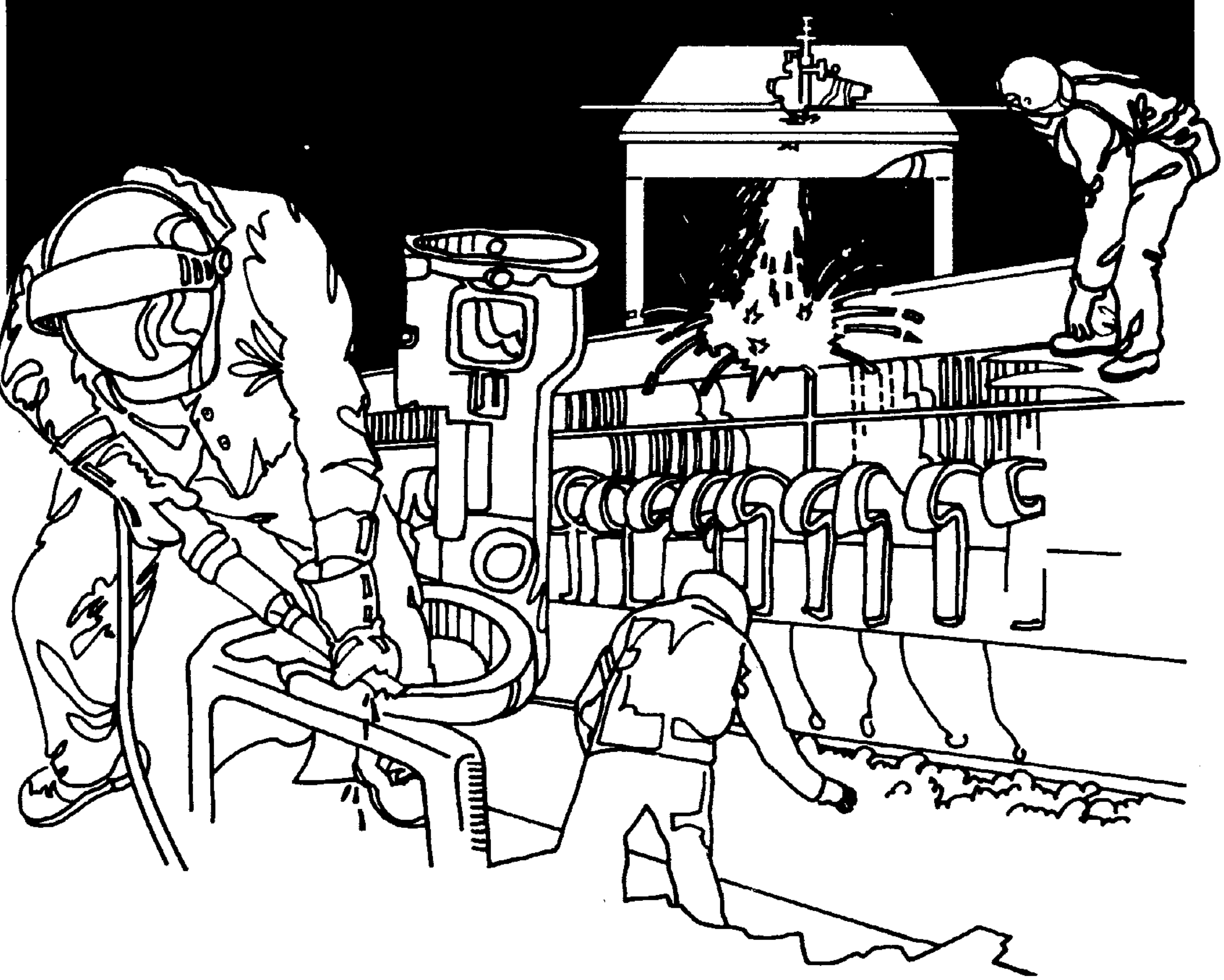
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HE 80-245 & 246 & 247-1210
COLORADO RIVER GIN, POSTON, ARIZONA
PLANTATION GIN, POSTON, ARIZONA
PARKER VALLEY GIN, PARKER, ARIZONA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

COTTON GINS, COLORADO RIVER INDIAN RESERVATION
HE 80-245-1210 COLORADO RIVER GIN, POSTON, ARIZONA
HE 80-246-1210 PLANTATION GIN, POSTON, ARIZONA
HE 80-247-1210 PARKER VALLEY GIN, PARKER, ARIZONA
OCTOBER 1982

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I. SUMMARY

In August, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Chairman of the Tribal Council to evaluate three cotton gins on the Colorado River Indian Reservation. The Tribal Council's concern was for potential health effects, both short and long term, to the approximately 10-18 workers at each gin from exposure to cotton dust, pesticide residue-laden materials, nuisance dust, and noise. The health concerns mentioned in the request were eye, skin, throat, and respiratory irritation.

NIOSH conducted industrial hygiene and medical evaluations from October 1980 through February 1981. Personal and area environmental samples were obtained and each gin's personal protective program was reviewed. The medical evaluation consisted of medical questionnaires, pulmonary function tests, blood cholinesterase tests, and hair arsenic evaluation.

NIOSH determined that most of the airborne levels of cotton dust samples taken at the three gins (range 0.19-6.43 mg/M^3) exceeded the NIOSH recommended criteria of 200 ug/M^3 (0.2 mg/M^3) time weighted average (TWA). The pesticide residue-laden materials analyzed indicated various levels of DEF®, Folex®, Lorsban®, methyl parathion, and Azodrin®. One of the 25 personal nuisance dust samples taken (10.55 mg/M^3) exceeded the 10 mg/M^3 criteria established for the survey. The noise surveys performed at the gins showed significantly high noise exposures (range 82.0 - 98.6 dBA) to each of the jobs evaluated with only outside gin operators having exposures below 85 dBA. Approximately 85 percent of the jobs evaluated had noise results exceeding the NIOSH criteria of 85 dBA and 65% exceeded the OSHA standard of 90 dBA.

The medical evaluation showed both acute and chronic symptoms in a portion of the workers who were evaluated from exposure to cotton dust and/or nuisance dust, as well as from exposures to organophosphate pesticides. Effects from the various exposures evaluated included eye, skin, and respiratory irritation (54% of workers), decreases in lung function over the work day (2 cases), symptoms of chronic bronchitis (6 cases), and reduced pulmonary function (2 cases). These symptoms are compatible with chronic effects of cotton and/or general dust exposures. There were also statistically significant decreases in red cell cholinesterase levels over the season (from a mean of 0.64 $\pm$ 0.06 to 0.53 $\pm$ 0.06 pH units), one to a clinically significant degree (late season value less than 70% of early season value).

Based on the data obtained in these investigations, NIOSH determined that health hazards existed at each of the three gins from exposures to cotton dust, pesticide residue-laden materials, and noise. The personal protective programs and the present engineering controls at all three gins were considered marginal to poor in their ability to adequately protect and/or reduce the exposures to the workers evaluated at the three gins. Recommendations are included in Section VIII of this report to assist the gins' operators in improving worker health.

KEYWORDS: SIC 0131 (Field Crops, Except Cash Grains-Cotton), cotton dust, nuisance dust, noise, pesticide residue laden materials, organophophates, DEF®, Folex®, Lorsban®, methyl parathion, Azodrin®, cholinesterase, pulmonary function, chronic bronchitis.

II. INTRODUCTION

On August 7, 1980, the Executive Director of the Colorado River Tribal Council-Tribal Health Department, Parker, Arizona, submitted a health hazard evaluation request. The Tribal Health Department is responsible for overseeing the health concerns for both environmental and occupational matters on the reservation. The request stated that a number of potential health hazards existed to approximately 40-50 employees who work at three cotton gins on the reservation (approximately 10-18 per cotton gin). Medical concerns addressed in the request included exposures to cotton dust, noise, nuisance dust, and pesticide residue laden materials. Environmental and medical surveys were conducted during October 27-31, 1980, December 15-17, 1980, and February 2-6, 1981, to evaluate the concerns stated in the request. After each evaluation, recommendations were given to the cotton gin managers and/or owners and to the Tribal Health Department. Individuals were contacted by mail regarding their medical results. An environmental and medical Interim Report were presented to the Tribal Health Department and the cotton gin representatives and owners on August 6, 1981.

III. BACKGROUND

Cotton growing and ginning is a major agricultural process that exists in many countries throughout the world. In the United States there are over 2,000 gins with Texas, California, New Mexico, and Arizona producing the majority of cotton grown. In these states, as well as others, cotton ginning normally occurs from September to January and there are usually 6-10 employees directly involved in the ginning process at a gin. Therefore, this equals approximately 20,000 employees who work from 6 to 8 months each year in the cotton ginning industry in the United States alone.

The Colorado River Indian Reservation is one of the major cotton growing areas in Arizona and is located along the Colorado River south of the Parker Dam. It is principally in Yuma County, Arizona, the northern tip extending into the Riverside and San Bernardino Counties in California. The reservation has approximately 265,000 acres and approximately 78,000 acres is devoted to agriculture. The major farm crops produced here are cotton, alfalfa, wheat, melons, and lettuce. Cotton is the primary agricultural crop and is in production approximately year round. That is, from the tilling, planting, cotton picking, to the final cotton ginning, there are only 1-2 weeks each year when some phase of the cotton production is idle in this valley. At present there are three cotton gins on the reservation: Colorado River Gin, Parker Valley Gin, and the Plantation Gin. The following discussions on process descriptions, employees at risk, engineering controls, and personal protective equipment were common in all three gins with minor exceptions which are noted in the supplement for each gin.

A. Gin Process Description

The gins on this reservation usually operate between 10-12 hours per day, 6-7 days per week normally from August to February. The cotton gins in this valley process three different stages (phases) of the cotton. These stages are referred to as First Picking, Second Picking, and Third Picking (also called Rood/Ground Picking). The first stage in the cotton picking process is the first picking of the crop which removes approximately 85-90 percent of the plant's matured cotton bolls. This picking phase also accounts for about 50-65 percent of the plant's total cotton. The cotton plant is left to continue its maturing process of the remaining cotton bolls. A few weeks after the initial cotton harvesting, the fields are picked a second time. The last stage in the harvesting process--Rood/Ground Picking--requires a special machine called a Rood® Picker which removes all the remaining cotton on the plant as well as cotton on the ground. Although the Rood Picker separates much of the trash from the cotton as it picks, much of the trash still remains with the cotton. This last stage accounts for approximately 3-5 percent of the plant's cotton material and is considered marginally profitable.

Harvested cotton is normally a mixture of cotton, cotton seed, leaves, sticks, bract, unopened bolls, and dirt. This is true for each of the three picking stages described above.

Characteristically, as these three stages or pickings are processed in the gins the first picking is normally clean in terms of production and generation of airborne materials. However, the second picking is much dirtier and the last picking is very dirty in terms of airborne dust concentrations produced during the ginning and picking process. Depending on the cotton yield and weather conditions through the season, the gins normally will operate two 12-hour shifts from the mid-ginning season through the end of the season.

The ginning process is similar at each of the three gins; however, two of the three gins (Parker Valley and Plantation Gins) have recently automated a portion of their ginning process in order to yield greater production rates.

The ginning process is basically a separation process that receives raw cotton material from the fields and eventually produces a bale of clean cotton as the final product. The ginning process is designed to remove sticks, leaves, and bolls. The cotton seed removed from the boll is sold for cotton seed oil or in some states used as animal feed.

The process flow in a gin is as follows:

1. Large trailers filled with cotton or cotton modules are transported from the fields to the gins. Cotton modules are raw picked cotton which is pressed into blocks in the fields and transferred to the gins for processing.

2. Cotton is sucked from the trailers or modules into the initial ginning process--inside the gin.

3. Once inside the gin a preparation box receives the raw cotton which provides for an evenly regulated flow into the remaining cleaning processes.

4. The cotton then goes through a horizontal or vertical dryer which removes moisture from the raw material.

5. Next the material goes through a Burr/Stick machine and up an Incline Cleaner where dirt, sticks, and leaves are removed.

6. Once again the material goes through another dryer and then through a second Incline Cleaner for further leaf and dirt removal.

7. The material is now predominantly cotton boll and begins its stripping process in the cotton gin.

8. Most gins have numerous gin stands which are designed, via stripping blades, to remove the cotton seed and bract (outer shell/hull of the pure cotton) from the boll.

9. Once this stripping process takes place the extracted seed is transferred via a pipe (called a sucker pipe) to a seed pile outside the gin yard.

10. The stripped cotton then goes to a Moss Cleaner where low grade cotton material is separated and sent to a mote (low grade material) baler. This material is used primarily in upholstery manufacturing.

11. The higher grade cotton continues on until it is received at the Bale Press station. Here the finished cotton is pressed into finished bales of clean cotton, wrapped in fiber bags, and bound with wire.

12. Once a finished bale is wrapped it is removed from the baling press, transferred to a trailer, and placed outside in the gin yard.

B. Existing Engineering Controls and Personal Protective Equipment

The three gins studied in this investigation had moderately effective to no engineering controls for reducing the various occupational hazards evaluated. The sources of dust generated in all gins were numerous.

There were numerous sources of noise exposures in the gins including fans, fan belts, piping that transferred material, vibrating metal, saw blades, etc.

During the survey periods the only personal protective equipment worn by a few workers were hard hats and disposable paper respirators which were not NIOSH approved. Only ten percent of the employees wore these respirators and hard hats. One worker was seen wearing hearing protection; however, no hearing conservation program existed at this gin. There was no indication of any other personal protection available at any of the gins, such as protective clothing, safety shoes, hearing protection and/or a hearing protection program.

C. Employees at Risk

The employees considered to be at risk to the exposures evaluated in this study were all of the employees who work directly with the ginning production. This includes the head ginners, assistant ginners, standwalkers, pressmen, and suction and outside operators. The employees at each gin normally work 10-12 hours per day, 6-7 days per week for the entire ginning season. The fact that these employees work 60-70 hours per week places them at higher risk when comparing exposure criteria and/or standards for 8 to 10 hours per day, 40 hours per week.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

A variety of sampling techniques were used to evaluate the suspected contaminants at each of the gins. Personal and area samples were taken on all of the employees in each of the gins.

The following is a description of the sampling techniques used.

1. Cotton Dust

Cotton dust exposures were evaluated at each of the three gins during the February survey. The methods used to characterize the cotton dust exposures in these gins were performed in two manners. The first sampling technique used to evaluate airborne concentrations of elutriated cotton dust was a small battery operated vertical elutriator (SVE) operated at a flowrate of 3.2 liters per minute (lpm).[1] The SVE, which is an area sampler, consists of an elutriation separation chamber and a battery operated pump (Dupont 4000) to supply the required flow rate. A 3-piece open face cassette containing a 5.0 micron polyvinyl chloride (PVC) filter was inserted at the top of the separation chamber. A total of 5 SVE's were used to evaluate each ginning facility. The SVEs were turned on when the gin began operating; shut off after approximately six hours of sample time. If the gin shut down for lunch, the SVEs were shut off. Otherwise samplers ran the entire six hour period. SVE filters were inspected midway during the sample period if heavy visible dust was observed in the vicinity of the SVE sampling station. Filters were changed if a dust buildup was observed on the filter.

Both the SVE and vertical elutriator (VE) are area samplers. Monitoring employee dust exposure with area samplers is a difficult procedure. Individuals conducting this type of sampling must insure that sampling locations are adequate to estimate employee exposures. At least one NIOSH investigator remained at the facility, while SVEs were operating, monitoring employee movements. Sampling locations were adequate for estimating gin employee cotton dust exposures with the exception of suction personnel. It was not possible to position SVEs near suction operations.

Filters used to collect cotton dust samples were analyzed under the NIOSH Comprehensive Analytical Services Contract (CASC). Instrumental precision of the electrobalance used to weigh filters was $\pm$ 0.01 milligram (mg). A total of five control (Blank) filters were collected during each shift sampled. The average weight change for each set of controls was used to correct sample weights obtained on the corresponding shift. Average weight changes for the four shifts sampled during the gin surveys were 0.03 mg.

The second technique used to evaluate cotton dust in the gins was a GCA RDM-101 dust monitoring instrument and attached to the inlet/orifice was a small vertical elutriator.

2. <u>Pesticide Residue Laden Materials</u>

Pesticide residue laden materials (PRLM) are defined by the project officers as any material (e.g., cotton fiber, bract, dust, etc.) which is laden with a pesticide residue (i.e., insecticide, herbicide or growth regulators, etc.) and where such materials have the potential to adversely effect the health of the worker by contamination through inhalation of airborne substances and/or skin contact by such materials.

Approximately 40 different pesticides, e.g., insecticides, herbicides, and defoliants, were used during the cotton growing season in 1980-81 at the operations under study. (Refer to Table 1). Therefore, numerous bulk samples were collected from each of the gins during all of the surveys performed in order to evaluate for pesticide residue laden materials, e.g. finish cotton seed, trash, rafter samples, etc. Personal samples consisted of drawing air at 1.5 liters per minutes (lpm) through AA filters mounted in closed face cassettes.

All of the bulk and personal samples were initially analyzed for those organophosphates and carbomates listed in Table 1. This table also describes the period and concentration sprayed during the 1980-81 season.

It should also be noted that there was a considerable effort devoted to the development of the analytical procedure used in this study. It was necessary to verify each step of the procedure in the particular matrix (cotton) for the requested compounds. For those without standards this was accomplished by adding known amounts of the compounds to clean cotton and analyzing. It should also be noted that gas chromatography/mass spectrometry (GC/MS) was used as needed to verify the presence of some of the compounds. Due to the complexity of analytical development the time required from sampling to analysis, approximately one year, may well have been a factor in the results by affecting the stability and/or desorption of the sample.

3. Nuisance Dust

Nuisance dust (dust containing nontoxic materials) was sampled by drawing air, at a flow rate of 1.5 lpm, through a preweighed filter. The filter was mounted in a closed faced cassette and then weighing the amount of dust collected on an electrobalance.

4. Noise Exposure

Noise evaluations were performed at each gin during all of the surveys. Numerous noise measurements were taken inside the gins using a Type 1565-B Sound Level Meter in both the A and C weighted (slow response) network. Measuring in the A weighted network simulates response of the human ear. The purpose for measuring in both the A and C networks is to estimate the range of frequencies (pitch) in the environments. That is, if the values obtained in the A versus C network were substantially different this would be an indication that the noise frequency varies substantially. However, if the noise values were within ± two dB from the A to C network then these results would indicate that the majority of noise is in the narrow frequency range. The noise frequency range was also evaluated by a sound level meter equipped with an octave band analyzer.

The last method used to evaluate the noise levels in the gins was with noise dosimeters which register, on a memory cell, the average dose or noise level received during the exposure period. Therefore, each worker's Time Weighted Average (TWA) noise level can then be compared against the present noise standards and/or criteria established for this survey.

B. Medical

On the initial visit early in the ginning season, only two gins were in operation. In order to evaluate the potential for exposures to organophophate pesticide residues, a sample of blood was obtained from each worker for cholinesterase determination. A sample of hair was obtained for arsenic determination.

On the follow-up visit all three gins were in operation. At two gins all available workers (23) were interviewed using a pre and post shift questionnaire for acute symptoms and a modification of a NIOSH, Division of Respiratory Disease Studies (DRDS), Morgantown, West Virginia, cotton gin respiratory questionnaire. A Spanish version was developed for Spanish speaking workers. Pre and post shift pulmonary function tests were obtained using an Ohio Medical Products Model 822 Spirometer. Blood was obtained for cholinesterase determinations. At two gins most workers participated in the follow-up studies. At the other only four workers did. Table 7 details the study population by job, age, and seasons involved in ginning activities.

Red blood cell and plasma cholinesterases were determined by Laboratory Procedures, Inc., Woodland Hills, California, using the California State Department of Health mandated delta pH Michael method for red cell and a similar mandated method for plasma.

The hair arsenics were determined by the Utah Biomedical Test Laboratories (UBTL), Salt Lake City, Utah, by the hydride generation procedure of Pierce.[7] Lower limit of detection was 130 ng/gm hair (nanograms per gram or parts per billion).

V. EVALUATION CRITERIA AND TOXICOLOGY

A. Environmental

In this study, numerous sources of environmental exposure criteria and existing research data were used to assess the worker's exposure to the suspected chemicals evaluated in the workplace.

The exposure limits to toxic chemicals are derived from existing human and animal data, as well as industrial experience, to which it is believed that nearly all workers may be exposed for an 8-10 hour day, 40-hour work week, over a working lifetime with no adverse effects. However, due to variations in individual susceptibility, a small percentage of workers may experience effects at levels at or below the recommended exposure limit; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by development of an occupational illness. Also, as noted earlier, workers at the gins often work an average of 70-80 hours per week.

Three sources of criteria are generally used to assess the workroom concentrations of air contaminants: (1) NIOSH criteria for a recommended standards; (2) recommended Threshold Limit Values (TLVs) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1981; and (3) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), July 1980. The following is a description of the sampling techniques and criteria used:

1. Cotton Dust

The Occupational Safety and Health Administration's standard for exposure to cotton dust in textile and non-textile facilities (excluding gins) requires that airborne cotton dust samples be collected with a vertical elutriator (VE) operating at a flow rate of 7.4 ± 0.2 lpm or a method of equivalent accuracy and precision.[2] The SVE used in these gin surveys is a small scale version of the VE. The NIOSH investigators conducting these surveys decided not to use the VE due to the following primary (#1) and secondary (#2) considerations:

a. Experience of the NIOSH investigator in conducting side by side field comparisons of VEs and SVEs. Preliminary analysis of approximately 200 field comparisons indicated that the SVE had potential as a alternative to the VE.[3]

b. Logistical problems and time factor involved in transporting VE across the United States in order to conduct gin surveys.

Subsequent analysis of the field comparisons revealed that the SVE did not meet the OSHA criteria for an alternative sampler. However, a correlation was shown in dust concentrations ranging from 0.25 to 1.0 mg/M^3. In addition, 27 side by side comparisons conducted in a model cardroom were all within + 25%, thus in that environment (model cardroom) the SVG met the criteria for an equivalent sampler.[4].

Currently there are no specific environmental criteria from exposure to cotton dust in ginning facilities. NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend controlling airborne cotton dust exposures to 200 micrograms/cubic meter or 0.2 mg/M^3. The ACGIH criteria is based on data collected in textile facilities and does not discuss non-textile exposures.[5] The NIOSH recommended standard for exposure to cotton dust is based primarily on data obtained in textile facilities. No distinction is made between textile and non-textile facilities.[6] OSHA has developed two separate standards. The first covers textile and non-textile facilities (excluding gins). The second standard is specific for gins but no environmental cotton dust exposure limit is listed.

NIOSH is currently analyzing medical and environmental data collected in over twenty cotton ginning facilities. When published this data will provide information for establishing an environmental limit for exposure to airborne cotton dust in ginning facilities.

None of the environmental criteria discussed previously would be suitable for direct comparisons to cotton dust concentrations obtained during the gin surveys. However, it is possible to select the most feasible criteria for a reference point when discussing cotton dust concentrations obtained at each gin. Until the NIOSH ginning study data is available the most feasible criteria is the OSHA standard for cotton dust exposure in non-textile facilities. This standard is 500 ug/M^3 or 0.5 mg/M^3 based on an 8 hour time weighted average. In addition it is possible to discuss, in general terms, how the three gins compare to one another.

2. Pesticides

Of the original 40 pesticides evaluated in this investigation (refer to Table 1) only ten had criteria or standards that were applicable and these are listed below:

	Permissible Exposure Limits 8-Hour Time Weighted Exposure Basis (mg/M^3)		
Substance	NIOSH	OSHA	TLV(ACGIH)
Carbaryl (Sevin)....................	5.0	5.0	5.0
Methyl Parathion....................	---	---	0.2
Parathion...........................	0.5	0.11	0.1
Malathion...........................	15.0	15.0	10.0
Methomyl (Lannate, Nudrin)..........	---	---	2.5
Demetron (Systox)...................	---	0.1	0.1
Toxophene...........................	---	---	0.5
Azodrin.............................	---	---	0.25
Bidrin..............................	---	---	0.25
Azmphosmethyl (Guthion).............	---	0.2	0.2
Paraquat............................	---	0.5	0.5

mg/M^3 = milligrams of substance per cubic meter of air.

3. Nuisance Dust

At present the only criteria for nuisance particulate, i.e., dust containing nontoxic materials, is that established by the American Conference of Governmental Industrial Hygienists (ACGIH) and this is 10 mg/M^3.

4. Noise

OSHA's existing standard for occupational exposure to noise (29 CFR 1910.95) specifies a maximum permissible noise exposure level of 90 dBA for a duration of 8 hours, with higher levels allowed for shorter durations. NIOSH, in its Criteria for a Recommended Standard (1977), proposed a limit of 5 dB less than the OSHA maximum standard. OSHA, after consideration of NIOSH's and other research, recently issued a hearing conservation amendment to its noise standard. For workers exposed at or above a TWA of 85 dB, the amendment will require noise exposure monitoring, employee education, and audiometric testing as a minimum.

Time-weighted average noise limits as a function of exposure duration are shown below:

Duration of Exposure (hours/day)	Sound Level, dBA NIOSH	Sound Level, dBA OSHA
16	80	---
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115*
1/8	115*	---
	---	140 dB**

* No exposure to continuous noise above 115 dBA.

** No exposure to impact or impulse noise above 140 dB peak sound pressure level (SPL).

B. Medical/Toxicology

The following toxicology is the most recent medical information on the signs and symptoms associated with the exposures evaluated in this investigation.

1. Nuisance Dust

Nuisance dust, considered nontoxic dust, has little adverse effects on the lungs and does not produce significant disease if exposures are kept under reasonable control. Any reaction provoked is potentially reversible. These dusts are biologically inert in that when inhaled the structure of the alveoli remains intact and little or no scar tissue is formed. Excessive concentration in the work area may decrease visibility and cause eye, ear, and nose discomfort. This can also create injury to the skin due to vigorous cleansing procedures necessary for their removal.

2. Cotton Dust[6]

Cotton dust under prolonged exposure can cause byssinosis. Early symptoms are reversible when exposure ceases, with no permanent disability. In the later stages of the disease the changes in the lungs becomes permanent and symptoms persist. Early symptoms consist of chest tightness and/or breathlessness on the first day back to work after being off for a few days. As the disease progresses symptoms will be noted on more days until they become permanent. Changes in pulmonary function (the FEV_1) follow the same pattern, but do not necessarily relate well to the symptoms. Exposure to cotton dust can also cause chronic bronchitis which is indistinguishable from any other chronic bronchitis.

Pulmonary function testing was used to determine the extent of pulmonary impairment in the gin workers from cotton dust exposure.

The forced vital capacity (FVC) measures the total amount of air one can rapidly force out of his lungs after breathing in as deeply as possible. The one-second forced expiratory volume (FEV_1) measures the amount of air one can breathe out in the first second. The FVC can be impaired by restrictive lung disease, such as pulmonary fibrosis, etc. FEV_1 can be impaired by cigarette-related lung damage, byssinosis ("brown lung"), or some other conditions causing obstruction to air flow. Any condition that impairs FVC also impairs FEV_1, but the reverse is not true. Conditions that impair FEV_1 do not necessarily impair FVC. The FEV_1/FVC ratio is also used to help evaluate obstructive lung disease.

Some exposures to substances that irritate the lungs and bronchi will cause a temporary decrease in pulmonary function over the work shift.

3. Pesticide-Organophosphates/Carbamates

The most immediate effect of an organophosphate pesticide exposure is inhibition of cholinesterase, an enzyme necessary to "reset" nerves after they have carried an impulse. Chronic low level exposure can lead to progressive depression of cholinesterase until a level is reached where symptoms occur. Symptoms can include respiratory tightness, sweating, nausea, vomiting, abdominal cramps, constriction of the pupils of the eyes, muscular fatigue and weakness, twitching, muscle cramps, anxiety, headache, emotional instability, confusion, unsteady gait, slurred speech, convulsions and, in the extreme case, circulatory and respiratory depression and death.

Some organophosphates have also caused delayed toxic effects on the nervous system, manifested as peripheral neuritis and paralysis.

Carbamates can also cause cholinesterase inhibition, but it is more readily reversible than that caused by organophosphates. Symptoms of acute toxicity would be the same.

As the plasma cholinesterase level is affected sooner and recovers sooner after exposure, the red cell cholinesterase level is the more important measure of cummulative effects of exposure to cholinesterase inhibiters, such as organophosphates. The ideal measure is to establish a base line for the individual before exposure. Subsequent values are then compared to this base line. Values below 70 percent of baseline show an unacceptable exposure to cholinesterase inhibiting substances and values below 60 percent of base line call for removal and medical observation.

In the absence of a base line, values can be compared to laboratory normals, in this case 0.44 - 1.09 pH units for red cell cholinesterase and 0.38 - 1.54 pH units for plasma.

4. Arsenic

Hair arsenic gives an indication of how much arsenic was present in the blood at the time the hair was being formed. Possible surface contamination is minimized by obtaining hair close to the scalp and washing it before analysis. Thus it can serve as a measure of chronic exposure. Besides possible occupational exposure, some arsenic may be present in drinking water and food. Shellfish are a significant dietary source of arsenic. Although "normal" levels for hair arsenic have not been established, in a study in five cities, the city with the lowest median hair level had a median level of 400 ng/gm.[9] (The median is that value where half the values are higher and half are lower.)

5. Noise

Noise, commonly defined as unwanted sound, covers the range of sound which is implicated in harmful effects.

Exposure to intense noise causes hearing losses which may be temporary, permanent, or a combination of the two. These impairments are reflected by elevated thresholds of audibility for discrete frequency sounds, with the increase in dB required to hear such sounds being used as a measure of the loss. Temporary hearing losses, also called auditory fatigue, represent threshold losses which are recoverable after a period of time away from the noise. Such losses may occur after only a few minutes of exposure to intense noise. With prolonged and repeated exposures (months or years) to the same noise level, there may be only partial recovery of the threshold losses, the residual loss being indicative of a developing permanent hearing impairment.

Temporary hearing impairment has been extensively studied in relation to various conditions of noise exposure. Typical industrial noise exposures produce the largest temporary hearing losses at test frequencies of 4,000 and 6,000 Hertz (Hz).

The actual pattern of loss depends upon the spectrum of the noise itself. The greatest portion of the loss occurs within the first two hours of exposure. Recovery from such losses is greatest within one or two hours after exposure.

The amount of temporary hearing loss from a given amount of noise varies considerably from individual to individual. For example, losses at a given frequency due to noise intensities of 100 dBA may range from 0 to more than 30 dB.

Physiologic reactions to a noise of sudden onset represent a typical startle pattern. There is a rise in blood pressure, an increase in sweating, an increase in heart rate, changes in breathing, and sharp contractions of the muscles over the whole body. These changes are often regarded as an emergency reaction of the body, increasing the effectiveness of any muscular exertion which may be required. However desirable in emergencies, these changes are not desirable for long periods since they could interfere with other necessary activities. Fortunately, these physiologic reactions subside with repeated presentations of the noise.

For performance on a task to remain unimpaired by noise, man must exert greater effort than would be necessary under quiet conditions. When measures of energy expenditure--for example, oxygen consumption and heart rate--are made during the early stages of work under noisy conditions they show variations which are indicative of increased effort. Measurements in later stages under continued exposure, however, show responses return to their normal level.

VI. RESULTS AND DISCUSSION

A. Environmental

Employee exposures to suspected airborne concentrations of cotton dust, pesticide residue laden materials, and nuisance dust were evaluated at three gins. Also a noise evaluation was performed at the gins during each of the survey periods. The following are the results and conclusions of these evaluations:

1. Cotton Dust

Various conditions were evaluated in the different gins with the small vertial elutriators (SVE) during the February surveys.

The Parker Valley Gin was processing first and second picked cotton at the time of the evaluation and had some local exhaust ventilation equipment to help control dust. The Plantation Gin was processing only first picked cotton and had no exhaust ventilation equipment. The Colorado River Gin was processing rood/last picked cotton and also had no exhaust ventilation equipment.

The areas evaluated during this operation at each gin were the yard, gin stand, and press areas. Findings in the yard samples ranged from 0.19 to 0.29 mg/M^3 (mean = 0.21 mg/M^3). Ranges for the gin stand areas were 0.26 to 6.43 mg/M^3 (mean = 1.85 mg/M^3), and ranges for the press area were 0.41 to 1.36 mg/M^3 (mean = 0.69 mg/M^3). (Refer to Table 2.)

In general, when comparing the final results there appears to be a distinct difference in the SVE results when one compares the different conditions evaluated. This is especially true when comparing indoor operations, which includes the gin stand and bale press processes (when module-first picked cotton is being processed) compared to the same indoor operations where rood/ground picked cotton ginning was evaluated. Thus, it is strongly suggestive that when rood/ground picked cotton is being processed versus first picked cotton the results taken in the gin stand areas and the bale press areas are approximately twice as high.

There are numerous questions that can be raised regarding these comparisons and/or results, e.g., state or condition of the gin and machinery, number of bales being processed, number of samples run per gin, etc. However, these results are suggestive that higher cotton dust concentrations will be found in a gin when evaluating rood or ground picked cotton versus first picked cotton.

2. Pesticide Residue Laden Materials

Due to the complexity in analysis development and time between sampling and analysis, the personal samples were not analyzed. However, the bulk samples obtained at the gins during the survey periods were analyzed for pesticide residue laden content. These samples consisted of first picked cotton, cotton bolls, trash cotton, seed, motes, waste/bract cotton, finished cotton, and rafter samples. Rafter samples are accumulated dust particles which are found on elevated surfaces. These samples were collected at about 5-7 feet off the ground where the employee would be working and could be considered in the respirable range.

DEF was by far the most abundant organophosphorous compound detected in the sample extracts. There is evidence that some of the DEF detected may have come from Folex. DEF was found on all the bulk samples and the results ranged from 0.4 - 140.0 ug/sample. The following results were also found: Azodrin, 0.8 - 13.8 ug/sample; methyl parathion, 0.1 - 0.5 ug/sample; and Lorsban, 0.2 - 7.1 ug/sample. (Refer to Table 3.)

Ethyl Parathion, Bolstar, Guthion, and Supracide which were also analyzed were not detected on these samples. It should be noted that it is possible that those bulk samples chosen and analysed may not have been from a farm that used these pesticides. Another consideration is that the time between receiving the bulk and performing the analysis (approximately 6-12 months) may have reduced and/or eliminated any residual that might have been present in the original bulk sample.

3. Nuisance Dust

Personal samples were collected at the gins for total/nuisance dust, i.e., samples which were analyzed for total material present. The results ranged from 0.66 - 10.55 mg/M^3. The results per job title were 2.60 - 10.55 mg/M^3 for gin stand operators and assistant ginners; 3.62 - 4.34 mg/M^3 for pressmen operators, and 2.97 - 6.79 mg/M^3 for suction operators. (Refer to Table 4.)

4. Noise

As described earlier various methods were used to evaluate the noise exposures to the employees in the gin. The first technique--sound level meter--was used to evaluate each of the gin stands, dryers, and cotton press locations in the gin. The noise levels received in the gin stand areas ranged from 99-101.5 dBA and in the cotton press areas of the gins from 98-102.3 dBA. The noise exposure results obtained in the cotton press area ranged from 92-98 dBA.

The results obtained for the personal noise levels (TWA via noise dosimeters) by job category in the gins were 92.0-98.6 dBA for ginners and assistant ginners, 89.6 - 95.0 dBA for the pressmen, and 82.0-85.2 dBA for suction operators. (Refer to Table 5.)

The Octave Band Sound Pressure evaluation performed at the gins indicated that in the 4000-6000 frequency (the level which produces hearing damage) the results ranged from 84.6 - 100.0 dB (refer to Table 6). All but one of these values was below the 85 dB level.

B. Medical

1. Pesticide Residue Laden Exposures

Potential exposures to gin workers from organophosphate and carbamate type pesticides was determined by evaluating the workers' cholinesterase levels.

Table 8 summarizes the cholinesterase findings. Plasma cholinesterases remained within the normal range with no appreciable difference between early season and late season results. However, although all red cell cholinesterases were within normal limits on the early season tests, a drop is demonstrated over the season. (Early season mean 0.64 $\pm$ 0.06 pH units; late season 0.53 $\pm$ 0.06 pH units; mean % drop 76% $\pm$ 7%.) The difference between early and late season is statistically significant ($t = 5.6270$, d.f. = 40, $p = 0.01$)

a. Two tests were below normal limits on the late season tests and one of these two workers also had an early season test. His late season reading was less than 70 percent of the early season reading, a drop which shows unacceptable exposure to organophosphate.

b. All workers who had both early and later season readings showed a drop in their red cell cholinesterases over the season, although only the one worker mentioned previously showed an excessive drop.

c. The ginners and helpers, pressmen and helpers, and suction men as a group had statistically significantly lower mean levels late in the season than early in the season. (See Table 8.)

This drop in red cell cholinesterase over the ginning season strongly suggests the workers are being affected by organophosphate residues from the cotton materials, either by inhalation or skin contamination. Because those working inside the gin building (ginners and pressmen) are affected to a statistically significantly greater extent than the rest of the workers ($t = -3.6708$, d.f. = 22, p less than 0.01) this finding is, in all likelihood, due to activities directly related to the indoor operation of the gin.

Hair arsenic levels were all below the median level of 400 ng/gm reported for the lowest of five cities studied, with 11 of 18 not detectable (limit of detection 130 ng/gm). Although there were more with detectable levels in one of the gins as opposed to the other gin in which hair arsenics were obtained, this did not reach statistical significance. Further, diet could have been an important confounding factor in causing this difference as many of the workers with detectable levels in this gin were related and might be expected to share a fairly common diet. Subsequent industrial hygiene investigation showed that arsenicals had not been used this season.

2. Respiratory Problems

The potential for respiratory problems associated with cotton dust were evaluated in the worker population at each of the three gins.

In interpreting the results from this evaluation, the best test results from all of each individual's tests are used. They are compared to "predicted values" which take into account age, height, sex, and race.[10,11] Pulmonary function is considered "normal" if the best FEV_1 and the best FVC are each 80 percent or more of their respective predicted values and the FEV_1/FVC ratio using the best values is 70 percent or more. It is expected that a person's test results will vary somewhat from time to time. A drop in results over shift of less than 10 percent in FVC or FEV_1 and of less than 6 percent for FEV_1/FVC is considered within normal variation. A drop greater than this may indicate a problem with exposures to noxious substances in the work place.

Pulmonary function data is presented in Table 9. Overall there did not appear to be work-related pulmonary function changes over shift, although one worker around the press and one outside worker did show significant decreases in pulmonary function over shift with accompanying symptoms of nasal irritation and breathing difficulty.

By history four of 25 workers had chronic bronchitis, two attributing it to "valley fever", and an additional six had symptoms during the ginning season which had not lasted long enough (cough and/or phlegm production for at least three months a year for at least two years) to be classified as chronic bronchitis. Another three workers reported cough and chest tightness from the dust, particularly when sweeping about the gin. Only ten of the 25 gave a history without any respiratory problems.

Six workers showed decreased pulmonary function--two with a history of asthma, two with a history of chronic bronchitis, and two without symptoms but a history of at least 1-1/2 packs a day smoking.

Of 24 workers questioned both pre and post shift, 13 (54%) developed irritation of eyes, nose and/or throat, 5 (21%) developed chest complaints (such as tightness, shortness of breath, wheezing), and 3 (12%) complained of dizziness. Ten (42%) had no complaints.

Of 12 workers whose only history was obtained on the first visit early in the season, one mentioned an allergy to defoliants and another mentioned the dust at the gin bothered him worse after he had been away a while.

VII. CONCLUSIONS

A. Environmental

It is felt by the environmental and medical officers that all of the employees evaluated during the NIOSH surveys were being exposed to the chemical and physical agents addressed in this report and that these employees' health was being adversely affected. The following are the environmenal and medical conclusions.

1. Pesticide Residue Laden Materials

The environmental results obtained from the pesticide residue analysis performed on the bulk samples described earlier are very significant, especially in relation to the medical cholinesterase findings. It is felt that the employees evaluated in these gins are being overexposed to pesticide residue laden materials, e.g., organophosphates and carbamates. There is sufficient evidence to draw a strong correlation between the pesticide residue laden exposure concern and the decrease in cholinesterase levels found in the gin workers evaluated in this study.

Based on the concentrations found on bulk sample analysis and the period of application, results are suggestive that the chemical with the greatest likelihood of producing the depressed cholinesterase levels in these workers is DEF/Folex. It is also suggestive that Azodrin, methyl parathion, and Lorsban may also be contributing to the workers' exposure over the season. If less time had elapsed between sampling and analysis, higher levels and/or additional chemicals may have been found.

2. Cotton Dust

In this phase of the cotton industry (i.e., cotton picking and ginning), there is no standard at present for cotton dust and/or exposures to many of the pesticides used. However, the results determined in this investigation would suggest that further attention be given for such standards or criteria.

The results obtained especially for the cotton dust sampling performed during the February survey are strongly suggestive, when compared to either the 0.2 or 0.5 mg/M^3 (200 and 500 ug/M^3) criteria described earlier, that gin workers are being over exposed to cotton dust when processing cotton, especially rood/ground cotton. NIOSH, Morgantown, West Virginia, is presently concluding a major cotton gin study and the criteria mentioned above may be lowered once the final environmental and medical data is correlated. However, for this investigation it is felt that the 0.2 - 0.5 mg/M^3 criteria are reasonable and should be considered by the Tribal Health Board as a guide when establishing and/or evaluating the cotton dust exposures in this gin.

It is also felt that results obtained with the SVE used during these studies can be used to compare with current environmental criteria.

3. Nuisance Dust

The results obtained from the nuisance dust sampling did not indicate overexposures. However, there did appear to be significant differences in results when comparing either the amount of dust produced by the three phases of picked cotton or the amount of dust exposures found when comparing the various job categories. This is important when considering the medical cholinesterase levels found. Since the greater concentration of dust in the gins occurs to the ginning operators, pressman, and suction operators during the rood/ground ginning process, these may be the stages (places and time) to attempt to reduce the pesticide exposures via engineering controls and/or by personal protective devices.

4. Noise

All but one of the the noise levels received during the sound level testing, as well as the personal testing, exceeded the present OSHA standards and NIOSH recommended criteria. The majority of the noise measurements were in excess of the criteria; therefore, it is concluded that all of these employees were over exposed to excessive noise levels during the survey periods. No hearing protection program had been developed at any of the three gins.

The sound level readings obtained during the survey indicate that these levels are continuous throughout the gins, as well as throughout the ginning season. The noise data obtained during our investigations are consistent with other investigators' cotton gin noise findings.[12,13,14] These earlier studies concluded that the higher noise frequency levels obtained (80-100 dBA) were primarily between 2000-8000 Hertz (Hz). That is, when the influence of the sound-pressure level at each frequency band was considered relative to its effect on the A-network, the 2000-8000 Hz range was most important. These findings are very important since the primary level that is considered to cause hearing damage is above 85 dBA with noise frequencies in the 4000-6000 range.

B. Medical

Considering the combined results from the three gins studied, the statistically significant lowering of red cell cholinesterase between the early season and late season tests indicates the gin workers are being affected by organophosphate residues in the raw cotton. Two workers had low enough cholinesterases that greater protection or removal would have been recommended if the season had not been over by the time the results were available.

The considerable proportion (54%) of workers developing irritative symptoms over shift, with two showing clinically significant decreases in lung function over shift, indicates there is a problem with cotton dust and/or general dust in and about the gin. The fact that several workers mentioned sweeping as the worst time emphasizes this, as well as suggesting that vacuuming would be preferable. Additional respiratory protection should be provided at least until the exposures are controlled or eliminated.

It should be recognized that chronic bronchitis might relate to the residents in the valley as readily as to the ginning work force. In the case of the six workers with bronchitic symptoms during the current season their symptoms most likely relate to the ginning as their exposures at work would be much more intense than their general exposure in the valley.

The fact that these six workers developed symptoms of bronchitis during the ginning season and that over half the workers developed symptoms over shift suggests that additional dust control is necessary to prevent ill effects from dust exposure at the gin.

C. Other Concerns

In general, the suction and outside operators were not considered to be as exposed as those employees who work inside the gin. However, during the dirtier ginning periods (second and third picked cotton), these employees were also considered to be at risk to pesticide residue laden (organophosphates) exposures.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental and medical study, as well as personal communications with individuals at the the gins, the following recommendations are made to ameliorate potential health hazards and to provide a better work environment for the employees covered by this report. Recommendations specific to each gin are included in the individual supplements.

A. Environmental

Whenever possible engineering controls are the preferred method for decreasing environmental exposures to toxic substances and harmful physical conditions for the protection of the employees' health.

1. Ventilation

Exhaust ventilation is the most effective means of removing the contaminant from the work environment. One gin on the Reservation, Parker Valley Gin, has developed such controls and this system, when operating, should reduce the cotton dust exposures considerably. This same gin was also considered to be the cleanest of all the gins evaluated and it was felt that the Parker Valley's exhaust ventilation system contributed to this condition. Therefore, this type of local exhaust system should be considered to reduce the dust exposure in other gins.

2. Noise Control

Noise control in a cotton gin is difficult and would require numerous alterations to reduce the various noise sources found in a gin. However, over time this can be accomplished and various techniques are described in Appendix 1. This article (by W. S. Anthony and O. L. McCaskill, 1977) describes noise control principles, plant design and layout, machinery design and methods of noise control, e.g., vibration, sound absorption, sound barriers and sound enclosures.

3. Housekeeping

Due to the numerous sources of dust in the gin environment it is felt that a rigorous housekeeping program is essential. This should include periodic cleaning as well as a thorough cleaning at the end of each shift. A vacuum system and brooms should be used for cleaning. High pressure air nozzles should not be used due to the high dispersion of dust created by this method.

4. Personal Protection Equipment

a. Respiratory Protection

When the limits of exposure cannot be immediately met by limiting the concentrations in the work environment, via engineering and administrative controls, a program of respiratory protection should be utilized to protect those persons exposed who are working in the gins. This program should be an official written respiratory program.

At present there are two types of NIOSH approved respirators (disposable and non-disposable) available from different manufacturers to reduce and/or eliminate exposures to the pesticide residue laden materials which are of concern in this study.

The following is a brief description of some of the primary concerns which should be addressed in a respiratory program when using either a disposable or non-disposable respirator:

(1) There should be an established procedure and means and facilities provided to issue respiratory protective equipment, to decontaminate and disinfect the equipment (non-disposable type), and to repair or exchange damaged equipment.

(2) Employees should be given instructions/education on the proper use of respirators assigned to them, cleaning respirators, and testing for leakage.

(3) Respirators should be issued with caution. There might be individuals in the group for whom wearing a respirator (either disposable or non-disposable) carries certain specific dangers, i.e., highly increased resistance to airflow in a person with compromised pulmonary function may be associated with acute respiratory insufficiency. Employees experiencing frequent and continuous breathing difficulty while using respirators should be evaluated by a physician to determine the ability of the workers to wear a respirator.

(4) The information described above should also be given or available in Spanish when needed.

Further information on this topic is available in the NIOSH Publication 76-189, "A Guide to Industrial Respiratory Protection." Finally, for those individuals who are not getting a proper respiratory face mask fit, alternative respirators should be made available. There are a number of different designs and sizes, both large and small, on the market today and these alternatives should be sought out.

b. <u>Personal Protective Clothing</u>

Personal protective clothing should be provided to employees working in those areas where dust is presently being generated in excessive amounts. This clothing should be disposable clothing or clothes to be worn at work only. Nondisposable clothing should be laundered outside the home in order to eliminate exposures to family members.

c. Hearing Protection Program

When workers are exposed to sound levels exceeding the OSHA standard, feasible engineering or administrative controls must be implemented to reduce levels to permissible limits. OSHA has recently issued a hearing conservation amendment to its noise standard. For workers exposed at or above a TWA of 85 dB, the amendment requires noise exposure monitoring, employee education, and audiometric testing. Review of audiograms have to be made by an audiologist, otolaryngologist, or a qualified physician in their absence. Employees also must be notified of monitoring results within 21 days. Employee records must be kept by the employer for up to five years after termination of employment. Finally, for those employees exposed to noise levels exceeding 90 dBA for eight hours and/or where audiometric testing results indicate a hearing loss, ear protection must be worn.

To insure that full personal protection is being provided during those periods of exposure the Environmental Protection Agency's Noise Reduction Ratings (NRR) should be consulted and understood when selecting hearing protection in order to provide the most effective device. Each protective device (ear plugs or muffs) has a NRR rating which, for that particular type and model, describes what percent of noise attenuation may be obtained when using a particular device. However, these ratings can be misunderstood, i.e., suppose a muff (X) has good attenuation at all frequencies except at 4000 Hertz where it has excellent attenuation and its overall NRR rating is 23. Another muff (Y) has great attenuation at all frequencies except 4000 where its attenuation is poor and its overall NRR rating is 26. Therefore, if one picks muff (Y) because of the higher NRR when the greatest noise intensity is 4000 Hertz, he would get less protection where he needs it most.

It should also be pointed out that certain ear plug-type hearing protectors can potentially produce ear infections. That is, ear plugs are frequently removed and replaced during a work day and due to the amount of dirt and grime on the workers hands it is possible that this type of hearing protection could carry the material from the hands onto the ear plugs and eventually into the canal of the ear.

Based on conversations with research groups concerned with noise reduction in gins, it does not appear at present that engineering techniques can be developed into a gin in a short time frame; therefore, a thorough hearing protection program is recommended until appropriate noise reducing changes can be instituted.

5. Personal Hygiene

Attention to personal cleanliness and avoiding contamination of food, drinking water, and tobacco products with the gin dust should minimize absorption of noxious pesticides and/or other chemicals from the dust by either ingestion, inhalation, and/or skin absorption.

B. Medical

1. Red blood cell cholinesterase screening should be instituted.

   a. At the start of the season each worker should have a red cell cholinesterase determination. If the individual has worked with pesticides in the recent past, or if the start of season test differs from a previously established start of season levels by more than 15%, a baseline should be established using the mean of two cholinesterase determinations on separated samples of blood taken at least a day apart. If the two values differ by more than 15%, additional determinations should be made until two successive tests do not differ by more than 15%.

   b. Red blood cell cholinesterase determinations should be repeated at bimonthly intervals during the ginning season. After one or two season's experience it may be determined that the consistent use of adequate respiratory protection may make cholinesterase monitoring unnecessary in some groups of workers.

   Any decrease of an individual's red cell cholinesterase activity to less than 70% of his original or baseline value is cause for concern and should (1) trigger an investigation on how to decrease both airborne and dermal exposure to dusts which may contain pesticide residues (consider both on and off job exposure), and (2) require a prompt repeat cholinesterase determination.

   If an individual's cholinesterase activity is less than 60% of his baseline, he should be removed from further exposure and receive a medical evaluation. Return to work should be delayed until the red cell cholinesterase has risen to at least 75% of baseline.

2. A policy is needed regarding respiratory evaluation, particularly for workers who are employed more than one season. A rather comprehensive scheme for medical surveillance can be found in Title 29, Chapter XVII, Section 1910.1046 of the Code of Federal Regulations, 1980, which can serve as a basis for such an evaluation.

C. Other Recommendations

1. Repair all leaks in the interior and exterior processing equipment.

2. Enclose processing machinery as much as possible to reduce and/or eliminate dust and noise problems.

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NIOSH is thankful to the Colorado River Tribal Council, Tribal Health Department, and the management and employees of the Colorado River, Plantation, and Parker Valley Gins for their cooperation and assistance with this Health Hazard Evaluation. The information gathered from this study will not only assist in maintaining the health and safety of those persons working here, but also other companies who perform similar operations.

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Colorado River Gin, HE No. 80-245.
2. Plantation Gin, HE No. 80-246.
3. Parker Valley Gin, HE No. 80-247.
4. Colorado River Tribal Health Department.
5. U.S. Department of Labor/OSHA - Region IX.
6. NIOSH - Region IX.
7. Arizona Department of Health.
8. State Designated Agency.
9. Pheonix Area Indian Health Service
10. PHS Indian Hospital, Parker, Arizona

For the purpose of informing the affected employees, a copy of this report shall be posted in a prominent place during the season and should accessible to the employees for a period of 30 calendar days.

TABLE 1

Pesticides Used During Cotton Growing Season 1980-81
Parker, Arizona

Pesticide	Type Pesticide	Criteria mg/M^3 OSHA	NIOSH	TLV (ACGIH)	Time Sprayed	Dose Sprayed
Insecticides						
Carbaryl (Sevin)	C	5.0	5.0	5.0	M	L
Methyl Parathion	O.P.	--	--	0.2	M/L	L/M
Parathion	O.P.	0.11	0.05	0.1	M/L	L/M
Malathion	O.P.	15.0	15.0	10.0	NA	NA
Methomyl-(Lannate, Nudrin)	C	--	--	2.5	E/M/L	H
Trichlorfon (Dylox)	O.P.	--	--	--	E/M	M
Demetron (Systox)	O.P.	0.1	--	0.1	NA	NA
Dimethoate	O.P.	--	--	--	NA	NA
Bacillus Thurigiensis	Microb.	--	--	--	M/L	H
Toxophene	C.H.	--	--	0.5	E	L
Heliothis Virus (Elcar)	Microb.	--	--	--	NA	NA
Dicofol (Kelthane)	O.P.	--	--	--	E/M/L	H
Supracide	O.P.	--	--	--	M	M/H
Phosphamidon	O.P.	--	--	--	NA	NA
Lorsban*	O.P.	--	--	--	M/L	M
Orthene	O.P.	--	--	--	M/L	L
Ambush	S.P.	--	--	--	M/L	H
Karmex (Diuron)	O.P.	--	--	--	E	L/M
Pounce	S.P.	--	--	--	M/L	H
Pydrin	S.P.	--	--	--	M/L	H
Bolstar	O.P.	--	--	--	M/L	L/M
Chlordimeform-(Galecron-Fundal)	Form.	--	--	--	M/L	H
Azodrin*	O.P.	--	--	0.25	E/M/L	H
Aldricarb (Temik)	C	--	--	--	E	M
Bidrin	O.P.	--	--	0.25	M/L	L
Azinphosmethyl-(Guthion)	O.P.	0.2	--	0.2	M	M

Herbicides (continued next page)

TABLE 1 (continued)

Pesticides Used During Cotton Growing Season 1980-81
Parker, Arizona

Pesticide	Type Pesticide	Criteria mg/M3 OSHA	NIOSH	TLV (ACGIH)	Time Sprayed	Dose Sprayed
Herbicides						
Protluralin-(Tolban)	Amiole	--	--	--	E/L	Pre Plant
Fluchloralin-(Baselin)	Nitroamiline	--	--	--	NA	NA
Trifluralin-(Treflan)	Nitroamiline	--	--	--	Pre Plant	H
Pendinethalis-(Prowl)	O.P.	--	--	--	Pre Plant/M	H
Diuron	Subst. Urea	--	--	--	Lay By	L
Prometryn (Caparol)	Triazine	--	--	--	Pre Plant/Lay By	H
Bensulide (Prefar)	O.P.	--	--	--	NA	NA
DCPA (Dacthal)	O.P.	--	--	--	NA	NA
Glyphosate-(Roundup)	O.P.	--	--	--	E/M/L	H
DSMA	Inorg. Arsen.	--	--	--	E/M	L
MSMA	Inorg. Arsen.	--	--	--	E/M	L
Pronamide (Kerb)	Amide	--	--	--	NA	NA
Cotoran	O.P.	--	--	--	Lay By	H
Defoliants						
Sodium Chlorate	Inorg.	--	--	--	L	H
Paraquat	Dipyridylium	0.5	--	0.5	L	M
Folex*	O.P.	--	--	--	L	H
DEF*	O.P	--	--	--	L	H

* NOTE: Chemicals found on bulk samples analyzed.

TLV (ACGIH) = Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists.

LEGEND NO. 1

C = Carbamate
O.P. = Organophosphate
C.H. = Organochlorine
Microb. = Microbial
Inorg. = Inorganic

LEGEND NO. 2

Time Sprayed: E = Early season (May-July); M = Midseason (July-August); L = Late Season (August-October).
Dose Sprayed: L = Light spraying; M = Moderate spraying; H = Heavy spraying.
NOTE: Time and Dose sprayed are normal periods and concentrations.
NA = Non-applicable, i.e., was not used during 1980-81 cotton growing season.

TABLE 2

RANGE OF COTTON DUST LEVELS

COLORADO RIVER GIN
PLANTATION GIN
PARKER VALLEY GIN

FEBRUARY 1981

JOB/TASK DESCRIPTION	SAMPLING TIME (minutes)		mg/M^3 Cotton Dust
Bale Press	303 - 365		0.25 - 0.96
Bale Press	370 - 380		0.24 - 1.36
Gin Stand	357 - 382		0.51 - 1.83
Gin Stand	302 - 363		0.57 - 6.43
Yard Area	348 - 425		0.19 - 0.29
EVALUATION CRITERIA		NIOSH/ACGIH	0.2
		OSHA	0.5

mg/M^3 = milligrams of substance per cubic meter of air

TABLE 3

RANGE OF PESTICIDE RESIDUE LADEN BULK RESULTS (ug/sample)

COLORADO RIVER GIN
PLANTATION GIN
PARKER VALLEY GIN

FEBRUARY 1981

JOB/TASK DESCRIPTION	DEF	AZODRIN	METHYL PARATHION	LORSBAN
Cotton Trash/Inside Gin	10.0 - 54.0	0.8 - 2.1	ND	ND - 0.8
Cotton Trash/Outside Gin	16.0 - 24.0	1.2 - 8.5	ND - 0.5	ND - 0.4
Raw Trailer Sample	1.3 - 6.6	ND - 8.5	ND - 0.5	ND - 0.4
Rafter Sample	16.0 - 140.0	9.6 - 11.7	0.1 - 0.2	1.2 - 7.1
Preprocessed Cotton	1.9 - 10.1	3.4 - 13.8	ND - 0.4	ND - 0.9
Finish Cotton	0.9 - 3.3	ND - 1.2	ND	0.2 - 0.7
Seed	0.4 - 1.0	ND - 0.9	ND	ND
LIMIT OF DETECTION (ug/sample)	0.4	0.6	0.4	0.5

DEF = Defoliant (s,s,s,-tributylphosphorotriethiate)
ug/sample = micrograms per sample
ND = non-detected

TABLE 4

RANGE OF NUISANCE DUST LEVELS

COLORADO RIVER GIN
PLANTATION GIN
PARKER VALLEY GIN

FEBRUARY 1981

JOB/TASK DESCRIPTION	SAMPLING TIME (HOURS)	mg/M^3 NUISANCE DUST
Head Ginner	7.5 - 8.0	3.64 - 10.55
Assistant Ginner	7.5 - 8.0	2.60 - 3.76
Hardman/Press	7.5 - 8.0	3.62 - 4.34
Suction Opeator	7.5 - 8.0	2.97 - 6.79
Pressman	7.5 - 8.0	0.66 - 3.36
EVALUATION CRITERIA	ACGIH/TLV 8-hour	10.0

ACGIH/TLV = American Conference of Governmental Industrial Hygienists/Threshold Limit Value

TABLE 5

RANGE OF NOISE DOSIMETER LEVELS

COLORADO RIVER GIN
PLANTATION GIN
PARKER VALLEY GIN

FEBRUARY 1981

JOB/TASK DESCRIPTION	SAMPLING TIME (HOURS)	8-HOUR TWA NOISE (dBA)
Personal Samples		
Head Ginner	7-8	95.7 - 98.6
Assistant Ginner	7-8	92.0 - 96.7
Hardman/Press	7-8	89.6 - 95.0
Suction Operator	7-8	83.8 - 85.2
Suction Operator	7-8	82.0 - 84.7
Press/Behind	7-8	90.0 - 94.5
Area Samples		
Bale Press	NA	93.6 - 97.0
Gin Stand	NA	99.2 - 101.5
Gin Stand	NA	98.2 - 100.0
Gin Stand	NA	99.0 - 100.0
Gin Stand	NA	100.2 - 101.0
Behind Stands	NA	97.6 - 99.8
Incline Cleaner	NA	96.5 - 99.9
Baler	NA	97.0 - 99.2
Loading Dock	NA	89.3 - 93.7
Cyclone-Trash	NA	99.7 - 105.0
Cotton Press	NA	98.0 - 102.3
Sucker Pipe	NA	92.0 - 96.5
EVALUATION CRITERIA	NIOSH 8-hour TWA	85 dBA
	OSHA 8-hour TWA	90 dBA

NOTE: OSHA Revised Hearing Conservation Regulation requires employer to institute a hearing protection program if TWA noise exceeds 85 dBA.

NA = Non Applicable--their value is the average of three measurements at each gin.

TABLE 6

RANGE OF OCTAVE BAND SOUND-PRESSURE LEVELS FOUND BETWEEN 1000 - 8000 (Hz)

COLORADO RIVER GIN
PLANTATION GIN
PARKER VALLEY GIN

FEBRUARY 1981

LOCATION	(dB-A) NETWORK	(dB) OCTAVE BAND CENTER FREQUENCIES (Hz)			
		1000	2000	4000*	8000*
Gin Stand	99.2 - 101.5	91.5 - 94.3	91.5 - 94.3	89.7 - 92.6	86.6 - 88.2
Gin Stand	98.0 - 100.0	91.8 - 93.7	90.7 - 91.2	86.3 - 88.3	82.5 - 84.2
Gin Stand	99.0 - 100.0	93.0 - 96.0	92.8 - 95.0	87.1 - 90.0	84.1 - 85.7
Gin Stand	100.2 - 101.0	97.0 - 98.6	92.6 - 95.9	88.6 - 89.1	85.7 - 87.3
Incline Cleaner	96.5 - 99.9	93.5 - 95.7	89.3 - 91.4	87.1 - 90.2	81.1 - 84.5
Baler	97.0 - 99.2	94.2 - 96.8	91.7 - 95.3	88.3 - 89.5	84.3 - 87.6
Loading Dock	89.3 - 93.7	92.0 - 96.8	91.5 - 93.5	88.2 - 89.9	86.7 - 89.1
Cyclone Trash	99.7 - 105.0	99.0 - 101.8	97.0 - 100.0	86.5 - 87.5	78.6 - 79.4
Cotton Press	98.0 - 102.3	89.7 - 94.5	88.9 - 90.2	84.6 - 86.8	75.9 - 77.3
Sucker Pipe	92.0 - 96.5	91.7 - 93.8	89.0 - 95.0	91.5 - 94.7	83.9 - 85.6

Hz = Frequency

* = 4000-6000 Hz is that range which has the greatest physiological impairment to hearing in man.

TABLE 7

CATEGORIZATION OF STUDY POPULATION BY JOB, AGE, AND SEASONS GINNING
Colorado River Indian Reservation, Parker, Arizona
1980-1981 Ginning Season

	Seen 10/80	Seen 2/81	Total Seen	Age		Seasons Ginning		
				Mean	SD	#	Mean	SD
Ginners, Ginner Helpers, and Standwalker	3	6	6	31.5	11.5	6	14.3##	10.9
Pressmen and Helpers	6	10 (1)*	13	25.6**	9.9	12	2.3@	1.4
Suction	2 (1)*	6	7	30.4	10.8	6	2.9	2.6
Other Outside	3	1	4	39.8	3.8	4	4.0	3.9
Managers and Other Office	3	2	4	56.8#	7.8	4	19.0@@	9.1
Other and Mixed	2	2	3	34.0	17.8	3	2.1	2.5
TOTALS	19	27	37	33.1	13.6	35	6.5	8.3

SD = Standard Deviation
* One worker seen once in each category. Included in the mixed category for mean age and seasons ginning.
** Statistically significantly different from rest of study group; t=-2.6558 (d.f.=35) p=0.012.
\# Statistically significantly different from rest of study group; t=4.6401 (d.f.=35) p less than 0.01.
\## Statistically significantly different from rest of study group; t=2.7734 (d.f.=33) p less than 0.01.
@ Statistically significantly different from rest of study group; t=-2.3569 (d.f.=33) p=0.025.
@@ Statistically significantly different from rest of study group; t=3.7723 (d.f.=33) p less than 0.01.

Cholinesterase Levels (pH Units) by Job Group
Colorado River Indian Reservation, Parker, Arizona
1980-1981 Ginning Season

		Ginners	Pressmen	Suction	Others	Total Study Group
RBC Cholinesterase						
October 1980	Number	3	6	3	6	18
	Mean	.60*	.66**	.67@	.62	.64#
	SD	.00	.05	.06	.08	.06
February 1981	Number	5	10	5	4	24
	Mean	.49*	.50**	.57@	.59	.53#
	SD	.07	.06	.04	.02	.06
% Feb '81/Oct '80						
	Number	2	4	0	1	7
	Mean	79	74	---	79	76
	SD	6	8	---	---	7
Plasma Cholinesterase						
October 1980	Number	1	4	2	6	13
	Mean	.75	.72	.65	.75	.73
	SD	---	.05	.21	.15	.12
February 1981	Number	5	10	5	4	24
	Mean	.68	.71	.72	.62	.69
	SD	.13	.06	.04	.10	.08
% Feb '81/Oct '80						
	Number	1	1	0	1	3
	Mean	107	114	---	100	107
	SD	---	---	---	---	7

Normals: Red Cell Cholinesterase 0.44 - 1.09 pH units.
Plasma Cholinesterase 0.38 - 1.54 pH units.
Change less than 70% drop.

SD = Standard Deviation
* Statistically significant drop t=2.8297 (d.f.=6) p=0.034.
** Statistically significant drop t=5.6019 (d.f.=14) p=0.01.
@ Statistically significant drop t=2.6772 (d.f.=6) p=0.040.
\# Statistically significant drop t=5.6270 (d.f.=40) p=0.01.

TABLE 9

Pulmonary Function by Job Group
Colorado River Indian Reservation, Parker, Arizona
1980-1981 Ginning Season

		Ginners	Pressmen	Suction	Others	Total Study Group
Best Values						
	Number	6	11	6	4	27
Forced Vital Capacity (FVC) (% Predicted) (Normal: 80% or better)						
	Mean	102.0	104.6	103.5	102.0	103.4
	SD	8.4	12.9	12.3	17.9	12.0
Forced Expiratory Volume - 1 second (FEV_1) (% Predicted) (Normal: 80% or better)						
	Mean	103.3	101.8	102.5	85.0*	99.8
	SD	10.8	17.1	11.9	16.5	15.3
FEV_1/FVC (%) (Normal: 70% or better)						
	Mean	83.7	80.8	82.2	66.2**	79.6
	SD	7.8	8.1	4.4	9.4	9.2
Change Over Shift (% Post Shift-Pre Shift/Pre Shift)						
	Number	4	11	5	4	24
FVC (Normal: less than 10% drop)						
	Mean	-1.90	-2.11	-0.88	-3.72	-2.09
	SD	3.48	3.25	2.60	6.18	3.63
FEV_1 (Normal: less than 10% drop)						
	Mean	-3.48	-3.13	+0.08	-1.60	-2.26
	SD	3.94	4.99	4.77	4.82	4.66
FEV_1/FVC (Normal: Less than 6% drop)						
	Mean	-1.25	-0.60	+0.22	+2.88#	+0.04
	SD	2.29	2.63	3.88	2.26	2.983

SD = Standard Deviation
* Statistically significantly lower than rest of group; t=-2.2629 (d.f.=25) p=0.036.
** Statistically significantly lower than rest of group; t=-3.9250 (d.f.=25) p less than 0.01.
\# Statistically significantly higher than rest of group; t=2.2654 (d.f.=22) p=0.028.

Noise Control

The basic principles of noise control are quite simple, and ginners are personally exposed to them, although they may be unaware of their exposure. The basic principles of noise control deal with the noise source, the path the noise takes, and the receiver of the noise. When a fan is started in the fan room, it radiates noise that a ginner perceives at the control console. Closing the door to the fan room (altering the noise path) reduces the noise level at the console. If a ginner walks inside an enclosed office area (isolating him as the receiver), the noise level he perceives also decreases. When the fan speed is reduced (modifying the noise source), the noise level decreases. Most applications of noise control technology available to ginners involve an alteration of the noise path.

Most noise is emitted from the source in the form of pressure waves in the air. The waves travel in all directions from the source until they strike a surface or simply decay with distance. When a wave strikes a surface it is partially absorbed, transmitted, and reflected. Noise reaches the ear by a direct path without interruption, and by an indirect path, through reflection. The direct path is the most critical. In a gin, reflections from such surfaces as walls, ceilings, floors, metal piping, and gin machinery contribute significantly to the noise level. Noise control by isolation of the receiver or the source must interrupt the paths between the noise source and the receiver. Paths for sound include transmission through or around objects such as ducts, piping, machinery, walls, and doors. The effectiveness of a good acoustical barrier can be easily destroyed by loose-fitting openings or other small cracks.

Plant Design and Layout

Initial decisions on plant design and layout should be made with noise control in mind. Design parameters must give consideration to the ginning processes and material flow. The directional characteristics of noise emissions from certain pieces of gin equipment such as gin stands and lint cleaners should be considered. Noise sources such as fans that do not require constant attention should be grouped and isolated. The length of sheet-metal piping used to convey seed cotton should be minimized by careful placement of seed-cotton handling and processing equipment. When seed or seed-cotton conveying pipes cannot be isolated from the gin employees, they should be insulated. Air intakes should be placed outside the gin building. In many gins an air intake for a centrifugal blower used for seed conveyance is located near a gin stand. The siren-like noise is quite objectionable. Location of the air intake outside the building or near the ceiling of the building will subdue the noise. Many similar applications and additional principles should be considered when plant design and layout are being planned.

Machinery Design

Noise reduction by machinery design or modification should be conducted by personnel qualified in acoustical engineering. One example of a modification that will reduce the noise produced by machinery with rotating doffing brushes is replacement of the conventional doffing brush with a solid-face brush. Research at the U.S. Cotton Ginning Research Laboratory at Stoneville, Mississippi, indicated that the noise produced by a conventional lint cleaner was reduced 20 dBA when a spirally wound, solid-face brush was used instead of the conventional brush. The overall noise level was lowered 4 dBA, a 40-percent reduction in sound intensity, when the gin machinery necessary to process cotton was operated at the same time as the modified lint cleaner. In effect, the other equipment produced enough noise that much of the noise reduction gained by replacing the brush in one lint cleaner was overshadowed. The amount of noise reduction possible through modification of all of the high-speed brush cylinders has not been determined.

Machinery noise is directly proportional to the speed at which the machinery operates. Machinery such as fans, gin stands, and lint cleaners should be operated at the minimum speed that will insure efficient and effective operation. The replacement of small, high-speed fans with large, slow-speed fans will reduce noise substantially. Since fans generate minimum noise when they are operated at their maximum efficiency, the fan performance curve should be used as a guide in design of air systems in gins.

Methods of Noise Control

Vibration

Dynamic unbalance of equipment resulting from poor or faulty installation and maintenance can generate unnecessary noise, decrease equipment life, and interfere with its proper operation. Factory-balanced equipment may need additional balancing after installation. Accumulation of grease and dirt in working parts can upset the dynamic balance of rotating equipment. Crede (3) indicated that dynamic unbalance is the most common cause of excessive vibration in rotating machinery. Vibration is transmitted to and through floors, walls, piping, and duct work. Noise reductions of 10 to 20 dBA are not uncommon when poorly balanced equipment is properly balanced.

Vibration measurements should be taken first at each machinery bearing. A vibration meter is helpful; however, observation and personal contact (sense of touch) may be used as a field expedient. One can often determine the extent of vibration by touching the piping and ductwork. When excessive unbalance is evident, qualified vibration professionals must balance the machinery components to reduce noise and increase the life span of the equipment.

Machinery vibration can produce excessive noise by direct transmission of the vibration to other machinery and metal piping and radiation.

Ginners can decrease radiated noise by increasing the stiffness of the material from which the noise is vibrating or by the addition of structural braces. Damping materials that may be brushed on, sprayed on, or troweled on may also be used. Another possible way that noise radiation can be reduced is by substitution of machine components. Some examples are:

1. Substitute helical gears for straight-cut gears.
2. Substitute nylon, plastic or sintered gears for steel gears.
3. Use large, low-speed machinery instead of small, high-speed machinery.
4. Use enclosed speed reducers in lieu of open reduction gears.

Enclosed speed reducers can be quite effective noise-reduction devices when used on bale-press tramper and seed-cotton separators. Excellent results were obtained at the U.S. Cotton Ginning Research Laboratory when the back gears on a separator were replaced by an enclosed speed reducer.

Structure-borne vibration can be transmitted long distances and regenerated as noise at locations far from the machine. Structure-borne vibration and noise can be controlled by vibration isolation. This procedure involves the placing of resilient material such as flexible joints, steel springs, rubber, cork, and felt, between vibrating machines, the supporting structure, and the associated piping. For example, lint cleaners should be isolated from the associated ductwork by a flexible connection. Machinery should be isolated from metal floors with vibration isolation mounts. The mounts must be specifically selected for each machine, based primarily on the frequencies at which the machine vibrates. Some typical materials used for vibration isolators are: elastomers, elastomeric foam, cork, fiber glass, felt, and steel in such forms as springs, mesh pads, and coiled cables. The essential features of vibration isolators are a resilient load-supporting mechanism (stiffness) and an energy-dissipating mechanism (damping).

Piping should be isolated from the building structure by use of resilient pipe hangers. Care should be exercised in the use of sheet metal machinery guards. One may add stiffening ribs to prevent the sheet metal guards from acting as a loud speaker. Expanded metal guards are satisfactory; however, they provide no noise reduction.

In summary of the material in this section, noise due to excessive vibration can be reduced by:

1. Reduction of unbalanced forces (balancing).
2. Isolation of a vibration source from a noise radiator by use of a vibration isolation mount.
3. The use of vibration damping material for reduction of noise radiation from undamped surfaces.
4. The use of flexible connections between the vibration source and the connected machinery piping and ductwork.

Successful results may require the use of any or all of these techniques in addition to others that contribute to the reduction of noise due to vibration.

Sound Absorption

Acoustical materials and structures may absorb a substantial portion of the sound which strikes the surface. Porous, absorptive materials are the best acoustical absorbers. Fibers, foams, perforated board, and fabrics are absorptive materials generally used. Fiber glass materials absorb sound by allowing the sound waves to enter and travel between the fibers, where the pressure waves become scattered and dissipate. Dense materials such as steel structures, sheet metal, and hard-surfaced sheathing do not absorb sound, but reflect it.

Sound absorptive materials may be applied as coverings to the surfaces of walls and ceilings, as individually suspended units, as linings for barriers and enclosures used for the confinement of a noise source, and as linings in the form of exterior lagging for the reduction of noise transmission through pipes and ducts.

Mufflers and silencers may be used for the reduction of noise emitted by air compressors and fans. The simplest muffler to construct is an absorptive one that consists of a sheet-metal duct or pipe lined with an acoustical material for the absorption of sound. Four experimental mufflers were constructed at the Laboratory at Stoneville and compared with a commercially available muffler. We constructed mufflers of concentric pipes 18 inches and 26 inches in diameter. We made the inner pipe from flattened expanded metal and the outer pipe from 22-gage sheet metal. The void between the two pipes was filled with 4 inches of acoustical fiber glass. The commercial muffler was similarly constructed, but had a cylindrical, sound-absorbing insert in the center of the pipe. The insert prevents the muffler from being used in a materials-handling situation. The mufflers were installed in separate treatment combinations on the intake side of a No. 45 fan, on its discharge side, on both its intake and discharge sides, and on the pipe outlet about 35 feet downstream from the fan.

Results indicated that the fan noise was not appreciably reduced near the fan when mufflers were installed on its intake side, on its discharge side, or on both its intake and discharge sides. However, the fan rotational and airflow noises 25 feet downstream from the fan were reduced by about 5 dBA. Noise at the pipe outlet was dramatically reduced from 95.5 to 75.0 dBA when two experimental mufflers were placed in series on the discharge side of the fan and the commercial muffler was placed at the pipe outlet.

Cocke (2) reported that when the housing of a No. 35 fan that driven at 1,800 rpm by a 25-hp motor was covered with a 1/2-i thickness of glass fiber over 2 inches of felt, the noise level of the was reduced 9.5 dBA. Cocke (2) also reported that noise levels n elbows in seed-cotton conveying pipes increased 4 dBA, or m when seed cotton was processed through the sheet-metal pip When he wrapped the elbow with 3 inches of felt and loaded v sheet (0.5 lb/ft² density), the noise near the elbow was reduce dBA. Loaded vinyl is vinyl impregnated with high-den materials such as lead.

Sound Barrier

Sound absorbing materials are effective in reducing noise le in the area where the noise originates; however, they are of lim use in the prevention of noise transmission from one are another. Hard, smooth, nonporous materials with a density lb/ft², or greater, are much more effective as noise barriers. To enclosed barriers are not effective sound reducers, since the n level inside the enclosure greatly increases due to the confinen of the noise to a small volume. However, totally enclosed bar do prevent noise transmission to adjacent areas. One should lin barrier with an absorptive material to increase its effectiveness noise-reduction device. Noise barriers can often be designed that they will have a minimal effect on process operations. geometry of a barrier is important because it must block all d and reflected noise between the source and the receiver. usefulness of barriers can be understood by a simple exan Install a temporary barrier between a noise source and a rece Now, move the barrier closer to the receiver and then closer to noise source. Install a larger barrier and move it back and f between the noise source and the receiver. Significant deviat should occur in the noise level perceived by the receiver. operator should be at least 30° into the "shadow" or protected a behind the barrier. Barriers must be located properly and hav proper dimensions so the operator will be protected from high n levels. The dimensions and locations of the barrier ca calculated theoretically from information presented by Cred

The following suggestions should be considered when s barriers are used. The barriers should:

1. Have a length and width that are greater than the wavele of the noise. Note that the wavelengths of most gin machi noises that contribute to the A-weighting scale range 0.25 to 4.5 feet (table 1).
2. Be located near the source or the receiver.
3. Be lined with an acoustical-absorptive material that prevent the reflection of noise in the area between the ba and the noise source

Some examples of common building materials that are effect barriers are: steel, concrete, wood, brick, gypsum board, gla plaster, and lead. Many specialty products designed as effect barrier materials are available. Specialty barrier products such sheet lead laminated to plastic foam or fiber glass and loaded vi laminated between foam absorptive face and foam insulation la are available.

One can achieve some sound reduction by use of solid machinery guards to shield rotating machinery components. Standard fiber glass guards were installed on a lint cleaner and lint cleaner condenser at the U.S. Cotton Ginning Research Laboratory at Stoneville, and noise on each side of the lint cleaner was reduced 2 dBA. We applied a 1/2-inch-thick foam-rubber seal to the perimeter of the guards to provide an airtight seal between the guards and the lint cleaner and condenser. When we applied 2 inches of acoustical fiber glass to the interior of the standard guards, the noise near the lint cleaner was reduced an additional 1 dBA. In addition, a barrier was placed in the rear of the lint cleaner as shown in figure 3. The front and back of the barrier were constructed of 1/2-inch-thick plywood, and 1-inch-thick fiber glass was sandwiched between the front and back.([illegible] 3. The noise near the lint cleaner was reduced over 4 dBA when the fiber-glass-lined guards and the acoustical barrier at the rear of the lint cleaner were installed and tested together. Application of the limited noise control methods mentioned above produced effective results. Additional noise reduction might be obtained by the application of acoustical treatments other than those we used.

Cocke (2) installed an 8-foot by 8-foot by 3/4-inch-thick plywood barrier lined with 3 inches of glass fiber about 1 foot from the rear of a lint cleaner and reduced the noise level 3 feet behind the lint cleaner by over 10 dBA.

An example of the utilization of existing barriers would be the relocation of the vane-axial fans used for the conveyance of lint cotton to a position outside the gin. Such a relocation of one 26-inch vane-axial fan reduced the noise level near the control console by 2 dBA. Rain hoods should be installed on the discharge of the fan, and the motor should be mounted under the fan when the fan is moved outside. In addition, the fan should be located perpendicular to the pipe or duct that is inside the building so that direct-path noise will be reduced.

We constructed a sound enclosure at the Stoneville Laboratory to house a floor-mounted, 2-hp variable-speed motor that was producing excessive noise near an experimental lint cleaner. The principles mentioned above were employed in construction of the enclosure. A plywood box with an open bottom was constructed from 1/2-inch-thick plywood and lined with 2 inches of fiber glass and 3 inches of acoustical foam. We provided ventilation air by cutting 6-inch by 6-inch openings in the left rear and right front of the box. We constructed plywood ducts lined with the same insulation as the enclosure to transmit air from behind the box to the ventilation intake and away from the discharge outlet of the enclosure. Noise levels at a location near the motor (4 feet away horizontally and 5 feet away vertically) were reduced from 86 to 54 dBA by the sound enclosure. Care must be exercised when enclosing equipment such as motors so overheating will be prevented. Extended periods of operation allowed the 2-hp motor to overheat and ventilation air had to be forced in by a remotely located fan.

Because of the problem of motor temperature rise that are associated with total enclosures, and because of their associated size, weight, and construction cost, a simple muffler offers an attractive alternative for totally enclosed fan cooled (TEFC) motors. Such commercially available mufflers can reduce the noise of a motor-cooling fan to within acceptable limits. Mufflers for motors other than TEFC motors are not available except as enclosures.

When enclosures are used for the confinement of processing operations such as lint cleaning, closed-circuit television systems are essential. Ginners can strategically locate cameras to monitor as many operations as necessary to properly control the ginning operation.

Sound Enclosures

When a large amount of noise reduction is desired, a total enclosure is the most effective sound-reduction device. An effective enclosure must:

1. Have airtight joints since even a small crack can transmit a large amount of noise. A small crack in an enclosure is similar to a leak in a high-pressure air tank.
2. Be constructed of heavy walls that do not vibrate from excessive noise.
3. Be lined with material that will absorb noise and prevent reverberation.
4. Provide ventilation, if needed. Ventilation air may be ducted to and from the enclosure with flexible piping. In some instances, acoustically lined openings can be left in the enclosure if one exercises care to eliminate the direct path from the noise source to the exterior of the enclosure.
5. Be vibrationally isolated from the noise source.
6. Not cause a large reduction in efficiency or create a safety hazard.

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