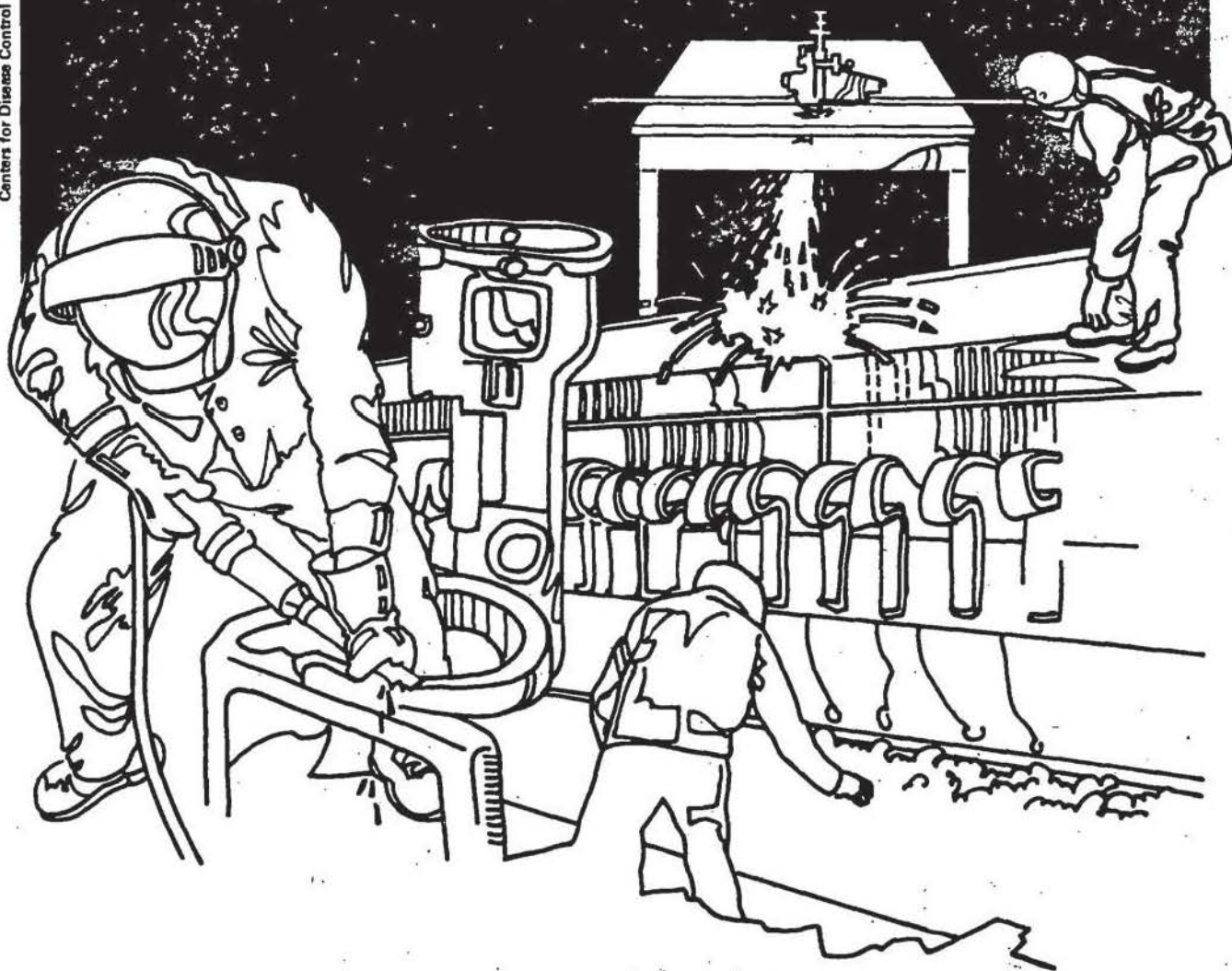


# NIOSH



## Health Hazard Evaluation Report

HETA 83-327-1402  
WEATHERWAX GOLF COURSE  
MIDDLETOWN, OHIO

## 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.



## I. SUMMARY

On June 23, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Middletown, Ohio Health Department to investigate an outbreak of acute respiratory illness among workers who had unloaded a truck filled with wood chips at the Weatherwax Golf Course near Middletown. NIOSH investigators commenced an environmental/medical survey later in the same day.

The NIOSH investigators inspected the unloading site and collected samples of wood chips and dust for culture of organisms. They also interviewed all 11 employees (5 ill; 6 well) who had had contact with the chips; reviewed records of medical examinations and laboratory tests; and obtained serum samples for determination of precipitating antibodies against fungal antigens, including any organisms grown from the wood samples.

The chips at the back of the truck had appeared (to the workers) fresh and loose while those at the front had been older and were clumped together. Conditions were reported to have been very dusty in the truck during the shovelling. The NIOSH investigators observed strands of fungi at the front of the truck. Moderate quantities of a large number of fungi grew from the wood chips, including species of *Thermoactinomyces*, *Aspergillus*, *Mucor*, and *Candida* but there did not appear to be qualitative differences in types of organisms or in amount of growth between samples from the back and those from the front of the truck.

Five employees (the ones already known to have been ill) reported experiencing five or more of the following six symptoms: weakness, cough, difficulty breathing, fever, chest tightness and headache. All five had worked directly unloading the front part of the truck on the afternoon of June 21 while none of the other six workers had performed the unloading during that time period ( $p=0.002$ , Fisher's exact test, one-tailed). The median interval to onset of symptoms after performing the unloading was approximately 13 hours. All five ill workers recovered within three days. The precipitating antibody studies showed that there were no diagnostically meaningful serological responses. Although the history was superficially compatible with hypersensitivity pneumonitis, the time course of onset, the duration of symptoms, the fact that this was probably the first major exposure of these workers to moldy dust, and the lack of antibody responses, argue against this diagnosis. This outbreak may represent an episode of pulmonary mycotoxicosis, a toxic reaction due to inhalation of large amounts of fungi.

Based on the results of this evaluation, NIOSH concluded that a health hazard existed at the time of unloading the wood chips at Weatherwax Golf Course in June 1983. Recommendations for avoiding or reducing the hazard in the future are presented in Section VII of this report.

KEYWORDS: SIC 7992 (Public golf courses), pulmonary mycotoxicosis, hypersensitivity pneumonitis, fungi, wood chips, gardening

## II. INTRODUCTION

On June 23, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the City Health Department, Middletown, Ohio for assistance in the investigation of an outbreak of acute respiratory illness. The outbreak had occurred among employees of the city Parks Division and had begun with onset 6-18 hours following the unloading of a truck filled with wood chips at the Weatherwax Golf Course near Middletown. The flu-like illness was reported to consist of fever, chills, weakness, cough, chest tightness, and headache, and it involved five employees.

NIOSH conducted a medical/environmental investigation at Weatherwax Golf Course on June 23-27, 1983. Notification letters informing individuals of their blood results were distributed on December 29, 1983.

## III. BACKGROUND

Middletown (population 46,000), is located 35 miles northwest of Cincinnati in Butler County, Ohio. The Division of Parks of the city's Department of Public Services administers the municipal golf courses. Weatherwax Golf Course, a municipal golf course, is a part of Sebald Park. The park is actually within Madison Township, about six miles west of Middletown, but is owned and operated by the city. From time to time, the golf course purchases wood chips to be used for decorative purposes around plants and other vegetation. In the past, wood chips had usually been purchased from the city's Division of Streets, Department of Public Services, and had been used without incident. However, in June 1983, wood chips were obtained from a private vendor (a lumber and pallet plant/saw mill) in Gratis, Ohio. This was the first time that products had been purchased from this vendor. The chips arrived at the golf course by truck on June 21, 1983. Unloading of the truck filled with wood chips began that day. The truck was 40 feet long and the only ventilation was from five 12-inch circular vents in the roof. Discussions on June 23, 1983, with the employees and with the Commissioner and Deputy Commissioner of Health revealed that employees engaged in removing the wood chips from the front of the truck on the afternoon of June 21 became ill that evening and night with complaints of fever, chills, chest-tightness and a flu-like feeling; these problems continued into the next day. At the time of the survey, the golf course employed about 20 workers, including permanent and seasonal staff, two assistant superintendents, and a superintendent.

## IV. EVALUATION DESIGN AND METHODS

### A. Environmental

The wood chip unloading site was inspected, and samples of the wood chips and dust were collected for analysis. Three sample sets were collected: one from a pile of shredded bark which had been deposited at the site two weeks earlier; one from the wood chips that had resided



in the front (closed end) of the trailer; and one from the wood chips that had resided in the back of the trailer. We assumed that the wood chips furthest from the back of the trailer came off first, and that the chips closest to the trailer came off last (therefore being the chips located in front of the truck). Each sample set consisted of a bulk chip/bark portion, and two sieved (1.0 and 0.18 mm pore size) portions. The sieved portions were collected in order to approximate the type of material which might have become airborne. These sample sets were sent for fungal culture and identification. In addition a sample of chips was sent to the U.S. Department of Agriculture's (USDA) Forest Products Laboratory for taxonomic identification of wood type.

#### B. Medical

The NIOSH medical officer evaluated all 11 employees who had had any contact with the truck of wood chips. These included the five individuals (identified in the request) who had been engaged in unloading the truck on the afternoon of June 21; three other employees who had been engaged in transferring the wood chips from the truck to the ground during the morning of June 21; two employees involved in completing the removal of chips from the truck during the morning of the next day; and the golf course superintendent who stopped briefly by the truck during the unloading. The latter six employees were evaluated by NIOSH on June 24 and June 27. During the evaluation, the medical officer interviewed and briefly examined each employee. NIOSH obtained for review the records of the medical examinations and laboratory tests performed by a local physician employed by the City Health Department. NIOSH also obtained venous blood samples from all 11 employees for fungal serology tests. During the NIOSH interview, information was elicited regarding demographic data, symptoms during the current episode, job activity, and social and occupational history. Tests ordered by the city physician (and performed at a local hospital laboratory) included complete blood count with differential white blood cell count, arterial blood gases, spirometry, electrocardiogram and chest x-ray. To rule out hypersensitivity pneumonitis, the sera obtained by NIOSH were shipped frozen for determination of precipitating antibodies. Each sample was tested against a standard panel of fungal antigens, against buffered saline extracts of the wood samples, and against organisms grown from the wood samples.<sup>10</sup> To rule out acute histoplasmosis as an etiology for the outbreak, paired sera from two symptomatic employees (acute sample in June and convalescent sample in October) were tested for evidence of Histoplasma capsulatum antibodies by the complement fixation test at the Division of Mycotic Diseases, Center for Infectious Disease, Centers for Disease Control.

## V. RESULTS

### A. Environmental

Discussions with golf course personnel and employees engaged in the removal of the wood chips from the truck disclosed that the wood chips in the back of the truck (during the morning of June 21) appeared fresh and were easily shovelled. However, those at the front (removed in the afternoon of June 21) were different in nature, appearing older, clumped together, and requiring a pitch fork to separate. Heat could be felt coming from inside the pile of old chips. The inside of the truck was described by those doing the work as very hot and dusty. Follow-up investigation disclosed that although the golf course superintendent had requested fresh chips, the vendor had had some old chips that had been stored in the truck for perhaps as long as one year. The chips had not been treated chemically. The NIOSH investigators noticed strands of fungi on the remains at the front of the truck.

The wood chips were identified by the USDA as primarily sycamore (Platanus) and cottonwood or aspen (Populus), with lesser amounts of ash (Floxinus), oak (Quercus), and soft maple (Acer).

Although fungal cultures yielded moderate quantities of fungi (Table I), the laboratory did not perform quantitative studies. Thus, it was not possible to determine if the wood at the front produced greater counts per plate than the wood from the back of the trailer. Qualitatively speaking, there did not appear to be any difference in types or in amount of growth between samples from the back and those from the front of trailer. Also, no microorganisms were detected which were unique to the front of the trailer.

### B. Medical

#### 1. General

No similar outbreaks of illness were reported to have occurred previously at the golf course. One employee sought medical attention at an emergency room but did not require hospitalization. The very dusty conditions inside the truck during the afternoon of June 21 forced a rotation of jobs among those using pitchforks at the very front and those performing shovelling further back. Workers had to go for fresh air to the back of the truck periodically.



## 2. Questionnaire data

The eleven employees evaluated were all males, with mean ( $\pm$  S.D.) age of 23.1 ( $\pm$  6.5) years (range 17-40). Nine were white, and two black. The most frequently reported symptoms were weakness (reported by 7), cough (6), difficulty breathing, fever, chest tightness, and headache (5 each) (Table II). These symptoms were similar to those identified initially by the requestors. For purposes of identifying factors that might be associated with illness, a case was defined as an employee reporting five or more of these six symptoms. The five symptomatic individuals (including the worker seen in the emergency room) identified in the initial telephone request were the only ones who met this case definition. Cases reported more symptoms, as would be expected by the case definition. Difficulty breathing, fever, chest tightness, headache and weakness were reported significantly more frequently by cases than by non-cases. Of the symptoms not included in the case definition, only the presence of sweats was reported significantly more frequently by cases.

The ages of cases were similar to those of non-cases, and only one had any past history of allergic disorder (Table III). No participant reported a history of asthma, eczema, or well-defined drug allergies. Only one case and one non-case were cigarette smokers. An inquiry into previous dusty/farm work revealed that among cases, two had worked with hay briefly in school, one had worked in tobacco fields, and one had lived on a farm for 10 years. Among non-cases, two currently lived on farms.

Present duration of employment (Table III) was extremely varied among both cases and non-cases, probably because the golf course personnel included permanent employees, college students who had worked during previous summers, and a number of students who had only recently begun work through temporary job opportunity programs. Many of the activities on the golf course such as mowing grass, raking sandtraps, and planting trees were done by most of the employees, regardless of job title. According to the golf course superintendent, the assignment of employees to morning and afternoon groups to empty the woodchips from the truck was random.

Exposure to unloading the truck: All cases worked directly on unloading the front part of the trailer on the afternoon of June 21, while none of the non-cases did ( $p=0.002$ , Fisher's exact test, one-tailed) (Table IV). One case had also worked during the morning of June 21 at the back of the trailer. Employees who had unloaded wood chips only in the morning of June 21 or June 22 did not become symptomatic. Disposable dust masks were worn by the two employees during the work of June 22 but not at other times.

Onset and duration of symptoms: Among cases, the median (and range) time interval, in hours, from beginning of wood chip removal on the afternoon of June 21 to onset of symptoms was: headache, 13 (1-24); difficulty breathing, 13 (4.5 - 18); fever, 13 (7 - 30); chest tightness, 13 (4.5 - 18); cough, 12.5 (7 - 24); weakness, 7 (4.5 - 16). One case did not come to work on June 22 and did not work for the remainder of the week. A second case left work at noon on June 22, feeling ill. The other three worked for the remainder of the week after unloading the chips but felt ill. By June 23 (48 hours), all were improving. By 72 hours, the affected employees were complaining only of minor residual chest tightness on deep inspiration.

### 3. Signs on physical examination

Results of temperature determinations were available on four of the five cases from their evaluation at the Middletown Health Center on the day following the exposure. Temperatures were minimally elevated in all four (range 98.8 - 99.6°F). The employee with the lowest temperature had taken aspirin prior to being assessed but reported that his temperature had been 102°F when taken at home. When examined by the NIOSH medical officer, two cases felt warm to the touch. End inspiratory crepitations were heard in one worker. None of the non-cases felt warm, and examination of the chest was normal in all non-cases.

### 4. Laboratory data

Chest x-rays were normal in all employees except for evidence of previous chest surgery in one case; no active disease was seen.

Among cases, electrocardiograms were normal in three; in one, sinus bradycardia (rate less than 50 beats/minute) was reported, and one had minor T-wave abnormalities. Among non-cases, electrocardiograms were normal in three; sinus bradycardia was reported in three.

Review of blood tests (Table V) revealed that there were no significant differences between cases and non-cases in mean arterial pO<sub>2</sub> (arterial partial pressure of oxygen), and mean lymphocyte count. Mean total white blood count (11.0 vs 8.1 x 10<sup>3</sup>) and mean absolute polymorphonuclear leukocyte count (8.3 vs 5.6 x 10<sup>3</sup>) were significantly greater in cases than in non-cases. The sedimentation rate was slightly or moderately elevated (according to the local hospital laboratory classification) in all five cases but only in two (33%) of the six non-cases.



Spirometry recordings performed at the local hospital showed normal results in all cases except the individual with previous chest surgery. Spirometry was normal in all non-cases except one worker with FEF<sub>25-75</sub> (average rate of flow during the middle two quarters of the forced expiratory effort) of 57.9% of predicted, suggesting minimal small airways disease.

The results of serological studies for precipitating antibodies to fungal antigens are displayed in Table VI. The scattering of weak positive reactions does not appear to be medically or epidemiologically significant for any one antigen and was not different between cases and non-cases. Testing paired sera for Histoplasma capsulatum complement fixing antibodies in two cases showed that titers were unchanged in acute and follow-up specimens (1:8 in one subject, 1:16 in the other). These data suggest old, not active, disease.

## VI. DISCUSSION

This investigation of an outbreak of acute respiratory illness in golf course workers found an association between development of illness and exposure to large amounts of wood dust that was moderately contaminated with fungal organisms. The exposure which appeared to cause illness occurred during the afternoon of June 21 when workers were being exposed to dust from moldy wood chips. Individuals shovelling wood chips in the morning of June 21 (fresher wood chips) or briefly on the morning of June 22 (short duration of exposure to moldy chips with concomitant use of disposable respirators) avoided illness.

The possible mechanisms or etiologies for the illness that were considered included a direct toxic effect, an infectious cause, and hypersensitivity pneumonitis, with the latter thought initially most likely.

Hypersensitivity pneumonitis (HP),<sup>1-4</sup> results from repeated inhalation of a variety of organic dusts. Farmer's lung [caused by exposure to mouldy hay contaminated with thermophilic (heat-loving) organisms], pigeon-breeder's disease (associated with bird droppings), and humidifier/forced-air-system lung<sup>2,3</sup> are some of the best known examples. Some of the more common occupational exposures that have resulted in the development of HP are listed in Table VII.<sup>4</sup> Thermophilic fungi have also been isolated from self-heated piles of wood chips.<sup>5</sup> The intensity of the exposure (i.e. whether regular or intermittent) affects an individual's response to antigen. High exposure of short duration may result in an acute, reversible interstitial pneumonia, while chronic, low-level exposure may lead to insidious and irreversible symptoms and lung disease.<sup>4</sup> The clinical features of the acute form include nonproductive cough, dyspnea (without wheeze), chills, fever, sweats, chest tightness, malaise, and headaches occurring four to six<sup>1</sup> (or eight<sup>4</sup>) hours after intermittent antigen

exposure. The symptoms generally resolve spontaneously within 12 to 24 hours, only to recur on re-exposure.<sup>4</sup> Crepitations may be found on examination, and pulmonary infiltrates on chest x-ray and leukocytosis may be present. High titers of precipitating antibodies against the offending antigen can usually be demonstrated in the serum of affected patients; asymptomatic individuals may also demonstrate precipitating antibodies. A combination of Type III and Type IV immunologic mechanisms may be involved.<sup>1,4</sup>

Although the histories obtained during the initial discussions with affected employees and with health department officials appeared compatible with HP, there is evidence against this as an explanation for the illness. First, the episode under investigation was probably the first major exposure to these fungi for at least some of the workers, rather than representing one of a series of repeated exposures. Second, there was an absence of detectable immunologic responses to fungi seen in the serologic studies. Third, the time course from exposure to onset of symptoms and for recovery was not typical for HP. Although some of the cases subjects had onset of symptoms within the usual 6-8 hours, the median interval was about 13 hours; some were up to 18 hours. The symptoms lasted between 48-72 hours, longer than is typical of HP.

Although an infectious cause was not considered very likely, an infectious disease specialist who was informally consulted suggested ruling out histoplasmosis. Conditions that favor heavy inhalation exposures to H. capsulatum resulting in large amounts of airborne spores include: 1) a site providing a source of fungi; 2) dusty conditions; and 3) an event that raises the dust.<sup>6</sup> These were generally present during the unloading. The incubation period for histoplasmosis has been reported to be between 10-18 days for the primary type and between 3-7 days for the reinfection type.<sup>6</sup> Only the longest exposure-to-onset of symptom intervals among the present group of subjects came close to these ranges. The serological test results revealed no evidence of active histoplasmosis.

The wood chips being unloaded had come directly from the sawmill and had not been chemically treated or preserved. Thus, there was no evidence for a toxic chemical exposure. However, in recent years there has been evidence that inhalation of large amounts of a variety of saprophytic fungi may



result in a syndrome which resembles HP but appears to be toxic rather than allergic.<sup>7</sup> In 1975, Emanuel et al. described 10 patients who had inhaled massive amounts of fungi which resulted in an "apparent toxic pulmonary reaction".<sup>8</sup> Emanuel et al. cite a previous Russian report and add their cases as supporting inhalation as an important route of entry. They termed the disorder "pulmonary mycotoxicosis".<sup>8</sup> Mycotoxicosis refers to a toxic reaction or poisoning due to the ingestion of toxins produced by fungi. The 10 patients reported by Emanuel et al. (who were farmers or family members providing assistance) gave very similar histories of fungal inhalation while cleaning mold from the top of their silos. The duration of illness lasted from a few days to four weeks. Onset of symptoms generally occurred the evening after exposure, and included cough, chills, fever, headache and generalized malaise. No sensitivity to various fungal antigen preparations was demonstrated. Temperature elevation developed in most, an elevated white blood cell count in some, and x-ray findings of diffuse interstitial disease in half. A pulmonary biopsy performed in the most severely affected patient showed a multifocal acute process containing large numbers of various spores involving terminal bronchioles, alveoli and interstitial areas. Culture of the lung biopsy revealed at least five different fungi, including Fusarium, Penicillium and Aspergillus.<sup>8,10</sup> With avoidance of the silos and exposure to molds, there was no further illness. In the accompanying editorial, it was noted that the important differences between "mycotoxicosis" and HP included the lack of detectable serologic responses in the patients as well as the fungi present in the lungs.<sup>7</sup> However, it was recognized that the presentation of this entity and farmer's lung disease can be confused. A recent study using an animal model of pulmonary mycotoxicosis<sup>9</sup> suggested that the intensity of exposure to dust is responsible for the disease, not a microbial component, and that prior sensitization is not required. These investigators also suggested that the etiology may be an endotoxin or endotoxin-like activity inhaled with the dust.<sup>9</sup> Pulmonary mycotoxicosis, then, appears to be a possible explanation for the outbreak among the golf course employees.

#### CONCLUSION

An outbreak of acute respiratory illness occurred in five workers 6-18 (median 13) hours after they had unloaded a truck filled with wood chips contaminated with fungi. No evidence of an immunologic or infectious response was detected in the employees. This outbreak may represent an occurrence of pulmonary mycotoxicosis, a toxic reaction due to inhalation of large amounts of fungi.

#### VII. RECOMMENDATIONS

1. Avoidance of moldy dust and wood chips will prevent further outbreaks of illness in workers handling such materials.
2. In the future, attempts should be made to purchase fresh wood chips when possible.

3. If the presence of old, moldy wood chips is suspected, or there is uncertainty as to the quality of the wood chips, respiratory protection should be utilized. The recommended type of respiratory protection is an orinasal type with high efficiency particulate filter, due to the microorganisms' small size. These filters have a tendency to load up in heavy concentrations and cause increased breathing resistance necessitating periodic filter changes. However, this particulate loading increases filtering efficiency.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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. City Health Department, Middletown, Ohio
2. Weatherwax Golf Course Employees
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Microorganisms from Culture: Tree Bark,  
Chips from Front of Truck; Chips from Back of Truck

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-327

Microorganism	Source		
	Tree Bark	Back of Truck	Front of Truck
Thermoactinomyces candidus	-	+	+
Thermoactinomyces vulgaris	-	-	+
Thermoactinomyces intermedius	+	-	-
Aspergillus flavis	+	+	+
Aspergillus fumigatus	+	+	+
Aspergillus niger	+	+	+
Mucor	+	+	+
Candida sp.	+	+	+
Saccharomyces sp.	+	+	+
Thermophilic bacteria	+	+	+
Mesophilic bacteria	+	+	+
Unidentified fungus	+	-	-
Pullalaria	-	-	-
Saccharomonospora viridis	-	-	-
Fusarium sp.	-	-	-
Penicillium sp.	-	-	-
Trichoderma	-	-	-
Micropolyspora faeni	-	-	-
Cladosporium	-	-	-
Alternaria	-	-	-
Cephalosporium	-	-	-
Yeast	-	-	-
Gymnoascus	-	-	-
Thermophilic fungus	-	-	-

KEY: (+) = growth; (-) = no growth



TABLE II

Symptoms Reported By Golf Course Employees

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-327

June 23-27, 1983

<u>Symptom</u>	<u>Cases*</u> (N=5)	<u>Non-Cases</u> (N=6)	<u>p**</u>
Weakness, Feeling Tired	5	2	0.045
Cough	4	2	0.162
Difficulty Breathing	5	0	0.002
Fever	5	0	0.002
Chest Tightness	5	0	0.002
Headaches	5	0	0.002
Sweats	4	0	0.015
Runny Nose/ Sneeze	1	3	0.303
Chills	3	0	0.061
Muscle Aches In Limbs	2	1	0.364
Dizziness, Lightheadedness	2	1	0.364
Nausea	2	0	0.182
Vomiting	1	0	0.455
Watery Eyes	0	1	0.545
Wheeze	1	0	0.455

\* Definition of case: 5 or more of the following 6 symptoms: weakness, cough, difficulty breathing, fever, chest tightness, headache.

\*\* Fisher's Exact Test, 1 tail.

TABLE III

Comparison Of Cases And Non-Cases

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-237

June 1983

	5 Cases	6 Non-Cases
Age Range (Yr)	20-26	17-40
Allergic History (#)	Seasonal Rhinitis (1)	Hives in Past (1)
Smoker (Y/N)	1/4	1/5
Duration of Employment, Median Range	2.5 months 1 month - 4.5 yrs.	3 weeks 2 wk - 12.5 yrs.
Jobs (#):	Seasonal Maintenance II (4) Assistant Superintendent (1)	Temporary Laborer (4) Assistant Superintendent (1) Superintendent (1)



TABLE IV

Association of Case Status With Unloading  
Trailer During Afternoon Of June 21

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-237

June 1983

		Case Status		
		Yes	No	Total
Unloaded Trailer During Afternoon of June 21	Yes	5	0	5
	No	0	6	6
Total		5	6	11

P=0.002, Fisher's exact test, 1-tailed

TABLE V

Laboratory Data

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-237

June, 1983

Test	Cases (N=5)	Non-Cases (N=6)	t	p*
pO <sub>2</sub> <sup>a</sup>	97.1 $\pm$ 17.6 (mean $\pm$ S.D.)	106.7 $\pm$ 10.0	1.07	0.31
WBC Count <sup>b</sup>	11.0 $\pm$ 1.9	8.1 $\pm$ 1.9	2.53	0.03
PMN Count <sup>c</sup>	8.3 $\pm$ 1.0	5.6 $\pm$ 1.7	3.39	0.008
Lymphocyte Count	1.3 $\pm$ 0.7	1.9 $\pm$ 0.7	1.40	0.192
Slightly or Moderately Elevated Sedimentation Rate	5 of 5	2 of 6	--	0.045**

\* Probability in right tail

\*\* Fisher's Exact Test, 1 tail

a partial pressure of oxygen in arterial blood gases

b WBC = white blood cell count - cell counts are 10<sup>3</sup> / mm<sup>3</sup> blood

c PMN = polymorphonuclear leukocyte - cell counts are 10<sup>3</sup> / mm<sup>3</sup> blood



TABLE VI

Serology Data: Precipitating Antibody Studies with Standard Panel, Crude Wood Extracts, and Cultures

Weatherwax Golf Course  
Middletown, Ohio  
HETA 83-327

Antigen Source	Microorganism	Sera Identification Number										
		1	5	Cases 6	7	8	2	3	Non-cases 4	9	10	11
Standard Panel	Micropolyspora faeni	-	-	-	-	-	-	-	-	-	-	-
	Thermoactinomyces vulgaris	-	-	-	-	-	EW	VW	-	-	-	-
	Thermoactinomyces candidus	-	-	-	-	-	-	-	-	-	VW	-
	Saccharomonospora viridis	-	-	-	-	-	-	-	-	-	?	?
	Aspergillus fumigatus (Var. 507)	-	-	-	-	-	-	-	-	-	-	-
	Aspergillus fumigatus (Var. 515)	-	-	?	-	-	-	-	-	-	?	?
	Aspergillus fumigatus (Var. 534)	-	-	-	-	-	-	-	-	-	-	-
	Penicillium notatum	-	-	-	-	-	-	-	-	-	-	?
	Candida albicans	-	?	-	-	-	-	?	-	-	-	-
	Aspergillus niger	-	-	-	-	-	-	-	-	-	-	-
	"Pigeon Serum"	-	-	-	-	-	-	-	-	-	-	-
Crude wood Extracts	Tree bark	-	-	-	?	-	-	?	-	-	-	-
	Chips from front of truck	-	-	-	?	?	?	?	-	-	VW	?
	Chips from back of truck	?	-	-	?	-	VW	?	-	-	?	VW
Culture	Thermoactinomyces candidus	-	-	-	-	-	-	-	-	-	-	-
	Thermoactinomyces vulgaris	?	-	-	-	EW	-	-	-	-	-	-
	Thermoactinomyces intermedius	EW	-	-	?	?	-	-	-	-	-	EW
	Mucor	-	-	-	-	-	-	-	-	-	?	?
	Candida sp.	-	-	EW	-	VW	-	-	W	-	W	W
	Saccharomyces sp.	-	-	-	-	-	-	-	-	-	VW	-
	Aspergillus flavus	-	-	-	-	-	-	-	-	-	-	-
	Aspergillus fumigatus	-	-	-	-	-	-	-	-	-	-	-
	Aspergillus niger	-	-	-	-	-	-	-	?	-	?	-
	Thermophilic bacteria	-	-	-	?	-	-	-	?	-	EW	?
	Mesophilic bacteria	-	-	-	-	-	-	-	-	-	-	-
	Unidentified fungus	?	-	-	?	-	-	-	-	-	-	?

KEY: (+) = positive; W = weak; VW = very weak; EW = extremely weak; ? = questionable; (-) = negative.

TABLE VII

Some Occupational Exposures Resulting in  
Hypersensitivity Pneumonitis\*

Disease	Exposure	Specific inhalant
Farmer's lung	Moldy hay	<i>Micropolyspora faeni</i> <i>Thermoactinomyces vulgaris</i>
Malt worker's disease	Fungal spores	<i>Aspergillus clavatus</i> <i>Aspergillus fumigatus</i>
Maple-bark stripper's disease	Moldy logs	<i>Cryptosporium corticale</i>
Wood-pulp worker's disease	Moldy logs	<i>Alternaria</i>
Sequoiosis	Moldy redwood sawdust	<i>Graphium</i> <i>Aureobasidium pullulans</i>
Humidifier/air conditioner disease	Fungal spores	Thermophilic actinomycetes
	<i>Amoeba</i>	<i>Naegleria gruberi</i>
Bird breeder's disease	Avian dust	Avian serum
Bagassosis	Moldy sugarcane	<i>Thermoactinomyces vulgaris</i>
Mushroom worker's disease	Mushroom compost	<i>Micropolyspora faeni</i> <i>Thermoactinomyces vulgaris</i>
Suberosis	Moldy cork dust	<i>Penicillium frequentans</i>
Isocyanate disease	Isocyanates	Toluene diisocyanate Diphenylmethane diisocyanate

\* from reference 4



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