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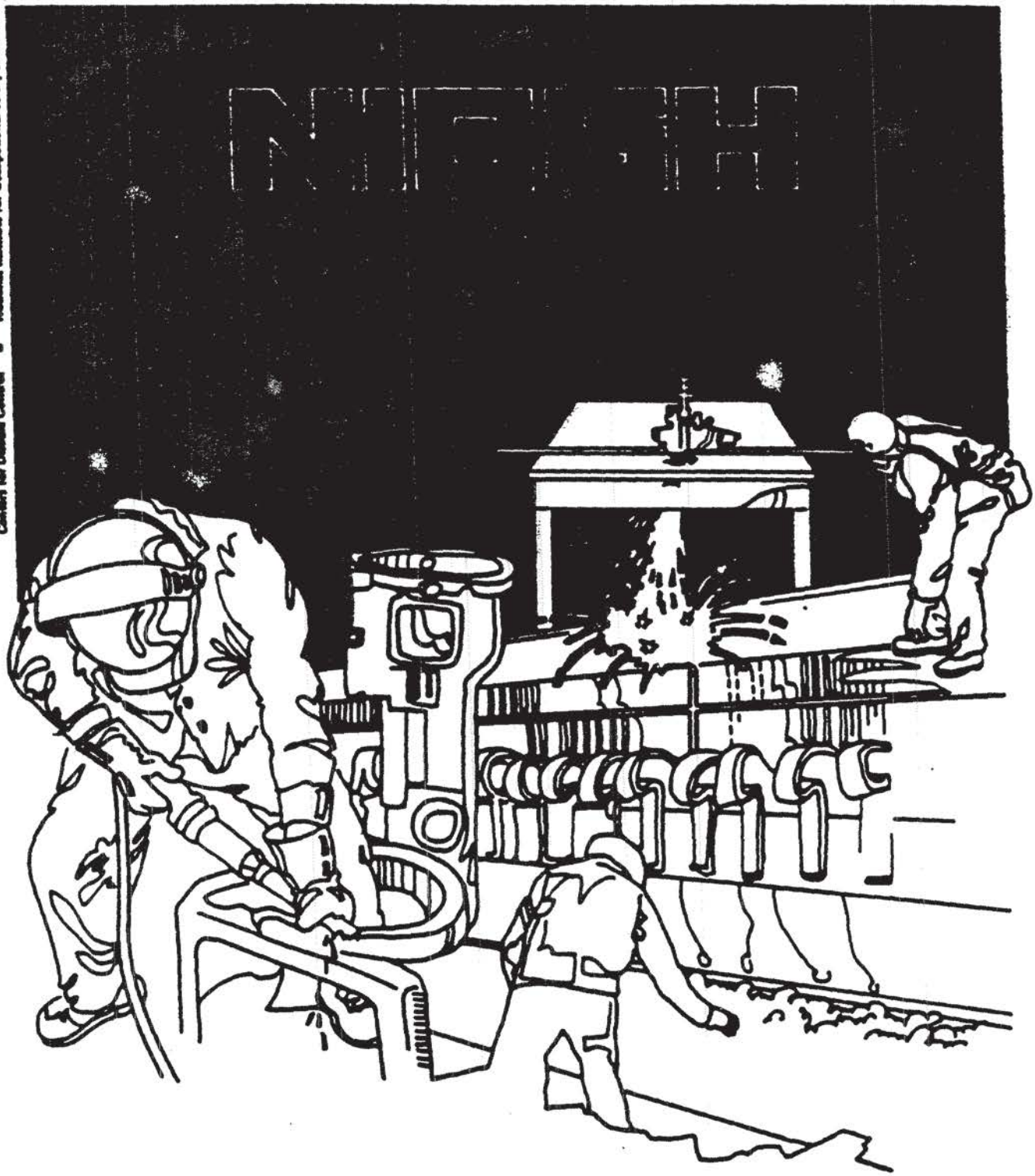

Health Hazard Evaluation Report

HETA 81-134-1079
METROPOLITAN SEWER DISTRICT
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.

HETA 81-134-1079
March 1982
Metropolitan Sewer District
Cincinnati, Ohio

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I. SUMMARY

In December, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from a representative of employees at the Metropolitan Sewer District located in Cincinnati, Ohio. The request stated that employees were experiencing stomach illness and occasional breathing difficulties while working inside a decant tank located in Building "H". The request did not specify particular exposures.

Environmental samples were collected using direct reading indicator tubes on March 4, 1981, to determine work area exposures. In addition, a NIOSH physician interviewed 10 employees, nine of whom worked periodically inside the decant tank.

Direct reading indicator tubes detected benzene at 2 to 3 ppm (OSHA standard 10 ppm; NIOSH 1.0 ppm ceiling) and carbon dioxide at 150 ppm (OSHA standard 5000 ppm). It should be noted that this method of sample collection can be influenced by other gases and vapors. Additional gases and/or vapors monitored for but not detected included: methane, hydrogen sulfide, sulfur dioxide, ammonia, oxide of nitrogen, phosgene and mercaptan.

The employees interviewed by the NIOSH physician reported symptoms of nausea and irritation of the eyes and mucous membranes. In several instances symptoms occurred after a brief period in the decant tank area (a few hours or less). Nine of the 10 interviewed reported an extremely noxious odor which lingered on the skin and clothing for days.

The quality of the atmosphere inside the decant tank is unpredictable from one day to the next depending on the quality of the plant influent. Therefore, exposures within the tank should be considered potentially hazardous and certain protective measures, as explained in Section VII, should be taken for all tank entries. Benzene was detected, however, the detector tube sampling method used is subject to interference from several organic vapors, therefore, its presence is questionable. The reported symptoms were non-specific and could result from exposure to common sewer gases such as hydrogen sulfide, sulfur dioxide or ammonia.

KEYWORDS: SIC No. 4952 Sewage treatment plant, decant tank, hydrogen sulfide, sulfur dioxide, benzene, nausea and irritation of the eyes and mucous membranes.

II. INTRODUCTION

During December 1980 the Hazard Evaluations and Technical Assistance Branch of NIOSH received a request from Ohio Council #8 of the American Federation of State, County and Municipal Employees to evaluate certain work conditions at the Metropolitan Sewer District, Cincinnati, Ohio. The request concerned exposure(s) emitted by H Building decant operations. Field visits concerning this request were made by NIOSH medical and industrial hygiene personnel on January 6, and March 4, 1981. NIOSH distributed Interim Report (#1) in March 1981 outlining the preliminary results, future action and recommen- dations.

III. BACKGROUND

The Metropolitan Sewer District is located in Southwest Cincinnati, Ohio and services the greater part of Hamilton County. The plant has both primary and secondary treatment facilities, with an average flow of 120 million gallons per day (MGPD). Primary treatment removes a substantial amount of suspended matter and scum by mechanical processes, while secondary treatment uses biological methods in which aerobic microorganisms reduce the soluble and insoluble contaminants present in the wastewater. As the wastewater enters the plant, through interceptor and/or outfall sewers it is channeled through a screened chamber and distributed for grit removal and cleaning. The screened materials removed from the flow are conveyed to incinerators or to loading bins for hauling. The channeled wastewater then passes through aerators and is channeled on to primary settling tanks. In the settling tanks the wastewater is retained (1 to 3 hours) to permit suspended solids to settle. Mechanical rakes supported on rails above the wastewater move the settled solids to sludge hoppers located at the tanks bottom. Raw sludge is continuously pumped from the hoppers to anaerobic digesters. Anaerobically digested materials are mixed with aerobic liquors and piped to a thermal conditioning system. Liquids from this system are then passed on to a gravity decant thickener, dried into cakes by vacuum filtering and then incinerated.

The decant tank was of major concern during the survey. This 750,000 gallon tank is responsible for thickening the suspended sludge-based materials. Most activities take place in the tank in a quite warm and humid atmosphere. Because of the action of the chemicals being processed and the high humidity generated by the processing, frequent scheduled and nonscheduled maintenance of equipment is needed. These maintenance functions require the worker to enter the decant tank, thus exposing him to numerous sewage degradation products.

IV. EVALUATION METHODS

Colorimetric (direct reading) detector tube units (8 types) were used during the survey to determine contaminant concentrations. This method of sample collection was incorporated because of the high humid environment and the number and nature of the exposure potentials. The chemical components sampled for included benzene, carbon dioxide, oxygen level, methane, hydrogen sulfide, sulfur dioxide, ammonia, oxide of nitrogen, phosgene and mercaptan (methyl). While the samples were being collected, the NIOSH medical officer obtained data and information from employees working in the decant tank area.

V. EVALUATION CRITERIA

The environmental evaluation criteria used for the study are presented in Table I. Listed in this Table are recommended environmental limits, the source of the recommended limit, principal or primary health effects and the current OSHA legal standard. The NIOSH and American Conference of Governmental Industrial Hygienists (ACGIH) recommendations are often lower than the legal standards because they incorporate newer information on health considerations and technical feasibility.

VI. RESULTS/DISCUSSION

A. Environmental

Detector tube measurements obtained from the decant tank indicated that benzene levels (2 to 3 ppm - Table II) exceeded the current NIOSH 1.0 ppm recommended criteria. However, it should be noted that certain airborne contaminants can interfere with this collection media. Toluene, xylene and ethyl benzene - all of which are less toxic than benzene, are known to interfere with this method. Carbon dioxide emissions were also found in the decant tank however, the levels detected (150 ppm) were well within the current OSHA and NIOSH recommended standard (Table I). Other contaminants sampled for but not detected included: methane, hydrogen sulfide, sulfur dioxide, ammonia, oxides of nitrogen, phosgene, and mercaptan.

It should be noted that gases such as methane, hydrogen sulfide, sulfur dioxide and carbon monoxide are common sewage breakdown by-products and can be fatal to humans.[1] Asphyxiants such as methane can kill by displacing needed oxygen or by preventing red blood cells from absorbing oxygen and transferring it to the body tissues. Irritants such as hydrogen sulfide will attack the respiratory and/or nervous system(s) and can cause death by damaging or paralyzing the body functions.[2] The oxygen (O_2) content registered 19.5% during the sampling period however, continuous O_2 monitoring while working in the decant tank should be mandatory.

B. Medical

Of the ten employees interviewed by the NIOSH medical officer, nine had worked inside the decant tank. The worker that did not perform duties inside worked in an area above a vent that extended from the decant tank. He became ill experiencing malaise and weight loss. Symptoms of ill-health developed shortly after onset of employment in August 1980. As a result of his illness he was out of work for nine days, during which time the decant vent system was improved. Since the system was improved, the employee's symptoms have not recurred.

The other nine workers interviewed reported that the longest period of work in the tank was for two-weeks during the summer of 1980. During that time, one worker recalled working in the tank 6-days per week, 8 to 14 hours per day. Aside from the 2-week period, most work activities require minimal entry ranging from 10 minutes to 4 hours. Regular scheduled entry required electrical maintenance employees to enter the tank briefly each month to supply "anti-corrosion" pills and regular maintenance workers to inspect the tank periodically (usually 1 to 2 hours every 2 months).

Nine of ten employees interviewed reported that an extremely noxious odor was and is invariably present in the decant tank. It was also mentioned that the odor lingers in clothing and on the skin for days, despite vigorous hygiene. Symptoms reported by the interviewees included headache, nausea, anorexia (diminished appetite), irritation of eyes and mucous membranes, chest tightness, and shortness of breath. Most symptoms were transient and resolved shortly after the worker left the tank.

VII. CONCLUSIONS

Because of the constant changes taking place within the decant tank caused by anaerobic activities and chemical waste discharged into the treatment system, no one set of health and safety rules will apply 100% of the time. Therefore, ventilation should be provided in the area prior to and during tank entry. Ventilation provides fresh air as well as diluting and dispersing harmful vapors or gases. Another precaution before entering the tank would be to 'don' protective equipment. Respiratory protection should be mandatory. Devices such as mechanical filter masks, chemical cartridge, combination filter/chemical filter respirators and gas masks are not suitable for use in the decant tank. The proper type of breathing protection is an air line respirator, hose mask, or self-contained breathing apparatus. These systems supply fresh air which is needed if an oxygen deficiency exists.[1]

The medical symptoms as reported to the NIOSH medical officer were non-specific and could result from exposure to several substances, including hydrogen sulfide, phosgene, sulfur dioxide, or ammonia. Although it is possible that the reported symptoms were caused by exposures that represent a nuisance rather than a threat to health, it is also possible that the decant tank periodically contains substances at levels that do represent potential health hazards. Accordingly, all personnel working in the decant area and other confined spaces should be formally instructed as to the potential health risks that are involved with entering and working in confined areas.

VIII RECOMMENDATIONS

Some of the working conditions as described during the interviews and noted by the NIOSH evaluation team represent serious safety hazards and should be abated as soon as possible. Recommendations are suggested as follows:

1. Employees reported that in the past they did not wear masks in the decant tank, but brought combustion and oxygen meters with them. They began using Scott Air Paks in January 1981 (in lieu of the test meters, because the alarms on the meters repeatedly sounded). It is recommended that an education program be implemented to inform employees of the hazards associated with confined spaces. Such a program should include:

A. Emergency entry and exit procedures.
B. Use of oxygen and combustion meters.
C. Use of applicable respirators.
D. First aid, may include cardio-pulmonary resuscitation.
E. Lock-out procedures.
F. Safety equipment use.
G. Rescue drills.
H. Permit System.

Proper work practice procedures are outlined in the NIOSH Recommendations for Occupational Standard for Working in Confined Spaces and should be referenced concerning the above areas.

2. Many of the jobs in the decant tank are done by one individual, without a back-up person available in event of an accident or emergency. Because of the uncertainty of the exposure(s) in the tank, it is recommended that self-contained breathing units or supplied-air respirators be used by the workers entering the tank and that each worker have a back-up for emergency situations.

3. Some work activities require the employee to maneuver himself into awkward positions (e.g., leaning over the side of the catwalk to check torque switches) without safety straps or lines. Accordingly, all confined space entry and work activities should be done by a team rather than by one individual. In addition, safety lines should be incorporated and secured where possible while working inside the decant tank.

4. Because of the high humidity and chemical activities taking place in the tank, metal structures deteriorate at faster than normal rates. Therefore, inspection of the structural integrity of catwalks and other appropriate areas in the tank should be made on a regularly scheduled basis.

5. Entry into confined spaces should be prohibited until initial testing of the atmosphere has been conducted. The tests performed should include explosibility, oxygen deficiency, and carbon dioxide. The percent of oxygen for confined space entry should be no less than 19.5% nor greater than 25%.[4] Approved respiratory equipment should be mandatory (e.g., self-contained breathing units or supplied air respirators).

6. Personal Protective Equipment - disposable coveralls, caps, and gloves should be provided to employees working inside the decant tanks.

IX. REFERENCES

1. & 2. Neu, Bruce A. Avoiding Confined Space Hazards in Wastewater Treatment Plants. Digester, Environmental Protection Agency, Operation Certification Section, Springfield, Illinois

3. Occupational Safety and Health for General Industry; 29 CFR Part 1910; OSHA, U.S. Department of Labor, January 1978, 1910.134.

4. Recommendations for an Occupational Standard for Working in Confined Spaces, U.S. Department of Health, Education and Welfare, Public Health Service, NIOSH, Feb. 1979.

5. Kleinfeld M, Giel C, Rasso A. Acute Hydrogen Sulfide Intoxication. Industrial Medicine and Surgery, Sept. 1964, pp. 656.

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XI. 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. Cincinnati Health Department
2. Ohio Council #8 of the American Federation of State, County and Municipal Employees
3. Metropolitan Sewer District
4. NIOSH, Region V
5. 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

ENVIRONMENTAL EVALUATION CRITERIA
METROPOLITON SEWER DISTRICT
CINCINNATI, OHIO

SUBSTANCE	RECOMMENDED ENVIRONMENTAL LIMIT	SOURCE	PRIMARY HEALTH EFFECTS	OSHA STANDARDS
Benzene	1.0 ppm (60 minute ceiling)	NIOSH**	Blood changes including leukemia	10 ppm, 8-hr.
Carbon Dioxide	5000 ppm, 8-hr. TWA	ACGIH*	Headache, shortness of breath, dizziness	5000 ppm, 8-hr.
Methane	Limiting factor available oxygen, oxygen must not be less than 18%	ACGIH	Unconsciousness from asphyxia	Available oxygen in area
Hydrogen Sulfide	10 ppm (10 minute ceiling)	NIOSH	Comma, convulsions, eye irritation, irritation of respiratory system, dizziness, headache, fatigue, insomnia	20 ppm 10 min. ceiling
Sulfur Dioxide	0.5 ppm TWA	NIOSH	Eyes, nose and throat irritation, choking, coughing, eye and skin burns	5 ppm, 8-hr.
Ammonia	50 ppm (5 minute ceiling)	NIOSH	Eye, nose and throat irritation, shortness of breath, chest pain, pink frothy sputum, skin burns	50 ppm, 8-hr.
Oxide of Nitrogen	1 ppm (15 minute ceiling)	NIOSH	Cough, shortness of breath, chest pain, pulmonary edema, heart problems, eye irritation	5 ppm, 8-hr.
Phosgene	0.1 ppm (TWA 8-hr.) - 0.2 (ceiling)	NIOSH	Eye irritant, burning throat, vomit, foamy sputum, shortness of breath, chest pain, skin burns	0.1 ppm, 8-hr.
Mercaptan	0.5 (8-hr. TWA)	ACGIH	Narcosis, cyanosis, convulsions, pulmonary irritant, respiratory paralysis, nausea	10 ppm, 15-min. ceiling

* American Conference of Governmental Industrial Hygienists. Threshold Limit Values (TLV's) for Chemical Substance and Physical Agents in the Workroom Environment with Intended Changes for 1982.

**Benzene is a suspect carcinogen and exposure should be minimized.

TABLE II

DETECTOR TUBE SAMPLES COLLECTED INSIDE DECANT TANK
METROPOLITAN SEWER DISTRICT BUILDING H, A CHAMBER
MARCH 1981

VAPOR	CONCENTRATION	MEASUREMENT BETWEEN 1445 AND 1530 HOURS 4 MARCH 1981
Methane	ND	
Sulfur Dioxide	ND	
Ammonia	ND	
Nitrogen (oxides)	ND	
Benzene	2 ppm to $\underline{<}3$*	All samples were collected at the center of the decant tank while sludge was being recirculated at 140 gallons per minute.
Hydrogen Sulfide	ND	
Methyl Mercaptan	ND	
Carbon Dioxide	0.15%	
Oxygen Content	19.5%	

*Benzene cannot be confirmed as being present by this method because other aromatic hydrocarbons such as toluene and xylene have similar sensitivities to this test.