U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-28-674

GETTY REFINING & MARKETING COMPANY
WASTE WATER TREATMENT PLANT
DELAWARE CITY, DELAWARE

March 1980

I. SUMMARY

On November 24, 1978, NIOSH received a request to evaluate worker exposure to various chemicals at the Waste Water Treatment Plant (WWTP) at Getty Refining and Marketing Company, Delaware City, Delaware. Workers were exposed to contaminants such as hydrogen sulfide, ammonia, benzene, hydrocarbons and other substances emitted during the various stages of the treatment process. Symptoms were stated to have ranged from mild headaches to nausea, vomiting, skin irritation, allergic reactions and respiratory infections.

To evaluate the cause of those symptoms, NIOSH conducted an industrial hygiene and medical evaluation. Personal and area air samples for determination of organic vapors, amines and lead were obtained. Detector tube measurements were made to spot-check airborne concentrations. Airborne microorganisms were sampled to evaluate aerosol exposure in the area of the aeration tanks. The health of employees was evaluated through worker interviews, review of medical records, and consultation with the refinery medical staff and private physicians.

Personal breathing zone sampling results for benzene were equal to or less than 0.2 ppm except for one of the 12 samples which was 0.51 ppm (NIOSH recommended standard is 1 ppm). Six of 20 area samples for benzene revealed concentrations exceeding 1 ppm. The highest was 7.2 ppm obtained at the American Petroleum Institute (API) Separator outlet. Breathing zone concentrations of other organic vapors were less than 1% of NIOSH and OSHA standards. Detector tube readings indicated the potential for intermittent exposure to ammonia, triethylamine and phenols in concentrations above current health standards in the immediate vicinity of the API separators and aeration tanks. Acute health effects of headache, eye and throat irritation, light-headedness and nausea were experienced by 45% or more of the 11 employees interviewed. Additionally, three of the 11 operators associated episodes of diarrhea with rotation through the WWTP. No stool pathogens were identified. There was no evidence of chronic health problems.

While there was no evidence of chronic (long-term) health problems, there are acute health effects occurring due to intermittent high levels of hydrogen sulfide, ammonia and organic vapors. The potential for exposure to benzene constitutes a serious long-term health risk. Area sampling documented benzene concentrations in excess of health standards at the API Separator, Dual-Cell-Gravity Separator and Aeration Tanks. Recommendations for reducing operator exposures are detailed on page 11.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. On November 8, 1978 the President, OCAW Local 8-898 requested a health hazard evaluation of the Waste Water Treatment Plant (WWTP) at the Getty Refining and Marketing Company, Delaware City, Delaware, to evaluate WWTP operators' exposure to chemical and biologic emmissions resulting from the operation of the various treatment processes. An initial survey was accomplished on February 28 - March 1, 1979 to observe the conditions of exposure and collect the information necessary to develop a specific evaluation plan. Follow-up medical/environment studies were conducted on August 21-22, 1979 and on September 25-26, 1979 to obtain area and personal exposure data to facilitate making a toxicity determination.

III. BACKGROUND

The Getty Refining and Marketing Company is located on 5,500 acre tract of land adjacent to the Delaware River in Delaware City, Delaware. The basic raw material is crude oil, which can be refined at a rate of 150,000 barrels per day into products such as propane, gasoline, jet fuel, kerosene, diesel fuel, and no. 2 fuel oil. The original installation was completed in 1957.

The major operating facilities are:

- Marine Terminal
- Crude Unit
- Fluid Coking Unit
- Fluid Catalytic Cracker
- Gas Plants
- Polymerzation Unit
- Alkylation Unit
- Catalytic Reformer and Extration Plant
- Hydrodesulfurizers
- Hydrogen Plants
- Hydrocracker
- Sulfur Recovery Unit
- Oxo-Alcohol and Napthalene Plants
- DP&L Power Station

From the standpoint of this evaluation, the significance of these facilities is that most of them generate some form of liquid waste which eventually flows to the WWTP for treatment and subsequent discharge into the Delaware River. The components of these liquid wastes are responsible for the gases and vapors of concern to the WWTP operators.

*Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorized the Secretary of Health, Education, and Welfare, following a written request by 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.

There are two projects under construction - foul water stripper and WWTP expansion - that will have an impact on contaminant levels in the WWTP area. Both projects are discussed on page 8.

The flow through the WWTP is briefly explained as follows and is diagrammed in Figure 1, next page.

The Getty Refining and Marketing Company WWTP was started in 1974 and is an activated sludge-type installation treating an average flow of 5.5 million gallons per day (MGD). Water enters the plant through two sewers. A chemical waste sewer brings approximately 1 MGD containing relatively high concentrations of ammonia (NH_3) and hydrogen sulfide (H_2S) with the remaining flow coming from the oily waste sewer. The oily waste sewer contains less H_2S and NH_3 than the chemical sewer. Both contain hydrocarbons. The oily wastes flow through an API separator designed to gravimetrically separate oil and sludge from water. The chemical sewer water passes through the API separator in an independent channel going to a holding tank where it is aerated to remove H_2S and NH_3.

The two waste streams are then combined and flow to a flocculator where polymers are added to produce a light floc. This floc is then removed by one of two dissolved air flotation (DAF) tanks operated in parallel. The flows leaving the DAF units are mixed and 50% of the total flow is recycled after it is dissolved under pressure to improve collection efficiency. The effluent from the flotation tanks goes to one of two aerators where the remaining wastes in the liquid are biologically degraded. The biological sludge and waste water mixture flows from the aeration tanks to clarifiers (inner ring) where the sludge is permitted to settle out. The clarified liquid is discharged to the Delaware River via No. 4 guard basin. Excess biological sludge is pumped to a digestor for further biological degradation.

Treated sludge from the digestor is de-watered using dual-cell-gravity (DCG) units and then trucked away to a landfill. Liquid extracted from the sludge is recycled through the aeration tanks.

Three shifts are necessary to operate the WWTP on a 24-hour schedule. Two operators and a foreman are required per shift. Each operator also works two other jobs in the refinery - utilities and pump station - rotating from one job to the next every seven weeks. The time in the ulilities unit is spent entirely away from the WWTP but, during the seven weeks at the pump station, the operator has responsibilities at the API separator and spends much of his time at the WWTP. Thus, 14 out of every 21 weeks are spent wholly or partially at the WWTP.

Figure 1

Flow Diagram

Getty WWTP

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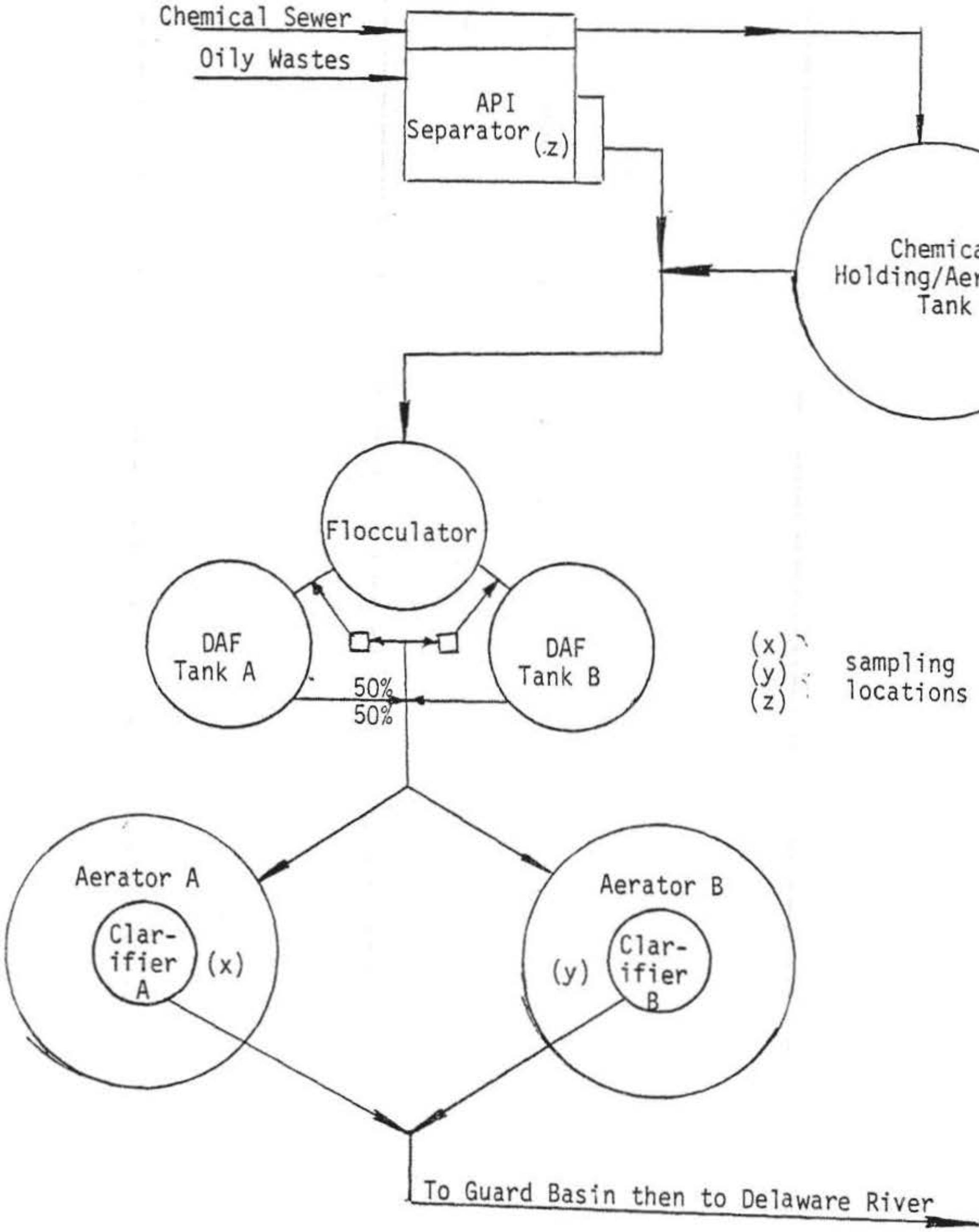

IV. EVALUATION DESIGN AND METHODS

Environmental

Area and personal breathing zone sampling techniques were utilized to measure airborne concentrations of hydrocarbons and lead. Area sampling provided Time-Weighted-Average (TWA) concentrations which approximate personal exposures while the operator is in the immediate area of the sampling location. Personal breathing zone sampling provided data representing WWTP operator exposures during the performance of their normal shift duties. The specific sampling and analytical procedures are contained in the NIOSH Manual of Analytical Methods, P&CAM 127 and S341.

Detector tubes were used to spot check airborne concentrations of as many as 11 substances at the API separator and aeration units.

A Hydrogen Sulfide Ecolizer*, equipped with a strip chart recorder, was positioned at the exit of the API separator in a location judged to have the most potential for high levels of H_2S on the day of the survey (March 1, 1979).

Equipment was purchased to sample for airborne microorganisms. The aerosol cloud formed over the aeration tanks was of specific interest. A contractor, familiar with the sampling equipment and capable of accomplishing the necessary bacteria and mold identifications, was commissioned to accomplish this part of the evaluation. Appendix A, page 14 describes the equipment the technique used for this facet of the evaluation.

The availability of adequate health and safety protective gear was evaluated.

Medical

Of the 14 men working at the WWTP during August 1979, three were recent transfers (less than one month). Of the remaining 11 workers, eight were interviewed. Interviews were also held with two men who had worked at the WWTP for several years and had transferred only recently and with one contract maintenance worker who is assigned to the WWTP.

In addition, the company medical files on all current WWTP employees were reviewed. Information was obtained from the refinery medical staff as well as from private physicians involved in the care of some of the employees.

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*Mention of trade names does not constitute NIOSH endorsement.

V. EVALUATION CRITERIA

There are three sources of criteria used to evaluate toxic air contaminants in the workplace: (1) NIOSH recommended Occupational Health Standards (2) Proposed and Recommended Threshold Limit Values (TLV) for the American Conference of Governmental Industrial Hygienists (ACGIH), and (3) Department of Labor Standards enforced by the Occupational Safety and Health Administration (OSHA). These values, which are subject to change as new information becomes available, are based on the current state of knowledge concerning the toxicity of the specific substances and are derived from available animal and human toxicity data and industrial experience. These levels are values to which it is believed that nearly all workers may be exposed for an 8 or 10-hour day, 40-hour workweek, over a working lifetime with no adverse health affects. However, because of a wide variation in individual susceptibility, a small percentage of workers may experience discomfort upon exposure below the recommended level. A smaller percentage may be affected more seriously by aggravation of a pre-existing illness.

Since the WWTP receives liquid wastes from all parts of the refinery, there is a broad range of potential exposures. Hydrogensulfide, ammonia, aromatic hydrocarbons and aliphatic hydrocarbons are the major sources of exposure. Health standards and brief toxicology information on those substances where analytical quantification was possible are shown in Appendix B, page 19. The following is supplemental toxicologic information on the major exposure sources.

Hydrogen sulfide can cause eye irritation which may result in permanent eye damage. It is also highly irritative to the respiratory tract and may cause bronchitis, pneumonia, and in severe cases, pulmonary edema and respiratory failure. Hydrogen sulfide can also cause acute effects such as headache and dizziness. High concentrations can cause respiratory paralysis leading quickly to death. Since high concentrations also result in a loss of the sense of smell, workers cannot depend upon odor to warn them of dangerously high concentrations.

Mild to moderate exposure to ammonia can produce headache, burning of the throat, nausea and vomiting. Eye and nose irritation may be sufficiently intense to compel workers to leave the area. Bronchitis or pneumonia may follow a severe exposure.

Aliphatic hydrocarbons are central nervous system depressants causing symptoms such as headaches, anxiety and drowsiness. Many are local irritants especially to the eyes, nose and upper respiratory tract. Repeated or prolonged skin contact with the liquid may result in dermatitis, due to defatting of skin.

Exposure to aromatic hydrocarbons may cause many of the same health effects as aliphatic hydrocarbons including central nervous system depression and defatting of the skin. Benzene, the simplest of the aromatics in structure, is known to have a toxic effect on bone marrow. This can result in anemia, leukopenia (low white blood cell count) and leukemia.

VI. RESULTS AND DISCUSSION

Environmental

Many of the same organic substances found in the initial bulk air survey, as reported in Interim Report #1, forwarded in June 1979, were also found in the follow-up area and personal breathing zone sampling accomplished on August 21-22, 1979. Some hydrocarbons such as benzene, toluene, xylene and 1,1,1-trichloroethane were quantifiable. Others such as several different alkanes (mainly C_{10}-C_{12} range) and numerous higher molecular weight aromatics such as trimethyl and tetramethyl benzene were identifiable but not quantifiable due to the many overlapping peaks on the chromatogram. Several light alkanes (C_5-C_6 range) were also identified. The concentrations of all unidentifiable organic substances were estimated to be less than 1 ppm each. The range of results for those organics quantifiable is shown in Appendix C, Table C1, page 20. Personal breathing zone samples for toluene, xylene and 1,1,1-trichloroethane were all 1% or less of health standards. The area samples for these substances were all 10% or less of health standards. The highest concentrations of benzene found in personal breathing zone and area sampling were 0.51 ppm and 7.2 ppm respectively. One short term, 15 minute benzene sample was 8.2 ppm (Table C2, page 21).

No detectable levels of airborne lead were found in the WWTP area.

Detector tube results are presented in Tables C3, Appendix C, page , and concentration ranges for hydrogen sulfide, ammonia, triethylamine and phenols are summarized in Appendix B. These readings indicate that there is a potential for violation of applicable health standards for at least ammonia, triethylamine and phenols in the immediate area of the API separator and aeration tanks.

The long-term (7-hour) hydrogen sulfide measurement obtained on March 1, 1979 documented levels that were consistently below 2 ppm, indicating that no health problems would have been expected from hydrogen sulfide exposure on this day. WWTP operators reported that the hydrogen sulfide levels can vary greatly from day to day. Occasionally (2-3 times per month) the levels have exceeded 10 ppm, which resulted in an alarm being activated. The WWTP area is evacuated in these circumstances until concentrations return below 10 ppm.

Results of the microorganism sampling are contained in Tables A1, A2, and A3 of Appendix A pages 16, 17 and 18. This endeavor was undertaken to obtain information necessary to more completely characterize the exposures related to the operation of this type of treatment plant. Although this type of sampling has been accomplished at sewage treatment plants, there was no data available for chemical waste treatment plants. Additionally, there were complaints of diarrhea which the workers associated with their tours at the WWTP. Airborne stool pathogens were a possible cause of this problem.

The kinds of organisms found did not vary between sampling sites. None of the organisms listed are pathogenic to man under normal circumstances. Bordetella bronchiseptica can occassionally cause a respiratory illness similar to whooping cough.[1] Pseudomonas aeruginosa is a common inhabitant of the intestinal tract and causes infection only when normal defenses break down. Since pseudomonas aeruginosa can produce infections in wounds, the respiratory tract, and the urinary tract, good hygiene, including handwashing prior to eating, is necessary when working in any area where it is found. The remainder of the organisms found are not pathogenic to man except under very unusual situations, such as immune deficiency.

In published studies, ambient airborne bacteria levels have generally been reported as one to five per cubic foot.[2] Even at sites upwind of the WWTP, workers are exposed to bacteria levels several times higher than this, while above aerator tank A levels are 60 or more times greater. Present evidence in the literature does not allow a firm conclusion as to whether or not such bacterial aerosols constitute a health risk. However, even though most of the organisms found at the WWTP are not pathogenic to man, levels so much higher than ordinarily found in the environment should be a source of concern - work above the tanks should not be done without protective equipment, and personal hygiene should receive careful attention.

Since the concentration of organisms was similar upwind and downwind, the tanks apparently contribute little to the environment beyond the boundaries of the WWTP in terms of bacterial aerosols.

The health and safety protective gear utilized by the WWTP operators includes:

5 pair of nomex (issued to each operator)
safety glasses
safety shoes
rubber gloves
face shields
one, self-contained-breathing-apparatus

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[1]Dubos and Hirsh, Baterial and Mycotic Infectious of Man, 4th Edition, 1965, Lippincott, page 749.

[2]Hickey, J.L.S., Reist, P.C., Health Significance of Airborne Microorganisums From Waste Water Treatment Processes, Part II: Health Significance and Alternatives for Action. J. Water Pollution Control Fed., 47 (12):2758, 1975.

This gear was adequate except in the area of respiratory protection. Although half-masks were available, they were not routinely used and there was no adequant respirator system available for prolonged work over the treatment tanks. Further comments are contained in the recommendations section of this report, page 11.

Two new construction projects were evaluated for their potential impact on the contaminant levels in the WWTP area. The sour water stripper will effectively reduce hydrogen sulfide and ammonia concentrations reaching the WWTP. This project will be on line very soon. The WWTP expansion project will contain many renovations or new treatment processes that will result in lower contaminant levels in the WWTP environment and a better quality effluent. This project is scheduled for completion in late 1980. Some aspects of the new projects that will reduce airborne contaminant levels and WWTP operator exposures are presented below.

- The forebag of the API separator is to be covered, thereby reducing airborne contaminant levels.

- Oil/water separators which will be constructed to handle the tank farms, will reduce hydorcarbon levels entering the WWTP.

- New, covered, corregated-plate-separators (CPI's) will allow for more efficient removal of hydrocarbons in the first stages of treatment thereby, reducing hydrocarbon levels further down stream.

- A new wet oil processing system will be available to further treat waste waters for oil removal.

- The holding tank now used to reduce hydrogen sulfide and ammonia concentrations will be used as a spill diversion tank to protect the WWTP from large spills that may decrease the treatment effeciency, and add to contaminant levels. Any substance diverted into this tank can be treated and/or fed back through the plant slowly to prevent a "shock" effect. Used in this capacity, this diversion tank may stop a particular substance from contaminating the entire WWTP but may result in a more serious concentrated hazard in the immediate area agove the tank. Extra caution will be necessary when this tank is utilized in such a manner.

- The new aeration system will be low speed, with deflector plates which should reduce aerosol concentrations over these tanks.

- The open sludge pit will be eliminated.

- There should be less hydrocarbons in the DCG area due to more efficient removal systems upstream.

- The new control room will be under positive pressure. Vestibules will help maintain this condition. This should prevent infiltration of contaminants into the areas where the operators spend the majority of their time. There will be lockers and shower facilities. The lunchroom will be separate from the control room area.

Medical

The interviews and the review of company medical records suggested that many employees have private physicians and rely only sporadically on the company medical clinic. Therefore, it is difficult to derive meaningful data from the company records. Symptoms recorded as reasons for absence included upset stomach, fever, diarrhea, and cold or flu symptoms.

The medical records reviewed included the results of complete blood counts (CBC), bilirubins, and platelet counts, which were done in July and August, 1978, as part of a "benzene surveillance program." All employees at the WWTP had received these tests, except for the contract maintenance worker, and two employees who had very recently transferred to WWTP. All of these tests were within normal limits.

The 11 men interviewed had worked at the WWTP for an average of 3.8 years, ranging from 2-5 years (the WWTP has been in operation for about five years). For the 10 on whom such information was obtained, average duration of employment at Getty was 15.7 years, ranging from 2 to 21 years. The average age for the 11 was 38.9, from 30 to 50 years. Median age was 40.

The symptoms noted during the interviews are listed below.

Symptom	Number of employees out of the 11 having symptom	Percent
headache	9	82
eye complaint	6	54
throat irritation	5	45
light-headedness	5	45
nausea	5	45
diarrhea	3	27
skin problem	2	18

A worker was listed as having a particular symptom only if he usually noted the complaint while working his rotation at the WWTP but not at utilities. The headaches described were generally frontal in distribution with resolution within 3-4 hours after leaving the refinery. Eye complaints included dryness, stinging, and wateriness. Nausea and lightheadedness were both noted only in the presence of strong odors and were relieved by leaving the area. The nausea did not generally lead to vomiting. The skin problem noted was the dryness expected from working with defatting agents. One worker noted some scalp sores which had been bothering him for about one year. This was biopsied and diagnosed as cicatrical alopecia. The etiology of this lesion is unknown.

Three of the 11 employees noted diarrhea. The workers who complained of it were convinced of its relation to working at the WWTP. One noted loose stools several times a day during some periods when large "spills" of chemicals occurred at the site, at which time large amounts of a particular chemical or chemicals would find their way to the WWTP. The second worker noted an attack of loose stools about once every two months or so, but only when he was working at the WWTP. When interviewed, he had not worked at the WWTP in two months and had not had may gastrointestinal complaints during that time. It was the wife of the third worker who first noted the pattern of his symptoms - she noted that he would have the onset of abdominal cramps and a loose, non-bloody diarrhea 3-4 days after starting his WWTP rotation. After 1-2 weeks these symptoms would resolve. He himself noted that he did not have diarrhea when working at any other area of the refinery.

VII. DISCUSSION

Although chronic health effects were not evident, the WWTP has only been in operation for approximately five years - a relatively short time for development of diseases of concern such as cancer, leukemia or renal disease.

Hydrogen sulfide, ammonia and amines are the most probable causes for the acute health effect described. NIOSH team members experienced occassional symptoms such as headache and eye, nose and throat irritation during the time spent at WWTP.

Sixty-four percent of the workers felt that, in terms of health effects, the WWTP was significantly worse than other areas of the refinery. Essentially all complained of offensive odors. Contaminant concentrations can vary significately from day to day and hour to hour depending on operational variables as well as weather conditions. During a temperature inversion, such as often occurs in the morning, contaminant concentrations are likely to be highest.

Results of this investigation indicate that there is a probable health hazard for anyone required to spend most of their shift in the immediate vicinity of the API separator DCG's or the aeration tanks. Of particular concern is the fact that benzene, a cancer producing agent, has frequently been detected at the WWTP. It was detected in all areas of the WWTP. Should a benzene spill occur, such as the one just after a NIOSH survey in early 1979, air concentrations of benzene could reach dangerously high levels. There is no adequate evidence for the existence of a safe exposure level for a carcinogen. The frequency of tumor formation may decline as the dosage declines, but the risk of carcenogenisis may not disappear until the dosage reaches zero.

While diarrhea (allegedly related to work at the WWTP) was not as common as other symptoms, it was present on a regular basis in a higher percentage of workers than one might ordinarily expect in a healthy adult population. Although none of the chemicals or organisms identified are known to cause diarrhea this symptom should be a source of concern.

The major sources of contaminants at the WWTP are the API separators, holding tank, aeration tanks and dual-cell-gravity separators. The levels of contaminants generated by these sources should be significantly reduced after completion of the new foul water stripper and WWTP expansion project.

VIII. RECOMMENDATIONS

Engineering controls that will result in lower contaminant concentrations in the WWTP area should be utilized whenever possible. This can be accomplished either upstream of the WWTP or at the WWTP. The new stripping tower is an example of an engineering control upstream of the WWTP that will result in much lower concentrations of hydrogen sulfide and ammonia in the waste water and therefore lower airborne concentrations of these substances at the WWTP. Many aspects of the new WWTP expansion project such as covering the API forebags, elimination of the open sludge pit and the pressurized control room are examples of engineering controls at the WWTP.

Rotating the WWTP operators is a form of a management control technique. For a period of 7-14 weeks out of 21 an employee is able to leave the WWTP area, which is generally considered an unpleasant work environment due to the objectional odors. It is recommended that this procedure be continued at least until the WWTP expansion project is completed. A significant improvement in working environment would lessen the need for this type of rotational work assignment, at least from the standpoint of health and well-being of the employees.

Environmental data suggests that on the days surveyed, time-weighted-average exposures were all below health standards during the performance of routine tasks. However, there was no instance when an operator was required to spend a significant amount of time around the treatment units. Based on this fact, and considering the potential for exposure to short-term, high levels and long-term, low levels of benzene and the general uncertainty in assessing the chronic health effects from exposure to the variety of substances in the WWTP environment, it is strongly recommended that the following forms of respirator protection be utilized by the WWTP operators or any other employee required to work in the WWTP area.

- All WWTP operators should wear respirators with organic cartridges as much as possible when in the immediate vicinity of the API separator, chemical holding tank, aeration tanks and DCG's. There is no one cartridge that will effectively protect against all the contaminants. It is recommended that an organic vapor cartridge be used since it will absorb benzene and other organics and may help with the sulfur gases.

- A full-face, forced air, respirator system utilizing portable compressed air tanks should be available for use by the WWTP operators or any worker engaged in maintenance activities in areas of potentially high contaminant levels. The compressed air tanks should be adapted to feed at least two face masks simultaneously.

- Self-contained-breathing-apparatus (SCBA) gear can be used when there is no time to set up the forced air system or in areas where the forced air system cannot reach.

The new control room air intake should be equipped with a filtration system as recommended by letter (Appendix D, page 23). The positive pressure system will be ineffective if contaminants are drawn into the building via the air intake.

Since benzene is a potential exposure at the WWTP and has been detected on each occassion that NIOSH sampled for it and on numerous occasions that refinery personnel have sample for it, the continuance of the benzene surveillance program, with periodic CBC's and urine phenols, would seem to be a prudent measure. Abnormal test results should result in a worker being closely monitored by more frequent testing and medical evaluation. Persistent abnormalities may require removal from exposure, as well as further environmental controls.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available upon request, from NIOSH, Division of Technical Services, Publication 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:

1. The Getty Refining and Marketing Company, Delaware City, Delaware 19706.
2. President, OCAW, Local 8-898 301 Christiana Road, New Castle, Delaware 19720.
3. U.S. Department of Labor, OSHA, Region III.
4. NIOSH, Region III.

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

Appendix A
Airborne Microorganisum Sampling
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Equipment

Airborne microbial air sampling was accomplished using an Anderson 1, Viable Sampler. Microorganisums are collected and enumerated into six aerodynamic size fractions. The sampler is comprised of six aluminum stages that are held together by three spring clamps. Each stage has an integral air inlet section that contains 400 orifices. The orifices are progressively smaller from top to bottom stages, ranging from 0.0465 inches diameter in stage 1 to 0.0100 inches diameter in stage 6. Each stage holds a glass petri dish containing 27 ml of agar which serves as the collection surface. A constant air flow of 1 CFM is provided by a continuous duty vacuum pump. Particles are aerodymanically impacted by size as follows:

Stage 1 - 7 microns and above
Stage 2 - 4.7-7 microns
Stage 3 - 3.3-4.7 microns
Stage 4 - 2.1-3.3 microns
Stage 5 - 1.1-2.1 microns
Stage 6 - 0.65-1.1 microns

Unimpacted particles flow around the petri dish and into the next stage. The design of this cascade impaction sampler permits the separation of respirable and non-respirable particles. The manufacturer suggests that respirable size particles (less than 5 um) would impact onstages 3, 4, 5 and 6. Particles larger than 5 microns, that are be trapped in the nasal and pharynx area, would be collected on stages 1 and 2.

Sampling

Sampling was accomplished upwind, downwind and on the cat walks for aeration tanks A and B. The upwind and downwind sampling sites are shown in Figure A1 page 15. The aeration sampling sites are identified as (x) and (y) on figure 1, page 3a.

The samplers were sterilized between sampling runs. Samples were usually run for 10 minutes at 1 CFM.

Culture Media

A general purpose bacterial culture media, glucose-tryptone-yeast extract-agar (GTE-agar), was used for the primary collection of bacteria. Immediately following the GTE sampling, a set of six potatoe dextrose agar plates was inserted into the same sampler for another 10 minute run. Additional types of media (MacConkey agar, Mycosel agar and Inhibitory Mold agar) were used in a sequential order at each sampling location. Each culture nutrient was selected to favor yeast, mold or gram negative bacterial growth. The exposed culture plates were incubated at 15-24°C during transport to the lab.

Figure A1

Airborne Microorganism Sampling Locations

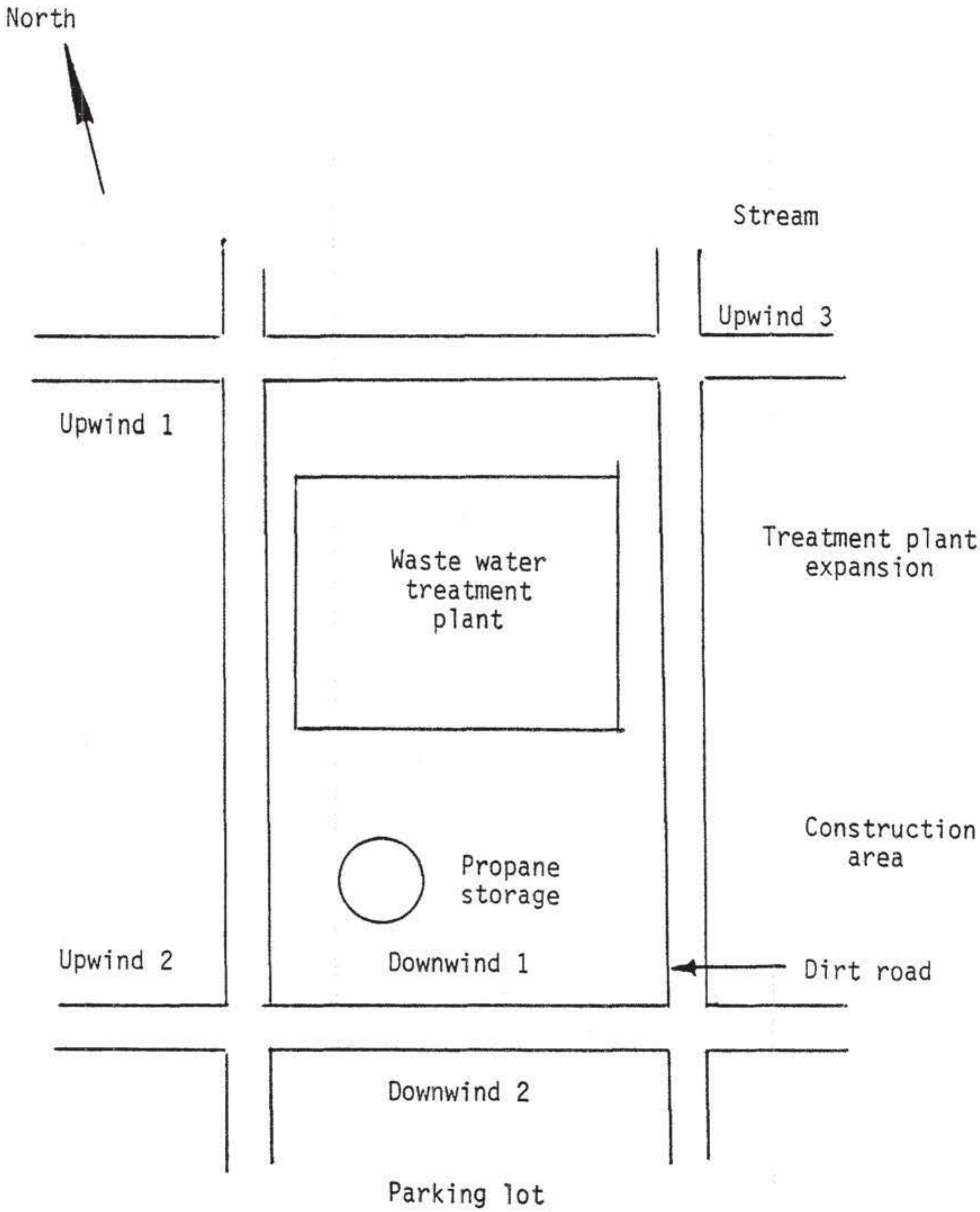

TABLE A1

RESPIRABLE AIRBORNE MICROORGANISM CONCENTRATIONS

COLONY FORMING UNITS/cu.ft.

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SITE	BACTERIA	MOLDS
Upwind #1	41.3	11.6
Upwind #3	33.6	23.9
Downwind #1	45.7	42.6
Downwind #2	26.0	59.2
Aeration Tank B	82.0	26.6
Aeration Tank A	184.1	31.8

TABLE A2

IDENTIFICATION OF BACTERIA ISOLATED FROM AEROSOL EMISSIONS USING THE ANDERSEN SIX STAGE CASCADE IMPACTOR

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BACTERIA ISOLATED	NUMBER OF ISOLATES	% OF TOTAL
Ps. fluorescens group	57	31.8
Bacillus group (*brevis, cereus*)	22	12.3
Ps. maltiphilia	20	11.2
Micrococcus luteus	18	10.1
Enterobacter agglomerans	16	8.9
Aeromonas hydrophilia	15	8.4
Alcaligenes sp.	10	5.6
Staphylococcus saprophyticus	6	3.4
Flavobacterium capsulatum	5	2.8
CDC group IV C-2 (*Bordetella bronchiseptica*)	4	2.2
Ps. aeruginosa	2	1.1
P. mirabilis	2	1.1
Acinetobacter sp.	2	1.1
Total	179	100.0

TABLE A3

IDENTIFICATION OF MOLD AND YEAST ISOLATED
FROM AEROSOL EMISSIONS USING THE
ANDERSEN SIX STAGE IMPACTOR

HE 79-28

ORGANISM	NUMBER OF ISOLATES	% OF TOTAL
Mold		
An unidentified group*	18	37.3
Penicillium group	11	23.0
p. funiculosum	(7)	(14.0)
p. martensii	(2)	(4.2)
p. herquei	(2)	(4.2)
Monilia sp.	8	16.7
Aspergillus flavus	6	12.5
Cladosporium herbarum	2	4.2
Scopulariopsis brevicaulis	2	4.2
Spicaria silvatica	1	2.1
Total	48	100.0
Yeast		
Rhodotorula sp.	10	58.8
Candida sp.	7	41.2
Total	17	100.0

* One mold is unidentified and undergoing further analysis. Results will be forwarded when available.

APPENDIX B

HEALTH STANDARDS/TOXICOLOGY SUMMARY

HE 79-28

SUBSTANCE	RANGE OF RESULTS (ppm)	SAMPLING* METHOD	OSHA STANDARD (ppm)	ACGIH** TLV (ppm)	NIOSH REC. STANDARD (ppm)	HEALTH EFFECTS/TRAGET ORGANS
Benzene	<.02 - .51	P (TWA)	10	10	---	Blood changes, including leukemia, CNS depressant, irritant
Benzene	0.20 - 8.2	P (ceiling)	50 (ceiling-15)***	---	1 (ceiling-60)	
Benzene	<.02 - 7.22	Area (TWA)	---	---	---	
Toluene	<.03 - .62	P (TWA)	200	100	200	CNS depressant, liver, kidney, skin
Toluene	<.03 -10.3	A (TWA)	---	---	---	
Xylene	<.02 - .14	P (TWA)	100	100	100	CNS depressant, airway irritant
Xylene	<.02 - 2.32	A (TWA)	---	---	---	
1,1,1-Trichloroethane	<.02 - 0.53	P (TWA)	350	350	350	Skin irritant, CNS depressant, liver & heart effects
1,1,1-Trichloroethane	<.02 - 2.8	A (TWA)	---	---	---	
Triethylamine	7 - 80	DT****	25	25	---	Upper respiratory system irritant, skin
Ammonia	3 - 70	DT	50	25	50 (ceiling-5)	Airway irritation, eye irritant, lungs
Hydrogen Sulfide	0 - 4	DT	20 (ceiling)	10	10 (ceiling-10)	Eye and respiratory system irritant
Phenol	0 - 5	DT	5	5	20	Skin, eye, CNS, liver and kidney effects

* Sampling Method: P (TWA) Personal Breathing Zone (Time-weighted-average); P (ceiling) Personal Breathing Zone (15-min time period); A-Area

** ACGIH-TLV: American Conference of Governmental Industrial Hygienist - Threshold Limit Value (1979)

*** (ceiling-15) - 15 min. ceiling level. The levels cited are currently being enforced; the proposed standard of 1 ppm TWA with a 5 ppm ceiling level is going through judicial review.

**** Detector tube results not related to TWA health standards values.

APPENDIX C

TABLE C1

ORGANIC VAPOR SAMPLING RESULTS

TIME-WEIGHTED AVERAGES, ppm

HE 79-28

	August 21, 1979								August 22, 1979							
	1ST SHIFT				2ND SHIFT				1ST SHIFT				2ND SHIFT			
	Benzene	Toluene	Xylene	1,1,1-Tric	Benzene	Toluene	Xylene	1,1,1-Tric	Benzene	Toluene	Xylene	1,1,1-Tric	Benzene	Toluene	Xylene	1,1,1-Tric
Personal Breathing Zone Samples																
Position																
WWTP Operator	.06	.06	<.02	.10	.05	.05	<.02	.27	.12	.15	<.02	.08	<.03	<.03	.02	.02
WWTP Operator	.02	.03	<.02	.05	.12	.14	<.02	.10	.20	.31	<.02	.11	<.03	<.03	<.02	<.02
WWTP Operator	-	-	-	-	<.02	<.03	<.02	<.02	-	-	-	-	.12	.20	<.02	.04
Utility Man	-	-	-	-					.14	.18	.05	.53	-	-	-	-
NIOSH Member	.51	.62	.14	.30	-	-	-	-	-	-	-	-	-	-	-	-
Area Samples																
Location																
API Outlet	3.28	4.40	1.01	.12	.06	<.03	<.02	<.02	7.22	10.3	2.32	.55	5.9	8.7	.20	.15
DCG	.22	.47	.19	.42	1.70	6.20	-	2.75	.19	.30	.09	.10	.14	.30	.19	.06
Aeration TK Catwalk	1.89	2.37	.51	.10	2.20	2.80	.53	.10	1.74	2.6	.59	.07	1.00	1.40	.31	<.02
Control Room	<.02	<.03	<.02	<.02	<.03	<.03	<.02	.23	<.03	<.03	<.02	.03	<.03	.03	<.02	<.02
Pumping in Control Room Building	.06	.07	<.02	.40	.15	.17	<.02	.09	<.03	<.03	<.02	<.02	.10	.10	<.02	.05

APPENDIX C
TABLE C2

BENZENE
SHORT-TERM PERSONAL BREATHING ZONE
AIR SAMPLING RESULTS (ppm)

HE 79-28
August 21-22, 1979

TASK/AREA	DATE	SAMPLING TIME	BENZENE
WWTP Operator in DC6 Area	8/21/79	1755-1610	0.2
WWTP Operator on rounds	8/21/79	1815-1830	0.8
WWTP Operator on rounds	8/22/79	0750-0805	0.5
WWTP Operator DC6 Area	8/22/79	1039-1057	0.4
NIOSH Employee API inlet area	8/22/79	1910-1925	8.2

APPENDIX C

TABLE C3

DETECTOR TUBE RESULTS, ppm
HE 79-28

SUBSTANCE	AERATOR B, LOCATION (Y)*						API SEPARATOR, LOCATION (Z)*					
	3pm, 2/28	9am, 3/1	9am, 8/21	9am, 8/22	5pm, 8/21	5pm, 8/22	2pm, 2/28	11am, 3/1	10am, 8/21	10am, 8/22	4pm, 8/21	4pm, 8/22
Phenol	0	0	5	0			0	Trace	5	0		
Triethylamine	15	18	20	30	10	20	7	25	80	70	10	20
Acrylonitrile	0	0					Trace	Trace				
Sulfur Dioxide	0	0					0	0				
Toluene	0	0					100	30				
Ammonia	5	10	30	15	4	50	25	33	70	40	4	50
Carbon Disulfide		0						0				
Trichloroethylene		Trace						Trace				
Hydrogen Sulfide		0	4	0	4	4		0	<1	0	5	4
Carbon Tetrachloride		0						0				
Benzene	<5	<5						5				

* Sampling location shown in Fig. 1, page 3a.

Note: In view of the number and variety of substances present in the WWTP environment, these results have to be considered with caution.

APPENDIX D

HE 79-28

September 17, 1979
HE 79-28

Mr. Ben Vilbert
Getty Refining and Marketing Co.
Delaware City, Delaware 19706

Dear Mr. Vilbert:

During my last survey at your Waste Water Treatment Plant (August 21-22, 1979), I had the opportunity to review the plans for the Waste Water Treatment Plant (WWTP) expansion project. The project was evaluated from the standpoint of what impact it is likely to have on the quality of the work environment at the treatment plant. This project, as well as the foul water stripper project, will result in much improved working conditions. Specific comments will be included in my final report.

There is one aspect of the new WWTP control room design that warrants further consideration. It appears that the intake for the environmental system will be located approximately 35 feet above grade on the North end of the new building. The amount of contaminants in the control room will again be dependent on weather conditions much as it is now.

The following recommendation is being made at this time so that changes can be incorporated into the design and accomplished as part of the original construction.

It is recommended that the intake for the environmental system that will service the new control room be equipped with a filtering system to insure that the control room is protected from build up of the contaminants present in the WWTP area. The potential application of a filtering system was discussed with a representative of Barnebey Cheney Company, P.O. Box 2526, Columbus, Ohio 45316, (614) 258-9501 (Mention of a company name does not imply that NIOSH endorses its products or services).

A typical filter would be 24" x 24" x 7.5" and have a pressure drop of approximately 0.2 inches of water. It will absorb 20-50% of its weight (a filter weighs approximately 45 pounds). Such a filter may cost around $250.00 and be reactivated for around $50.00.

Perhaps a dual inlet could be built so that outside air would go through the filter at the discretion of the shift supervisor. This would extend the time between filter replacement and yet offer adequate protection when weather conditions cause buildup of contaminants in the area.

It is recommended that the project officer for the WWTP expansion project contact companies such as Barnebey Cheney and discuss the application of the available filtering systems and that, if determined to be feasible, incorporate such a system in the design for the new control room.

Sincerely yours,

Richard Gorman, M.S., C.I.H.
Industrial Hygienist
Hazard Evaluations and
Technical Assistance Branch