five goals in mind: The filter would have to remove as much as possible of the lint and dust from the condenser exhaust air, would be available to the gin owner at the lowest possible price, would require the least amount of maintenance, would operate cheaply, and would require a minimum amount of time for making on-the-spot repairs or replacements. The first goal, efficient filtering action, was relatively simple to achieve, as a result of extensive research work done by the U. S. Department of Agriculture on the in-line filter(*1*). The last four, however, were to determine finally the actual working design of the filter.

Because mass production is the key to low prices, it was decided that only one size filter would be designed and built. This would enable the factory to manufacture the filter in the most economical lots at the lowest possible cost without sacrificing quality and long life.

Based on design information and recommendations of the USDA, it was decided that the filter screens to be tested would be 40- x 40- and 105- by 105-mesh, stainless steel, bolting-grade wire cloth. Moreover, the face velocity at the filter screen would not exceed 1,000 fpm under the maximum volume of airflow that could normally be expected. This was done to ensure that the exhaust fans would not be subjected to pressure sufficient to cause a backlash at the gin stand. The maximum cfm value used was 12,000, and this figure used with the available design information resulted in a 40-inch-wide separator with 24- x 40-inch rectangular inlet and discharge openings. The screen had 11.7 square feet of open area with a radius of 2 feet and an arc of 120 degrees (Figure 14).

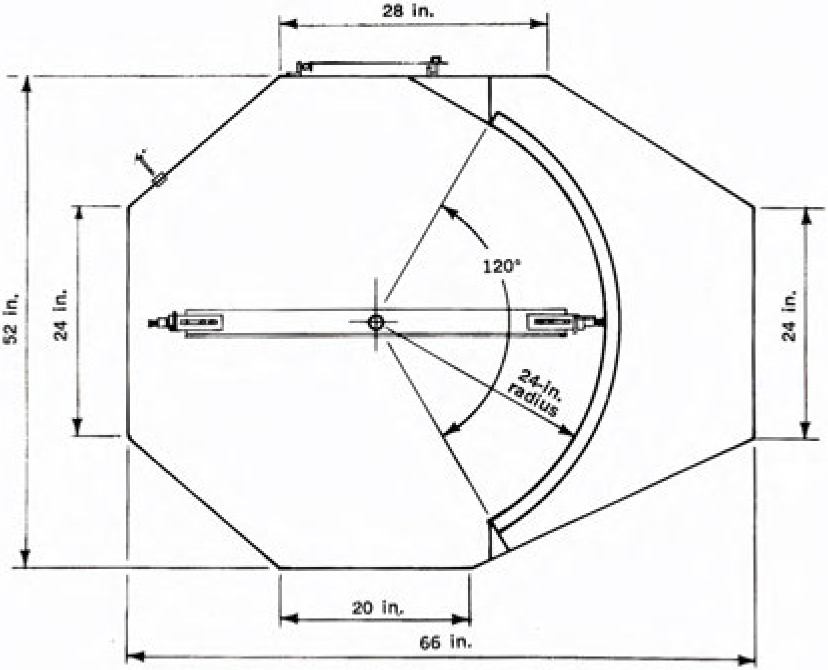

Figure 14 — Continental/Moss-Gordin, Inc., 40-inch-wide in-line filter.

The pressure differential across a 40- x 40-mesh screen in this housing with an airflow of 2,200 cfm is approximately zero, and with an airflow of 8,500 cfm, is 0.05 inch of water. With 105- x 105-mesh screen, the pressure differential is 0.02 for 2,200 cfm and 0.25 inch of water for 8,500 cfm. The vane-axial fans producing the airflows mentioned actually deliver 3,700 and 10,100 cfm, respectively. The difference between 3,700 and 2,200 cfm and between 10,100 and 8,500 cfm is the volume of air flowing out the bottom of the filter through the lint and dust discharge opening into the trash pickup line. The backpressures created by these two sizes of screen do not exceed the additional ½-inch water gage backpressure that propeller-axial-flow fans can withstand, or the ½- to ¾-inch water gage backpressure that vane-axial-flow fans can withstand.

The screen first tested in the filter installed at the Continental/Moss-Gordin Experimental Department was the 40 x 40 mesh. Machine-picked and machine-stripped cotton was ginned in the 16-inch-diameter, 79-saw brush gin, and the length of the cycles and the effectiveness of the filtering action obtained were observed and recorded. These data are presented graphically in Figures 15 and 16. The 105- x 105-mesh screen was then placed in the filter, and machine-stripped and machine-picked cotton was ginned. Figure 17 shows the results of the test with machine-picked cotton. No graph was made of the test with machine-stripped cotton because the fly collected so quickly on the screen that the wiper motor was energized almost continuously. These tests made us aware of some important points that are helpful in the selection of the size of the filter screen to be used.

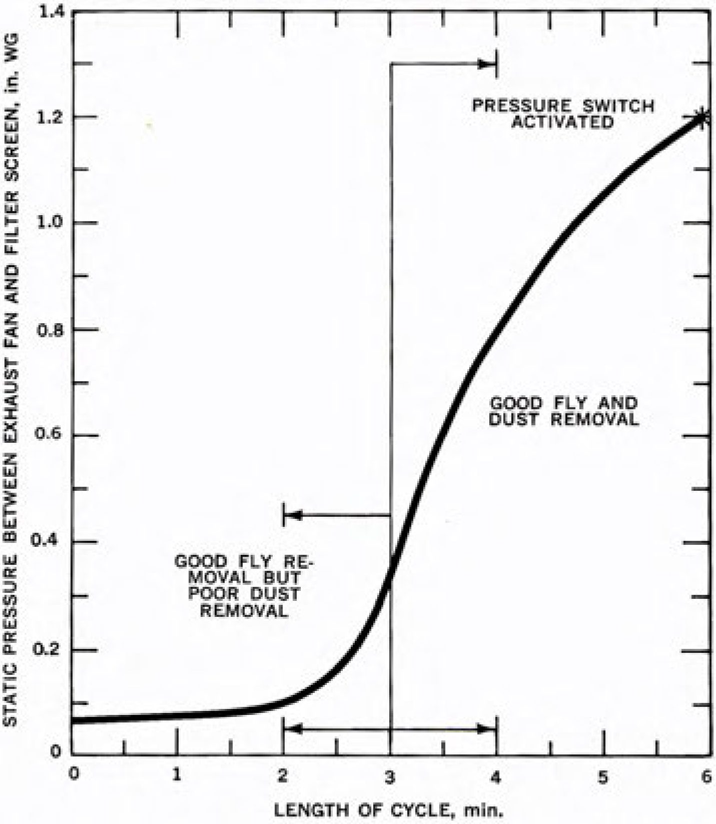

Figure 15 — Length of cycle and effectiveness of filtering action of 40- by 40-mesh, stainless steel, bolting-grade, wire cloth screen on machine-picked cotton.

Because the greatest amount of dust is discharged into the air during the wiping period, the time between wiping periods should be as long as possible. A great deal of dust, however, is discharged into the air immediately after the wiping motion stops and before a fine bat of fly is collected on the screen. The filter screen should, therefore, be sized so that the mesh is small enough to collect a fine bat of fly quickly on the screen, and at the same time, large enough to allow long collecting periods. Moreover, the greater the amount of lint fly in the discharge air, the larger the mesh of the filter screen can be and still collect the dust-filtering bat of fly in an acceptable length of time. The amount of lint fly in the discharge air should, therefore, determine the mesh of the filter screen. Since the method of harvesting the cotton being ginned determines the amount of lint fly in the discharge air, it was decided that the predominant method of harvesting the seed cotton in the area in which the filter was to be located would determine the mesh of the filter screen. Figures 15 and 16 and the USDA publication aided us in determining that 40- x 40-mesh screen should be used in filters to be located in areas where the predominant method of cotton harvesting is machine stripping. Figure 17 aided in selecting 105- x 105-mesh screen for filters to be located in areas where the predominant methods of cotton harvesting are machine picking and handpicking.

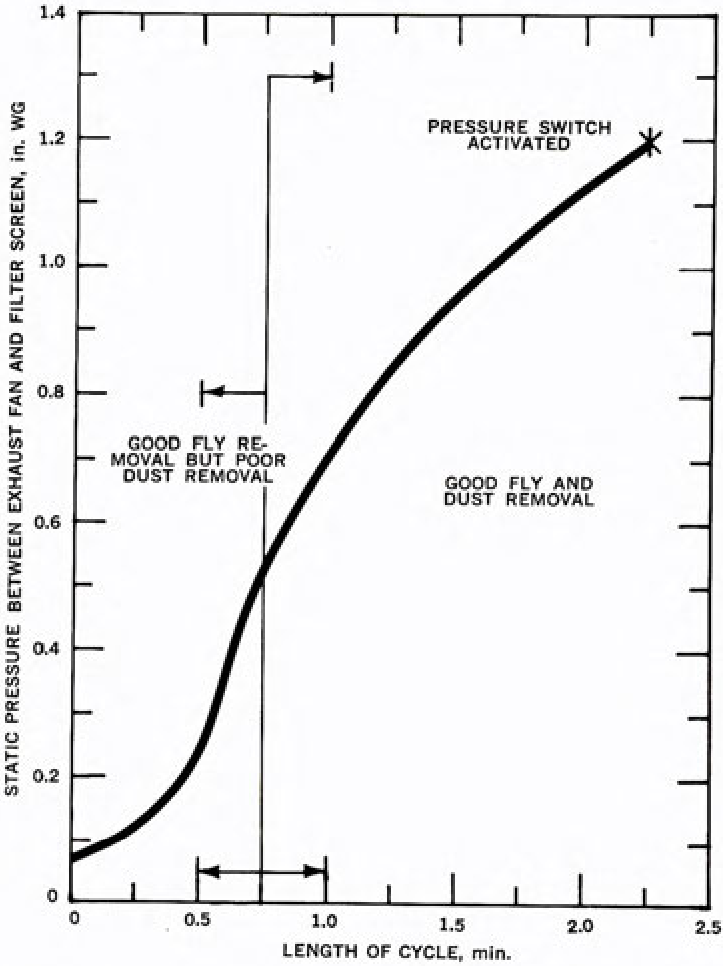

Figure 16 — Length of cycle and effectiveness of filtering action of 40- by 40-mesh, stainless steel, bolting-grade, wire cloth screen on machine-stripped cotton.

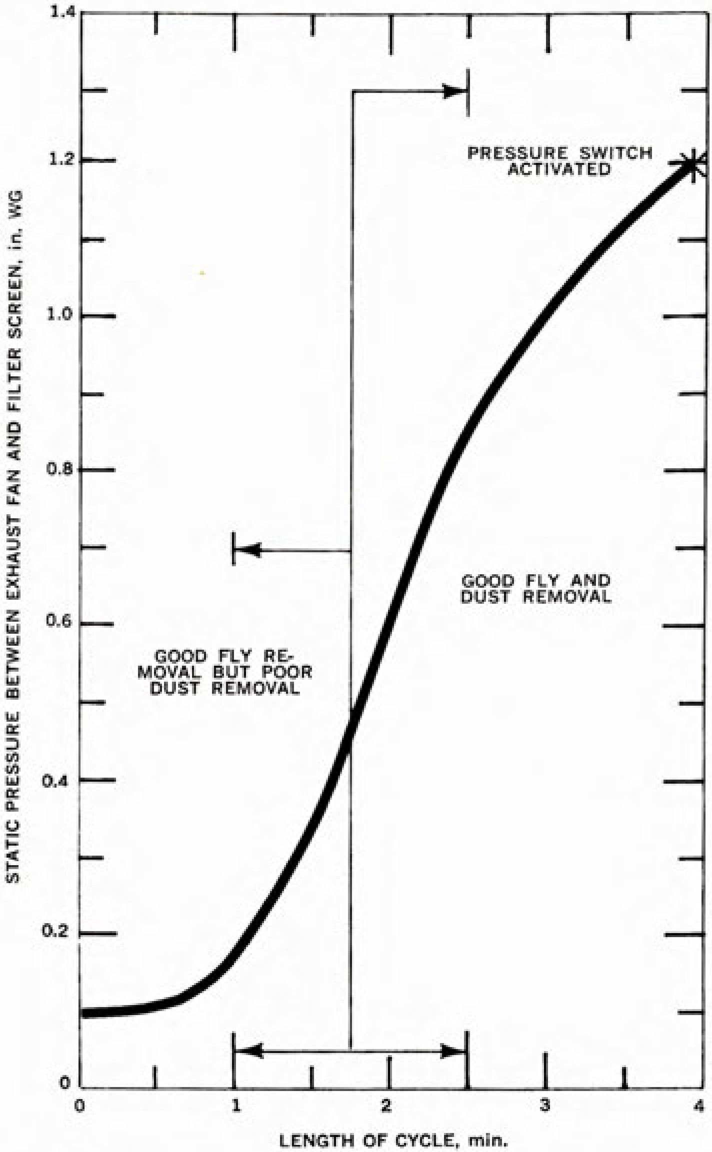

Figure 17 — Length of cycle and effectiveness of filtering action of 105- by 105-mesh, stainless steel, bolling-grade, wire cloth screen on machine-picked cotton.

The Honey Island Gin Company is located in the Mississippi Delta where the majority of the cotton crop is handpicked and machine picked; therefore, the filters located there have 105- x 105-mesh screens. Figure 18 shows the length of the cycles and the effectiveness of the lint and dust removal* observed at Honey Island. The results obtained from the Honey Island test upheld the conclusions reached at the Experimental Department, that is, the mesh of the filter screen should be determined by the predominant method of harvesting in the area in which the filter is to be located.

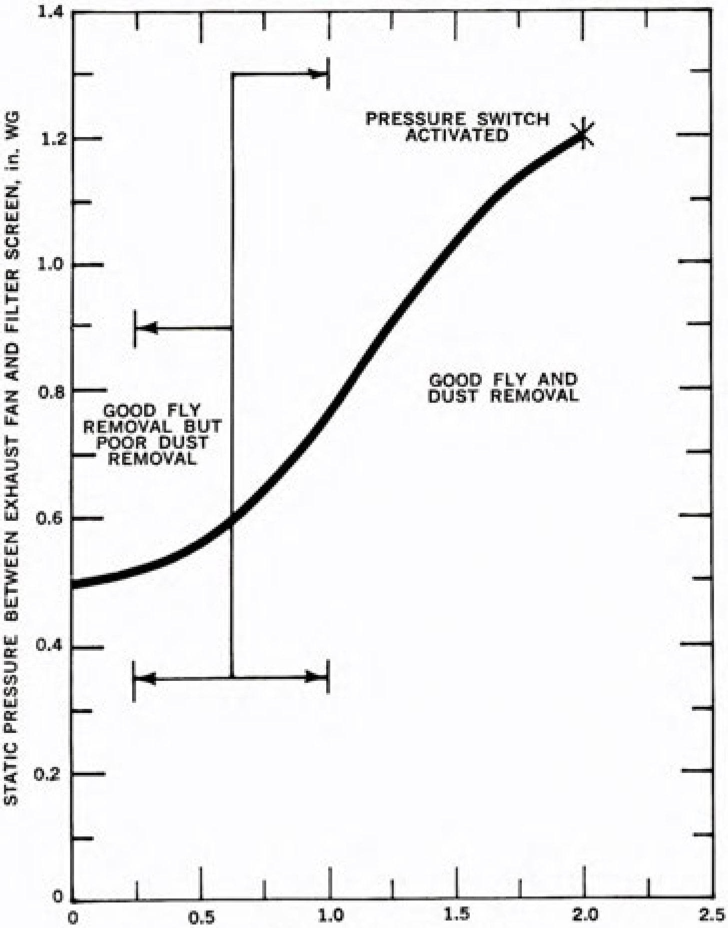

Figure 18 — Length of cycle and effectiveness of filter action of 105- by 105-mesh, stainless steel, bolting-grade, wire cloth screen on machine-picked and handpicked cotton at Honey Island Gin Co.

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*Effectiveness of lint and dust removal determined by visual observation.

OPERATION

To help simplify the pressure switch connections necessary for the filter to operate, the pressure rise between the condenser exhaust fan and the filter screen was used to activate a pressure-sensitive switch instead of the pressure differential across the screen. This method meant only one pressure tap connection in the filter housing instead of two. Continental/Moss-Gordin, Inc., uses two pressure-sensitive switches to move the gin breast out of ginning position when either of these switches registers a pressure rise in the gin flue or the lint flue caused by a choke in one of the lint cleaner condensers. For this reason the pressure switch connected to the filter has to be adjusted so that the screen is wiped clean before sufficient pressure is built up on one of the pressure switches in the flues to activate it and move the gin breast out.

The backpressure caused by the bat of lint fly and dust collected on the filter screen is relieved almost instantly when the wiping brush begins to wipe the screen. To ensure that the arms make several complete revolutions and that the screen is cleaned completely, the pressure switch activates a time delay relay instead of the wiping motor. The time delay relay is adjusted so that the wiping motor runs long enough to rotate the wiping arms three revolutions. Hence, even though the backpressure is relieved before one revolution is completed, the timer holds the motor in the circuit long enough to rotate the arms three revolutions and ensure that the screen is wiped completely clean. (Figure 19 shows the wiring diagram used to achieve this operation.)

The amount of clearance between the wiping brushes and the filter screen is essential for efficient filtering action and long filter screen wear. If the brushes are set too close to the screen, it is wiped clean each cycle, but the screen will be worn through before the end of one ginning season. By setting the brushes too far away from the screen, a very thin layer of fly is left on the screen after each wiping cycle. The fly eventually becomes saturated with dust and almost completely stops the flow of air through the screen. The pressure switch is activated by the ensuing rise in pressure and energizes the wiping motor circuit. Since, however, the brushes are not set close enough to the filter screen to clean off the bat of dirt-saturated fly, the pressure is not relieved, and the wiping motor circuit is continuously energized. Moreover, the condenser exhaust air is diverted into the 10-inch-diameter dust and fly pickup line. The resulting rise in pressure caused by this additional volume of air is great enough to cause a backlash at the gin stand. This would not happen, however, to a Continental/Moss-Gordin system. The pressure switches in the gin and lint flue would cause the gin breast to be moved out of ginning position before the pressure could become great enough to cause a backlash. The wiping brushes must, therefore, be set close enough to the screen to wipe it completely clean at the end of each cycle, but not so close as to cause any unnecessary wearing of the screen. Because this setting is so important, it should be done in the field after the complete erection of the filter and checked at regular intervals to compensate for brush wear.

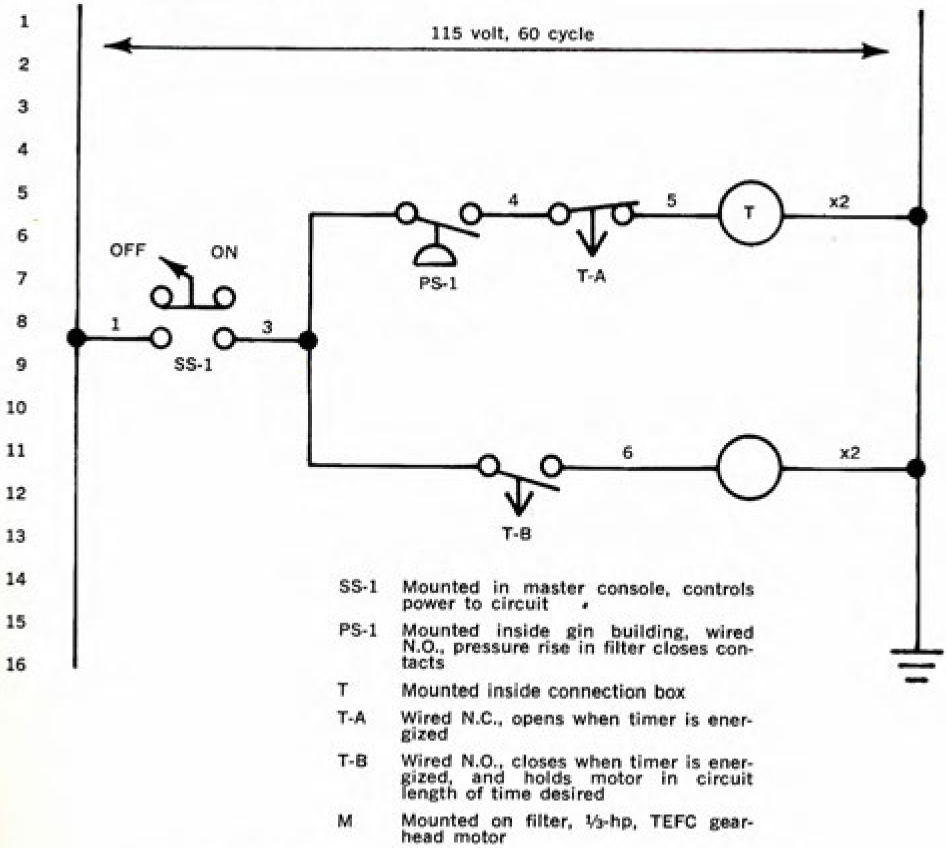

Figure 19 — Wiring diagram, Continental/Moss-Gordin, Inc., in-line filter.

MAINTENANCE AND OPERATING COSTS

Since the gin owner does not realize an actual cash return from the in-line filter, minimum maintenance, low operating cost, and quick repair or replacement are even more important than for most gin machinery. For this reason the design of the Continental/Moss-Gordin filter is functional, simple, and uncomplicated. The only items that require any attention are the wiping motor, the drive chain, the filter screen, and the wiping brushes.

The wiping motor is a ⅓-hp gear motor, and the grease level in the gearhead should be checked several times during the ginning season to maintain it at the proper level. Because the motor is totally enclosed fan cooled, it should require very little additional attention.

If the filter is located outdoors, the drive chain should be kept well lubricated during the ginning season and well protected from the elements during the remainder of the year. These simple steps will ensure long and trouble-free life for the motor and drive chain.

As pointed out before, the clearance between the filter screen and the wiping brushes is very important and should be checked several times during the ginning season. Because the wiping brushes are made for much more severe service than they are subjected to in the filter, they should last several seasons before they need to be replaced. The only attention that the filter screen requires is replacement when holes begin to wear in it. Because the life of the screen depends upon several variables, and because the Continental/Moss-Gordin filters have been in the field only two seasons, it is difficult to say how often the screens will have to be replaced.

The cost of this maintenance per season is almost impossible to calculate owing to the short time the units have been in the field, though the cost of the items most likely to be replaced at one time or another are available. The wiping brushes cost $3.86 per filter. The 105- x 105-mesh screen costs $69.40 per filter, and the 40- x 40-mesh screen costs $24.50 per filter.

Because very few man-hours are needed to operate the filters, only the electrical power requirements of the filters have been calculated in arriving at an operating cost. On the assumption that a single filter cycles every 2 minutes and that the motor is energized 7.6 seconds each cycle, the motor will be energized a total of 45.6 minutes per 12-hour day. With a power cost of 3.3 cents per kilowatt-hour, and a ginning rate of 6 bales per hour, the electrical power cost for one filter located in the Mississippi Delta would be 0.0165 cent per bale. In a gin that gins 3,000 bales per season, the total electrical cost for the filters would be 0.495 cent. This example points out the almost negligible operating cost of the filter.

The Continental/Moss-Gordin in-line filter was designed so that the filter screen could be replaced quickly and easily if worn through during the ginning season. If the wiping brush drive needs repair or replacement during ginning operation, a large door is provided in the housing that may be opened to allow passage of the exhaust air until the drive can be put back into operating condition.

CONCLUSION

Since the gin owner does not realize an actual cash return on his investment in the in-line filter, Continental/Moss-Gordin has attempted to design and build a low-cost, highly efficient, trouble-free filter. Only one size of housing is built to aid in mass production, but two different mesh screens are used, depending upon the predominant harvesting method in the area, to make the unit more versatile. Operation of the filter is simple, a minimum amount of maintenance is required, operating costs are almost negligible, and on-the-job repair or replacement is quick and easy. At Continental/Moss-Gordin we feel that, with the aid of the research and design work done by the USDA on the in-line filter, we have made available to the gin owner another method of controlling air pollution effectively and economically.

REFERENCE

[1]Alberson, D. M., and Baker, R. V., *An In-Line Air Filter for Collecting Cotton Gin Condenser Air Pollutants,* USDA, ARS 42-103 (Sept.) 1964.

Summary of Open Discussion

The speaker first explained that the in-line filter installation mentioned in his talk was not experimental but represented one of several installations that Continental/Moss-Gordin, Inc., has incorporated into practical dust control systems. The costs of the in-line filter with totally enclosed fan-cooled gear motors is $890.00. With a complete set of supports at $160 each, the total equipment cost is $1,050.00.

CONSIDERATIONS FOR DETERMINING ACCEPTABLE AMBIENT AND SOURCE CONCENTRATIONS FOR PARTICULATES FROM COTTON GINS

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and
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National Center for Air Pollution Control
Public Heallth Service
U. S. Department of Health, Education, and Welfare

At the planning session for this symposium, participants from state and local air pollution control agencies and the Department of Agriculture were asked to provide information on (1) ambient air quality and emission standards or objectives that have been adopted in other areas and may have application to cotton-ginning operations, (2) the bases upon which these standards were established, and (3) exit loadings of trash and lint from ginning operations that would be considered satisfactory for precluding nuisance complaints. The information was, of course, limited to particulates since these are responsible for most of the air pollution problems associated with the operation of cotton gins.

AIR QUALITY STANDARDS OR OBJECTIVES

We should first point out that air quality standards or objectives for suspended particulates have been established for entire geographic areas such as states and counties but that they do not generally refer to specific sources of emission such as a cotton gin or any other industrial operation. Normally, the task of those setting emission standards is to consider single emission sources in such a way that a desired air quality goal can be achieved for the entire region. Even though particulates from cotton-ginning operations are related to air quality goals in only their broadest aspects, a brief review of typical air quality standards for suspended particulates is worthwhile. Similar air quality objectives are likely to be established in some of the cotton-growing regions, and control of emissions from cotton gins will probably play an important role in ensuring that the air quality goals of the region are met.

Typical definitions of air quality standards or objectives are those of the States of New York and Colorado. The New York State Air Pollution Control Board(*1*) sets as its ambient air quality objective the level of air quality that will protect people from the adverse effects of air pollution and promote "maximum comfort and enjoyment and use of property consistent with the economic and social well being of the country." The Colorado Air Pollution Control Act(*2*) states:

"Standards of ambient air quality define the limits of air contamination by particulates and gases, above which limits, the ambient air is hereby declared to be unacceptable and to require air pollution control measures." These standards do not represent pollution concentrations at which there is a sharp demarcation between effect and no effect, rather, the standards afford suitable assurance that no adverse effects will occur.

Typical ambient air quality standards or objectives for particulates in several state or metropolitan areas are shown in Table 12. The California standards for gases and particulate matter include three concentrations: Adverse, serious, and emergency. For particulate matter, only the adverse concentration is applicable. This is the concentration at which there will be sensory irritation, damage to vegetation, or reduction in visibility. The standard for particulate matter is the concentration that is sufficient to reduce visibility to less than 3 miles when relative humidity is less than 70 percent. For suspended particulates, the standard is a measurement of a physical effect, that is, reduced visibility(*3*).

The Oregon State Sanitary Authority has set air quality standards for both suspended and settleable particulate matter and for a chemical substance, lime dust. In residential and commercial land use areas, the suspended particulate matter concentration is not to exceed the normal background value by more than 150 micrograms per cubic meter of air; the settleable particulate matter is not to exceed the normal background value by more than 15 tons per square mile per month. In heavy industrial land use areas, the suspended particulate matter concentration is not to exceed the normal background value by more than 250 micrograms per cubic meter of air; the settleable particulate is not to exceed the normal background value by more than 30 tons per square mile per month. For lime dust in particular, maximum concentrations are not to exceed the normal background values by more than 20 micrograms per cubic meter for suspended particulates and by 1 ton per square mile per month for settleable particulates(*4*).

The ambient air quality standards for Oregon are based upon measurements made in various localities and particularly around cement plants for suspended and settleable lime dust. These measurements were correlated with the frequency of public complaints, and the values chosen are those at which no significant dust nuisance problem would be expected(*5*).

In the air resource management study in the greater St. Louis area, ambient air concentrations of suspended particulates that have been selected as goals to be achieved in the interstate area are (1) not to exceed an annual geometric mean of 75 micrograms of suspended particulates per cubic meter of air and (2) not to exceed 200 micrograms of suspended particulates per cubic meter of air during more than one 24-hour period in any 3-month period(*6*). In setting these goals, consideration was given to the effects of suspended particulate matter in regard to visibility, soiling, corrosion, vegetation damage, and health. In addition, consideration was given to the relationship between measured particulate concentrations in ambient air and views expressed by citizens throughout the metropolitan area about air quality, as determined in a public opinion survey. The goals selected were those at which 90 percent of the people believed that the concentrations of suspended particulates and settleable dust were satisfactory and did not constitute an air pollution problem. Although not shown in Table 12, a comparable air quality goal, that 200 micrograms of suspended particulates per cubic meter of air not be exceeded more than 1 day during any 3-month period, has been recommended for the greater Nashville, Tennessee, area(7).

Up to this point, we have discussed air quality standards or objectives for particulates without regard to specific toxic possibilities. Emissions from cotton gins could contain various pesticides and defoliants such as arsenic compounds, chlorinated hydrocarbons, or organophosphorus compounds. Threshold limit values for occupational exposures are listed for many of these compounds, but these thresh-

TABLE 12 — SELECTED AMBIENT AIR QUALITY STANDARDS OR OBJECTIVES FOR PARTICULATES

State or area	Particulate category	Unit of measurement	Standard or goal	
California[a]	Suspended particulates	Visibility in miles	Sufficient to reduce visibility to less than 3 miles when the relative humidity is less than 70 percent.	
Oregon[b]	Nonspecific particulates			
	Suspended	$\mu g/m^3$	150[c]	250[c]
	Settleable	tons/mi^2/month	15[c]	30[c]
	Lime dust			
	Suspended	$\mu g/m^3$	20[c]	—
	Settleable	tons/mi^2/month	1[c]	—
Metropolitan St. Louis	Suspended particulates	$\mu g/m^3$	75 annual geometric mean 200[d] annual 99th percentile	

[a]Reference 3.

[b]Reference 4.

[c]Above normal background value.

[d]The suspended particulate concentration must be less than 200 $\mu g/m^3$ for 99 percent of the days in any 3-month period.

old values are based upon exposure of healthy workers 8 hours a day, 5 days a week, whereas ambient air quality standards must be based upon exposure of the entire population, including the very young, the very old, the sick, and the infirm, 24 hours a day, 7 days a week. Unfortunately, there are no published air quality standards for these compounds in the United States. The only published air quality standards for certain toxic particulates are those of the Soviet Union.

The Soviet air quality standard for arsenic compounds is 0.003 milligram per cubic meter of air (24-hour-average value) (*8*). This is considerably lower than the threshold limit value of 0.5 milligram per cubic meter of air set by the American Conference of Governmental Hygienists for the working environment. The industrial hygiene value is based upon industrial exposure of workers in a copper smelter. The bases for Soviet air quality standards according to Stern(*9*) are clinical and epidemiological experience and experimental studies on humans and animals. The Soviet scientists believe that air quality standards should be set at concentrations below those at which the most sensitive test shows any human response whatsoever, regardless of whether the response is known to be detrimental or not.

Stern also mentions that 24-hour-average air quality standards based upon consideration of harm to humans are often between one-tenth and one-hundredth the occupational health threshold limit value. Thus, a first approximation of the 24-hour-average air quality standard for a substance for which no air quality standard has been set is one-thirtieth the threshold limit value, unless evidence of specific effects on people or property indicates the need for a different standard.

EMISSION STANDARDS

An emission standard is a limit on the amount of pollutant that may be emitted from a source and is intended to bring the ambient air within acceptable air quality standards.

The first emission standards were adopted in the late 1880's to prevent local nuisance from fly ash, smoke, and odors. Regulations covering other pollutants were not adopted until 1947, in Los Angeles County. Because of the severity of the air pollution problem there, the various regulations on gaseous and particulate emissions were approached from the aspect of technical feasibility. Thus, the concentrations of gaseous or particulate pollutants that would be discharged from the most efficient commercially available control equipment were generally selected as emission standards. Even in Los Angeles, however, medium-efficiency collection equipment, for example, that with 80 to 90 percent collection efficiency, was allowed for small operations(*10*).

The most recent basis for setting emission standards for urban areas is the total air resource management concept(*11*). In essence, this involves measuring gaseous and particulate pollutants in the air and making an emission inventory to determine the sources of the various pollutants. With this information the percent by which specific gaseous and particulate pollutants must be reduced to achieve a desired air quality goal can be calculated. The percent reduction needed for a specific pollutant would be the basis for the emission standard for that pollutant. Cost and technical feasibility must be considered in arriving at the most advantageous reduction to apply to each class of pollutant source.

This concept could be applied to cotton gins located in urban areas. An emission limitation for particulates from cotton gins would, however, vary for different communities, depending upon the amount of suspended particulates emitted by cotton gins compared with those emitted by other sources. An emission limitation that would reduce suspended particulates would be expected to reduce also the nuisance problem from settleable dust because these large particles should be collected efficiently in the process that collects suspended particulates, that is, particulates less than 20 to 40 microns in size.

The categories of pollutants that are limited by emission standards are shown in Table 13. The first category is total particulate matter. This category normally includes particles larger than 30 to 40 microns as well as smaller particles. The larger particles usually settle out near the source of emission, and though comparatively few in number, they account for most of the particulate weight. Gravimetric emission standards are normally expressed as a weight of particulates per volume or weight of stack gas. Commonly employed units include grains per standard cubic foot (scf) or pounds per 1,000 pounds of dry flue gas corrected to 50 percent excess air. One grain per scf is equal to approximately 1.9 pounds per 1,000 pounds of air. The second category includes fine particulates, such as smoke, soot, tars, and dust, that are usually less than 30 microns in size. Most fine particulate matter remains suspended for a long time. The particles with the greatest light-scattering properties are those ranging in size from 0.3 to 0.7 micron. The visual emission standard is based upon the percent of light transmitted through the exit plume and is expressed as either a Ringelmann number or an equivalent opacity. For the last category, bases or vapors, a volumetric emission standard is normally used because the bases or vapors have comparatively little weight and are usually invisible. The volumetric emission standard is usually expressed as a volume of gaseous pollutant per volume of stack gas, that is, parts per million (ppm).

PARTICULATE EMISSION ORDINANCES FOR INDUSTRIAL PROCESSES

At present no emission ordinances or standards apply specifically to cotton-ginning operations. Examples of particulate emission standards that have been adopted by various air pollution control agencies to control particulates from industrial processes other than cotton ginning are shown in Table 14. Two different approaches are shown for limiting process particulate emissions: (1) The weight of particulates per weight of stack gas, that is, pounds of particulates per 1,000 pounds of stack gas, and (2) allowable emissions based upon process weight. For Pittsburgh and Detroit, the operating emission limitation of 0.2 to 0.4 pound per 1,000 pounds of stack gas is less stringent than the design limitation of 0.1 pound per 1,000 pounds of stack gas. This recognizes that field operating conditions do not always meet design conditions and that this could cause a temporary degradation in overall equipment performance.

TABLE 13 — CATEGORIES OF POLLUTANTS LIMITED BY EMISSION STANDARDS

Pollutant category	Type of emission standards	Typical units
Total particulate matter	Gravimetric	lb particulate/1,000 lb flue gas[a] or grains/scf[b]
Fine particulate matter	Visual appearance	Ringelmann number[c] % equivalent opacity[d]
Gases or vapors	Volumetric	ppm by volume[e]

[a]For combustion processes, the grain loading is usually corrected to 50 percent excess air.

[b]Standard conditions are usually 60°F and 14.7 pounds per square inch absolute.

[c]The Ringelmann Chart grades black or grey smoke into five shade categories, giving a Ringelmann No. 0 to a clean stack, and a No. 5 to a completely opaque plume.

[d]Equivalent opacity—of such opacity as to obscure the observers' view to the same degree as a smoke plume of the same Ringelmann number.

[e]Volumes of pollutant per million volumes of gas.

The regulation of allowable emissions based upon process weight was started in Los Angeles in 1949(*12*). The approach has since been used by several other cities(*13*). Allowable emissions are given in pounds per hour and range from about 0.5 per hour for a process weight of 100 pounds per hour to 40 pounds per hour for a process weight of 60,000 pounds per hour. In terms of particulate collection efficiencies, the Los Angeles County regulation requires from 85 percent for small sources to over 99 percent for large industrial processes. Grain loadings in stack gas from large plants must be less than 0.05 grain per scf, whereas dust loadings as great as 0.1 to 0.2 grain per scf of stack gas from small plants may be permitted if they do not violate the visible emission limitation of a No. 2 Ringlemann number or the equivalent opacity. In deriving the process weight emission limits, the Los Angeles County Air Pollution Control District conducted a number of stack emission tests at plants processing steel, grey iron, and nonferrous metal to determine the capabilities of particulate control systems.

TABLE 14 — PARTICULATE EMISSION ORDINANCES FOR INDUSTRIAL PROCESSES(*13*)

Air pollution control agency	Particulate emission limits
Allegheny County, Pennsylvania (Includes City of Pittsburgh)	0.5 lb/1,000 lb flue gas; for blast furnaces 0.2 lb/1,000 lb flue gas; for basic oxygen furnaces
Detroit, Michigan	0.10 lb/1,000 lb flue gas; for design[a] 0.2 to 0.4 lb/1,000 lb flue gas; for operation[b]
Los Angeles County, Dade County (Miami), New York City, San Francisco Bay Area, and Beloit, Wis.	Allowable emission rates vary with the process weight

[a]Design emission standards for ferrous cupolas and steel furnaces.

[b]Operating emission standards for ferrous cupolas and steel furnaces.

The New York State Air Pollution Control Board recommends air contaminant emission guides based upon potential emission rates from uncontrolled sources(*14*). The guides include recommended collection efficiencies for various classes of particulate and gaseous pollutants based upon toxicity. For Class A, the most toxic class, which includes beryllium and nickel carbonyl, collection efficiencies of at least 99 percent are required. For Class B, which includes particulates containing materials such as arsenic and lead, 95 to 98 percent removal is required for potential emission rates up to 20 pounds per hour, and 98 percent, for rates above 20 pounds per hour. Class C requires a 90 to 95 percent collection efficiency for potential emission rates of 20 to 4,000 pounds per hour for compounds such as phosphoric and sulfuric acid. For relatively nontoxic materials (Classes D, E, and F) collection efficiencies of 80 to 95 percent are recommended for potential emission rates ranging from 20 to 4,000 pounds per hour.

The recommended collection efficiencies in the New York State Air Contaminant Guides for controlling specific source emissions are based mainly upon technical and economic feasibility. Although no correlation was made between emission concentrations and ambient ground level concentrations for specific pollutants, consideration was given to the size of the source and the relative potential effect of the air contaminant on humans, animals, vegetation, and property. Thus, the larger the source and the greater the relative effect of the contaminant, the more stringent the guide(*15*).

The New Jersey Air Pollution Control Commission has established emission standards for the control of both coarse and fine particulates(*16*). In setting the standards, the Commission considered both stack height and distance from the stack to the nearest property line. Thus, higher emission rates are allowed for higher stacks and for greater distances from the stack to the nearest plant property line. Allowable emission rates for coarse particulates (larger than 44 microns) range from 0.5 pound per hour for a stack 20 feet high and 20 feet from the nearest property line to 1,000 pounds per hour for a stack 500 feet high and 7,500 feet from the nearest property line. For fine particulates, allowable emission rates, from comparable stack heights and distances to property lines, range from 1.8 to 1,125 pounds per hour.

The New Jersey regulation is designed to control emissions of coarse particulates so that no one stack will contribute more than 200 tons per square mile per year to the total dustfall off the premises of the emitter. This standard is based upon measured dustfall amounts in New Jersey and other places believed to be acceptably clean.

In establishing the relationship between the concentration of fine particulates (suspended) in the air and the allowable emission rate from the stack, the New Jersey Commission used the diffusion formula of Bosanquet. The maximum allowable concentration for suspended particulates is 615 micrograms per cubic meter of air. The long-time concentration at a point 10 stack heights downwind from the source is estimated to be 25 micrograms per cubic meter of air.

CONSIDERATIONS FOR PARTICULATE EMISSION LIMITATIONS FOR COTTON GINS

As a first step in considering emission limitations for cotton gins that would be effective in precluding nuisance complaints and undesirable health effects, we should look at existing emission and air quality data for particulates from cotton gins. In the progress report of an air pollution study of cotton gins in Texas(*17*), as reported by Mr. Otto Paganini earlier in the symposium, concentrations of suspended particulates (see Table 15) were noted at various distances downwind from operating gins. The concentrations of suspended particulates at distances of 150 to 300 feet from the gins were extremely large, the largest being at a distance of 300 feet. The much smaller concentrations of suspended particulates at distances beyond 1,200 feet would indicate that a good portion of the particulates measured within 300 feet of the gin are settleable and are larger than 40 microns in size. The concentrations of suspended particulates within 2,000 feet of the gins would not meet the air quality standards for Colorado or those for the metropolitan areas of St. Louis or Nashville. The degree of control of emissions of trash and lint from the gins tested was not detailed in the report; however, from the large particulate concentrations reported within 300 feet, it would appear that most of the gins operated with very low-efficiency emission control systems.

TABLE 15 — SUSPENDED PARTICULATE AND ARSENIC CONCENTRATIONS IN THE AIR NEAR COTTON GINS IN WEST TEXAS(*17*)

Distance from gin, ft	Range of suspended particulate concentrations,[a] $\mu g/m^3$	Range of arsenic concentrations,[b] $\mu g/m^3$
150 to 300	5,000 to 76,000	0.6 to 141
1,200 to 1,400	385 to 187	0.07 to 0.08
2,200 to 8,000	217 to 42	0.10 to 0.01

[a]Sampling times ranged from 1 to 8 hours.

[b]Analyzed by the pyridine-silver diethyldithiocarbamate method.

The concentrations of arsenic in the particulates were also correspondingly large within 300 feet of several gins. An arsenic loading of 141 micrograms per cubic meter is appreciably greater than the Russian air quality standard for arsenic, that is, 3 micrograms per cubic meter. The arsenic concentrations beyond 1,000 feet were, however, considerably less than the Russian standard. For healthy workers exposed 8 hours a day, 5 days a week in the immediate area, the maximum allowable concentration for arsenic compounds recommended by the American Conference of Governmental Industrial Hygienists is 500 micrograms per cubic meter, which is considerably greater than the measured concentrations.

As in the case of ambient air measurements, very little published data are available on particulate emissions from cotton gins. In the Public Health Service report entitled, *Airborne Particulate Emissions From Cotton-Ginning Operations*(*18*), particulate grain loadings were measured at each point of emission from the experimental cotton gin at the Agricultural Research Service Cotton-Ginning Laboratory at Stoneville, Mississippi. Particulates were collected in a 2-stage sampling train by isokinetic sampling procedures. The first stage consisted of a settling chamber that removed particles larger than 100 microns. In the second stage, the remainder of the particulates (those smaller than 100 microns) were collected on a fiberglass filter. Total particulate emissions from the unloading fan, the six-cylinder cleaner, and the stick and bur machine ranged from 0.12 to 0.55 grain per scf (Table 16). These loadings are relatively large, and particulate fallout would be expected to cause a nuisance. The particulate grain loadings from the six-cylinder cleaner and the stick and bur machine for particles less than 100 microns in size were relatively small; they ranged from 0.3 to 0.04 grain per scf. These loadings of fine particulate matter are within the emission limitations set by air pollution control agencies. Emission limitations could, therefore, be achieved by removing the particles larger than 100 microns in high-efficiency cyclone collectors. Where cyclone collectors were used on the seven-cylinder cleaner, the exit grain loading from the 84-inch-diameter standard cyclone was 0.01 grain per scf, and the loading from the 34-inch-diameter high-efficiency cyclone was only 0.005 grain per scf. These are very small grain loadings for particulate emissions from any type of source, that is, they are the exit particulate concentrations one would expect from a high-efficiency (99 percent) electrostatic precipitator or a fabric filter baghouse serving a Portland cement plant, a grey iron cupola, or a grain-processing plant. Dust fallout nuisance would not be expected from these small particulate emissions. Likewise, if emissions of trash and lint from operating commercial cotton gins equipped with centrifugal collectors were at the same small concentrations, one would not ordinarily expect a significant air pollution problem. Particulate emissions from many operating cotton gins, both with and without mechanical collectors are said, however, to cause lint and trash fallout problems. Apparently, therefore, the definition of emission and ambient air concentrations of suspended and settleable particulates from both cotton gins and trash incinerators should be more detailed.

TABLE 16 — PARTICULATE EMISSIONS FROM STONEVILLE COTTON GIN(*18*)

Sampling point	Settling chamber, gr/scf	Sampling filter, gr/scf	Total gr/scf
Unloading fan	—	0.36	0.36
Six-cylinder cleaner	0.08	0.04	0.12
Stick and bur machine	0.52	0.03	0.55
Seven-cylinder cleaner	[a]	0.01	0.01
	[b]	0.005	0.005
Condenser	—	0.02	0.02

[a]Standard cyclone—84-inch diameter.

[b]High-efficiency cyclone—34-inch diameter.

RECOMMENDED FIELD TESTING PROGRAM

A field testing program that would provide this information should include several elements. The various types of commercially available emission control systems for cotton trash and lint should be tested on operating cotton gins in different sections of the country and on experimental gins at Agricultural Research Service Laboratories. The system should be tested at varying loads while processing cotton harvested by hand or by machine picking, stripping, or scraping. Particulate samples should be collected simultaneously before and after trash and lint collectors to determine efficiencies of and exit grain loadings from the latter collectors. A sample train for collecting the trash or lint samples would include: (1) A settling chamber for collecting settleable particulates, that is, particles larger than 40 microns; (2) a high-efficiency cyclone for collecting particles 3 to 40 microns in size, and (3) a fiberglass filter for collecting the remaining fine particulates below 3 microns in size. Collection of particulates smaller than 3 microns would include the portion that could reach the lower section of the respiratory tract.

The basic design parameters or operating procedures, or both, for various types of trash and lint emission control systems should also be investigated to determine their effect on particulate emissions.

Concentrations of particulates in the ambient air should be determined at various distances downwind from cotton gins and from trash incinerators. The measured particulate levels would provide useful information for determining the distances from controlled and uncontrolled cotton gins and trash incinerators beyond which dust and fly ash fallout would not be expected to be a problem. For relatively isolated gins in rural areas, the same degree of control for dust and lint may not be needed as would be the case for gins located in or near urban areas. This approach has been used for isolated portable, asphalt batch plants in Florida. For rural plants with a buffer zone of 1 mile's radius or more between the plant and any population, lower efficiency dust control equipment is required than for plants located in populated areas(*19*).

Particulate samples should also be analyzed for pesticides and defoliants known to be used in the area. If the concentrations found are believed to be significant from the standpoint of effects on health, epidemiological studies should be initiated in that area.

Since the control of emissions from cotton-ginning operations is more of an economic problem than one of technical feasibility, information should also be secured on the installation and operation cost of efficient particulate control systems for use on both large and small cotton gins.

This type of information on performance and costs of particulate control systems and measurements of source and ambient air concentrations of particulates, pesticides, and defoliants would then provide the baseline data needed for setting effective source emission or ambient air standards for cotton-ginning operations.

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Summary of Open Discussion

In regard to the 1-mile radius buffer zone for portable asphalt plants in Florida, no population would be allowed within this area. A cyclone collector is still required for portable asphalt plants within the buffer zone, whereas in or near an urban area, both a cyclone collector and a water scrubber are required.

RECOMMENDATIONS FOR NEEDED RESEARCH AND DEVELOPMENT

Ralph C. Graber
National Center for Air Pollution Control
Public Health Service
U. S. Department of Health, Education, and Welfare

Before I outline the areas of needed research in the control and disposal of cotton-ginning wastes, I think it is important to identify the broad objectives to which our efforts should be directed. These objectives are: (1) To develop efficient, less costly systems and techniques for the control and disposal of cotton-ginning wastes; (2) to provide reliable information on emission sources and ambient air concentrations of emissions from cotton gins and trash incineration; and (3) to provide more specific information on possible effects of atmospheric emissions from cotton-ginning operations on health.

As previous speakers have reported, the primary emissions of air pollutants are trash, dust, and lint from cotton gins, and fly ash and smoke from incineration of cotton trash. A field testing program should, therefore, be undertaken to determine the concentrations and amounts of suspended and settleable particulate from both cotton ginning and trash incineration. Information on particle size distribution is needed for estimating the fraction of dust that settles near the gin or remains suspended, and, more importantly, the portion of particulate smaller than 3 to 5 microns that could reach the lower section of the human respiratory tract. Source sampling for concentrations of particulate before and after dust and lint control systems would provide needed information on collection efficiencies and exit grain loadings for particulates. Basic control equipment, such as the in-line filter and high- and low-efficiency cyclones, and secondary collection devices such as the wet cyclone and the wiped wire screen mentioned by previous speakers should be tested further. Although some of this information could be obtained from studies conducted in the Agricultural Research Service laboratories, much of the field testing should be conducted at operating commercial gins in various sections of the country.

As an extension of the work conducted by the Texas State Department of Health, ambient air concentrations for suspended and settleable particulate should be determined at various distances downwind from cotton gins and from trash incineration. This information would be of interest in determining the distances from a controlled or uncontrolled cotton gin that dust nuisance problems would not be expected to occur. Particulate samples collected from both ambient air and source sampling at or near cotton gins should also be analyzed for concentrations of pesticides, defoliants, and desiccants that are known to be used in the immediate area—to determine whether the concentrations of these toxic substances are significant from the standpoint of effects on health.

Another area of needed research is the disposal of cotton trash. There is no general agreement that incineration is a satisfactory method of trash disposal from an air pollution standpoint. It is hoped, therefore, that composting studies, such as those conducted by Mr. O'Neal, will be continued and new techniques developed.

Since the degree of source control should be related to the environmental effects of these particulates, epidemiological studies should be conducted in the immediate vicinity of cotton gins. Additional and more specific information is needed on the effects of cotton-ginning dust on health when the dust contains pesticides, defoliants, bacteria, and other microorganisms that may contribute to irritation and disease in the human respiratory system.

Another area of recommended research relates to a more or less preventive approach to air pollution control. I refer to a need for additional development work on picking machines that would harvest cleaner cotton and thereby reduce the equipment needed.

The last area of recommended research, which is as important as any, is the development of low-cost, effective dust and lint collection and disposal systems. The Department of Agriculture's research laboratories have done a fine job in developing relatively low-cost lint collection equipment. Because of the economics of this seasonal industry, however, there is a need, particularly for smaller gins, for dust and lint control concepts and innovations that are less costly to install, operate, and maintain. It is hoped that the Agricultural Research Service laboratories will continue work along this line of research. It is assumed, too, that the manufacturers of control equipment will step up their efforts to develop the needed hardware.

In summary, I suggest that these areas of research and further investigation be conducted by the Public Health Service, the Department of Agriculture, universities, and interested health agencies and cotton-ginning associations. In order to accomplish the outlined research most effectively, cooperation and participation by these several organizations will be needed.

PANEL DISCUSSION

V. L. Stedronsky
Andrew O'Neal
Otto Paganini
Edward H. Bush
Stanley T. Cuffe

Mr. Taylor: Can ambient air quality standards be the basis for effective enforcement?

Mr. Cuffe: Ambient air quality standards have been established and are used for a county, city, or even a state. Trying to enforce these standards or goals for one particular source would be difficult if the source were located in an urban area. Applying an emission limitation, such as a maximum pounds per hour of allowable particulate emission, or visual limitations such as the Ringelmann number or equivalent opacity, is preferable for enforcement purposes.

Mr. Herzik: I think that somewhat similar problems exist in the field of water pollution control since I know, being active in that field as well as air pollution control, that the question frequently arises. I am sure they know the answer when they ask: "What are you going to do about meeting standards for water pollution control when the body of water about which you are talking already exceeds the standards that you have established?" I think this might apply in this case; it would be a very specialized one that would probably have to be considered on the merits of the case alone.

Mr. Bath: In dealing with emission and air quality standards for particulates, the situation might arise whereby any one basis, that is, weight, volume, and so forth may not prove effective in dealing with the problem. Would you then find new standards or criteria or simply make the old standards more rigid?

Mr. Cuffe: Emission standards are usually applied to general particulates and specific gases. It would be that portion of dust of less than 3 to 4 microns that can be a problem in the respiratory tract. If it were shown that this was the case, then there would have to be a special limitation for that specific dust, but I am not familiar with cases where that has been actually applied. I should add that the Public Health Service is establishing air quality criteria. In the past year and a half they have gathered a great deal of published information on the effects of sulfur dioxide on humans, plants, animals, and other substances. I cannot say exactly when, but I should expect that within the next 6 months the Public Health Service will issue air quality criteria for sulfur dioxide. This will be followed by criteria for oxidants. Particulates are a very difficult category and I suspect it will be several years before the Public Health Service issues air quality criteria for this category.

Mr. Paganini: If I may interject here on these analyses that we made, we listed total suspended particulate matter, and usually, suspended particulate matter consists of particles of a size of 100 microns or less. You will probably have a certain percentage, depending upon the process of emission, that may range from submicron up to 100 microns in size; this is something that can be taken into account in these ambient air standards as far as suspended particulate matter is concerned.

Question: It takes a lot of money to control gin dust. I wonder if it is possible to set up three or four demonstration units to show people how to control cotton-ginning effluents?

Mr. Cuffe: Well, I think what the Public Health Service would prefer before model gins are set up is to conduct source tests to determine the most effective design parameters and operating procedures for various types of particulate control systems for cotton gins. The results could be published in a report and made available to all interested parties.

Comment: The ginner has to spend $25,000 fixing up a cotton gin and has no way of measuring whether it is effective or not.

Mr. Cuffe: I think Mr. Graber covered this in some recommendations for needed research. It may be of interest to know, however, what the Public Health Service has done these past several years with other industries. We have a cooperative study agreement with the Manufacturing Chemists' Association and have made comprehensive studies of emissions from sulfuric acid- and nitric acid-manufacturing processes. We determined the types and concentrations of various gaseous and particulate pollutants, collection efficiencies of abatement equipment normally employed, and the effects of various process operating conditions on emissions. I should expect that this type of study could be done cooperatively with the Public Health Service, Department of Agriculture, and other interested state or local agencies and cotton-ginning associations.

Mr. Moore: One substance we have discussed is arsenic. Would arsenic standards that you are speaking of be uniform for the United States, that is, hotel rooms in Dallas, Texas, or New York City as opposed to a gin system here in Texas?

Mr. Cuffe: If and when there are air quality standards for arsenic, I should expect that the Public Health Service would recommend their use nationally. Again there may be others adopted by states themselves. There are presently only threshold limit values published by the American Conference of Governmental Industrial Hygienists for working atmospheres for 8 hours a day, 5 days a week, for healthy adults. Air quality standards would apply to people 24 hours a day, 7 days a week, and include, in addition to healthy adults, the young, the old, and the sick. Values that were chosen may be lower than the threshold limit values by a factor one-tenth to one-hundredth that value.

Question: Has any thought been given to financial assistance to aid the gin owner in purchasing control equipment? Has consideration been given at the state or local level or any level?

Mr. Cuffe: From what has been said here by Mr. Bush and others, apparently many gins, particularly those ginning less than 1,700 bales per day, do have an economic problem. One thing that could be done is to exempt air pollution control equipment from taxes at either the state or local level. There are two states, California and, I believe, Wisconsin, that allow an accelerated amortization on this equipment of 5 years.

Mr. Bush: I should like to speak on this subject. I am thinking of a parallel to the recent highway beautification program where, I believe, $2,500 per junk yard is provided for screens. This is a subsidy paid to the owner either directly or through the highway department of the various states for screening off his property. To me and to some of us in the industry, this is a rather similar type of parallel. Here we are being called upon to enter into something overnight, so to speak, that may or may not in every instance be because of a health hazard or nuisance. It is conceivable that this same type of thinking can be applied to air pollution.

Mr. Cuffe: Mr. Hickman, would you care to make a few comments about the operations of the Federal solid-waste program?

Mr. Hickman: I represent the Office of Solid Wastes* of the U. S. Public Health Service. We have been in existence as a Federal agency since the first of the year. I should like to make a few comments and shall be glad to answer questions afterwards.

In his State of the Union message to the Congress in January 1965, President Johnson proposed to increase the beauty of America and end the poisoning of our rivers and of the air we breathe. In October 1965, he made good his proposal by signing the Clean Air Act Amendments and the Solid-Waste Disposal Act.

The Surgeon General of the Public Health Service, Dr. William H. Stewart, publicly committed our agency to this new field of environmental control when he established the Office of Solid Wastes in January 1966. He said that "in establishing the Office of Solid Wastes, we are taking another step in our fight against environmental pollution. We are reinforcing our efforts to stem the tide of air, water, and land pollution, to restore the beauty of our land, and to protect the millions of our citizens affected by these man-made threats to health and well being."

Solid wastes include a vast variety of salvageable, nonsalvageable, convertible and nonconvertible materials discarded every day by us as individuals, by industry, by commercial and agricultural operations, and by urban living. These include garbage, rubbish, ashes, street refuse, demolition and construction debris, abandoned automobiles, old refrigerators, furniture, dead animals, and the wastes from slaughter houses, canneries, manufacturing and processing plants, farms, and hospitals.

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*Now part of the National Center for Urban and Industrial Health.

Current national production of solid wastes amounts to almost 900 million pounds daily or about 4½ pounds per person. It is estimated that the total will be 3 times that amount by 1980. What are we going to do with all this solid waste our high-class society is generating?

When the Gemini Astronauts returned from their 8-day mission in 1965, they singled out "stowage" as the principal problem aloft. Where did they put all the garbage, what to do with it? The question of what to do with trash has worried engineers ever since the design of spacecraft became a matter of practical concern. To the engineering purist, the answer lies in a "closed ecological system," in which everything is endlessly reused and never wasted or lost. A system of this sort, engineers feel, exists right here on earth. In fact, the planet earth itself is an efficient closed ecological system, or so it has generally seemed.

Restoring the Quality of Our Environment, a report issued last November by the Environmental Pollution Panel of the President's Science Advisory Committee, summarizes thoughts on the subject that have been circulated for a number of years. Perhaps, the report suggests, our terrestrial spaceship with its 3 billion passengers is not really operating as a closed ecological system at all, for in the onrush of civilization, man is wasting, ruining, corrupting, poisoning, and breaking things faster than nature can regenerate them and put them back into the supply line. The Panel's report includes 22 recommendations specifically on solid waste.

Enacted in October 1965, the Solid-Waste Disposal Act, like the Clean Air Act, the Water Pollution Act, and other legislation in the area of environmental pollution control, recognizes that the primary responsibility for dealing with these problems rests with state, local, and regional agencies. Nevertheless, these levels of government also look to the Federal Government for guidance and aid. The Solid-Waste Disposal Act is intended to enable the Federal Government to help create a coordinated national solid-waste disposal program by bolstering the efforts of the state and local governments.

The Act authorizes a broad basic program of the Federal Government—research, training, technical services, and grant support for demonstrations and planning of local and state programs. The research needed is chiefly to devise and perfect methods that effectively collect, treat, and dispose of solid wastes while avoiding environmental contamination, and hopefully, permitting the recovery of the vast amounts of salvageable materials now being lost through primitive disposal practices.

Balancing the research and training efforts that the Federal Government will be making, the Solid-Wastes Disposal Act provides a method of stimulating state and local agencies to develop and operate more sanitary, efficient, and economical waste programs. The Secretary of HEW is authorized to provide financial and technical assistance to public agencies—and to institutions and individuals engaged in research—to promote research, demonstrations, surveys, and training concerned with the operation of solid-waste disposal programs.

We are also authorized to make grants to state and interstate agencies on a matching fund basis for the development of local programs.

To carry out these new activities, the Solid-Waste Disposal Act authorizes the appropriation of over 92 million dollars in the next 4 fiscal years. For the last half of Fiscal Year 1966 we received 4 million dollars. We should receive approximately 13 million or maybe 14 million dollars in Fiscal Year 1967.

The Solid-Waste Disposal Act gives the cities, states, and Federal Government an unparalleled opportunity to reverse the relentless trend of the discard of abundance, the erosion of the natural beauty of this country, and the health hazards created by improper solid-waste disposal practices.

Mr. Cuffe: Mr. Hickman, would you classify cotton trash as an agricultural solid waste?

Mr. Hickman: Yes, it was so defined by the Congress in the Solid-Waste Disposal Act when they defined solid wastes as garbage, refuse, and other discarded solid materials including solid waste material resulting from industrial, commercial, and agricultural operations.

Mr. Cuffe: In addition to state or local government agencies, can nonprofit organizations qualify for a grant?

Mr. Hickman: Any nonprofit organization is eligible for a grant for demonstration of a new or improved technique of solid-waste disposal.

Mr. Paganini: Would that be an outright grant or would it have to be a matching grant?

Mr. Hickman: Well, demonstration grants have to be 2 to 1; we match two-thirds against one-third.

Comment: Under the current practices we have today, the disposal of agricultural wastes is about the same as that of municipal or other types. Composting is one method; incineration and landfill are other methods of disposing of agricultural wastes. Here again, we can foresee many areas that will need research and study to develop practices and methods of disposing of agricultural solid wastes. One thing about cotton-ginning wastes that has merit, compared with others, is that they are almost entirely organic and have value for plant food and other uses, whereas urban solid waste is going from the organic to the inorganic, very markedly, and this is creating an additional disposal problem.

Mr. Herzik: Mr. Hickman, for the benefit of the health department people and other enforcing agencies here, on your fund program, this matching 2-to-1 ratio is for different situations. Is this as it was in the air pollution program? Must the money matched be new money?

Mr. Hickman: It does not have to be new money; it cannot be Federal grant money allotted for anything else.

Mr. Herzik: If the state, in our case for example, already has two people paid by the state on solid-waste disposal activities, could this be used for matching purposes?

Mr. Hickman: This could be brought in under the planning grant, yes.

Mr. Paganini: Mr. Hickman, in expanding on Mr. Herzik's question, could this include nonprofit organizations that now have people working and could they assign their salaries and any other equipment or so forth for this? Could it be applied that way?

Mr. Hickman: I am not sure about existing equipment. Any new equipment they would have to purchase could, of course, be considered under the grant. If they are assigning people from another activity to a solid-waste disposal activity, there is no reason why their salaries cannot be counted toward part of the matching fund. Of course, all applications are on a competitive basis. They submit theirs, and then they take their chances like any other organization.

Mr. Paganini: Mr. Hickman, before you get away, in regard to this, is there a percentage allocation to each state? And if so, are you competing with all other municipalities in that state on that percentage basis?

Mr. Hickman: No state can receive more than 12.5 percent of the total grant funds appropriated under any one section of the Act.

Mr. Cuffe: Mr. Hickman, if there were individuals or organizations here today interested in filling out forms, who could give them assistance?

Mr. Hickman: Well, of course, we shall staff our regional offices, that is, the Public Health Service Regional Office, just like our other environmental health programs do. Presently, though, we have only three regional program directors. The rest of the regional offices, such as the Dallas Office, are being handled by our Division of Environmental Engineering and Food Protection.* They have the material and can provide forms and assistance in their preparation.

Mr. Paganini: In regard to the report that will be coming out on the study we did around cotton gins; when it is completed it will become available. If you wish to obtain a copy, write us a letter for our files and we shall send the report out to you when it is made available.

In behalf of the representatives of manufacturing companies who may be present, I should like to ask Mr. Stedronsky to give us a list

*Now part of the National Center for Urban and Industrial Health.

of all the manufacturers of in-line filters or other air pollution control equipment.

Mr. Stedronsky: I don't know whether I can give you the names of all the firms that make that type of equipment. We have plenty of material on file at the office, but I don't have any with me now. As far as in-line filters are concerned, every few days I hear of someone else who is making them, and as of now, these are the names that I have picked up. If I overlook anyone, it is certainly unintentional. At present it is my understanding that, of the gin machinery manufacturers, the Continental/Moss-Gordin and Lummus Cotton Gin Company are making in-line filters. I believe I heard somewhere that the Murray Company is interested; if Hardwick-Etter is making any, I haven't heard of it. Those are the major machinery manufacturers of the full line of ginning equipment. The other folks, I have heard, are the Anderson-Bigham Sheet Metal Works; the Metal Products Company, also of Lubbock; the Bruton Manufacturing Company at Lamesa, Texas; the El Paso Sheet Metal Works of El Paso; and Wonderstate Manufacturing Co. of Paragould, Arkansas. Those are all the people I have heard of. I don't know whether Mission Sheet Metal or Mission Engineering have made any or not.

Mr. O'Neal: Well, I have been thinking a little bit about private business. This was all government we have been talking about, I believe. I think many good ideas for improving on dust-collecting equipment may simply be sat on instead of patented, unless there is some method, for the people who are going to push this program, of either making recommendations, or helping to test, or even buying the patents for public consumption. I have wondered something about that. Is there any comment that Mr. Cuffe or anybody can make on that?

Mr. Cuffe: Andy (O'Neal), were you referring to the availability of funds from the Solid-Waste Disposal Act?

Mr. O'Neal: I certainly would not have any idea where the funds would come from. I just wondered whether any thought was given to the funds at all.

Mr. Cuffe: Not to my knowledge. That is why I specifically asked Mr. Hickman whether only nonprofit organizations can qualify for Solid-Waste funds. As far as providing money for it, do you have an improved or new process for composting?

Mr. O'Neal: I know some good ideas for handling materials—taking care of fines or sacking them; if the people who have patents are generally pretty proud of them and just don't give them away, as I did this one up here, they are going to sit on them.

Mr. Cuffe: You have a worthwhile point there. It would be nice to have some encouragement from private initiative, particularly from those with limited resources. Offhand I don't know what it would be.

Mr. Bush: Yes, I should like to throw one other thought out here: I think these two days have brought us, at least I hope they have brought us, to the realization that the problem of controlling waste disposal, trash disposal, and air pollution of the cotton gin is not simple. It is limited by many factors, but one factor that has occurred to me has not been discussed. This is a very real factor and one that heavily influences a ginner's actions. It is the competitive factor. Sometimes we find that complaints have been stimulated, justifiably or not, by competitors, a get-even sort of proposition. These cause everybody in the industry headaches before they finish with them. I have in mind any number of cases over the past several years wherein this has actually happened: Using either state, local, or Federal authorities of one type or another to make complaints against the competitor. It is a dirty kind of business, but it is unfortunately true that people are people and these things occasionally happen. I should urge that, in any deliberations that might be given to any type of standard or whatever you want to call it, the criteria for acceptable limits in controlling waste in and around gins include consideration of this type problem. It causes us in the association business untold headaches from many angles, and I think those of you who have been in either state or Federal health departments long enough have run into this situation.

Mr. Herzik: Mr. Bush, this is an excellent point. Having been in public health work for 30 years, I know that the first thing we usually look at when we get a complaint and begin investigating is this: Is it a spite thing or is it a real thing? As you imply, we frequently find that it is a spite thing rather than a real thing, and I hope that all health departments will continue, as we do here in Texas, to try to separate the "wheat from the chaff" in these cases.

Mr. Graber: I should like to expand on the expression Stan (Cuffe) used, that is, Federal standards, as it relates to what the Public Health Service is developing. What we are developing and what we are required to develop under the Clean Air Act are air quality criteria. There is a difference between criteria and standards in my opinion; criteria are amounts of various pollutants that affect people, animals, vegetables, materials, and so forth, to a varying degree at various concentrations and that form the basis for legal standards; they are not in themselves standards. Our criteria are developed after an extensive review of the literature. We are about to put out the first air quality criteria on sulfur dioxide. To give you an example of how it might appear, we shall list the various effects that research has shown to occur at various concentrations. It would then be the decision of the states and communities to make their choices as to the concentrations they want to adopt as standards, the economic and other factors that may be involved being considered. We are not in effect setting national standards for air quality for specific pollutants.

SUMMARY OF CONFERENCE

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Chief, Environmental Sanitation Services
Texas State Department of Health
Austin, Texas

I think that this meeting, probably long overdue, has served a very useful purpose. As far as I am concerned, there were several real points made. One, for example, was expressed by Mr. Welsh, who emphasized that air pollution control is a state and local responsibility, and he added that cooperation among all involved is vital. I think it could not be said more clearly than this and I am sure that we from the state level, and I hope, the ginners themselves, agree that this is a problem for local handling. By way of philosophizing and not being critical, I believe that we in the states have been too prone to let the Federal Government preempt us, not because they are a preempting group of people, but because we fail to do what we are supposed to be doing and to fill the vacuum, and so the Federal Government moves in. I, too, shall emphasize, therefore, that I think that any air pollution control, whether it is for cotton gins or other sources, is a state and local responsibility. I hope all of us on this level of government will make every effort to see that it stays there, mostly by doing what we are supposed to be doing.

In regard to the cotton-ginning operations, I was impressed with a statement, or at least an implication, by Mr. Reeves that the cost of lost time is tremendous. Those of us in the enforcement field should recognize that it is a pretty difficult thing, when talking with a ginner, to be casual about putting his equipment out of operation. I think the statement was made that it was 10 percent of his per-bale ginning capacity for each minute lost on a 6-bale-per-hour plant, and I am not sure that I know just what this means, but 10 percent for 1 minute lost looks like a tremendous figure, and certainly I should be in sympathy with anyone's objecting to losing that kind of return on his investment. In other words, I think that what I am saying, and rephrasing Mr. Reeve's statement, is that the equipment must be used at maximum efficiency at all times. This, of course, will govern the thinking of the gin operator in anything he does, whether it is air pollution control or actual ginning.

I want to thank Mr. Bush for the complimentary remark he made about the Texas State Health Department. I think he said something to the effect that we helped them more than we hurt them. This pointed out to me, or it confirms, what we have always hoped we were doing, and that is working with industry instead of against them. There may be times when we have wide differences of opinion, wide disagreement, but basically, at least in this state (and I would almost presume to speak for the other state agencies as well) we realize that, without the support of an industry, our enforcement program will fail of its own accord. For that reason, let me assure you, at least for the Texas State Department of Health, that we shall continue to work with you and not against you in every possible way.

Mr. Bush made one further remark: Owing to mechanization we have tremendous increases in the amount of trash we have to handle. The problem is extremely different from what it was when I was a youngster in Fayette County in Texas. Several of my uncles and several of my cousins have owned and today do own gins. And I remember, as a child, the trash problem was minimal in that you had cotton on one hand and seed on the other, and you didn't throw either away. Now you have a big trash problem, so I can well appreciate the fact that mechanization has changed our whole outlook on the matter of cotton ginning.

Mr. Pendleton also emphasized the tremendous amounts of trash and said, in effect, that we have come a great distance in handling our problems, but there still are problems to be solved, and I believe he said, particularly in the field of incineration. Mr. Stedronsky said essentially the same thing; much study is still needed though commendable results have been secured up to this point.

Mr. Paganini pointed out, and this to me is certainly a point to consider, that, unless continued improvement is realized, some people are going to bring the matter, not only of cotton gin waste, but of all air pollution problems, before the Air Control Board in Texas. This is probably true in other states. Remember, this is not the Board itself or the State Health Department saying this; these are people complaining. I think it then behooves us to take every reasonable approach that can be taken to prevent any source of complaint, or at least eliminate any source of complaint. I look at this air pollution problem, whether from gins or other sources, very much as I do the water pollution program.

Let me interject here that I wear several hats, that of the Health Department representative on the Water Pollution Board, and that of the Health Department representative on the Air Control Board. I look with some degree of concern, tying in with the statement I made earlier about abdication of our responsibility by allowing the Federal government to preempt us, at what appears to be a trend now that cost is of no significance when you are talking about controlling water pollution. I see now that when people come before the Texas Water Pollution Control Board and say they do not want to control their sewage because it costs too much money, the enforcing agencies (and this comes down from the Federal Government to the state agencies) feel that this is a very poor method of justifying a failure to do something. I realize that, as long as he is working on the profit motive, it is a very serious matter to a ginner, when you say the cost be darned, go ahead and do something. I am sure, and this may answer several of the questions that have come up during this conference, that in some way or other, the cost of controlling pollution will be worked into the overall program. Whether it will be in tax rebates, grants from the Federal or state government, or an increase in the price of the product, I don't know; but some way or other, it is going to come into the picture. I feel that the same remark will ultimately be made about air pollution that was made by our Federal Government in Washington about water pollution: That it is a national disgrace. Whether I agree with that particular evaluation of the problem is beside the point; the fact is that this statement governs pretty well the thinking of those concerned with eliminating water pollution, and by implication will apply to air pollution. Certainly you cannot ignore the cost factor, but I am not sure that those concerned with eliminating pollution are as concerned with it as the ginner himself is. Be that as it may, I feel sure that, somewhere along the line, this will work itself out. Having been in governmental activity for so many years, I feel that, in the end, the solutions are usually fairly reasonable, though they may sound fearful to those in industry who read a statement or hear a public statement and say: "This will just kill us, or this will just put the ginning industry out of business," or, in the case of water pollution: "This will put the plastics industry out of business, or the rayon industry out of business." None of these industries have gone out of business, and I am inclined to feel that, somewhere along the line, things do get adjusted. So, while I do not want to say that we do, or should, ignore the cost factor, I am not really as concerned with it as I am with the feeling that, unless we do something, we will be forced to do something by "higher authority."

Nonetheless, let me say in closing, I think we have had a fine meeting. I think we have essentially reached a meeting of the minds. It is obvious to me that we have worked together. I am sure we shall continue to work together. This idea has continued to impress me during the course of the meeting. Nobody was calling anybody names; I am sure that, as long as we can communicate with one another, whether we are on the same side of the fence or on opposite sides of the fence, we shall continue to solve our problems.

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