U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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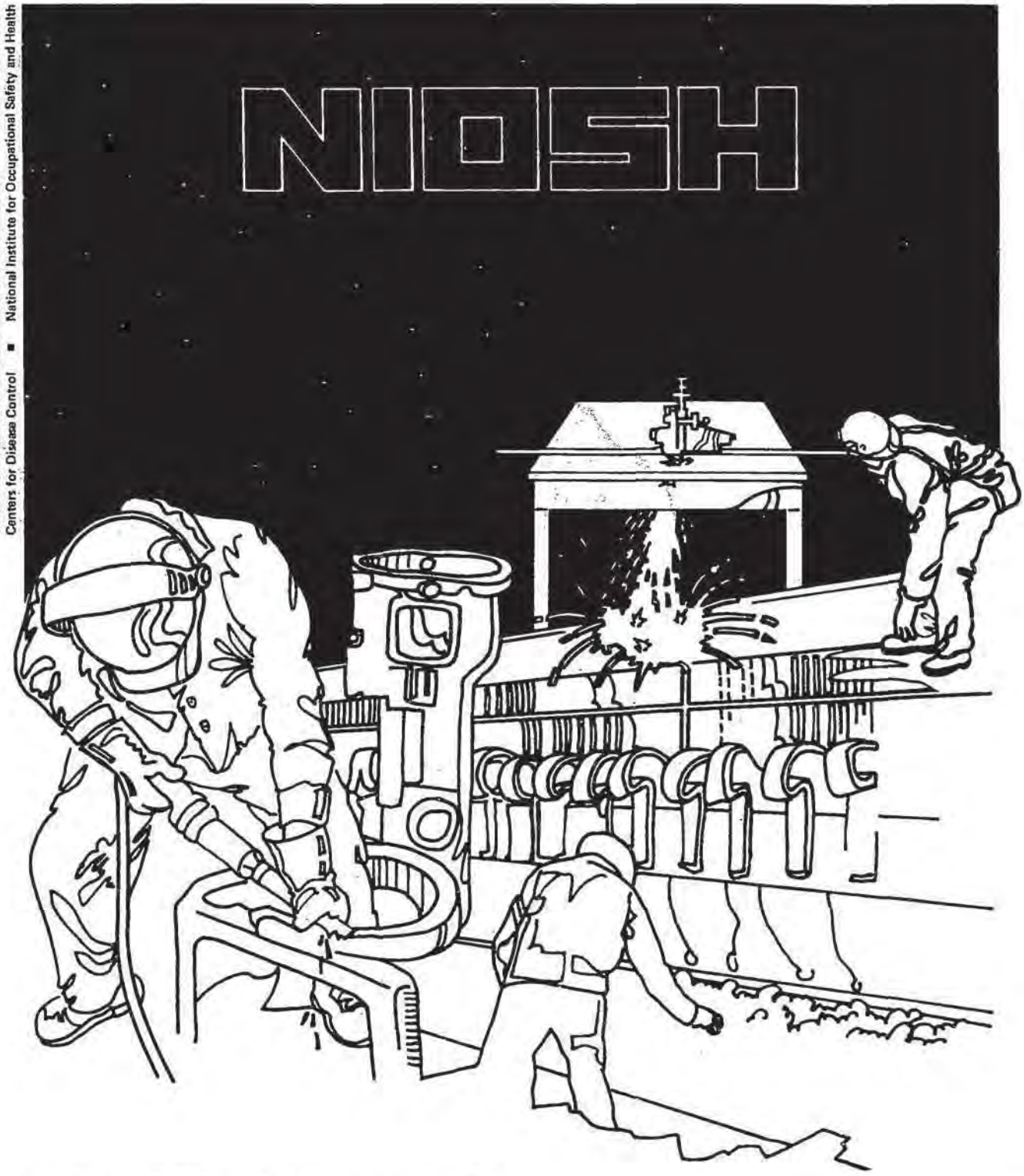

Health Hazard Evaluation Report

HETA 83-381-1411
RIVERFRONT STADIUM
CINCINNATI, 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 83-381-1411
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RIVERFRONT STADIUM
CINCINNATI, OHIO

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I. SUMMARY

On August 5, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate occupational exposure to ammonia during the removal of painted lines (line conversion) from Riverfront Stadium's artificial turf. On August 6, 1983, NIOSH investigators conducted a preliminary investigation of the line conversion operation following a night football game. Short-term area air samples for measurement of exposure to airborne ammonia were collected using direct-reading Draeger® tubes. Ammonia levels ranged from 20 parts per million (ppm) to greater than 350 ppm depending upon the operation which was sampled. NIOSH's recommended short-term (5 minute) exposure limit (STEL) for ammonia is 50 ppm. The American Conference of Governmental Industrial Hygienists (ACGIH) STEL (15 minute) for ammonia is 35 ppm. Ammonia concentrations in four of the six short-term samples exceeded these limits.

On August 18-19, 1983, a NIOSH study team conducted a follow-up industrial hygiene and medical evaluation. During this follow-up study, 18 personal breathing-zone air samples were collected from line conversion workers for approximately 6 hours to measure their exposure to airborne ammonia. The ammonia concentrations ranged from 11.9 ppm to 52.4 ppm (arithmetic mean: 21.9 ppm). Assuming no exposure for the remaining 2 hours, an 8 hour time weighted average (TWA) exposure has been calculated. For the 18 personal samples, the TWA values range from 8.9 to 39.3 ppm. The Occupational Safety and Health Administration's (OSHA) 8 hour TWA exposure limit is 50 ppm. None of the 18 TWA air samples exceeded this limit. However, since the primary health effect is acute irritation, the STELs (NIOSH-50 ppm, ACGIH-35 ppm) are the appropriate environmental criteria for evaluation. It is likely that the personal samples exceeded NIOSH's STEL of 50 ppm some time during the work shift.

In the follow-up evaluation, 29 medical questionnaires were administered to 17 line conversion, 10 ground crew, and 2 other workers. The questionnaires revealed that, during the line removal operations, eye irritation was experienced by both line conversion (100%) and grounds crew (100%) workers. Skin irritation was noted by 50% of the line conversion and 60% of the grounds crew workers. Respiratory irritation was cited by 87% of line conversion and 90% of the groundscrew personnel. Nasal congestion and dryness were reported by 81% of the line conversion and 50% of the grounds crew workers. Smaller percentages of workers reported headache (38%) and dizziness (27%).

Although NIOSH approved respirators were available, their condition and use were unacceptable. Also, few workers were observed wearing protective gloves and goggles.

Based on these results, NIOSH concluded there was a health hazard (eye, skin, respiratory irritation) from exposure to ammonia at Riverfront Stadium during line removal operations. Of particular concern were the documented high short-term levels of exposure which in one case exceeded 350 ppm. Recommendations are contained in Section VII of this report.

KEYWORDS: SIC 9999 (Nonclassified Establishments); ammonia, artificial turf, stadium.

II. INTRODUCTION

In August 1983, NIOSH received a request from an employee of the Cincinnati Reds groundskeeping crew to evaluate worker exposure to ammonia during the removal of painted lines from the stadium's artificial turf. On August 6, 1983 NIOSH personnel conducted a preliminary environmental evaluation of line conversion personnel for exposure to ammonia. On August 18-19, 1983 NIOSH investigators conducted an environmental and medical evaluation of line conversion and other stadium personnel for exposure to ammonia.

III. BACKGROUND

Following each football game during the overlapping period between football and baseball seasons (mid-August to mid-October), the line conversion crew of the Cincinnati Reds removes water-base, acrylic painted lines from the stadium's artificial turf using anhydrous ammonia. The line conversion crew consists of five teams of 3 workers each. On a rotating basis, each worker of every team performs three major job tasks, 1.) application of anhydrous ammonia from buckets to the water base acrylic latex paint, 2.) removal of the paint by an electric powered rotary buffing machine, and 3.) washing of the paint and ammonia mixture from the field by water hose.

The entire line conversion operation takes about six hours to perform. At any given time during this operation, there are four teams on the field removing lines while the fifth team is taking a 15 minute break. By this rotation method, each team works 1 hour and then has a 15 minute break. The workers take a half-hour lunch break about midway through the work-shift.

According to the Monsanto Company, which manufactured the artificial turf, approximately 4 line conversions occur per year during the overlapping period between football and baseball seasons for 6-8 stadiums in the United States.

IV. EVALUATION DESIGN AND METHODS

During the preliminary investigation on August 6, 1983, direct-reading measurements of airborne ammonia levels were made with short-term ammonia Draeger® tubes. During this study, 2 short-term measurements of ammonia concentration were made of each of the three major line conversion jobs (ammonia application, buffing, water hosing). On the evening of August 18-19, 1983, 18 personal breathing-zone air samples were collected from workers on these jobs for approximately five hours at a flowrate of 100 cubic centimeters per minute (cc/min). The samples were collected on treated silica-gel sorbent tubes and analyzed

according to NIOSH method P&CAM S347. All 15 members of the 5 line conversion teams as well as 2 ammonia pourers and a NIOSH employee were sampled. The air samples were not stopped during the lunch break or the 15-minute rest periods.

Also on the evening of August 18-19, 1983, a total of twenty-nine medical questionnaires were administered to 17 line conversion, 10 grounds crew, and 2 other workers. Only 16 of the 17 line conversion questionnaires were reviewed because one individual had just started working at the time of this study.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Listed below are the evaluation criteria for ammonia.

SOURCE	ENVIRONMENTAL EXPOSURE LIMIT	
	TWA	STEL
NIOSH	____	50ppm (5 minute exposure)
ACGIH	25ppm	35ppm (15 minute exposure)
OSHA	50ppm	____

B. Toxicology

Ammonia (NH_3) is a colorless, strongly alkaline, and extremely soluble gas with a characteristic pungent odor. Ammonia can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It may also affect the body if it is swallowed.

With short-term exposure, ammonia is a severe irritant of the eyes, respiratory tract, and skin. It causes burning and tearing of the eyes, runny nose, coughing, and chest pain. Exposure of the eyes to high gas concentrations may produce severe eye damage. Exposure of the skin to high concentrations of the gas may cause burning and blistering of the skin. Contact with anhydrous ammonia may produce severe eye, nose, and skin burns. Repeated exposure to ammonia gas may cause chronic irritation of the eyes and upper respiratory tract.

VI. RESULTS AND DISCUSSION

A. Environmental

A sample of the aqueous ammonia solution used to remove the painted lines was analyzed by a NIOSH contract laboratory and was found to contain 20% ammonia. "Strong aqua ammonia" is defined as aqueous solutions containing more than 10% ammonia.[1]

During the preliminary study, 6 short-term measurements of ammonia concentrations (Table II) were made, 2 each of the 3 major line conversion jobs (ammonia application, buffing, water-hosing). The short-term ammonia concentrations for the 2 water-hosing measurements averaged 20 ppm. The 2 measurements for the buffing operation averaged 90 ppm, while the 2 for the ammonia application exceeded 300 ppm. The ammonia exposures for workers performing the latter buffing and application operations exceeded the short-term exposure limits (STEL) recommended by NIOSH (50 ppm for 5 minute exposure) and ACGIH (35 ppm for 15-minute exposure).

The airborne ammonia concentrations for eighteen personal samples ranged from 11.9 ppm to 52.4 ppm (Table I) as average for the six-hour work shift (which includes air sampled during the lunch break and rest periods.) The arithmetic mean of the eighteen personal air samples was 21.9 ppm. The arithmetic mean of the air samples for the 15 line conversion workers was 20.9 ppm while the 2 ammonia pourers averaged 32.4 ppm. The NIOSH investigator had an average exposure of 16.6 ppm. Assuming no exposure for the remaining 2 hours, an 8 hour time weighted average (TWA) exposure has been calculated. For the 18 personal samples, these TWA values range from 8.9 to 39.3 ppm. The Occupational Safety and Health Administration's (OSHA) 8 hour TWA exposure limit is 50 ppm. None of the 18 TWA air samples exceeded this limit. However, since the primary health effects are acute irritations, the STELs (NIOSH-50 ppm, ACGIH-35 ppm) are the appropriate environmental criteria for evaluation. It is likely that the personal samples exceeded NIOSH's STEL of 50 ppm some time during the work shift.

Although NIOSH certified respiratory protection was available, the respirators appeared to be old and were poorly maintained. For example, several of the half-mask respirators had missing or non-functioning inhalation and exhalation valves. Also, the ammonia cartridges of all the respirators had rarely, if ever, been changed and the disposable respirators had never been replaced. The respirators were not cleaned and were placed together in a large cardboard box after each use. Few workers were observed wearing gloves and goggles.

B. Medical

The data (Table III) were analyzed by two separate cohort designations, one designation assigned according to job classification (those engaged in line conversion directly versus those working on ground crew) and a separate analysis based on seasons of job experience, regardless of job classification. Descriptively, line conversion workers were older and tended to have a significantly greater smoking experience than the grounds crew. Mean seasons of work exposure were comparable for the two groups.

The frequency of reported symptoms were similar regardless of group examined. The most frequent complaint was eye irritation, burning, tearing, or crying. Respiratory complaints were almost as numerous, shortness of breath and cough being most common. However, wheezing was noted in over one-third of all workers. Among complaints related to nasal irritation, nasal congestion and loss of taste sensation were more commonly noted than "nasal dryness", which the NIOSH Criteria Document on ammonia emphasizes as a nasal effect of ammonia exposure.[1] According to workers who reported the symptom, loss of taste sensation lasts up to 48 hours after a typical conversion shift. Loss of taste may reflect a direct effect on taste sensory endings or a subtle effect of decreased nasal sensation. Smell is an important aspect of taste sensation. Headache and dizziness were reported by over one-third and one-quarter of workers respectively, but nausea was an infrequent complaint. Skin burning, redness, and itching were common complaints, with over half of the workers expressing some form of skin irritation. Only one worker, however, complained of eczematous rash. One other worker complained of nosebleeds which he felt were related to ammonia exposure, three workers complained of "chest tightness" and one worker complained of double vision.

Eye, respiratory, and skin complaints were markedly similar between those engaged directly in the conversion and grounds crew members working on the field at the same time, suggesting that exposure levels for both groups are similar. Furthermore, smoking history did not seem to be a confounding factor in spite of the marked difference in smoking patterns (68.7% of line conversion workers versus 0.0% of grounds crew workers) between the two cohorts. Although there were more frequent nasal complaints among line conversion workers, this difference was not statistically significant (Fisher's exact test, $p>0.2$).

Similarly, although those with more seasons of work experienced a number of respiratory, skin, and nasal symptoms with greater frequency than the less experienced cohort, these differences were not statistically significant (Wilcoxon rank sum, $p>.05$).

VII. DISCUSSION AND RECOMMENDATIONS

High levels of ammonia gas were documented during both the preliminary and follow-up survey at Riverfront Stadium. Symptoms compatible with ammonia exposure were reported by the line conversion workers and grounds crew during the removal of painted lines from the artificial turf. Because the line conversion operation is not a day-to-day process, our primary concern for the workers are the acute irritant effects from short-term exposure to ammonia.

The following recommendations should help minimize worker exposure to ammonia.

1. The Monsanto Corporation recommends an 8% aqueous ammonia solution be used for paint removal from the artificial turf. Therefore, depending upon the initial concentration, the bulk ammonia should be diluted 3 or 4 parts to 1 with water. Doing so would significantly lower the airborne concentration of ammonia. Follow-up sampling should be done to confirm this.

2. Respiratory protection should continue to be made available to all workers upon request. However, many improvements need to be made in equipment maintenance and cleaning. All respirators should be cleaned, inspected, and placed in a zip-lock bag after each use. For half-mask respirators, the ammonia cartridges should be changed after each use. The disposable respirators should also be discarded after each use. One employee should be designated to perform the cleaning and maintenance of respirators.

3. To prevent eye irritation and damage, all employees should wear splash-proof safety goggles or face shields. If ammonia gas or concentrated ammonia solution is splashed in the eyes, immediate flooding of the eyes with large quantities of water for 15 minutes is advised, followed at once by medical examination. Eye-wash bottles should be readily obtainable from the store-room.

4. To minimize skin irritation protective clothing impervious to ammonia (including gloves, aprons, and boots) should be required. Work clothes wetted with concentrated ammonia solution should be changed immediately, and the exposed area of the body washed throughly with water. Showers or other facilities for quick drenching of the body should be provided within the immediate work area.

VIII. REFERENCES

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Confidential Requestor
2. The Cincinnati Reds, Inc.
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

Ammonia Concentration for Personal Samples
Riverfront Stadium
Cincinnati, Ohio
HETA 83-318
August 18 - 19, 1983

Job Classification	Sample Duration	Ammonia Concentration (ppm)	
Line Conversion		Sampling Period	Conversion to 8-hr TWA
Team 1	0:47-5:55	16.5	12.4
Team 1	0:48-5:55	42.7	32.0
Team 1	1:20-5:57	19.9	14.9
Team 2	0:53-5:50	12.4	9.3
Team 2	0:53-5:50	11.9	8.9
Team 2	0:58-5:50	21.0	15.8
Team 3	0:58-5:48	18.8	14.1
Team 3	0.58-6:00	27.1	20.3
Team 3	0:58-5:45	16.8	12.6
Team 4	1:08-5:45	15.1	11.3
Team 4	1:08-6:06	16.7	12.5
Team 4	1:08-5:45	32.7	24.5
Team 5	0:50-6:00	31.9	23.9
Team 5	1:16-5:48	15.2	11.4
Team 5	1:16-5:53	14.9	11.2
Ammonia Pourer	1:28-5:01	52.4	39.3
Ammonia Pourer	1:24-5:57	12.3	9.2
NIOSH Ind. Hygienist	1:30-5:52	16.6	12.5

Table II

Ammonia Concentration for Short-Term Air Samples (Draeger® Tubes)
Riverfront Stadium
Cincinnati, Ohio
HETA 83-381
August 6, 1983

Job Classification	Ammonia Concentration
Line Conversion	
Ammonia Application (#1)	>350 ppm
Ammonia Application (#2)	250 ppm
Buffing (#1)	80 ppm
Buffing (#2)	100 ppm
Water Hosing (#1)	20 ppm
Water Hosing (#2)	20 ppm

Table III

Medical Questionnaire Results
Riverfront Stadium
Cincinnati, Ohio
HETA 83-381
August 18-19, 1983

Interviews conducted, N = 29

Workers engaged in the li e conversion interviewed, N = 17, one interview discarded as worker did n t meet questionnaire criteria (first time on job)

Grounds crew workers inter/iewed, N = 10

Other interviews, N = 2: f reman and storeroom worker, data not analyzed.

Total interviews analyzed, N = 26

	Line	Grounds	1-2 SEAS	3+SEAS	TOTAL
Number	16.0	10.0	13.0	13.0	26.0
Mean Age	29.3	18.9	24.8	26.5	25.7
S.D.	7.0	2.2	7.8	8.2	7.9
Means Seasons Of Work	2.9	3.4	1.5	4.9	3.2
S.D.	2.1	1.8	0.5	1.3	2.0
% Smokers(Ever Smoked)	68.7	0.0	38.4	46.1	46.1
% Any Eye Symptoms	100.0	100.00	100.0	100.0	100.0
Eye Burning Or	93.8	90.0	100.0	84.6	92.3
Irritation, Tearing Or	62.5	80.0	61.5	76.9	69.2
Crying Red Or Swollen Eyes	37.5	20.0	7.7	53.8	30.8
% Any Skin Symptoms	50.0	60.0	38.4	69.2	53.8
Itching	40.0	30.0	30.8	46.2	38.4
Skin Burns Or Burning	19.0	40.0	15.4	23.1	19.2
Redness Of Skin	25.0	10.0	15.4	38.4	26.9
% Any Respiratory Symptoms	87.0	90.0	84.6	92.3	88.5
Shortness Of Breath	69.0	60.0	61.6	69.2	65.4
Cough	56.3	60.0	76.9	38.5	57.8
Wheezing	37.5	20.0	30.8	38.4	34.6

(Continued)

(Table III Continued)

	Line	Grounds	1-2 SEAS	3+SEAS	Total
% Any Nsaal Symptoms					
Nasal Congestion	81.3	50.0	69.2	69.2	69.2
Loss Of Taste	56.3	20.0	38.4	46.1	42.3
Nasal Dryness	50.0	30.0	30.8	53.8	42.3
Loss Of Smell	37.5	20.0	30.8	30.8	30.8
% Headache	37.5	40.0	23.1	53.8	38.4
% Dizziness	25.0	30.0	23.1	30.8	26.9
% Nausea Or Vomiting	6.3	20.0	15.4	7.7	11.5