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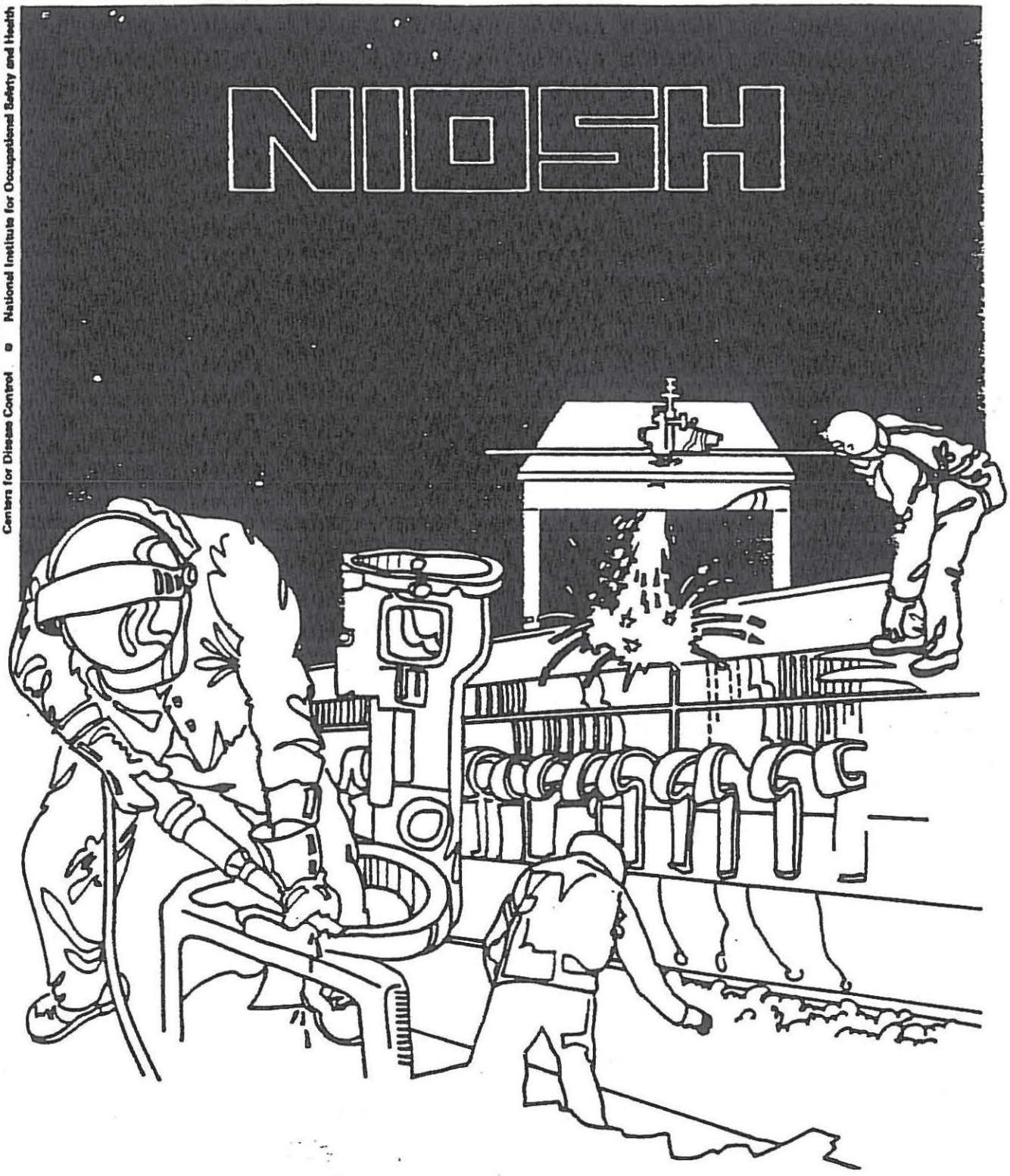

Health Hazard Evaluation Report

HETA 82-051-1269
NATIONAL STARCH AND CHEMICAL
MEREDOSIA, ILLINOIS

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 82-051-1269
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NATIONAL STARCH AND CHEMICAL
MEREDOSIA, ILLINOIS

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I. SUMMARY

On November 23, 1981, the National Institute for Occupational Safety and Health (NIOSH) was asked to evaluate an apparently increased number of abnormal pulmonary function test (PFT) and chest x-ray results among workers at National Starch and Chemical Company, a polymer manufacturer in Meredosia, Illinois

NIOSH investigators reviewed the previous chest x-ray and PFT results and concluded that the reported radiological abnormalities were only minor and required no further follow-up. The PFT results were considered ambiguous and further investigation was planned.

On April 13-14, 1982, NIOSH investigators conducted a medical and environmental evaluation at the plant. A standard PFT was administered to 47 workers in the A and B wings who had been previously tested in either 1980 or 1981. Six of 47 (13%) tests were abnormal using NIOSH criteria. Applying the same criteria to the PFTs of those workers tested in both 1980 and 1981 shows no evidence of an increasing proportion of abnormal PFTs.

A respiratory questionnaire was administered to 47 A and B wing employees. They did not experience a significantly higher rate of respiratory symptoms than a comparison group studied previously in a different plant.

Five area air samples were collected for organic vapors in the A and B wings of the main building. The primary volatile organic compounds identified from these samples were vinyl acetate, ethyl acetate, butyl acrylate, and n-butyl acetate. Five personal breathing zone air samples yielded the following concentration ranges for the identified compounds: vinyl acetate, <0.1 to 5.1ppm, environmental criterion - 10ppm; ethyl acetate, <0.1 to 4.7ppm, environmental criterion - 400ppm; butyl acrylate, <0.1 to 0.4ppm, environmental criterion - 10ppm; n-butyl acetate, <0.1 to 0.1ppm, environmental criterion - 150ppm. The threshold limit of the mixture (criterion - 1), ranging from 0.02 to 0.52, was not exceeded.

Based on our environmental and medical survey, NIOSH determined that a health hazard from airborne chemicals did not exist at National Starch and Chemical Company. An artifactual increase in percentage of abnormal PFTs between 1980 and 1981 apparently reflected a change in criteria used to interpret the tests. A recommendation is made for improving the reporting of medical test results to workers, and for follow-up sampling for acid gases in the parts cleaning operation.

KEYWORDS: SIC 2821 (plastics materials, synthetic resins, and nonvulcanizable elastomers); polyvinyl acetate polymers/copolymers, vinyl acetate, ethyl acetate, butyl acrylate, n-butyl acetate.

II. INTRODUCTION

In November 23, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from employees at the National Starch and Chemical Corp., Meredosia, Illinois. The request asked for an investigation into an apparently increased number of pulmonary function test (PFT) and chest X-ray abnormalities among workers in the A and B wings tested in 1981, compared to the results of 1980 tests. Of 39 workers receiving pulmonary function tests in both 1980 and 1981, two were classified as having abnormal results in 1980, while 15 were classified as abnormal in 1981 by the company's medical consultant. It was reported that approximately 200 chemicals are in use at the plant, and the employees were concerned that these abnormal test results might be related to overexposure to toxic chemicals.

III. BACKGROUND

The National Starch and Chemical Corporation is a batch process polymer manufacturer located in Meredosia, Illinois. Vinyl acetate is the primary ingredient in the batch process operation which produces poly vinyl acetate polymers and copolymers used for manufacturing adhesives. The potential contaminants are organic compounds from the batch operations and nitric acid from the tank used to clean process parts. The Meredosia facility employs approximately 150 workers on a three-shift, round-the-clock operation. The primary batch process production area is located in two wings (A and B) of the main building.

Yearly X-ray and pulmonary function tests of employees in A and B wings were begun in 1980 in response to a recommendation by OSHA that these tests be performed on all workers who might be required to use respiratory protective equipment.

Prior to the site visit, NIOSH obtained the 1980 and 1981 chest X-ray and pulmonary function test results from the company's medical consultant. A review of the chest X-ray results by NIOSH revealed only minor non-occupational abnormalities that did not require further investigation. With respect to the pulmonary function tests, analysis of the data suggested that different criteria for interpretation of results had caused an artifactual increase in pulmonary function test abnormalities in 1981. To clarify this, NIOSH decided to repeat the pulmonary function tests.

IV. EVALUATION DESIGN AND METHODS

NIOSH investigators conducted an environmental and medical survey on April 13-14, 1982.

A. Environmental

To evaluate employees exposed to the process solvents, personal breathing-zone and area air samples for organic vapors were collected on charcoal tubes at a flow rate of 1.0 liters per minute

(lpm) for the area samples and 0.1 lpm for the personal samples. Both area and personal samples were collected for approximately six hours. A total of five personal breathing zone samples were collected on five individuals, two each in the A-wing and B-wing, and one in an adjacent building (PE building). A total of five area samples were collected at the work stations of those employees wearing the breathing zone samplers.

The five area samples were analyzed for major organic components by gas chromatography and mass spectroscopy (GC/MS). Analyses identified were quantitated on the five personal samples, which were analyzed by GC using NIOSH Method P&CAM 127.

B. Medical

Of 54 workers who had been tested in either 1980 or 1981, 48 participated in our medical study. The remainder were either on vacation, refused to participate, or were no longer employed at National Starch and Chemical. A respiratory questionnaire, based in part on that of the Medical Research Council of Great Britain[1], was administered to each participant. Included were questions pertaining to demographic information, occupational history, present and past exposure to chemicals, and smoking history. Respiratory questions dealt with current symptoms and/or history of chronic bronchitis, emphysema, pneumonia, asthma, wheezing, breathlessness, and chest tightness, with additional questions about frequency and the setting in which these symptoms occurred.

In addition to the questionnaire, NIOSH investigators administered a standard pulmonary function test to each participant. Forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) were measured with an Ohio Medical Products Model 822 dry rolling seal spirometer attached to a Spirotech dedicated computer. Three properly performed - as judged by the pulmonary function technician- exhalation maneuvers were obtained on each participant, and the best FEV1 and FVC were used in subsequent calculations[2]. Predicted normal values for FEV1 and FVC were calculated according to the Morris formula[3]. A PFT was considered normal if the FVC was at least 80% predicted, and the FEV1/FVC was at least 70%[4].

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).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

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 solely 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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The following are the evaluation criteria and health effects for the sampled substances in this evaluation:

Substance	Environmental Exposure Limit	Source	OSHA Standard	Health Effects
Vinyl acetate	10ppm	ACGIH	-	Eye, nose, and throat irritation; weakness, drowsiness, and unconsciousness
Ethyl acetate	400ppm	ACGIH	400ppm	Eye, nose, and throat irritation; weakness, drowsiness, and unconsciousness
Butyl acrylate	10ppm	ACGIH	-	Eye, nose, and throat irritation; weakness, drowsiness, and unconsciousness
N-butyl acetate	150ppm	ACGIH	150ppm	Eye, nose, and throat irritation; weakness, drowsiness, and unconsciousness

VI. RESULTS AND DISCUSSION

A. Environmental

A total of five area air samples were collected for organic vapors in the A and B wings of the main building. The primary volatile organic compounds identified from these samples were vinyl acetate, ethyl acetate, butyl acrylate, and n-butyl acetate. The five personal breathing zone air samples collected in the A and B wings yielded the following concentration ranges for the identified compounds: vinyl acetate, <0.1 to 5.1ppm, environmental criterion ethyl acetate, <0.1 to 4.7ppm; environmental criterion butyl acrylate, <0.1 to 0.4ppm; environmental criterion, n-butyl acetate, <0.1 to 0.1ppm; environmental criterion (See Table I). All substances except vinyl acetate were less than five percent (5%) of their environmental exposure limit.

Since the identified compounds have similar health effects, it is appropriate to consider their total effect as additive. That is, if the sum of the fractions in the following algorithm exceeds unity, then the threshold limit for the mixture should be considered as being exceeded.(5)

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

where C_i is the observed atmospheric concentration for the i^{th} compound
T_i is the corresponding threshold or environmental exposure limit
n is the total number of compounds in the mixture

For the five personal samples, the threshold limit of the mixture ranging from 0.02 to 0.52, was not exceeded.

Although no samples were collected for nitric acid gas, there was a noticeable acid gas smell during the acid cleaning operation, particularly in the A-wing. Outside of both the A and B-wing are nitric acid tanks for cleaning parts. Although both tanks are covered when not in use, acid gas appears to be entering the building during the manual parts cleaning operation.

The environmental data collected during this study indicate that workers in the A and B-wing of the main building at the National Starch and Chemical Corporation in Meredosia, Illinois, were not exposed to excessive levels of vinyl acetate, ethyl acetate, butyl acrylate, or n-butyl acetate.

B. Medical

Forty-eight employees participated in the study. All were chemical workers, mostly operators, assistant operators, or helpers. Each participant filled out a questionnaire, and all but one (who declined since he was recovering from a recent bout of flu) had pulmonary function testing. Years employed at National Starch ranged from 1-27 (mean 11, median 10).

For analysis of the questionnaire data, the employees' responses were compared to those of 22 workers who had responded to a similar questionnaire when they served as a comparison group in a previous NIOSH study of a different chemical plant.[6] The age distribution of the study group (Range 22-58 years, Mean 37, Median 36) was similar to that of the comparison group (Range 24-63 years, Mean 42, Median 40).

Four of 48 National Starch employees (8%) had symptoms suggestive of chronic bronchitis (cough and phlegm, with phlegm production occurring on most days for at least three consecutive months a year for at least two years), compared to 3 of 22 employees (14%) in the comparison group, a difference not statistically significant (P=0.66, Fisher's exact test, two-tailed). Eleven of 48 employees(23%) had symptoms of acute respiratory discomfort (chest tightness, wheezing, or difficulty breathing) at least once a month compared to 1 of 22 (5%) in the comparison group, again a

difference which is not statistically significant (P=0.09, Fisher's exact test, two-tailed). Prevalence of respiratory discomfort among employees was similar among smoking categories : 6 (30%) of 20 current smokers, 2 (15%) of 13 former smokers and 3 (20%) of 15 persons who never smoked (defined as a person who has smoked fewer than 20 packs of cigarettes in his lifetime). Differences in prevalence of acute respiratory discomfort by work area were not significant.

Six (13%) of 47 employees tested had abnormal pulmonary function tests; four are current smokers, two are former smokers. Five of these employees were classified as having mild obstructive change (impairment of ability to rapidly blow out air) and one was classified as having mild restrictive change (reduction of lung capacity). Applying the same criteria to the pulmonary function tests of those workers tested in both 1980 and 1981 gives 10 of 39 (26%) abnormal in 1980 and 11 of 39 (28%) abnormal in 1981. Thus there is no evidence of any increased proportion of abnormal pulmonary function tests in 1981 compared to 1980, The decreased proportion of abnormalities in 1982 may reflect changes in participant effort, technician, or equipment.

VII. RECOMMENDATIONS

1. Pulmonary function tests detect obstruction to exhalation, whereas the increased breathing resistance from respirators is to inhalation. Therefore, rather than annual PFT's and chest x-rays, a more efficient evaluation program would be a medical history and physical examination for heart and lung disease, with PFT's and other medical tests only when clinically indicated. We suggest that the actual values of the tests be reported to the workers, rather than just an indication of normality or abnormality, since a number of criteria for normality exist. In this way, any worker whose results are interpreted as abnormal could discuss the results with his family physician, who could then decide if medical follow-up is necessary.

2. Better control methods are required to control acid gas from the nitric acid tanks. For example, a passive ventilation hood with a stack could be designed to direct the gas over the top of the building. Also, designated workers trained in good work practices specific to this cleaning operation should be assigned to the acid cleaning process. Workers with symptomatic obstructive airway disease should not be assigned to this process, because exposure to irritating acid gases might cause exacerbation of symptoms.

3. Although acrylonitrile is used during the batch process operation, acrylonitrille vapor was not detected in the air samples taken during this study. However, workers who are potentially exposed to airborne concentrations of this compound

in excess of the personal exposure limit (PEL-2ppm) should wear respiratory protection. Air-purifying respirators with organic vapor cartridges are appropriate up to 20 ppm for half-face respirators and 100 ppm for full-face respirators. Since the National Toxicology Program[7] and OSHA[8] consider acrylonitrile a chemical carcinogen, every effort should be made to minimize exposure by engineering controls. OSHA requires periodic air monitoring and medical surveillance of workers potentially exposed to acrylonitrile.[8]

4. An environmental sampling program should be developed to monitor the work areas for organic vapors, nitric acid gas, and other contaminants on an annual basis or when process changes occur.

5. One person should be assigned the responsibility for the safety and health program at the facility. This person would be responsible for monitoring and providing safe and healthful work practices, protective clothing, adequate engineering controls such as ventilation, and general hazard control techniques.

VIII. REFERENCES

1. Medical Research Council: Questionnaire on Respiratory Symptoms and Instructions for Interviews. London, MRC, 1976.

2. Horvath, E.P., ed. Namual of Spirometry in Occupational Medicine. National Institute for Occupational Safety and Health, Cincinnati, Ohio 1981

3. Morris J.F., Koski A., Johnson L.C., Spirometry standards for healthy non-smoking adults. Am. Rev. Respir. Dis. 102: 57-67, 1971.

4. Horvath, E.P., Pulmonary function testing in occupational medicine. Technical Manual 77-1. Naval Environmental Health Center, Cincinnati, Ohio 1977

5. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1982. Cincinnati, Ohio: ACGIH, 1982.

6. NIOSH Health Hazard Evaluation Determination Report, HE #78-90-739, FMC Corporation, Nitro, West Virginia, September 1980.

7. National Toxicology Program, Second Annual Report on Carcinogens, 1981.

8. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1045. Occupational Safety and Health Administration, revised 1980.

9. Mackison, F.W., et al, Occupational Health Guidelines for Chemical Hazards. DHHS (NIOSH) Publication No. 81-123.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. National Starch and Chemical Corporation
2. Requester
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

Air Sampling Results

National Starch and Chemical Company
Meredosia, Illinois
HETA 82-051

April 15, 1982

Sample Identification:	Operator (B-Wing)	Helper (B-Wing)	Operator (A-Wing)	Helper (A-Wing)	Operator (PE-Bldg)
Sampling Period:	0716-1451	0717-1455	0729-1109	0730-1046	0734-1502
Analyte Concentration:					
Vinyl acetate (environmental limit-10ppm)	5.1 ppm	4.3 ppm	2.1 ppm	3.5 ppm	<0.1[1] ppm
Ethyl acetate (environmental limit-400ppm)	0.7 ppm	0.6 ppm	4.7 ppm	4.4 ppm	<4.4 ppm
Butyl acrylate (environmental limit-10ppm)	<0.1[3] ppm	0.1 ppm	0.1 ppm	<0.2[3] ppm	<0.1[3] ppm
N-butylacetate (environmental limit-150ppm)	0.1 ppm	0.1 ppm	0.1 ppm	0.1 ppm	<0.1[4] ppm
Mixture Threshold Limit: $\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$	0.52	0.44	0.26	0.38	0.02

1. Less than analytical limit of detection (10 ug)
2. Less than analytical limit of detection (10 ug)
3. Less than analytical limit of detection (20 ug)
4. Less than analytical limit of detection (10 ug)

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