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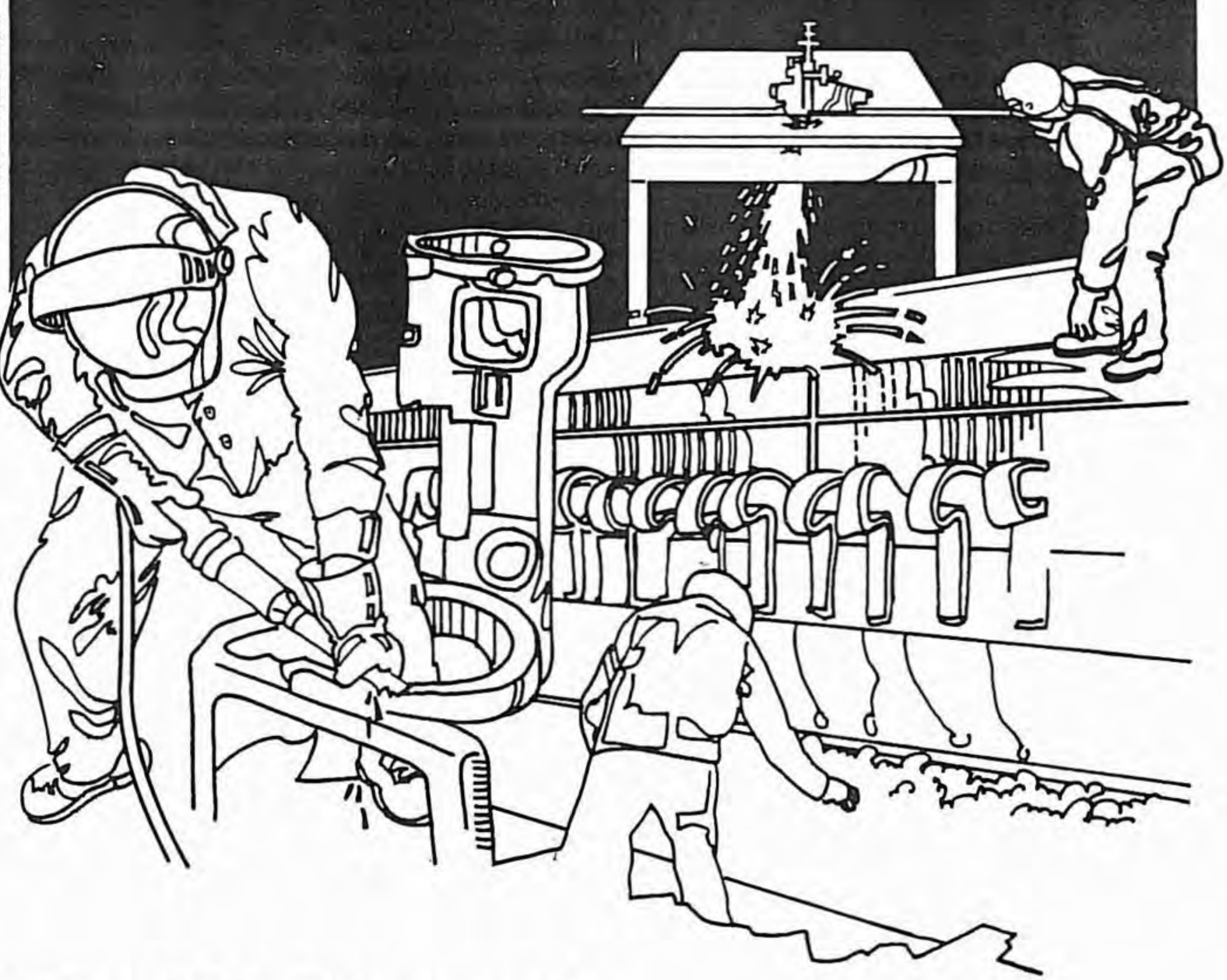

Health Hazard Evaluation Report

HETA 82-119-1454
JAMES RIVER POWER PLANT
CITY UTILITIES
SPRINGFIELD, MISSOURI

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.

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JAMES RIVER POWER PLANT
CITY UTILITIES
SPRINGFIELD, MISSOURI

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I. SUMMARY

In February 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Safety Department of City Utilities, Springfield, Missouri, for a health hazard evaluation at the James River Power Plant. NIOSH conducted a preliminary walk-through in March 1982 and a combined environmental/medical follow-up survey on July 20-27, 1982.

The environmental evaluation consisted of measuring employee exposures to airborne concentrations of chemical agents including coal dust, fly ash, crystalline silica, metals, nitric oxide, nitrogen dioxide, sulfur dioxide, and carbon monoxide; and to physical agents including noise and heat stress. In addition, bulk material samples of insulation were collected and analyzed for asbestos content.

All personal samples for coal dust, fly ash, crystalline silica, nitrogen dioxide, nitric oxide, and sulfur dioxide were below the lowest current criterion (coal dust = 2 mg/m^3 - ACGIH, fly ash = 5 mg/m^3 - OSHA and ACGIH for nuisance particulate, nitrogen dioxide = 1.8 mg/m^3 - NIOSH, nitric oxide = 30 mg/m^3 - NIOSH, OSHA, and ACGIH and sulfur dioxide = 1.3 mg/m^3). Thirteen of twenty-five personal noise measurements exceeded the NIOSH and ACGIH criteria of 85 dBA. Personal noise measurements ranged from 77.7 to 99.4 dBA.

Heat stress measurements indicate the potential for employee exposure to heat stress in certain areas of the plant.

The medical evaluation consisted of administration of a respiratory questionnaire, pulmonary function tests, and chest x-rays. The questionnaire showed that 3% of the participants had chronic bronchitis. Those with abnormalties in pulmonary function tests had a mean duration of employment in the power plant of 4.7 years (S.D. = 2.2 years) compared to 3.4 years (S.D. 2.3 years) for those with normal pulmonary function. Chest x-rays for 69 employees showed no evidence of pneumocomosis.

Based on the results of this evaluation NIOSH has determined that a potential health hazard did exist, since the noise levels exceeded NIOSH and ACGIH criteria. In addition, the potential for heat stress exposure existed in some plant locations. The results of the medical survey did not indicate significant respiratory problems related to duration of employment in the power plant. Recommendations to improve personal protective equipment and to reduce occupational exposures are contained in Section VIII of this report.

KEYWORDS: SIC 4911 (electric services) electricity generation, coal-fired-power-plant, coal dust, fly ash, crystalline silica, noise.

II. INTRODUCTION

On February 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Safety Department of City Utilities, Springfield, Missouri for a health hazard evaluation at the James River Power Plant. The request was for environmental characterization of employee exposures and for medical evaluation of the employees.

NIOSH conducted an initial survey at the James River Power Plant in March 1982. The initial survey consisted of an opening conference, a walk-through survey, interviews with employees and representatives of union and management, and a closing conference. NIOSH conducted a follow-up medical and environmental survey on July 20-27, 1982.

An interim report presenting the preliminary environmental results was distributed in March, 1983. Results of each individual's medical tests were forwarded to the corresponding participant.

III. BACKGROUND

The James River Power Plant is a coal-fired electric generating station which can also be fueled with natural gas. It began production in 1957 with Units 1 and 2 (22 megawatts each). Unit 3 (44 megawatts) was added in 1960, Unit 4 (60 megawatts) in 1964, and Unit 5 (105 megawatts) in 1970. Units 1, 2, 3 and 5 are balanced draft units which means they operate under a slight negative pressure. Unit 4 however, operates under positive pressure. Each unit is a separate electric generating plant consisting of a boiler, a generator, a turbine, and auxillary equipment. Any combination of the five units can be operated depending on the prevailing demand for electricity and maintenance needs of the individual units, with a resulting range of electrical production of approximately 30 to 275 megawatts.

Coal is brought to the James River Plant via rail car or truck and either stored in the coal yard or transferred via conveyors to the tripper deck. From the tripper, the coal is distributed (using a common conveyor) into storage hoppers called bunkers. From the bunkers, coal is gravity-fed through stand pipes into feeders, which regulate the flow of coal into a coal mill. Three types of coal mills called bowl mill, trita (or hammer) mill, and ball tube mill are used. Each type of mill is designed to crush the coal into a powder. The powdered coal is blown through distribution pipes into burner pipes, which directs it into the boiler. A spreader, located in the end of each burner pipe, acts to disperse the powder as it enters the boiler fire, thus resulting in more efficient burning.

After burning, the remaining gases and particulates are carried via the airstream through economizer hoppers, where larger particulate material settles out. The airstream next passes through an electrostatic precipitator, where charged plates attract and remove the oppositely charged remaining particulate material. The air then passes into the smoke stack and is vented into the atmosphere.

Solid material called klinker that accumulates on the walls and inner boiler pipes is knocked loose and subsequently falls to the bottom of the boiler. In this area, called the wet bottom, the klinker is ground and then mixed with fly ash from the electrostatic precipitator and transferred by water to the fly ash pond.

The walls of the boiler consist of pipes through which water flows upward. Heat generated in the boiler heats the water, which is sent to the steam drum and then through superheat sections of the boiler. By this time, the water has been converted to superheated steam. The superheated steam is sent to the steam chest of the turbine, where a valve controls the flow of steam into the turbine. The steam subsequently goes through the high-pressure turbine, intermediate turbine, and low-pressure turbine. At this point, the turbine system has extracted all usable pressure from the steam. Steam from the low-pressure turbine is sent to the condenser, where cooler lake water flowing through pipes inside the condenser converts the steam back to water. This creates a vacuum in the condenser, which helps reduce back pressure on the low-pressure turbine and also prevents shock that would occur if steam were not converted to water prior to being sent to the water side of the steam drum. As the turbine revolves at approximately 3600 RPM, it turns a shaft. The shaft extends into the generator. A rotor positioned on the shaft revolves inside a coil. This action produces electricity.

The total workforce at the James River Plant is approximately 90 employees. The nonadministrative staff consists of 84 male employees, which includes 17 operators and 57 maintenance men. The operators are responsible for running the control rooms, from which they monitor all phases of the plant's operation. The maintenance employees (including electricians and janitors) are responsible for routine maintenance duties including unloading coal, janitorial duties, general maintenance, and emergency repairs.

IV. METHODS AND MATERIALS

A. Environmental

Airborne monitoring was conducted to evaluate employee exposures to airborne concentrations of chemical agents including nitric oxide, nitrogen dioxide, sulfur dioxide, carbon monoxide, fly ash, coal dust, metals and crystalline silica; and to physical agents including noise and heat stress (Table I). In addition, bulk material samples of insulation suspected of containing asbestos were collected.

Nitric oxide and nitrogen dioxide samples were collected on three section molecular sieve sorbent tubes attached via flexible tubing to a battery-operated pump calibrated at 0.02 liters per minute (LPM). Nitric oxide and nitrogen dioxide samples were analyzed using spectrophotometry according to NIOSH Method No. P&CAM 231.[1]

Sulfur dioxide samples were collected using a two filter sampling train consisting of a cellulose ester membrane filter followed by an impregnated cellulose filter containing potassium hydroxide. These filters were attached via flexible tubing to a battery-operated pump calibrated at 1.5 LPM. Sulfur dioxide samples were analyzed by first determining particulate and gaseous sulfate and sulfites using ion chromatography. Then a formula was used to determine sulfur dioxide collected on the treated filter according to NIOSH Method No. P&CAM 268.[2]

Fly ash samples were collected on polyvinyl chloride filters attached via flexible tubing to a battery-operated pump calibrated at 1.7 LPM. Coal dust samples were collected on polyvinyl chloride filters attached via flexible tubing to a battery-operated pump calibrated at 2.0 LPM. Both fly ash and coal dust were respirable samples collected by loading each filter cassette into a 10 millimeter nylon cyclone. Fly ash and coal dust samples were analyzed by weighing the samples plus the filters on an electrobalance and subtracting the previously determined tare weight of the filters. Subsequent to gravimetric analysis, all personal samples were retained for potential analysis of metals and/or crystalline silica content. Some of the personal samples were subsequently analyzed for crystalline silica. These samples were analyzed according to a modified version of NIOSH Method No. P&CAM 259.[1]

Bulk area airborne samples of coal dust and fly ash were obtained for analysis of metals and crystalline silica. The results of these analyses were used to determine which, if any personal coal dust and fly ash samples should be analyzed for metals and/or silica. Bulk area coal dust and fly ash samples for crystalline silica analysis were collected on PVC filters loaded into a 1/2-inch stainless steel cyclone attached via flexible tubing to an electric vacuum pump. Critical orifices were used to control the flow rates to approximately 9 LPM. These samples were analyzed using X-ray diffraction according to a modified version of NIOSH Method No. P&CAM 259.[1] Bulk area coal dust and fly ash samples for metals analysis were collected on mixed cellulose ester membrane filters attached via flexible tubing to battery-operated pumps calibrated at 1.5 LPM. These samples were analyzed by inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

Noise measurements were collected using electronic passive dosimeters.[3] The specific dosimeters used had a measurement range of 60 to 123 dBA. During a measurement, the dosimeters calculate and store 1 minute OSHA average levels (LOSHAS) with a 5 dB exchange rate. Each minute's exposure is stored sequentially for a total of 480 minutes or 8 hours.[4] The dosimeters present hourly time-weighted averages (TWA) in addition to an 8-hour TWA.

Heat stress measurements were made using a Wet Bulb Globe Temperature (WBGT) meter. The instrument calculates the WBGT index by simultaneously measuring the air temperature, humidity, and radiant heat.[5,6]

In addition to the personal and area monitoring listed above, certified-direct reading indicator tubes were utilized to evaluate airborne concentrations of boiler gases (sulfur dioxide, oxides of nitrogen, and carbon monoxide) in specific areas of the plant.[7,8] Bulk insulation samples were collected in glass sample vials. These samples were analyzed using polarized light microscopy and dispersion staining techniques to determine if they contained any asbestos material. Following field collection, all samples (except direct-reading) were returned to NIOSH laboratories for analysis.

B. Medical

The medical evaluation consisted of the administration of a standardized questionnaire, chest x-rays, and pulmonary function tests. The questionnaire focused on occupational history, respiratory symptoms, and smoking status. The chest x-rays (postero-anterior view) were read by a consultant radiologist and classified according to the ILO (UICC/Cincinnati) classification.[9] Lung function tests were done using a Ohio Medical Products Model 822 dry rolling seal spirometer. The best reading from three valid attempts on the spirometer were computed for comparison with standard predicted values for persons of the same age, sex, and height.[10] The predicted values for black persons were calculated by multiplying the standard predicted values by 0.85.[11] The indices of lung function evaluated were:

1. FEV_1 (Forced expiration volume in 1 second)
2. FVC (Forced vital capacity)
3. FEV_1/FVC %

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

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

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily 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 industries covered by the OSHA act are legally required to meet only those levels specified by an OSHA standard. However, since the James Power Plant is a municipally owned facility, it does not come under the OSHA Act. The OSHA PEL's are still used together with the NIOSH and ACGIH criteria for evaluating employees exposures at this facility.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The current criteria for nitric oxide is 30 milligrams per cubic meter of air (mg/m^3) for NIOSH, OSHA, and ACGIH.[12-14] The criteria is based on 8-hour (OSHA and ACGIH) or up to a 10-hour (NIOSH) time-weighted average (TWA). The NIOSH recommended standard for nitrogen dioxide is 1.8 mg/m^3 as a ceiling value not to be exceeded during any 15-minute period.[12] The OSHA permissible exposure limit (PEL) is 9 mg/m^3 and the ACGIH TLV is 6 mg/m^3.[13,14] The NIOSH recommended standard for sulfur dioxide is 1.3 mg/m^3 for up to a 10-hour TWA.[12] The OSHA PEL is 13 mg/m^3 and the ACGIH TLV is 5 mg/m^3.[13,14]

The inhalation of coal dust causes coal workers' pneumoconiosis (CWP). Simple CWP has no clinically unique symptoms since it often occurs concomitantly with other respiratory impairments. CWP is associated with chronic bronchitis and emphysema which are associated with shortened life span; the importance of CWP is that it is a precursor of progressive massive fibrosis (PMF) of the lungs.[15]

PMF is associated with a reduction in ventilatory capacity, low diffusing capacity, abnormalities of gas exchange, low arterial oxygen tension, pulmonary hypertension, and premature death.

The ACGIH TLV for respirable coal dust is 2 mg/m^3 based on an 8-hour TWA.[13] This criteria is for coal dust containing less than 5% crystalline silica. Currently, there is no specific criteria for fly ash. Fly ash is subject to the crystalline silica criteria depending on the percent crystalline silica it contains. In addition, there is a criteria for nuisance particulates. The criteria for the respirable fraction of nuisance particulates containing less than 1% quartz is 5.0 mg/m^3 based on an 8-hour TWA.[13]

There are various criteria for the metals detected on area airborne bulk samples. However, three metals were of particular interest on the fly ash and coal dust samples. The criteria for these three metals (arsenic, nickel, and lead) are 0.002 mg/m^3 for arsenic not to be exceeded during any 15-minute period (NIOSH), 0.015 mg/m^3 for nickel for up to a 10-hour TWA (NIOSH), and 0.05 mg/m^3 for lead (OSHA and NIOSH) as a TWA.[12,14,16,17]

The current criteria for respirable free silica is 0.05 mg/m^3 for up to a 10-hour TWA for NIOSH and 10 mg/m^3 divided by the percent crystalline silica plus 2, as an 8-hour TWA for OSHA and ACGIH.[12-14]

Noise is generally identified as unwanted sound. Vibration rates of an object correspond to the frequency of sound expressed in Hertz (Hz), which is one vibration cycle per second. The frequency range of audible sounds is approximately 20 to 20,000 Hz. Sound may consist of regular oscillations at a single frequency, called a pure tone, or complex sounds consisting of different frequency sounds, as in music and speech.

Sound pressure levels are measured to determine the intensity of energy characteristics of the sound. The unit of measurement is the decibel (dB). When measuring intense noise, one usually uses the "A-weighting" scale which most closely simulates the response of the human ear (other scales include "B" and "C"). Whichever scale is used is added to the decibel designation (i.e. dBA).

Exposure to intense noise causes hearing losses which may be either temporary, permanent, or a combination of the two. The actual pattern of temporary loss depends upon the spectrum of the noise. The greatest portion of the loss occurs within the first 2 hours of exposure and recovery from such losses is greatest within 1 to 2 hours after exposure. Permanent hearing loss in workers exposed to daily noise for many years is similiar to the pattern of temporary hearing loss except the permanent loss is not recoverable. Other causes of permanent hearing loss include disease, mechanical injury, and misuse of drugs.[17]

The current criteria for noise is 85 dBA as a TWA for NIOSH and ACGIH).[13,19] The OSHA standard is 90 dBA as an 8-hour TWA, but if employee noise exposures equal or exceed 85 dBA as an 8-hour TWA, the employer is required to administer a continuing effective hearing conservation program.[20]

The body's heat load derives from basic metabolic processes, muscular activity, environmental sources such as the sun, hot surfaces through contact or by radiation, and the air (if it is above body temperature). The body maintains a fairly uniform internal temperature through a number of adaptive mechanisms either to produce more heat or to get rid of excess heat as the situation demands. The three most important methods involve blood flow to the skin, muscular activity, and sweating. Blood flow to the skin is inceased when the body needs to lose heat to the environment and decreased when it needs to conserve heat. Muscular activity is increased when more heat is needed (shivering for example) and decreased (if possible) when less heat is desired. Sweating is the major method of losing heat in a hot, non-humid environment and depends on the evaporation of sweat to produce the cooling. When regularly exposed to hot environments the body acclimates over about a week so the individual can better handle the stress caused by heat.[21,22]

The current environmental criteria for heat stress is rather complex and depends on a number of factors, including heat stress measurements, work load, age, sex, and degree of acclimatization of the employee. The wet bulb glob temperature (WBGT) index is the most widely accepted index for measuring the parameters which contribute to human heat stress: air temperature, humidity, wind speed, and radiant heat. The WBGT index has been proposed by NIOSH for civilian employees in the United States.[22] NIOSH defines a hot environmental condition as one where the WBGT value exceeds 79°F. ACGIH has a variable criteria for exposure to hot environments where the WBGT ranges from 77 to 90°. These criteria depend on the work-rest regiment and the workload.[13,22]

Environmental criteria for the materials evaluated during this investigation are listed in Table I.

VI. RESULTS

A. Environmental

1. Initial Walk Through Survey

Production during the visit was low. This was due to a seasonal fluctuation in the demand for electricity and the hydroelectric production available because of high water levels. Discussions with management and employees indicted that the summer months (July-September) would be a good time for the follow-up survey due to increased production.

Efficient operation of the power plant requires chemical treatment of various water systems (boiler water, cooling water, ash pond, etc). Some additions are handled using bulk automated systems. Many additions however, require employees to manually add the chemicals. Among the chemicals are many that are corrosive and some that are quite toxic. Hydrazine (an oxygen scavenger) is added routinely to units four and five. It is also used for occasional boiler lay-ups (temporary boiler shut down) for all five units. The routine additions are performed by pumping hydrazine from a drum into a plastic measuring bottle and then draining the required amount into a mixing tank. The pump used was plastic and did not fit tightly into the hydrazine drum. Detector tubes used at the hydrazine loading station for unit four did not detect hydrazine in the general area but hydrazine was detected at an air vent on the siphoning pump indicating hydrazine vapors were leaking at this point. The system is vented and if maintained should help reduce employee exposure.

When boiler lay-ups occur greater quantities of hydrazine are required. Reportedly this also requires more manual handling of the chemicals.

Hydrazine is a proven animal carcinogen and thus NIOSH concludes that it is a potential human carcinogen. NIOSH recommends that the limits of exposure be kept at the lowest detectable concentration.[23] In addition to the inhalation hazard, hydrazine can also be absorbed through the skin, thus skin contact should be avoided.[23]

Employees observed making chemical additions did not wear protective clothing other than a hard hat. The specific additions observed involved small amounts of material and most of it was in a powder form. Other additions require greater quantities of materials (including acids) in powder and/or liquid form.

Eye wash bottles and first aid kits located throughout the plant were coated with dust. Both items should be kept in a more sanitary condition.

2. Follow-up Survey

a. Coal Dust

Table II presents the results of sampling for airborne coal dust. Concentrations ranged from 0.02 milligrams per cubic meter of air (mg/m^3) to 0.40 mg/m^3 for 20 personal samples. All values are below the lowest current environmental criteria of 2 mg/m^3 (ACGIH), which is a time-weighted average (TWA) based on an 8.0-hour workday. Table II also presents the results of sampling for quartz on some of the personal coal dust samples. All five samples evaluated were below the lower laboratory limit of quantitation (0.03 mg).

b. Fly Ash

Table III presents the results of sampling for airborne fly ash. Concentrations ranged from <0.01 to 0.65 mg/m^3. The nuisance dust criteria is not suitable for these values because the area airborne fly ash dust samples contained up to 4.7% crystalline silica. The ACGIH criteria specifically states that the TLV is for dust containing <1.0% crystalline silica. The nuisance criteria is used only for comparison, to show that the values obtained are relatively low. All values are below the current criteria for nuisance particulates of 5 mg/m^3 (OSHA and ACGIH), which is a TWA for an 8-hour workday. Table III also presents the results of sampling for quartz on some of the personal fly ash samples. All four samples evaluated were below the lower laboratory limit of quantitation (0.03 mg).

c. Oxides of Nitrogen

Table IV presents the results of sampling for airborne nitric oxide and nitrogen dioxide. Concentrations for nitrogen dioxide were all below the limit of detection (3 ug/sample) for four personal and two area samples. Concentrations for nitric oxide ranged from 0.20 to 0.29 mg/m^3 for four personal samples and two area samples had concentrations of 0.57 and 1.1 mg/m^3. Concentrations for both materials are well below the lowest current criteria, which are 1.8 mg/m^3 for nitrogen dioxide (NIOSH) as a ceiling value for any 15-minute period, and 30.0 mg/m^3 for nitric oxide (NIOSH, OSHA, and ACGIH) which is a TWA value.

d. Sulfur Dioxide

Table V presents the results of sampling for airborne sulfur dioxide. Concentrations ranged from <0.01 mg/m^3 to 3.94 mg/m^3 for two area and four personal samples. All personal samples are less than 25% of the lowest current criteria. One area sample (3.94 mg/m^3) is above the NIOSH recommended standard for sulfur dioxide of 1.3 mg/m^3.

e. Crystalline Silica

Table VI presents the results of sampling for airborne crystalline silica using high-volume area samples. Concentrations for coal dust samples were 0.02 and 0.05 mg/m^3. The highest value was obtained in the yard area. Concentrations for fly ash samples were 0.72 and 0.75 mg/m^3. Both samples were obtained in the air stream of a leak from Boiler No. 4. The percent of crystalline silica in all four samples was consistent with the range being 4 to 5.2%. Three of the four samples are at or above the NIOSH recommended standard of 0.05 mg/m^3 for respirable crystalline silica.

f. Inorganic Metals

Table VII presents the results of sampling for airborne metals. Three metals were specifically requested (arsenic, nickel, and lead), although the technique used (ICP-AES) actually evaluates each sample for a total of 28 metals. The concentrations for the three subject metals on four area samples were below the limit of detection for all except nickel detected on one sample (23.8 ug/m^3) and lead detected on two samples (5 and 68.7 ug/m^3). The percentages for the metals were calculated by dividing the weight of the specific metal by the total weight for all metals on each filter. Percentages were all less than 2, and in some instances, less than 0.1% of the total weight.

The results of area sampling in addition to the relatively low concentration of personal dust samples, were used in deciding not to have personal coal dust and fly ash samples analyzed for metals. Low percentages for metals on area samples and low concentrations of personal fly ash and coal dust samples make the likelihood of finding metal exposures above current criteria very remote.

g. Grab Samples

Table VIII presents the results of grab sampling for carbon monoxide (CO), oxides of nitrogen (NO_x), and sulfur dioxide (SO_2). Concentrations for carbon monoxide ranged from nondetected to 1.0 part CO per one million parts of air (ppm). The highest reading is approximately 15% of the lowest current criterion, which is 35 ppm (NIOSH) as a TWA. Concentrations for NO_x ranged from nondetected to 9 ppm. All but one sample was at 0.5 ppm or less, which indicates that they are below the lowest current criterion, which is 1.0 ppm for nitrogen dioxide (NIOSH), as is a ceiling value for a 15-minute period. The high reading (9 ppm) was obtained in the air stream from a leak on Boiler No. 4. It is unlikely that any employee would be directly in the air stream. A reading taken 7 minutes earlier and out of the air stream had a concentration of 0.5 ppm. Concentrations for SO_2 ranged from nondetected to >25 ppm. A few of the samples were also collected in the air stream of the same leak. However, several samples were taken in areas where employees were working or could very possibly work in the future. In particular, samples taken directly above a location where employees were removing a deslager on Unit No. 4 ranged from 22 to in excess of 25 ppm. Employees working with the deslager probably had concentrations equal to or greater than those listed in Table VIII.

Certified direct-reading indicator tubes are certified to be accurate to ±35% at one-half the test gas concentration and ±25% at 1, 2, and 5 times the test gas concentration.[7,8] The test gas concentration usually corresponds to the OSHA PEL. In addition, most of the criteria for CO, NO_x, and SO_2 represent full-shift values (NO_2 is the exception). Grab samples which represent an airborne concentration at a specific point in time cannot be directly compared to full-shift criteria. However, the SO_2 values indicate the potential and in the case of the deslag removal, the actual exposure to hazardous airborne concentrations of SO_2.

h. Noise Measurements

Table IX presents the results of noise monitoring using electronic passive dosimeters. Time-weighted average values ranged from 77.7 to 99.4 dBA for 25 personal samples, two area samples had values of 73.1 and 94.5 dBA determined over the sample time (dosimeters sample for up to a maximum of 480 minutes). Thirteen of the 25 personal measurements exceeded 85 dBA which represents the criteria established by NIOSH and ACGIH and also the point at which a hearing conservation program is required under the OSHA standard promulgated in 1981.

The use of hearing protection in general was good. Some employees however, were observed not wearing hearing protection in areas where it was required. One employee who had to walk through a high noise area was observed holding his fingers in his ears for protection.

i. Heat Stress

Table X represents the results of heat stress measurements collected using a WBGT meter. WBGT values ranged from 67°F in the lunchroom to 96°F in the penthouse of Unit 4. The criteria for heat stress are variable, ACGIH recommends

WBGT values ranging from 77°F to 90°F depending on the work-rest regimen and the work load (light, moderate, or heavy). NIOSH considers a hot environment as one where the WBGT exceeds 79°F.

However, it should be noted that heat stress exposures involves much more than the WBGT readings. As discussed in the NIOSH and ACGIH criteria and in the Proceedings of a NIOSH Workshop on Heat Stress Standards held in 1979, other considerations include availability of potable water, work load, age, sex, and acclimatization of the worker. The measurements listed in Table X represent a limited assessment of the potential for heat stress. A more detailed study would be required to thoroughly evaluate the heat stress potential. The readings do, however, indicate that certain areas of the plant were in excess of recommended criteria, specifically the penthouse of Boiler 4.

j. Insulation Samples and pH of Fly Ash

One bulk insulation sample contained 1-5% chrysotile asbestos and the other bulk sample contained 40-50% amosite asbestos. Both samples were collected at the end of the steam drum (end of drum toward Unit 2) on Unit 3, where the insulation covering was cracked and exposed. One bulk was from a pipe on the end of the drum and the second bulk was from the insulation covering the drum.

Two airborne fly ash samples were analyzed for pH content. Both samples were collected in a boiler leak located on Unit 4 at Level 2-2/3. These samples had pH values of 4.1 and 4.2.

k. General Observations

Units 4 and 5 ran continuously during the survey. Unit 3 was brought on-line starting at midnight on July 21, 1982, and was completed at approximately 10:00 a.m. on the same day. Units 4 and 5 provide up to 65% of the maximum load, and when Unit 3 is added, they provide up to 81%.

Two primary boiler leaks were found and both were on Unit 4, the positive pressure boiler. One leak on Level 2-2/3 was located outside on a platform, and thus escaping gases and dust disipated fairly rapidly. The second leak was located in the penthouse at the corner of the boiler nearest Unit 3 and the tripper. This leak also resulted in leaking gases and dust, but the leak was not as noticeable as the one on Level 2-2/3. This leak is inside near the boiler, which is enclosed on three sides.

The removal of a deslager on Unit 4 presented a number of health hazards for the maintenance employees. One employee in particular had high exposure to SO_2, heat, and possibly fly ash. The SO_2 exposure was determined using detector tubes on a platform directly above the deslag removal area. Airborne concentrations of 25 ppm obtained above the work area are probably lower than that actually encountered by the employee as he was working within his arm length from the leak. Exposure to heat was determined by the discomfort of NIOSH personnel who were standing 10 to 15 feet from where the employees were working and by burns on the fingers and forearm of the employee who was closest to the deslager. While removing the deslager, the employees wore face shields, flameproof gloves and coats.

One employee wore a dust mask while the second employee wore no respirator. The employee working closest to the leak was there for approximately 45 minutes then left the area to rest. He subsequently reported cough, nose bleed,and bloody sputum. The personal protective equipment worn by the employees during the deslag removal was not suitable for the conditions encountered.

Employees questioned about the deslag removal indicated that it did not occur often. During the survey, however, a second deslager on Unit 3 was also removed. Unit 3 operates (a balanced draft boiler) under a slight negative pressure. Leaks which occur in a balanced draft boiler are usually going to be into the boiler. The conditions observed while this deslager was removed were entirely different. There was very little if any exposure to heat, gases, or dust.

Tools were observed on the grid floor of the conveyor walkway running up to the tripper deck. The tools represent a safety hazard for anyone using the walkway.

Water was used in many instances to control airborne dust. Water trucks wetted down the roads at the fly ash pond. Water is also used to control airborne coal dust as most of the coal received has been washed. One coal train was unloaded during the NIOSH survey. This particular load of coal had not been washed. A tremendous amount of airborne dust was created as the coal cars were emptied and subsequently as the coal was dropped from a conveyor belt to the coal yard. At about midpoint of the unloading process a heavy rain occured for approximatley one hour. After the rain, much less airborne dust was observed as the coal unloading continued.

B. Medical

Of the 84 male production workers in the power plant, 70 (83%) completed the respiratory questionnaire and had pulmonary function tests. Sixty-nine participants had chest X-rays. The characteristics of the 70 participants were: (1) mean age 35 $\pm$ 9 years, (2) duration of employment in the power plant 3.6 $\pm$ 2 years, and 3) smoking status: 29 (41%) = Current smokers, 41(59%) = non-smokers and ex-smokers.

1. Questionnaire Responses

The American Thoracic Society[24] definition of chronic bronchitis is "A clinical disorder characterized by excessive mucus secretion in the bronchial tree. It is manifested by chronic or recurrent productive cough. Arbitrarily, these manifestations should be present on most days, for a minimum of three months in a year for not less than two consecutive years'. Using this definition, two participants (3%) had chronic bronchitis. Both were cigarette smokers with a past history of asthma, bronchitis, and pneumonia.

Only two workers (3%) said that they were required to wear a respirator at work. Nevertheless, ten participants (14%) used a respirator while working. Twenty-five workers (36%) have been trained in respiratory protection, but only one person had ever been fit-tested for a respirator.

2. Chest X-rays

Fifty-four (78%) of the chest X-rays reviewed showed no abnormalities. Chest X-rays with positive findings include 12 (17%) showing calcified foci consistent with old healed tuberculosis, histoplasmosis, or other hilar calcification, with no evidence of active disease. Histoplasmosis is a fungal infection common in people living in the Missippi river valley and its tributaries.[25] The three other abnormal X-rays included one with a raised right diaphragm, one with features of previous thoracic surgery, and one with healed fractured ribs. None of the X-rays showed any evidence of pneumoconiosis.

3. <u>Pulmonary Function Tests (PFTs)</u>

Results of PFTs are considered abnormal[11] if:

1) Either the FEV_1 (forced expiratory volume in 1 second) or the FVC (forced vital capacity) is less than 80% of predicted, or

2) The FEC_1/FVC% is less than 70%.

Using these criteria, seven participants (10%) had at least one abnormal index of lung function. Table 1. summarizes the characteristics of those with abnormal PFTs compared to those with normal lung function. They were older, worked longer at the power plant, and were more likely to be current cigarette smokers than workers with normal pulmonary function tests.

Table I

Group	Number	Age (years)	Duration of Employment in Power Plant (years)	Smoking History
Abnormal PFTs	7	43.6 ± 11.4 yrs.	4.7 ± 2.2 yrs.	87% (6/7)
Normal PFTs	63	34.2 ∓ 8.4 yrs.	3.4 ∓ 2.3 yrs.	37% (23/63)
		(Mean ± S.D.)	(Mean ± S.D.)	

The difference in mean duration of employment in the power plant between those with abnormal pulmonary function test results and those whose results are normal is not statistically significant ($p>0.05$, $t=1.45$). The difference in age is significant ($p<0.05$, $t=2.12$) and there were significantly more current smokers in the group with abnormal pulmonary function test results ($p=0.018$, Fishers exact test). Those with abnormal PFTs included five with a reduced FEV_1 and/or a reduced $FEV_1/FVC\%$ (indicative of an obstructive lung disorder), and two with a reduced FVC and normal $FEV_1/FVC\%$ (indicative of a restrictive lung disorder). Three of the five with features of airways obstruction have a past history of asthma or bronchitis. One of the two with features of restrictive lung disease had a previous history of chest injury and surgery. These conditions can contribute to the PFT abnormalities seen.

VII. DISCUSSION AND CONCLUSION

The majority of the samples collected were below current environmental criteria, including all coal dust, fly ash, nitrogen dioxide, nitric oxide and crystalline silica personal samples. One area sulfur dioxide sample was above the NIOSH recommended criteria. In addition, crystalline silica was detected on an area sample collected in the coal yard at a concentration (51.5 ug/m^3) slightly above the NIOSH recommended standard of 50 ug/m^3. Metals on two area coal dust samples were below the laboratory limit of detection. Area fly ash samples had high concentrations of both crystalline silica and some metals. Silica, lead, and nickel were found at concentrations above NIOSH recommendations. The crystalline silica detected on the coal yard coal dust sample is the only one that has direct significance to employees, due to the fact that some employee work in the coal yard area. The fly ash samples were collected directly in a boiler leak at a location where employees are unlikely to work. An important consideration in evaluating the crystalline silica and metals results, is the percentage of these materials in the dust. In particular, the silica content is very consistent for fly ash and coal dust at approximately 5%. The fly ash and coal dust concentrations measured during this survey are relatively low. All 25 coal dust and fly ash samples are at or below 0.65 mg/m^3 and most (22) are below 0.3 mg/m^3. Additionally crystalline silica concentrations were below the lower laboratory limit of quantitation for all personal coal dust and fly ash samples evaluated. Assuming the percentage of crystalline silica remains relatively constant, if employees were exposed to dust concentrations of 1.0 mg/m^3 or higher they would be at or above the NIOSH recommended standard (0.05 mg/m^3). Metals could also be a potential problem, but due to the relatively low percentages found on area samples probably only in extremely high dust concentrations.

A number of personal samples for noise exposure were over the current criteria of 85 dBA. Most of the employees wore ear muffs or ear plugs. In a few instances, employees were observed not using hearing protection and one of them stated that they wore ear plugs in the "noisy" areas only.

The results of the medical evaluation do not indicate any specific abnormalities or pattern of abnormalities related to work in the power plant . Chest X-rays showed no evidence of pneumoconiosis. The pulmonary function tests (PFTs) showed abnormalities in seven individuals, but in four cases the abnormalities could be related to lung injury or disease preceding employment at the power plant. Abnormal PFTs were associated with age and current cigarette smoking, but not with duration of employment at the power plant.

NIOSH has conducted a number of environmental and/or medical investigations in other coal-fired power plants. In addition, the Tennessee Valley Authority (TVA) has conducted an extensive industrial hygiene study in several coal-fired power plants. Several of the NIOSH studies and the TVA study are similar in their design and scope to the subject investigation.[26-31]

VIII. RECOMMENDATIONS

1. Boiler leaks in the penthouse and on Level 2-2/3 of Unit 4 should be repaired.

2. Management should develop a written respiratory protection program as outlined in the NIOSH Guide to Industrial Respiratory Protection.[32] In addition, the available respiratory protection should be increased to include, for example, respirators certified for use in atmospheres containing sulfur dioxide.

3. Employees working near the boiler of Unit 4 should carry respirators suitable for use in atmospheres containing sulfur dioxide.

4. When equipment such as wall deslagers must be removed from the boiler of Unit 4 while it is operating, employees should be equipped with proper personal protective equipment. The protective equipment should include heat-protective coveralls and/or aprons and/or leg covers and a self-contained breathing apparatus respirator and/or a portable airline respirator. The exact protective equipment required will depend on the specific job being performed.[21,22]

5. Employee training programs should be initiated, by management, to emphasize the health problems associated with chemicals used in coal-fired power plants.

6. Due to the number of potential chemical and physical hazards encountered at coal-fired power plants, management should acquire industrial hygiene capabilities. Potential sources include consultants, hiring an industrial hygienist, and training an individual currently employed at City Utilities.

7. The personal protective equipment program should be improved with an emphasis on availability of protective equipment, development of standard operating procedures including required protective equipment for specific duties (i.e. chemical additions, deslag removal on positive pressure boilers) and insuring that employees follow the standard operating procedures.

8. A heat stress survey should be conducted to determine the potential for employee heat stress while working in hot areas such as the Penthouse of Unit 4.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. James River Power Plant, Springfield, Missouri
2. Authorized Representative of Employees Local 753, IBEW
3. NIOSH, Region VII
4. OSHA, Region VII

For the purpose of informing the approximately 75 affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Environmental Criteria And Sampling And Analytical Methods

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Chemical or Physical Agent	Flow Rate (LPM)	Sampling Method	Analytical Method	Environmental Criteria, mg/m^3 (unless otherwise noted)		
				OSHA PEL	NIOSH Recommendation	ACGIH TLV
Nitric Oxide	0.02	3 Section Sorbent Tube	P&CAM No. 231	30	30	30
Nitrogen Dioxide	0.02	3 Section Sorbent Tube	P&CAM No. 231	9	1.8[A]	6
Sulfur Dioxide	1.5	Cellulose Ester Membrane Filter With Impregnated Cellulose Filter	P&CAM No. 268	13	1.3	5
Coal Dust	2	PVC Filter Loaded Into 10 mm Nylon Cyclone	Gravimetric	2.4	None	2
Fly Ash[X]	1.7	PVC Filter Loaded Into 10 mm Nylon Cyclone	Gravimetric	5[X]	None	5[X]
Quartz*	**	PVC Filter Loaded Into 10 mm Nylon Cyclone	P&CAM No. 259	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$	0.05	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$

(continued)

TABLE I (continued)

Chemical or Physical Agent	Flow Rate (LPM)	Sampling Method	Analytical Method	Environmental Criteria, mg/m^3 (unless otherwise noted) OSHA PEL	NIOSH Recommendation	ACGIH TLV
Bulk Sample Of Insulation For Asbestos Content	-	Collected in Glass Sample Vial	Visual Estimate of % Asbestos Using Polarized Light Microscopy	-	-	-
Metals	1.5	AA Filter	ICP-AES	------------Variable----------		
Boiler Gases (CO, NO_x, SO_2)	-	Certified Direct Reading Indicator Tube	Direct-Reading, Visual	-------Used TWA Criteria------		
Noise	-	Electronic Dosimeter	Printout, Visual	90 dBA***	85 dBA	85 dBA
Heat Stress	-	WBGT Meter	Direct-Reading, Visual	None	Variable	Variable

- Does not apply.
A Ceiling value for a 15 minute period.
X Nuisance criteria was used only to show the relatively low airborne concentrations found. Due to the % crystalline silica found on area fly ash samples, the nuisance criteria is not a suitable criteria for fly ash concentrations.

* Quartz was only polymorph of crystalline silica present.

** Analysis was on coal dust and fly ash samples.
*** Employee exposures equal to or exceeding 85 dBA (as an 8-hour TWA) requires that the employer administer a continuing effective hearing conservation program.

TABLE II

Airborne Concentrations Of Coal Dust Samples
Personal Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July, 1982

Job/Location	Sample Time	Volume (Liters)	Date	Concentration (mg/m^3) Dust	Quartz*
Janitor - Sweeping	0740-1547	966	7-20-82	0.33	
Janitor - Sweeping, Also Cleaned Up Coal Spill On Level 2	0738-1540	964	7-20-82	0.16	
Janitor - Sweeping On Heater Floor	0740-1547	974	7-20-82	0.05	
Janitor - Sweeping	0736-1539	966	7-21-82	0.13	LLQ
Janitor - Sweeping	0745-1542	954	7-21-82	0.12	
Janitor - Sweeping	0748-1541	946	7-21-82	0.02	
Coal Crew - Tripper Floor	0735-1535	960	7-20-82	0.14	
Coal Crew - Tripper Floor And Crusher House	0736-1535	958	7-20-82	0.23	
Coal Crew - Front End Loader	0732-1543	982	7-20-82	0.04	
Coal Crew - Tripper Floor	0739-1547	976	7-21-82	0.40	LLQ
Coal Crew - Crusher House	0743-1546	966	7-21-82	0.14	
Coal Crew - Front End Loader	0731-1545	988	7-21-82	0.02	
Coal Crew - Unloading Coal Train	1533-2344	982	7-27-82	0.12	
Coal Crew - Unloading Coal Train	1535-2344	978	7-27-82	0.28	LLQ
Coal Crew - Unloading Coal Train	1538-2347	978	7-27-82	0.15	
Operator - Heater Floor	0725-1522	954	7-22-82	0.10	LLQ
Operator - Auxillary Pit	0730-1521	942	7-22-82	0.06	
Operator - Pit	0735-1523	936	7-22-82	0.05	
Operator - Pit	0745-1546	962	7-23-82	0.04	LLQ
Operator - Auxillary Pit	0738-1518	920	7-23-82	0.04	

*Quartz was the only polymorph of crystalline silica found on any sample.
LLQ = Below the lower laboratory limit of quantitation (0.03 mg).
Sensitivity of the analytical balance = 0.01 mg

Environmental Criteria = (mg/m^3): Dust = 2 (ACGIH), 2.4 (OSHA) Quartz = $\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$ (OSHA,ACGIH)

0.05 (NIOSH)

TABLE III

Airborne Concentrations For Fly Ash
Personal Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Job/Location	Sample Time	Volume (Liters)	Date	Concentration (mg/m^3) Dust	Quartz*
Maintenance - Removing Soot Blower On Unit 4, Level 3	0736-1020 1037-1525	768	7-22-82	0.65	LLQ
Maintenance - Removing Soot Blower On Unit 4, Level 3	0740-1525	790	7-22-82	0.14	LLQ
Maintenance - Working On Boiler Unit 3	0744-1559	841	7-22-82	<0.01	
Maintenance - Working at location where Soot Blower was removed, Unit 4. level 3	0735-1522	793	7-23-82	0.06	LLQ
Maintenance - Machine Shop most of the day	0737-1520	787	7-23-82	0.04	LLQ

* Quartz was the only polymorph of crystalline silica found on any sample
Sensitivity of the Analytical Balance = 0.01 mg
LLQ = Below the laboratory limit of quantitation

Environmental Criteria = (mg/m^3): Dust** = 5 (OSHA and ACGIH) Quartz = $\frac{10\ mg/m^3}{\%\ SiO_2+2}$ (OSHA, ACGIH)

0.05 (NIOSH)

** Nuisance particulate criteria

TABLE IV

Airborne Concentrations For Nitric Oxide And Nitrogen Dioxide
Personal And Area Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Job/Location	Sample Time	Volume (Liters)	Type Of Sample	Date	Concentration (mg/m^3) NO	NO_2
Unit 4 - Penthouse, At End Of Steam Drum	0946-1540	8.8	Area	7-21-82	0.57	LLD
Unit 4 - At Boiler Gas Leak, Level 2-2/3	0848-1314 1319-1541	10.6	Area	7-20-82	1.1	LLD
Operator - Heater Floor	738-1518	9.8	Personal	7-21-82	0.20	LLD
Operator - Pit	0746-1534	12.9	Personal	7-21-82	0.21	LLD
Operator - Pit	0755-1522	10	Personal	7-21-82	0.29	LLD
Maintenance - Working On Wall Deslager, Unit 4, Level 3	0740-1522	10.5	Personal	7-23-82	0.20	LLD

LLD = Below the laboratory limit of detection (NO = 2 ug/sample, NO_2 = 3 ug/sample)

Environmental Criteria (mg/m^3): NO - 30 (NIOSH, OSHA, ACGIH)
NO_2 - 1.8 (NIOSH as a ceiling concentration)

TABLE V

Airborne Concentrations For Sulfur Dioxide
Area And Personal Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Job/Location	Sample Time	Volume (Liters)	Type Of Sample	Date	Concentration mg/m^3
Penthouse - Unit 4, End Of Steam Drum	0901-1650	531	Area	7-21-82	3.94
Level 2-2/3 - Unit 4, Sample Taken Near Boiler Leak	1027-1547	480	Area	7-22-82	0.59
Operator - Heater Floor	0738-1518	690	Personal	7-21-82	0.03
Operator - Heater Floor	0817-1517	630	Personal	7-23-82	0.01
Maintenance - Removing Wall Deslager Unit 4, Level 3	0740-1525	698	Personal	7-22-82	0.29
Maintenance - Working At Wall Deslager Unit 4, Level 3*	0737-1454	655	Personal	7-23-82	>0.01

* Clip came off pump at 1415, employee left pump in supervisor's office until 1454.

Environmental Criteria (mg/m^3) = 1.3 mg/m^3 (NIOSH)

TABLE VI

Results Of Area Sampling For Crystalline Silica

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Location	Type Of Sample	Sample Time	Volume (Liters)	Date	% Of Total Weight On Filter	Concentration mg/m^3 Quartz*
Crusher House - 2nd Level At Transfer Point	Coal Dust	0901-1650	4220	7-21	5.2	0.02
Yard	Coal Dust	1350-1538	960	7-20	5.2	0.05
Unit 4 - In Air Stream Of Boiler Leak, Level 2-2/3	Fly Ash	0850-1115	1290	7-22	4	0.75
Unit 4 - In Air Stream Of Boiler Leak, Level 2-2/3	Fly Ash	0948-1121	840	7-20	4.7	0.72

*Quartz was the only polymorph of crystalline silica found on any sample.
Environmental Criteria (ug/m^3): 0.05 mg/m^3 (NIOSH)

TABLE VII

Results Of Area Sampling For Metals

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Location	Type Of Dust	Sample Time	Volume (Liters)	Date	Metal	% Of Total Weight On Filter	Concentration (ug/m^3)
Unit 4, In Air Stream Of Boiler Leak, Level 2-2/3	Fly Ash	0846-1530	606	7-20-82	As	<.1	ND
					Ni	<.1	ND
					Pb	.2	5
Unit 4, In Air Stream Of Boiler Leak, Level 2-2/3	Fly Ash	0850-1019	134	7-22-82	As	<.1	ND
					Ni	<.1	23.8
					Pb	<.2	68.7
Hopper Pit, On Pipe Supporting 2 Rheostato	Coal Dust	1020-1545	487	7-20-82	As	<1	ND
					Ni	<1	ND
					Pb	<1	ND
Crusher House, 2nd Level At Transfer Point	Coal Dust	0901-1650	704	7-21-82	As	<2	ND
					Ni	<2	ND
					Pb	<2	ND

ND = Not Detected

Environmental Criteria (ug/m^3): As - 2 (NIOSH as a ceiling value)
Ni - 15 (NIOSH)
Pb - 50 (OSHA, NIOSH)

TABLE VIII

Airborne Concentrations For CO, NO_x, SO_2
Grab Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Location	Sample Time	Date (1982)	Contaminant	Concentration (ppm)
Unit 4, Level 2-2/3, At Leak In FD Fan Duct Reading 18" From Leak And Not In Air Stream Of Leak	1308	7-20	NO_x	0.5
Unit 4, Level 2-2/3, At Leak In FD Fan Duct In Air Stream of Leak And Within 6" Of Leak	1310	7-20	NO_x	9
Unit 4, Level 2-2/3, At Leak In FD Fan Duct In Air Stream of Leak And Within 18" From Leak	1315	7-20	SO_2	2
Unit 4, Level 2-2/3, At Leak In FD Fan Duct In Air Stream of Leak And Within 1' From Leak	0856	7-22	SO_2	>25**
Unit 4, Level 2-2/3, At Leak In FD Fan Duct In Air Stream of Leak And Within 6' From Leak In Direction of Unit 3	0905	7-22	SO_2	ND
Unit 4, Level 2-2/3, Other Side Of Platform From Leak, Side Of Platform Toward Unit 5	0912	7-22	SO_2	ND
Unit 4, Level 4 (Approximate), Workers Removing Deslager No. B1, Samples Taken On Platform Located Directly Above A1 Deslager	0945 0950 0958	7-22 7-22 7-22	SO_2 SO_2 SO_2	22 25 >25**
Unit 4, Level 4 (Approximate), Deslager Removed And Plate Was Covering Part	1450	7-22	SO_2	ND
Unit 4, Level 2-2/3, Near Leak	1121	7-23	SO_2	Trace

(continued)

TABLE VIII (continued)

Location	Sample Time	Date (1982)	Contaminant	Concentration (ppm)
Unit 4, Penthouse, End of Steam Drum Toward Unit 5	0955	7-21	NO_x	ND
	1000	7-21	SO_2	0.2*
	1540	7-21	NO_x	0.5
	1544	7-21	NO_x	0.5
	1548	7-21	SO_2	3*
Unit 4, Penthouse, End of Steam Drum Toward Unit 5	1142	7-22	SO_2	ND
Unit 4, Penthouse, End of Steam Drum Toward Unit 5	1110	7-23	SO_2	ND
Unit 4, Penthouse, 4' From Boiler Wall, 6' From Penthouse Wall (Wall Toward Unit 3), And 15' From End Of Steam Drum	1415	7-22	SO_2	20
Unit 4, Penthouse, 4' From Boiler Wall, 6' From Penthouse Wall (Wall Toward Unit 3), And 15' From End Of Steam Drum	1320	7-23	SO_2	10
Unit 4, Penthouse, 4' From Boiler Wall, 6' From Penthouse Wall (Wall Toward Unit 3), And 15' From End Of Steam Drum	1416	7-23	CO	ND
Unit 4, Penthouse, 4' From Boiler Wall, 6' From Penthouse Wall (Wall Toward Unit 3), And 15' From End Of Steam Drum	1419	7-23	CO	1
Unit 4, Penthouse, 4' From Boiler Wall, 6' From Penthouse Wall (Wall Toward Unit 3), And 15' From End Of Steam Drum, Reading Taken At Corner Of Boiler Nearest Unit 3 And Tripper	1310	7-23	SO_2	ND
Basement, Unit 5, At Centrifuge	1414	7-23	CO	ND

ND = Not Detected

Environmental Criteria (ppm): CO - 35 (NIOSH)
SO_2 - 0.5 (NIOSH)
NO_x: NO - 25 (NIOSH, OSHA, ACGIH)
NO_2 - 1 (NIOSH ceiling value)

TABLE IX

Results Of Noise Measurements
Personal And Area Samples

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 1982

Job/Location	Sample Time	Date	Range Of Hourly dBA Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Janitor - Sweeping, Level 2	0740-1547	7-20-82	74.7-83.8	0	0	80.1	
Janitor - Sweeping, Level 2	0736-1539	7-21-82	79.5-89.7	5	0	86.0	
Janitor - Sweeping, Pit And Level 3	0738-1540	7-20-82	72.4-86.6	1	0	81.1	
Janitor - Sweeping, Basement	0745-1542	7-21-82	81.1-91.7	7	3	89.2	One Other Hour dBA Level Was 90.0
Janitor - Sweeping, Tripper Floor	0744-1547	7-20-82	77.2-90.4	3	1	85.5	Three Hourly TWA Levels Exceeded 88.1 dBA
Janitor - Sweeping, Heater Floor	0747-1541	7-21-82	74.2-85.4	1	0	81.1	
Coal Crew - Unloading Car	1533-2344	7-27-82	86.5-96.0	7	5	92.2	
Coal Crew - Unloading Car	1539-2351	7-27-82	76.1-87.1	4	0	84.1	
Coal Crew - Unloading Car	1538-2347	7-27-82	80.6-92.0	5	3	88.5	
Coal Crew - Tripper Deck	0735-1535	7-20-82	71.6-84.4	0	0	81.2	

(continued)

TABLE IX (continued)

Job/Location	Sample Time	Date	Range Of Hourly dBA Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Coal Crew - Tripper Floor	0739-1547	7-21-82	76.2-88.8	4	0	84.9	
Coal Crew - Crusher House And Tripper Floor	0736-1535	7-20-82	74.8-80.3	0	0	77.7	
Coal Crew - Crusher House And Tripper Floor	0743-1546	7-21-82	78.4-87.8	3	0	83.7	
Coal Crew - Front End Loader Operator	0731-1545	7-21-82	77.3-84.1	0	0	81.3	
Laboratory Technician -	0735-1602	7-21-82	78.1-88.7	2	0	82.8	
Heater Floor At Unit 3	0815-1605	7-21-82	88.9-99.7	8	4	94.5	Area Sample, Unit 3 Being Brought On-Line
Operator, Heater Floor	0725-1522	7-22-82	85.0-91.9	7	1	88.5	
Operator, Heater Floor	0817-1517	7-23-82	79.8-105.5	5	1	93.7	7-Hour Sample, 2nd Highest Hourly TWA Was 88.2 dBA
Operator - Pit	0730-1521	7-22-82	87.4-93.8	8	5	90.9	
Operator - Pit	0745-1546	7-23-82	82.4-92.5	6	4	89.6	5 of the 8 Hourly TWAs Exceeded 88.8 dBA
Operator, Auxillary Pit	0735-1523	7-22-82	85.5-93.5	6	3	90.1	6-Hour Sample

(continued)

TABLE IX (continued)

Job/Location	Sample Time	Date	Range Of Hourly dBA Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Operator, Auxillary Pit -	0738-1518	7-23-82	83.1-92.5	7	2	89.1	6 of the 8 Hourly TWAs Exceeded 87.6 dBA
Maintenance - Adjusting Exciter On Turbine Of Unit 3	0748-1525	7-22-82	83.8-104.9	7	6	99.4	Employee Wore Ear Muffs, 4 Hourly TWAs Exceeded 100.2 dBA
Maintenance - Removing Soot Blower Unit 3	0744-1559	7-22-82	80.3-92.1	6	1	87.5	
Maintenance - Working On Wall Deslager Unit 4, Level 3	0740-1522	7-23-82	81.8-84.9	0	0	83.4	Two Hourly TWAs Equaled 84.9 dBA
Maintenance - Wall Deslager No. 3 Boiler	0735-1528	7-23-82	79.6-86.2	2	0	83.1	
Control Room - On Wall Near Turbine Floor Attached To Steel Beam	0821-1540	7-23-82	72.4-74.1	0	0	73.1	Area sample

Environmental Criteria: 85 dBA (NIOSH, ACGIH)
90 dBA (OSHA - Employee exposures equal or exceeded 85 dBA require that the employer administer a continuing effective hearing conservation program)

TABLE X

Results Of Heat Stress Measurements Collected With WBGT Meter

James River Power Plant
City Utilities
Springfield, Missouri
HETA 82-119

July 27, 1982

Location	Time	WBGT Reading
Lunchroom - Meter Setting On Table	1740	69
	2151	67
Basement - 45 Feet From Elevator Near Unit 4	1800	85
	2200	84
Tripper Deck - Meter On Top Of Eyewash Bottle Cabinet Located On Side Of Coal Conveyor Toward Elevator. Cabinet On Steel Beam 10 Feet From Coal Conveyor	1807	94
	2207	93
Unit 4 Penthouse - End Of Steam Drum Toward Unit 5	1814	94
	2215	96
Yard Area - Meter On Phone Cabinet Attached To Wooden Utility Pole Near Box Car Shaker. Phone ID No. P904	1826	75
	2224	74

Environmental Criteria: Variable, WBGT measurement is one factor. Other factors include availability of potable water, age, work load, and acclimatization of employee.