| | | |
|---|---|---|
| TA-80-33 NA | | PB81 NA 111148 |
| 4. Title and Subtitle<br>Technical Assistance Report No. TA 80-33, Omaha Waste Pretreatment Plant, Omaha, Nebraska | | 5. Report Date<br>June 1980 |
| | | 6. NA |
| 7. Author(s)<br>Hervin, R. L. | | 8. Performing Organization Rept. No.<br>NA |
| 9. Performing Organization Name and Address<br>Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations, and Field Studies, Cincinnati, Ohio 45202 | | 10. Project/Task/Work Unit No.<br>NA<br>11. Contract(C) or Grant(G) No.<br>(C) NA<br>(G) |
| 12. Sponsoring Organization Name and Address<br>SAME AS ABOVE | | 13. Type of Report & Period Covered<br>Hazard Evaluation<br>02/1980 and 04/1980<br>14. NA |

15. Supplementary Notes

NA

16. Abstract (Limit: 200 words)

An environmental and medical survey was comducted on February 6 and April 3, 1980 at the Omaha Waste Pretreatment facility (SIC-9511) in Omaha, Nebraska. The management of the Public Works Department, City of Omaha, requested technical assistamce from NIOSH to determine if any health hazards were present at the facility which employs 19 workers. Long term detector tubes were used for evaluation of personal and area exposure to hysrogen sulfide (7783064) (H2S) . Personal and breathing zone samples were collected on charcoal tubes and analyzed by mass spectrometry to identify the presence of organic air contaminants. Short term detector tubes were used to detect other potential contaminants such as oxides of nitrogen and sulfur dioxide (7446095). Personal samples for H2S ranged from 0.5 to between 39.4 and 73.2 parts per million (ppm), with estimated 8 hour time weighted average (TWA) ranging from 4.2 to between 8.9 and 15.0 ppm. The current OSHA standard is 20ppm for an 8 hour TWA with a 10 minute ceiling value of 50ppm. Trace amounts of other contaminants were all less than 5 percent of the environmental criteria for these compounds. Interviewed employees reported past and current health problems such as irritations to the eyes and respiratory system. The authors conclude that a health hazard due to H2S existed at the pretreatment facility and probably existed as a prolonged intermittent exposure over the past several years. Recommendations are provided for improvements in ventilation, housekeeping, personal hygiene, and medical surveillance.

17. Document Analysis a. Descriptors

Toxic-gases
Work-environment
Air-contaminants
Technical-personnel
Analytical-instrumentation
Eye-irritants
Respiratory-irritants
Air-flow
Medical-examination

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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|---|---|---|
| 18. Availability Statement<br>AVAILABLE TO THE PUBLIC | 19. Security Class (This Report)<br>NA | 21. No. of Pages |
| | 20. Security Class (This Page) | 22. Price |

PB81-111148

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

TECHNICAL ASSISTANCE REPORT
TA 80-33

OMAHA WASTE PRETREATMENT PLANT
OMAHA, NEBRASKA

JUNE 1980

## I. SUMMARY

On February 6, 1980, and April 3, 1980, the National Institute for Occupational Safety and Health provided technical assistance to the City of Omaha in the evaluation of potential health hazards at the Omaha Waste Pretreatment Plant, SIC 9511. A request for technical assistance to evaluate potential exposures of 19 employees to hydrogen sulfide and/or other contaminants and to make any recommendations concerning solutions to any identifiable problems was received on January 7, 1980.

Long-term detector tubes were used for evaluation of personal and area exposures to hydrogen sulfide. Personal and breathing zone air samples were collected on charcoal tubes and analyzed by mass spectrometric procedures to identify the presence of organic air contaminants. Short-term detector tubes were used to detect possible exposure problems to other potential contaminants (e.g., oxides of nitrogen, sulfur dioxide, etc.). Some personal and area samples exceeded the NIOSH environment criteria of 10 ppm ceiling concentration for hydrogen sulfide over a 10 minute period (maximum 160 ppm). Personal samples obtained on one employee showed an exposure of greater than 8.9 ppm (estimated as less than 15 ppm) for hydrogen sulfide over an 8 hour time weighted average. Results of other samples (e.g., toluene, carbon monoxide, chlorotoluene, etc.) were all less than 5 percent of the environmental criteria for these compounds. Employees interviewed at the time of the evaluation on February 6, 1980, reported past and current health problems (e.g., effect on eyes such as irritation, halos, etc., irritation of respiratory system, etc.) which are typical symptoms of exposure to hydrogen sulfide.

Based on the environmental sample results, employee interviews, and information on exposure to hydrogen sulfide, NIOSH has determined that a health hazard due to overexposure to hydrogen sulfide existed at the pretreatment plant and probably existed as a prolonged intermittent exposure over the past several years. The overexposures were due to inhalation of hydrogen sulfide from the decay of animal matter. Recommendations on improved ventilation, housekeeping, personal hygiene, medical surveillance, and other considerations are presented in Section VII of this report.

## II. INTRODUCTION

The management of the Public Works Department, City of Omaha, requested technical assistance from NIOSH to determine if any health hazards were present during the pretreatment of wastes at the Omaha Waste Pretreatment Plant. The workplace was evaluated by means of environmental samples, employee interviews, and information obtained from past NIOSH and other evaluations on similar operations.

## III. BACKGROUND

The Omaha Waste Pretreatment Plant receives an average of 5,000,000 gallons of waste per day at the pretreatment building. This is a large enclosed facility divided into two areas; the bucket elevator-press area (two operating presses) and the basin area (four primary basins and four secondary basins). The waste first passes through a bar screen to remove the gross solids which are transferred to the haul-away storage bins. The influent flows into four gravity basins in parallel followed by two secondary basins operating in parallel. The effluent flows to the main treatment facility (a separate facility and not part of this evaluation) for further treatment. Each basin has a top and bottom skimmer with the sludge or skimmings from the secondary basins being transferred to the original influent to the facility. The bottom skimming or sludge from the primary basins is transferred to the bucket elevators. Sludge from the bucket elevators is transferred to the presses where the excess water is squeezed out of the solids and the liquid returned to the basins. The solids from the presses are transferred to a private firm's truck(s) for use as landfill. The top skimmings (e.g. grease and floatable materials) from the gravity basin are transferred to the process building for recovery of the grease which is sold to an outside contractor. The process building (separate facility) consists of two large two-story treatment tanks and one holding tank. The top skimmings are first treated in the North treatment tank by heating to 200° F with the overflow or grease going to the South treatment tank. The overflow from the South treatment tank goes to the holding or storage tank (maintained at 130° F so grease is liquid) prior to pickup by an outside firm. The bottom liquids from the treatment tanks are drained back to the basin area for further treatment.

One operator and one laborer work in the process building during the day shift only. There are two operators and two laborers involved in the pretreatment facility for each shift. The rest of the employees are maintenance personnel. The main area of concern is employees exposure to hydrogen sulfide which is an off-gas from decaying animal matter.

## IV. EVALUATION, DESIGN, AND METHODS

Personal breathing zone air samples were obtained on operators, laborers, and maintenance employees using long term detector tubes for hydrogen sulfide at a flow rate of 25 to 50 cc/minute. Some area and personal charcoal tube samples were also obtained in the main areas of concern to determine maximum

levels of other potential contaminants being released. The charcoal tube samples were analyzed by gas chromatographic/mass spectrometric procedures.

Short term detector tubes were used to ascertain potential exposures to sulfur dioxide, carbon monoxide, carbon dioxide, ammonia, and oxides of nitrogen. Results of the short term samples were non-detectable or well below any established health criteria or standard for these compounds. Therefore, they are not considered further in this report.

Employees present on the day of the evaluation were given medical questionnaires to determine work-related health problems.

## V. EVALUATION CRITERIA

### A. Hydrogen Sulfide

It is well known that exposure to hydrogen sulfide at high concentrations such as 935 ppm may cause immediate respiratory arrest and death. Upon inhalation, the gas is absorbed into the blood stream and can, within a few seconds, cause unconsciousness and paralysis of the respiratory center (in the brain) with subsequent anoxia. If the victim survives the initial exposure to high concentrations, pulmonary edema and bronchial pneumonia may ensue. Sub-acute and chronic exposure to lower levels of hydrogen sulfide may cause irritation of the mucous membranes, headache, fatique, irritability, insomnia and eye irritation. Low concentrations are readily detected by the characteristic rotten-egg odor; however, prolonged exposure dulls the sense of smell and makes the odor a very unreliable means of warning. The eyes are affected by palpebral edema, bulbar conjunctivitis mucopurulent secretion with perhaps a reduction of visual acuity. This form of keratoconjunctivitis or "gas eye" is directly related to hydrogen sulfide concentrations and can result in temporary blurred or hazy vision and rainbows or halos around lights or illuminated objects.

NIOSH recommends that exposure to hydrogen sulfide ($H_2S$) be controlled so that no employee is exposed to a ceiling concentration greater than 10 parts of $H_2S$ per million parts of air (10 ppm or approximately 15 milligrams of $H_2S$ per cubic meter of air - 15 mg/$M^3$) as determined with a sampling period of 10 minutes, during the workshift During the workshift, evacuation of the area shall be required if the concentration of $H_2S$ exceeds 70 mg/$M^3$. The current OSHA standard is 20 ppm of $H_2S$ as an acceptable ceiling; and 50 ppm $H_2S$ as a maximum ceiling value which should not be exceeded over a 10 minute period. (Refer to Appendix A for more information on hydrogen sulfide).

### B. Other Considerations

Toluene, o-chlorotoluene, dichlorobenzene isomers, perchlorolthylene, and refined petroleum solvents (e.g., stoddards solvent, etc.) were found in detectable levels in some of the charcoal tubes obtained during the surveys.

However, the levels found for these compounds were low (discussed in next section), and would contribute little to the irritation of the eyes and/or mucous membranes or other symptoms noted above for $H_2S$. Hence, further discussion of the toxicity or symptoms produced by these compounds is not necessary for purposes of this report.

## VI. RESULTS AND DISCUSSION

### A. Environmental Results

Samples taken for hydrogen sulfide ($H_2S$) on February 6, 1980, indicate, as shown in Table I, that five of 11 long-term personal samples (maximum > 39.4 - < 73.2 ppm) obtained from five employees were in excess of the environmental criteria of 10 ppm ceiling concentration for $H_2S$ over a 10 minute period. The estimated 8 hour TWA of a press room operator was greater than 8.9 ppm but less than 15 ppm for $H_2S$. Short-term detector tube samples indicated exposures up to 160 ppm of $H_2S$ around the press area and 100 ppm of $H_2S$ in the basin area at 7:20 a.m. on the day of the survey. All doors were closed and the ventilation was off at that time. Doors were opened, the ventilation turned on, and it was requested that employees evacuate the treatment facility into the open air, and spend as little time in the facility as possible. The levels were significantly reduced to 30 ppm in the press area and 15 ppm in the basin area at around 8:00 a.m. All subsequent readings in the basin area were 10 ppm or less for $H_2S$. Most subsequent short-term samples in the press area were between 10-20 ppm for $H_2S$, although a few samples were 50 to 60 ppm for $H_2S$. Employees spent as little time as possible in the treatment facility during the survey. Personal Samples as well as short-term samples were 1 ppm or less for $H_2S$ in the process building. Several short-term samples were obtained in the treatment and process facility during the survey.

A follow-up survey was made on April 3, 1980. Long-term samples for $H_2S$ indicate, as shown in Table II, that one out of nine personal samples obtained from eight employees were in excess of the environmental criteria of 10 ppm for $H_2S$ over a 10 minute period. The press room operator was exposed to 12.1 ppm of $H_2S$ over a 160 minute period, which exceeds the criteria of 10 ppm for $H_2S$ over a 10 minute period. The estimated 8 hour TWA for all employees was less than 10 ppm for $H_2S$ in the treatment facility. The maximum results in the process building were 1.2 ppm for $H_2S$. Several short-term detector tube samples obtained in the breathing zone air of employees in the treatment; and process facilities were 10 ppm or less for $H_2S$. A few short term samples in the immediate vicinity of the press showed up to 60 ppm of $H_2S$.

A total of 12 long-term personal and area charcoal tube samples were obtained during both surveys and analyzed via gas chromatographic and mass spectographic

methods. Trace amounts of toluene, perchloroethylene, refined petroleum solvents (e.g., stoddards solvent, etc.), o-chlorotoluene, and isomers of dichlorobenzene were detected in most but not all of the samples. However, exposures of employees would be less than five percent of any known current environmental criteria (e.g., NIOSH, OSHA, etc.) for these compounds on an individual basis or even when considering their effects on an additive basis. Hence, these compounds would contribute little to the overall exposure of employees and are not considered further.

A cursory ventilation survey was made primarily with smoke tubes and an Alnor Velometer, Jr. (not used too much, as not much ventilation). The treatment facility had little effective ventilation, and ventilation over the presses provided for increased exposure of the process operators. There was no ventilation in the process building, and two out of the three processing (e.g., two treatment and one storage) tanks had no top enclosures. Ventilation in the basin area also showed the air-flow through the employees breathing zone.

B. Medical Interview Results

During the initial survey, 16 out of 19 current male employees were interviewed concerning any symptoms which may be attributed to the work environment. The age range was 19-59 years with an average of 40 years. The plant has been operational by the city for 9 years and the average employment span was 6.0 years per employee. Ten employees were current smokers. Nine employees were operators or laborers; three employees were foremen and four employees were maintenance men. The following discussion does not involve routine complaints of odor, occasional irritation of eyes and/or respiratory tract as all employees have these types of complaints. It should be noted that in reviewing the problems below, some long-term employees did describe conditions as worse than existed during this survey. One recent employee complained only of cigarette smoke. In reviewing the information below, it should be noted that emphasis was made on complaints over the past year or so and does not include complaints occuring during previous operations.

Most all employees complained of mild eye irritation problems. Nine employees complained of moderate irritation of the eyes on a weekly basis. These symptoms were normally described as a scratching and abrasive action on the eyes although no apparent particulate matter was noted. Six employees complained of more serious eye problems occurring once or more per month. These complaints normally described symptoms such as halos or rainbows around illuminated objects (street lamps, TV, etc.) and hazy, blurred vision on clear sunny days. Over the past 2 years, eight employees have seen a physician at least once to a maximum of three to four times due to the severity of eye irritation symptoms plus other milder complaints such as headaches.

The complaints of eye irritation were the most prominent although secondary complaints of weekly to monthly irritation to the respiratory tract were also a problem. Eight employees complained of respiratory problems (e.g., irritation of nose,

mouth, and lungs; sores in nose; excess phlem production; etc.) primarily as a secondary problem. A third problem was that five of the employees complained of dermatitis problems (e.g., boils, pimples, dry skin, flaky skin, etc.) since working at the plant.

General discussions with employees during the second survey indicated that conditions were considerably improved, but the employees feel that environmental conditions still need improvement.

## VII. CONCLUSIONS AND RECOMMENDATIONS

Results of the environmental survey and the employee interviews show that employees were exposed to concentrations of $H_2S$ which are considered as toxic. Conditions were improved at the time of the second survey; however, results still show a need for further improvement. It is noted that management has taken short-term steps (e.g., lids on presses, partial boards on basin, doors open, medical exam on selected employees, limited monitoring) and is planning additional changes to improve conditions for employees at the pretreatment facility. Improvements (e.g., ventilation, monitoring, medical) were discussed in detail at the time of the surveys.

In view of the above information, the following recommendations are made to provide for a more desirable working environment for all personnel.

A. The medical and environmental (e.g., monitoring, medical examinations, etc.) recommendations contained under Section I (pages 1 through 18) of "Criteria for a Recommended Standard . . . Occupational Exposure to Hydrogen Sulfide"[5] should be implemented as soon as possible.

B. Particular emphasis should be made concerning improved ventilation, employee education, medical exams, work practices, sanitation, monitoring, personal hygiene, and similar practices.

C. The survey did not indicate a problem of exposure to hydrogen sulfide in the process building. However, interviews with employees as well as symptoms (e.g., irritation of eyes-respiratory tract, cough, nausea) experienced by the NIOSH investigator show that there is a similar problem in the process building. Hence, the recommendations in A and B above (e.g., ventilation, tops on two tanks) should also be implemented in the process building.

## VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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2. Patty, F.A. (ed.) Industrial Hygiene and Toxicology, Interscience Publishers, New York, 1963.

3. Amercian Conference of Governmental Industrial Hygienists, Documentation of the Threshold Limit Values, 3rd Edition, 1971.

4. Harrison's Principles of Internal Medicine, 6th Edition, McGraw Hill Company. 1970.

5. Criteria for a Recommended Standard . . . Occupational Exposure to Hydrogen Sulfide, DHEW (NIOSH) Publications No. 77-158.

## X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

a) Public Works Department, City of Omaha, Omaha, Nebraska
b) U.S. Department of Labor, Region VII
c) NIOSH, Region VII
d) Omaha City Employees Union - Local 251, AFL-CIO International Labor Union

For the purpose of informing the 19 "affected employees", the employer shall promptly "post" the determination report for a period of 30 days in a prominent place near where exposed employees work.

TABLE I

LONG-TERM DRAGER DETECTOR TUBE RESULTS FOR HYDROGEN SULFIDE - $H_2S$
OBTAINED DURING ENVIRONMENTAL SURVEY AT THE OMAHA WASTE PRETREATMENT PLANT
CITY OF OMAHA, OMAHA, NEBRASKA - TA 80-33
FEBRUARY 6, 1980

| Type of Sample | Job and/or Area Description | Sample Number | Time of Sample | Estimated PPM* $H_2S$ | Estimated 8 Hour TWA** ppm $H_2S$ |
|---|---|---|---|---|---|
| Personal | Operator A - Process Bldg. | 1 | 0700-1335 | 0.5 | 0.4 |
| Personal | Operator B - Press Room | 2 | 0705-0745 | > 39.4-<73.2 | >3.3-<6.1 |
| Personal | Operator B - Press Room | 3 | 07[illegible] 0900 | 12.8 | 2.0 |
| Personal | Operator B - Press Room | 4 | [illegible]1050 | 8.2 | 1.9 |
| Personal | Operator B - Press Room | 5 | [illegible] | 3.7 | 1.7 |
| | | Total Estima[illegible] TWA | | -- | > 8.9-<15.0 |
| Personal | Laborer A - Basin Area | 6 | 0710-0800 | 25.7 | 2.7 |
| Personal | Laborer A - Basin Area | 7 | 0800-1440 | 2.5 | 2.0 |
| | | Total Estimated 8 Hour TWA | | -- | 4.7 |
| Personal | Laborer B - Basin Area | 8 | 0715-0804 | 22.9 | 2.4 |
| Personal | Laborer B - Basin Area | 9 | 0804-1430 | 2.3 | 1.8 |
| | (Same Process Bldg.) | Total Estimated 8 Hour TWA | | -- | 4.2 |
| Personal | Operator C - Basin Area | 10 | 0800-1030 | 14.6 | 4.6 |
| Personal | Operator C - Basin Area | 11 | 1030-1435 | 7.4 | 3.8 |
| | | Total Estimated 8 Hour TWA | | -- | 8.4 |
| Area | Process Bldg. | 12 | 0840-1517 | 3.0 | 2.4 |
| | | Total Estimated 8 Hour TWA | | -- | 2.4 |
| Area | Press Room | | 0845-1535 | | |
| | | Total Estimated 8 Hour TWA | | Not valid as off scale | |
| | Environmental Criteria*** | | | 10.0 | 10.0 |

* PPM - Parts per contaminant per million parts of air.

** TWA - Time weighted average concentration for a normal 8 hour workday or 40 hour workweek to which nearly all workers may be exposed, day after day, without adverse effect.

*** Environmental Criteria - The current OSHA federal standard is 20 ppm for an 8 hour TWA and a ceiling value of 50 ppm for hydrogen sulfide. The current NIOSH recommendation for environmental exposure limit is 10 ppm (10 minute sample - ceiling concentration) of hydrogen sulfide during the workshift.

## APPENDIX A

### EFFECTS OF HYDROGEN SULFIDE INHALATION ON HUMANS*

(NOTE: 1.5 mg/M$^3$ of hydrogen sulfide is approxmiately 1.0 ppm of hydrogen sulfide)

| No. of Subjects | Concentration (mg/cu m) | Duration of Exposure | Effects |
|---|---|---|---|
| 1 | 17,000 | - | Death |
| 1 | 2,800-5,600 | <20 min | " |
| 10 | 1,400 | <1 min | Death 1/10, unconsciousness, abnormal ECG |
| 342 | 1,400-2,800 | <20 min | Hospitalization of 320, death of 22 including 13 in hospital, residual nervous system damage in 4 |
| 5 | 1,400 | Instant | Unconsciousness, death |
| 1 | 1,400 | <25 min | Unconsciousness, low blood pressure, pulmonary edema, convulsions, hematuria |
| 4 | 400 - 760 | - | Unconsciousness |
| 1 | 320 | 20 min | Unconsciousness, arm cramps, low blood pressure |
| 78 | 20 - 35 | - | Burning eyes in 25, headache in 32, loss of appetite in 31, weight loss in 20, dizziness in more than 19 |
| 6,500 | 15 - 20 | 4-7 hr | Conjunctivitis |
| City of Terre-Haute | 0.003-11 | Intermittent air pollution episodes over a 2-mon period | Numerous complaints of nausea (13), headache, shortness of breath (4), sleep disturbance (5), throat and eye irritation (5) |

*Obtained from Reference 5 of this report; Table III-1, page 61.