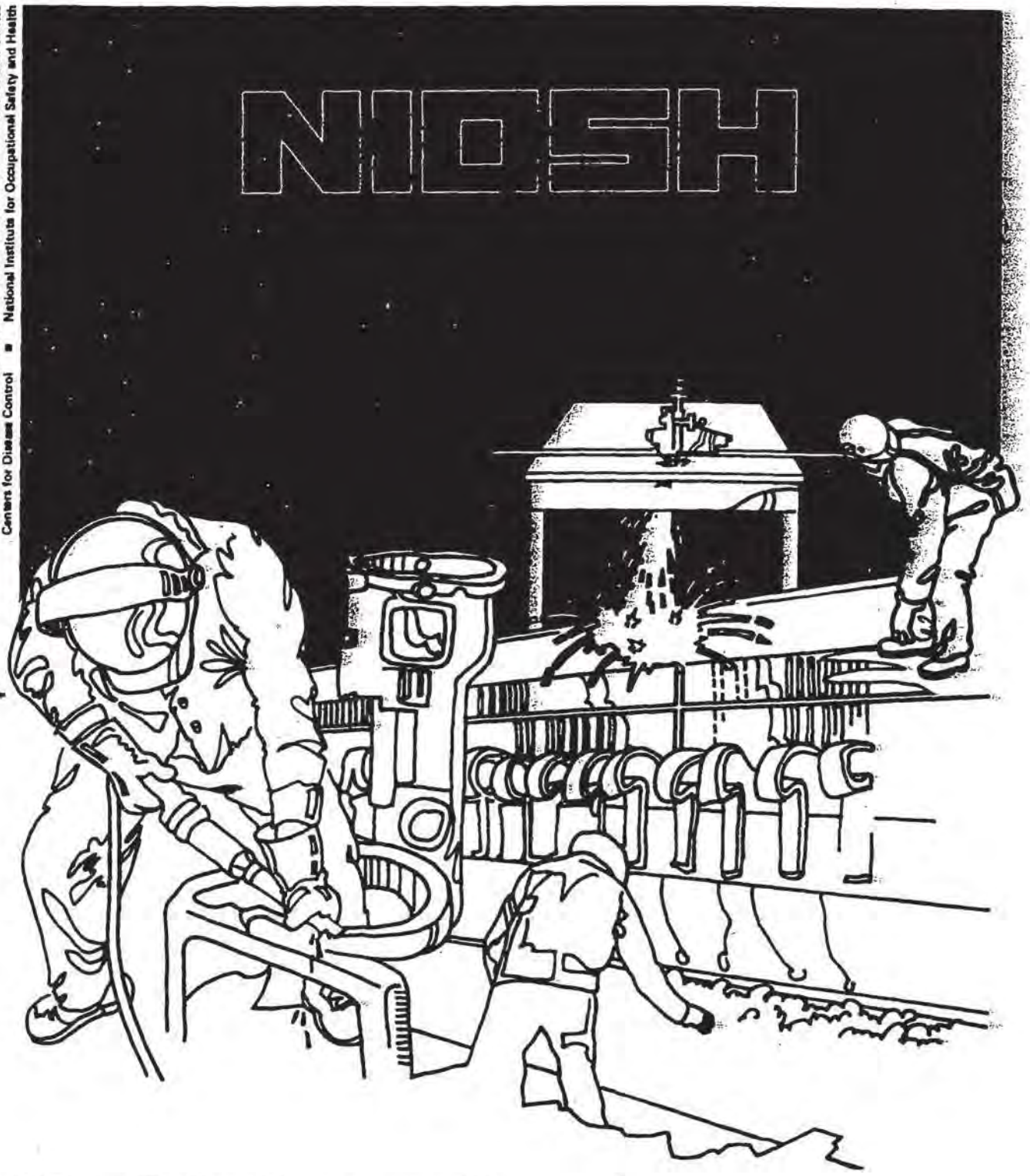
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



# Health Hazard Evaluation Report

HETA 82-259-1352
SCOTT PAPER COMPANY
EVERETT, WASHINGTON

## 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 82-259-1352
AUGUST 1983
SCOTT PAPER CO.
EVERETT, WASHINGTON

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## I SUMMARY

In June 1982 the National Institute for Occupational Safety and Health (NIOSH) was requested by the Association of Western Pulp and Paper Workers, Local 183, to determine if exposures to boiler fuels and their combustion products were the cause of persistent respiratory problems experienced by a boiler house worker at Scott Paper Company Everett, Washington.

In September 1982 medical interviews were conducted with the boiler house workers and subsequently medical records of one more seriously affected worker were reviewed. On February 7, 10, and 24, NIOSH investigators collected samples to measure workers exposure to sulfur dioxide, total particulates, polynuclear aromatics, chlorine and ammonia.

The No. 10 boiler operator and the assistant fireman had average exposures to sulfur dioxide of 0.71 ppm (range 0.67 to 0.78) and 1.02 ppm (range 0.67 to 1.60), respectively. These were the only two jobs with average exposures above the evaluation criterion of 0.5 ppm. The other jobs had three-day average exposures of 0.03, 0.18 and 0.29. Nine of the ten samples collected for total particulates ranged from 0.18 to 2.44 $mg/m^3$. The tenth was 6.44 $mg/m^3$. All levels were less than the criterion of 10 $mg/m^3$. Concentrations of ammonia, polynuclear aromatic compounds and xylene were below detectable limits in all samples. Chlorine concentrations ranged from not detectable to 0.06 ppm. The workers reported that occasionally they are exposed to short term higher concentrations of sulfur dioxide, ammonia and chlorine during upset conditions. No upset conditions occurred during the sampling periods.

Boiler house workers in aggregate experienced symptoms which they felt were work-related. Eleven (39%) of the 28 boiler house workers reported acute shortness of breath, headache and tearing eyes associated with short term exposure to high concentrations of sulfur dioxide, ammonia and chlorine gases occurring during upset conditions. Six (21%) of the 28 reported headaches, irritated eyes, nose, and throat; and "sinus congestion" associated with exposure to combustion products from burning automobile tires. Seven workers reported headaches; dizziness; and irritation of the eyes, nose and throat associated with exposure to combustion products of chemicals dumped on the hog fuel (wood chips) pile.

On the basis of this investigation, NIOSH determined that a health hazard exists at Scott Paper Co. Everett, Washington. The No. 10 boiler fireman and the assistant fireman are exposed to concentrations of sulfur dioxide that exceeded the NIOSH criterion of 0.5 ppm. Workers also reported experiencing shortness of breath, headache and eye irritation during upset boiler conditions. It was not possible to estimate past exposures that resulted from occasional placement of waste organic solvent and shredded tires on the hog fuel pile, therefore, it could not be determined if the workers' symptoms were caused by these conditions. Recommendations to reduce the exposures to sulfur dioxide, ammonia, chlorine and chemical combustion products are included in the report.

KEYWORDS: SIC 2611 (Pulp Mills), Sulfur dioxide, total particulates, polynuclear aromatics, chlorine, ammonia.

## II INTRODUCTION

In June 1982 NIOSH received a request from a representative of the Association of Western Pulp and Paper Workers Local 183 to determine if exposure to fuels used in the boiler and their combustion products were the cause of respiratory problems, shortness of breath and chest pains experienced by a boiler house worker. An initial survey was conducted on September 9, 1982. The NIOSH physician conducted interviews with boiler house workers and subsequently obtained and reviewed the medical records of the ill boiler house worker. On January 19, 1983 the investigators attended a meeting with union representatives to present the data collected up to that time and future work which was planned. Environmental samples were collected on February 7, 10, and 24, 1983.

## III BACKGROUND

Scott Paper Company in Everett, Washington, is a pulp and paper plant. In this request we were called to evaluate the boiler house that generates steam for use in the plant. There are two boiler houses connected by a corridor. One contains boilers number 1 - 9 and the other boiler number 10. Boilers 1 - 5 are hog fuel boilers that burn hog fuel which consists of bark, sawdust, wood chips and sometimes other combustible material to provide heat to generate steam. Boilers 6 - 9 are oil burners and are seldom used. Boiler number 10 burns spent sulfite liquor from the pulp digester as a fuel to generate steam. In this process, the materials removed from the wood (e.g., tannins and ligins,) along with the spent ammonium bisulfite cooling liquor are condensed and burned as a fuel. The sulfur dioxide gas is recovered and used to make new liquor. The heat from the burning liquor heats the water in a series of pipes to form steam which is used in the plant.

The concerns of the employees were (1) what the normal exposures are when the usual hog fuel, i e., wood products, is burned and (2) what could the exposure have been in the past several years when shredded tires were mixed with the hog fuel, when xylene and waste paint thinner were added to the hog fuel and when a large quantity of a product called SDA 400 was added to the hog fuel over a 10-day period.

Twenty-nine full time employees and four supervisors comprise four crews that rotate through 3 shifts, 7 days a week. An on duty crew consists of six workers. The jobs are shift engineer, fireman for boiler 1-9, fireman for boiler 10, assistant fireman, bulldozer operator and utility man. The shift engineer collects and analyzes water samples at various points in both boiler houses. The 1 - 9 fireman operates the hog fuel boilers. The controls, gauges, etc., are in the open in front of the boilers. He spends the entire shift in this area. The #10 fireman operates the # 10 boiler from a control room where he spends the majority of the shift.

The remaining time is spent on routine inspection checks in the boiler house. The assistant fireman assists both the 1-9 fireman and the #10 fireman so his time is divided between the two boiler houses. The bulldozer operator maintains the hog fuel pile. Hog fuel is brought in with trucks and dumped on the hog fuel pile. The bulldozer operator pushes the hog fuel up the pile where it feeds by gravity onto a conveyor belt which transports the hog fuel to the boiler. He operates the bulldozer the entire shift. The utility man assists where needed.

Airborne contaminants that these workers are routinely exposed to are sulfur dioxide and total particulates. Chlorine is used in the pulp mill and occasionally chlorine is released into the atmosphere and can drift into the boiler house area. Ammonia is also used in the pulp mill. The ammonia storage tank is located near the hog fuel pile and occasionally ammonia is released.

Waste xylene and paint thinner are burned in the hog fuel boiler. The waste thinner will vary from drum to drum. It would typically contain petroleum distillates, toluene, xylene, methyl ethyl ketone, acetone, alcohol and other organic solvents. Currently the thinner is pumped from a 55 gallon drum and injected directly into the boiler. In the past (until approximately September 1981) a depression was made in the hog fuel pile, and the thinner dumped into the depression. The hog fuel would absorb the thinner and would eventually be burned.

Shredded tire chips were used as a supplementary hog fuel for a two-year period that ended in July 1982. These chips were dumped on the hog fuel pile and used the same as other hog fuels.

In 1976 the company purchased 2500 gal. of a product called SDA 400 which was intended in use for cleaning. It was diluted with water to 8,000 gallons. This product did not work satisfactorily so little was actually used. In April 1981 it was dumped on the hog fuel pile in 500 gallon quantities each day and burned until it was gone. The base product consisted of from 10 to 30% xylene and other aromatic hydrocarbons, 10 to 30% $C_9$-$C_{12}$ hydrocarbons, 10-15% nonylphenoxy poly(ethyleneoxy)ethanol, less than 5% of triethanolamine and 10% water. The final product contained over 5500 gal of water.

We were unable to confirm reports that other products had also been put on the hog fuel pile.

## IV EVALUATION DESIGN AND METHODS

### A. ENVIRONMENTAL

Air samples were collected on the day shift on February 10 and 24 and the swing shift on February 7. Breathing zone samples were collected for sulfur dioxide, total particulates and polynuclear aromatics and xylene. General area samples were collected for chlorine and ammonia.

Listed below are the sampling and analytical methods used in this evaluation.

| Substance | Collection Method | Flow Rate | NIOSH Analytical[1] Method |
|---|---|---|---|
| ammonia | long term detection tube | 20 cc/min | direct reading |
| chlorine | long term detection tube | 20 cc/min | direct reading |
| polynuclear aromatic (PNA's) | teflon filter followed by XAD-2 resin tubes | 1 lpm | NIOSH Technical Bulletin TB-007 |
| sulfur dioxide | cellulose membrane filters followed by KOH treated filters | 1.5 lpm | P&CAM 268 |
| total particulates | PVC filters | 1.5 lpm | electrobalance |
| xylene | charcoal tubes | 200 cc/min | P&CAM S-318 |

### B. Medical

A NIOSH physician interviewed individual workers and reviewed the medical records of selected individuals.

## 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 becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations[1-4], 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), 3) the U. S. Department of Labor (OSHA) occupational health standards, and 4) the Washington State 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.

| Substance | NIOSH Recommended Criteria 10 Hr TWA | Washington State or (OSHA) Standard 8 Hr TWA | Health Effects |
|---|---|---|---|
| Ammonia | 50 ppm (5 min ceiling) | 50 ppm | Irritation of eyes, respiratory tract, and skin |
| Chlorine | 0.5 ppm (15 min ceiling) | 1 ppm (ceiling) | Irritation of eyes, nose & throat. May reach lung causing pulmonary congestion, tightness in chest and edema |
| Polynuclear aromatics (PNA) | 100 ug/$m^3$ | 200 ug/$m^3$ | Suspected to be able induce cancer |
| Total particulates (Nuisance dust) | (10 mg/$m^3$) | 10 mg/$m^3$ | Nuisance dust have little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control |
| Sulfur dioxide | 0.5 ppm | 5 ppm | Irritation of nose and throat, sneezing and coughing. Low levels can cause a reflex increase in rate and diminution of the depth of respiration with reflex broncho constriction resulting in pulmonary air flow resistance. Long exposure may result in conjunctivitis and frequent respiratory infections |
| Xylene | 100 ppm (200 ppm ceiling 10 min.) | 100 ppm | Dizziness, excitement, drowsiness, incoherence, staggering gait, irritation of eyes, nose and throat. Nausea, vomiting, abdominal pain. |

## VI RESULTS AND DISCUSSION

### A. Environmental

Breathing zone samples were collected to determine the workers' exposures to sulfur dioxide, total particulates and PNA's. The results are shown in Table 1. Since there are six separate jobs, they are discussed individually. The bulldozer operator spends his day outside on the hog fuel pile. His sulfur dioxide exposure ranged from 0.02 to 0.05 ppm which is less than 10% of the evaluation criterion. Only one sample was collected for total particulates and it was 2.18 $mg/m^3$ or 21% of the criterion. Since xylene had been put on the hog fuel pile in the past, the workers wanted to know if there was any xylene residual that was resulting in an inhalation exposure. All sample results for xylene were less than the detectable concentration of 0.1 ppm indicating there was no xylene residual present.

The No. 1-9 boiler fireman spends his entire shift in the No. 1-9 boiler area. The sulfur dioxide average exposure was 0.18 ppm (range 0.16 - 0.21 ppm) which is less than 50% of the criterion. The total particulates average concentration was 0.6 $mg/m^3$ or 6% of the criterion. The polynuclear aromatics (PNA), which can be formed when wood chips are burned, were below detectable limits. (See Table 1 for each specific PNA analyzed.)

Three job classifications spend time in both the No. 1-9 boiler area and the No. 10 boiler area. Their time varies from day to day. The shift engineer had a sulfur dioxide average exposure of 0.30 ppm which is less than the criterion of 0.5 ppm. The total particulate average concentration was 1.82 which is less than the criterion. Due to absence of the other crew members, the utility man position was only filled on one of the three sample days; therefore, the one day sample result for sulfur dioxide of 0.52 ppm is not conclusive. His total particulate exposure was 6.44 $mg/m^3$ and was the highest measured but still less than the 10 $mg/m^3$ criterion. A portion of the particulates is wood dust, but the percentage is unknown. The PNA's were less than detectable concentrations.

The assistant fireman, who also works in both areas, had an average sulfur dioxide exposure of 1.02 ppm (range 0.67 - 1.60 ppm). This is twice the criterion and on one day was three times the criterion of 0.5 ppm. On all three days his exposure to sulfur dioxide exceeded 0.5 ppm. His total particulate average exposure was 0.23 $mg/m^3$ which is only 2.3% of the criteria.

The No. 10 boiler fireman spends the majority of his shift in the No. 10 control room and the rest in the area around the boiler. His average sulfur dioxide exposure was 0.71 ppm or 1.4 times the criterion, with a range of 0.67 to 0.78 ppm. On all three days his exposure exceeded the criterion.

General area samples were collected for sulfur dioxide both inside and outside the No. 10 boiler control room. Sulfur dioxide concentrations were slightly higher inside the room then outside with both being close to, or slightly higher than, 0.5 ppm. The difference is probably due to the location of the air inlet to the control room. If the sulfur dioxide were removed from the supply air to control the No. 10 fireman exposure to sulfur dioxide would be greatly reduced and would probably be less than 0.5 ppm. With the amount of time the assistant fireman spends in the control room, his exposure would also be reduced.

General area samples were collected for chlorine and ammonia in both boiler areas and on the bulldozer. Chlorine and ammonia are used in the plant and occasionally there is a leak or upset condition. When the wind direction is toward the boiler house, the workers can be exposed to chlorine and/or ammonia. During the three days of sampling, ammonia was not detectable and the chlorine concentrations were from nondetectable to 0.06 ppm.

One of the major concerns of the workers was what their exposure was to substances put on the hog fuel and subsequently when they were burned. These include waste xylene, waste paint thinner, the product SDA 400 and shredded tires. The addition of waste xylene and paint thinner to the hog fuel was sporadic. The SDA 400 was added daily for one 2-week period. It is not possible to estimate the airborne concentration of the volatile materials that the bulldozer operator would have been exposed to. The shredded tires would not present a problem on the hog fuel pile. However, the burning in the boiler, the combustion products could enter the hog fuel boiler area under certain boiler conditions such as a back draft. Estimation of the composition and concentration of the emissions was not possible at this time.

B. Medical

Boiler house employees (hourly and salaried) were questioned about their occupational history, use of tobacco and alcohol, medical history and use of medications, and whether they had experienced the following symptoms during 1981 or 1982: chest pains, shortness of breath, burning sensation within the chest, sputum products, skin rash or a combination of headache, dizziness, tearing eyes, throat burning and shortness of breath. Twenty eight employees were interviewed: 3 of 4 supervisors, 25 of 29 full-time steam plant employees, one of whom had just transferred to the steam plant four days earlier. The 28 employees (2 were female; all were Caucasian) ranged in age from 28 to 64 years (mean = 44.8 years), and had worked at the mill from 7 to 41 years (mean = 18.5 years, median = 15.5 years). All except two had worked in the steam plants at least since January 1981. (One of the exceptions had worked in the steam plants 4 days, the other 5 months. Both had transferred to the steam plants from elsewhere in the mill.) Worker layoffs related to economic conditions have been common at this mill in recent years. Workers at the steam plants tend to have accumulated many years of seniority, and therefore the steam plant work force has been very stable.

The boiler house workers had experienced symptoms which they felt to be work-related. These symptoms can be described in 3 categories.

1. Acute-onset, short duration symptoms related to exposure to sulfur dioxide or ammonia

   All workers reported that the intermittent, apparently unpredictable release of these gases caused symptoms such as acute shortness of breath, headache and tearing eyes. Eleven of the 28 workers complained specifically of the discomfort associated with these work site exposures.

2. Symptoms related to combustion products associated with burning automobile tires

   Six of the 28 workers specifically complained of symptoms associated with burning automobile tires. The workers told of headaches and irritated eyes, nose and throat as well as "sinus congestion." Several additional workers complained that their skin and nasal passages became very dirty when tires were burned. This made the work conditions very undesirable.

3. Symptoms related to exposure to volatile and combustion products of chemicals which were dumped on the hog fuel pile (The chemicals may have been SDA - 400 as well as other chemicals.)

   Seven workers recalled experiencing symptoms in March and April 1981. Symptoms included headache, dizziness, nausea, and irritation of eyes nose and throat. Three workers worked one shift, while the other 4 workers were all on the preceding shift. One worker (a bulldozer operator) recalled having symptoms at work for several days after "the dump"; however, only the index worker had symptoms which persisted for weeks.

One worker reported more severe health problems. He reported a history of respiratory symptoms which predated his work in the boiler house. Persistent exacerbations of his symptoms were temporarily related to working in the boiler house. However, it was not possible to document a causal relationship between his persistent symptoms and workplace exposures. Both the severity and duration of his symptoms were unique among those reported by the boiler house workers. Futhermore extensive laboratory and other diagnostic testing done by his physicians did not demonstrate a measurable physiological defect in lung function.

We conclude that the boiler house workers in aggregate experienced symptoms which were related to workplace exposures. The symptoms were acute and included shortness of breath; irritated eyes, nose and throat; headaches; and dizziness. The symptoms were related to exposure to sulfur dioxide and ammonia, and combustion products of automobile tires and chemicals dumped on the hog fuel pile.

## VII SUMMARY AND CONCLUSIONS

The No. 10 boiler operator and the assistant fireman were exposed to airborne concentrations of sulfur dioxide that exceed the criteria of 0.5 ppm used in this evaluation. (The OSHA and WISHA current standard is 5 ppm.) The workers' exposure to sulfur dioxide in the other four jobs were less than the criterion. The workers' exposure to total particulates, polynuclear aromatic compounds, chlorine and ammonia were well below existing criteria. Exposure to these compounds at the concentrations measured are not known to cause the severe chest pains experienced by several of the workers. It was also determined that acute-onset of shortness of breath, headache, and tearing eyes may be experienced during infrequent upset boiler conditions. It was not possible to estimate past exposures that resulted from occasional placement of waste organic solvent and shredded tires on the hog fuel pile, therefore it could not be determined if the workers' symptoms were caused by these conditions. NIOSH was not able to document a causal relationship between work place exposures and the persistent symptoms reported by one worker.

## VIII RECOMMENDATIONS

1. The supply air to the No. 10 boiler control room should be filtered to remove the sulfur dioxide. Currently, the sulfur dioxide TWA concentration in the control room exceeds the criterion of 0.5 ppm. Due to the high percentage of time the fireman spends in the control room, his TWA exposure can be reduced considerably.

2. The No. 10 boiler fireman and the assistant fireman should be provided with NIOSH approved respirators for use with sufur dioxide. These respirators should be worn when working around the boiler when high sulfur dioxide concentrations occur.

3. All boiler house workers should have respirators available for use with ammonia and chlorine in case a high concentration of these vapors drifts into the boiler house area.

4. Materials other than wood products should not be added to the hog fuel pile.

## IX REFERENCES

1. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to ammonia. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1974. (DHEW publication no. (NIOSH) 74-136).

2. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to chlorine. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW publication no. (NIOSH) 76-170).

3. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to sulfur dioxide. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1974. (DHEW publication no. (NIOSH) 74-111).

4. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to xylene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1975. (DHEW publication no. (NIOSH) 75-168).

## X AUTHORSHIP AND ACKNOWLEDGEMENTS

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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 the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Scott Paper Company, Everett, Washington

2. Association of Western Pulp and Paper Workers, Local 183, Everett, Washington.

3. Washington State Department of Labor and Industries, WISHA, Olympia, Washington.

4. U. S. Department of Labor, Occupational Safety and Health Agency (OSHA), Region X, Seattle, Washington.

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 1

## Ammonia, Chlorine, Polynuclear Aromatic Compounds, Sulfur Dioxide, Total Particulate and Xylene Air Concentrations

Scott Paper Company
Everett, Washington
HETA 82-259

| Job or Location | Date | Sulfur Dioxide ppm | Sulfates as $H_2SO_4$ mg/cu m | Total Particulates mg/cu m | Chlorine ppm | Ammonia ppm | Xylene ppm | PNA's |
|---|---|---|---|---|---|---|---|---|
| #1 - 9 Fireman | 2-7-83 | 0.16 | <0.01 | 0.18 | - | - | - | * |
| (BZ) | 2-10-83 | 0.21 | 0.03 | 0.81 | - | - | - | * |
| | 2-24-83 | 0.18 | 0.02 | 0.81 | - | - | - | * |
| # 1 - 9 Boiler Area | 2-7-83 | - | - | - | ND | ND | - | - |
| (GA) | 2-10-83 | - | - | - | 0.04 | ND | - | - |
| | 2-24-83 | - | - | - | 0.06 | ND | - | - |
| #10 Fireman | 2-7-83 | 0.68 | <0.01 | - | - | - | - | - |
| (BZ) | 2-10-83 | 0.67 | 0.01 | - | - | - | - | - |
| | 2-24-83 | 0.78 | 0.02 | - | - | - | - | - |
| #10 Boiler Control Room | 2-7-83 | - | - | - | ND | ND | - | - |
| (GA) | 2-10-83 | 0.52 | 0.02 | - | 0.04 | ND | - | - |
| | 2-24-83 | 0.78 | 0.01 | - | 0.04 | ND | - | - |
| Outside #10 Boiler Room (GA) | 2-10-83 | 0.47 | 0.02 | - | - | - | - | - |
| | 2-24-83 | 0.48 | 0.01 | - | - | - | - | - |
| Asst Fireman | 2-7-83 | 0.67 | <0.01 | 0.27 | - | - | - | * |
| (BZ) | 2-10-83 | 0.79 | 0.01 | 0.27 | | - | - | * |
| | 2-24-83 | 1.60 | 0.01 | 0.15 | - | - | - | - |
| Utility Man (BZ) | 2-7-83 | 0.52 | 0.03 | 6.44 | - | - | - | * |
| Shift Engineer (BZ) | 2-10-83 | 0.24 | 0.15 | 2.44 | - | - | - | - |
| | 2-24-83 | 0.35 | 0.06 | 1.20 | - | - | - | - |
| Bulldozer Operator | 2-7-83 | 0.05 | <0.01 | - | 0.05 | ND | <0.1 | - |
| (BZ) | 2-10-83 | 0.03 | <0.01 | - | 0.04 | ND | <0.1 | - |
| | 2-24-83 | 0.02 | <0.01 | 2.16 | 0.04 | ND | <0.1 | - |

*All PNA samples were analyzed for the following individual PNA's and all were less than the indicated concentrations: Benz(a)anthracene <0.5 $ug/m^3$; Benzo(a)pyrene <0.5 $ug/m^3$; Benzo(e)pyrene <0.5 $ug/m^3$; Chrysene <1.5 $ug/m^3$; Fluoranthene <1 $ug/m^3$; Pyrene <1.5 $ug/m^3$