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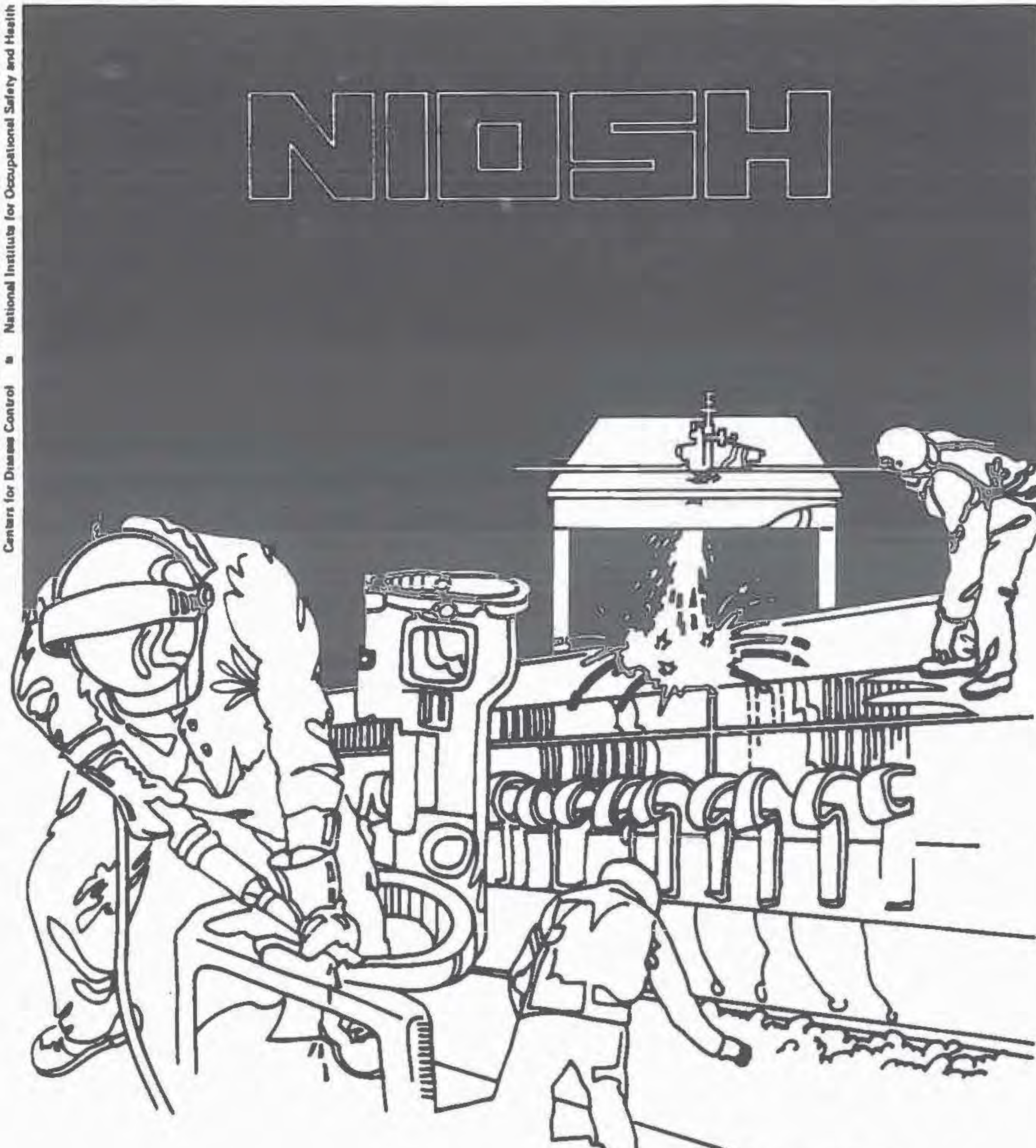

Health Hazard Evaluation Report

HETA 82-093-1453
SOUTHWEST POWER STATION
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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SOUTHWEST POWER STATION
CITY UTILITIES
SPRINGFIELD, MISSOURI

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I. SUMMARY

In January 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Safety Department of City Utilities to evaluate employee exposures to coal and other dusts and fumes at the Southwest Power Plant, Springfield, Missouri. NIOSH conducted a preliminary walk-through survey in March 1982, and a combined environmental and medical follow-up evaluation on July 26-29, 1982.

The environmental evaluation consisted of collecting samples to determine employee exposures to airborne concentrations of chemical agents including coal dust, fly ash, crystalline silica, metals, oxides of nitrogen, sulfur dioxide, and carbon monoxide; and to physical agents including noise and heat stress.

All personal coal dust, fly ash, crystalline silica, nitrogen dioxide, nitric oxide, and sulfuric acid samples 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, crystalline silica = 0.05 mg/m^3 - NIOSH, nitric oxide = 30 mg/m^3 - OSHA, NIOSH, and ACGIH, and nitrogen dioxide = 1.8 mg/m^3 - NIOSH as a ceiling concentration.

Four of eight personal sulfur dioxide samples exceeded the NIOSH recommended criterion of 1.3 mg/m^3. Seven of 17 personal noise samples exceeded the NIOSH and ACGIH criteria of 85 dBA.

The medical evaluation consisted of administration of a respiratory questionnaire, pulmonary function tests, and chest X-rays to 75 workers. The results showed three workers with chronic bronchitis (all three were cigarette smokers), eight workers with pulmonary function test abnormalities indicating obstructive airways disease, and two workers with features of restrictive lung disease. One chest X-ray was reported as consistent with pneumoconiosis. However, the duration of employment in the power plant in this case was less than the mean duration of employment for the group. There was also no significant previous dust or fume exposures in this individual.

Based on these results NIOSH has determined that a health hazard existed for employees exposed to sulfur dioxide and noise. In addition, a potential hazard for employee exposure to heat stress was found in certain locations in the facility. Recommendations are included in Section VII of this report for improvements in the respiratory protection program, personal protective equipment, and initiation of an employee training program and environmental monitoring by management.

KEYWORDS: SIC 4911 (Electric Services) electricity generation, coal-fired-power-plant, coal dust, fly ash, crystalline silica, sulfur dioxide, noise

II. INTRODUCTION

On January 4, 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 their Southwest Power Station. The request was for environmental characterization of employee exposures to dusts and fumes and medical evaluations of the employees at this coal-fired power plant.

NIOSH conducted an initial survey at the Southwest Power Station in March 1982 and a follow-up medical and environmental survey on July 26-29, 1982. An interim report presenting preliminary environmental data and recommendations for improving working conditions was distributed in March, 1983. Results of each individual's medical tests have been forwarded to each participant.

III. BACKGROUND

The Southwest Power Station began production in 1976. The plant operates one unit, which consists of a boiler, a generator, a turbine, and auxillary equipment.

The unit is rated at approximately 200 megawatts and has an operating range of 70 to 200 megawatts. The boiler operation is termed 'balanced draft' as opposed to 'positive pressure'. This means that the boiler normally operates under a slight negative pressure. It burns approximately 400,000 tons of coal per year. The coal comes into the Southwest Power Station by rail car. It is normally stored in the coal yard; though it is sometimes taken directly into the plant. From the storage pile, coal is moved to a hopper and then transferred via conveyor belts up to the coal distribution floor. On the distribution floor, coal is transferred via one of three conveyor belts into storage silos. Next, the coal is gravity-fed through feeders which control the flow to coal mills where it is ground to the consistency of face powder. From the mills, coal is blown through burner lines into the boiler, where it burns releasing energy as heat. A spreader, located in the end of each burner pipe, acts to disperse the coal as it enters the fire, thus resulting in more efficient burning.

After burning, the remaining gases and particulates are carried via the air stream through economizer hoppers where larger particulate material settles out; and then to an electrostatic precipitator where the smaller particulate material is removed. The remaining material enters the scrubber near its base and then rises. Concurrently a solution consisting of crushed limestone and water is sprayed from the top of the scrubber. This action removes sulfur dioxide from the air stream. Subsequently the air-stream is vented to the atmosphere. The limestone/sulfur dioxide/water slurry is pumped to the dewatering building where it is first thickened and then the solids are removed on a vacuum-filter-belt system.

Solid material called klinker that accumulates on the wall and inner boiler pipes is knocked loose and falls to the bottom of the boiler. In this area, called the wet bottom, the klinker is ground and then transferred via recycled pond water to the fly ash pond.

Dry particulate material consisting primarily of fly ash from the economizer hoppers and the electrostatic precipitator is transferred to a silo near the dewatering building. In the silo dry particulate are mixed with solids separated from the limestone slurry. This mixture is transferred via trucks to the fly ash pond.

The walls of the boiler consist of pipes through which water is pumped upward. Heat generated in the boiler heats the water, which is sent to the steam drum and then through superheated 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 available pressure from the steam. Steam from the low-pressure turbine is sent to the condenser, where cool lake water flowing through pipes inside the condenser convert 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 which extends into the generator. A rotor positioned on the shaft revolves inside a coil. This action produces electricity.

The total workforce at the Southwest Power Station is 98 employees. The nonadministrative staff consists of 87 male employees which include

20 operators and 55 maintenance personnel. The operators are responsible for monitoring 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. Other workers include lab technicians, other engineers and supervisors.

IV. METHODS AND MATERIALS

A. Environmental

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

Sulfuric acid samples were collected on mixed cellulose ester membrane filters attached via flexible tubing to battery-operated pumps calibrated at 1.5 LPM. The samples were analyzed using ion chromatography according to NIOSH Method No. P&CAM 268.[2] A gravimetric conversion factor of 1.02 was used to convert sulfate ion results to sulfuric acid.

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 tared polyvinyl chloride filters attached via flexible tubing to a battery-operated pump calibrated at 2 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 weights of the filters. Subsequent to gravimetric analysis, all personal samples were retained for potential analysis of metals and/or crystalline silica content. Subsequently, some of the personal samples were analyzed for crystalline silica 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 samples would be analyzed for silica and/or metals. Bulk area coal dust and fly ash samples for silica analysis were collected on tared PVC filters loaded into a 1/2-inch stainless steel cyclone attached via flexible tubing to an electric vacuum pump. Critical orifices located in the tubing controlled the flow rate at 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 dosimeters.[3] The specific dosimeters used had a measurement range of 60 to 123 dBA. During a measurement, the dosimeters calculate and store one 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 collected using a Wet Bulb Globe Temperature (WBGT) meter. The instrument calculates overall heat stress from 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] 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 included questions on occupational history, respiratory symptoms, and smoking history. The chest X-rays (postero-anterior view) were read by a consultant radiologist and classified according to the ILO (UICC/Cincinnati) classification. Lung function tests were performed using an Ohio Spirometer. The best readings from three valid attempts on the spirometer were computed for comparison with predicted values for persons of the same age, race, sex, and height. The indices of lung function recorded 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. The Southwest Power Station is a municipally owned facility and thus is not covered under the OSHA Act. For this report the PEL's are still used together with the other criteria in assessing employee 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.[9,10,11] The criteria is based on 8-hour (OSHA and ACGIH) or up to a 10-hour (NIOSH) 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.[9] The OSHA Permissible Exposure Limit (PEL) is 9 mg/m^3 and the ACGIH TLV is 6 mg/m^3.[10,11] The NIOSH recommended standard for sulfur dioxide is 1.3 mg/m^3 for up to a 10-hour TWA.[9] The OSHA PEL is 13 mg/m^3 and the ACGIH TLV is 5 mg/m^3.[10,11]

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.[12]

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

The ACGIH TLV for respirable coal dust is 2 mg/m^3 and the OSHA PEL is 2.4 mg/m^3 based on an 8-hour TWA.[10,11] This criteria is for coal dust containing less than 5.0% quartz. 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.[9,10,11] In addition, there is a criteria for nuisance particulates. The criteria for the respirable fraction of nuisance particulates is 5 mg/m^3 based on an 8-hour TWA (OSHA, ACGIH).[10,11] The ACGIH criteria states that it is for dusts containing less than 1% quartz.[10]

There are various criteria for the metals detected on area airborne fly ash and coal dust samples. Three metals, however, were of particular interest on these samples. The lowest current criteria for these metals (arsenic, nickel, and lead) are 2 ug/m^3 for arsenic, not to be exceeded during any 15-minute period (NIOSH); 15 ug/m^3 for nickel, for up to a 10-hour TWA (NIOSH); and 50 ug/m^3 for lead (OSHA and NIOSH) based on a full-shift TWA.[9,11,13,14]

The current criteria for respirable crystalline 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 free silica plus 2, as an 8-hour TWA for OSHA and ACGIH.[9,10,11]

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 or energy characteristics of the sound. The unit of measurement is the decibel (dB). When measuring intense noise, one usually uses the "A-weighing" 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 diseae, mechanical injury, and misuse of drugs.[15]

The current criteria for noise is 85 dBA as a TWA (NIOSH and ACGIH).[10,16] The OSHA standard is 90 dBA, 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.[17]

The body's heat load derives from basic metabolic processes, muscular activity, and 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 increased 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 (such as by shivering) and decreased 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.[18,19]

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 globe 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. NIOSH defines a hot environmental condition as one where the WBGT value exceeds 79°F.[19] ACGIH has variable criteria for exposure to hot environments where the WBGT ranges from 77 to 90°. These criteria depend on the work-rest regimen and the workload.[10]

Environmental criteria for all 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 seasonal fluctuations in the demand for electricity and the hydroelectric production available because of high water levels. Discussions with management and employees indicated that July-August 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 add the chemicals manually. 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 shutdown) 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 system is vented and if maintained properly should help reduce employee exposure. 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 its presence in the general area; but hydrazine was detected at an air vent on the siphoning pump, indicating hydrazine vapor leaks at this point.

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 animal carcinogen. NIOSH therefore recommends that the limit of exposure be kept at the lowest detectable level.[20] In addition to the inhalation hazard, hydrazine can also be absorbed through the skin, thus skin contact should be avoided.[20]

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 liquid form.

Eye wash bottles and first aid kits were coated with dust. Both items should be kept in a clean sanitary condition.

2. Follow up Survey

a. Coal Dust

Table II presents the results of sampling for airborne coal dust. Concentrations ranged from 0.08 milligrams per cubic meter of air (mg/m^3) to 0.32 mg/m^3 for 11 personal samples. All values are below the lowest current environmental criterion of 2 mg/m^3 (ACGIH), which is a time-weighted average (TWA) based on an 8-hour workday.[10] Table II also presents the results of sampling for crystalline silica on three of eleven personal coal dust samples. Concentrations for all three 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 0.17 to 0.88 mg/m^3 for 10 personal samples. The nuisance dust criteria is not a suitable criteria for these values because the area airborne fly ash bulk dust samples contained 1.8% crystalline silica. The ACGIH criteria specifically states that it is for dust containing <1% crystalline silica. The fly ash values, however, can be compared to the nuisance criteria in order to show that the relative dust concentrations were low. All values are less than 20% of the current criteria for nuisance particulates of 5 mg/m^3 (OSHA and ACGIH), which is a TWA for an 8-hour workday.[10,11] Table III also presents the results of sampling for crystalline silica on some personal fly ash samples. Crystalline silica was below the laboratory limit of quantitation (0.03 mg) on all five samples evaluated.

In addition to these analyses, two airborne bulk fly ash samples were analyzed for pH. The samples were alkaline with pH values of 8.9 and 10.2. The pH scale ranges from 1 (acidic) to 14 (alkaline) with a pH of 7 being neutral.

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 laboratory limit of detection (3 ug/sample) for two personal and two area samples. Concentrations for nitric oxide ranged from below the laboratory limit of detection (2 ug/sample) to 2.05 mg/m^3 (for an area sample). One of the two personal samples had a concentration of 0.41 mg/m^3. Concentrations for both materials were well below the lowest current criteria, which are 1.8 mg/m^3 for nitrogen dioxide (NIOSH) as a ceiling value for a 15-minute period, and 30 mg/m^3 for nitric oxide (NIOSH, OSHA, and ACGIH), which is a TWA value.[9,10,11]

d. Sulfur Dioxide

Table V presents the results of sampling for airborne sulfur dioxide. Concentrations ranged from <0.05 mg/m^3 to 4.87 mg/m^3 for eight personal samples. Four of the eight samples with exposure concentrations between 1.82 and 4.87 mg/m^3 were above the NIOSH recommended standard of 1.3 mg/m^3 and a fifth sample (1.26 mg/m^3) was approximately 95% of the NIOSH recommendation.[9]

e. Sulfuric Acid

Table VI presents the results of sampling for airborne sulfuric acid. Concentrations for three personal samples were all less than 20% of the current criteria of 1 mg/m^3 (NIOSH, OSHA, and ACGIH) as a TWA. Two area samples had concentrations of 0.08 and 1.25 mg/m^3.[9,10,11]

f. Crystalline Silica

Table VII presents the results of sampling for airborne crystalline silica using high-volume area samples. Concentrations for coal dust samples were 0.04 and 0.08 mg/m^3. Both samples were collected on the coal distribution floor. Concentrations for fly ash samples were 0.25 and 1.97 mg/m^3. Both samples were obtained in the fly ash silo. The percent silica in all four samples was consistent with the range being 1.8% for fly ash and 4.4 to 4.8% for coal dust. Three of the four samples are above the NIOSH recommended standard of 0.05 mg/m^3 for respirable quartz.

g. Inorganic Metals

Table VIII presents the results of sampling for airborne metals on area fly ash and coal dust samples. Three metals were of particular interest (As, Ni, and Pb), although the technique used (ICP-AES) actually evaluates each sample for a total of 28 metals. Concentrations for these three metals on both area coal dust samples were below the limit of detection.

Concentrations for all three metals were above the current NIOSH recommended standards for both fly ash samples. The concentrations for arsenic were 85 and 110 ug/m^3, nickel was at 107 and 110 ug/m^3, and lead was 351 and 390 ug/m^3.

All concentrations are at least seven times greater than the lowest current criteria. In the case of arsenic, the airborne concentrations were approximately 42 and 55 times the NIOSH recommended standard. Fortunately, no employees work in the fly ash silo for extended periods. Some members of the Dewatering Crew were observed entering the building for very short periods (1-2 minutes).

Two of the metals (Ni, As) are known to be occupational carcinogens.[11,14]

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. Percentages for crystalline silica and metals were consistent on the four area samples analyzed. The low concentrations of personal fly ash and coal dust samples make the likelihood of finding overexposures to a specific metal very remote. The highest percentage of the three metals on any sample was 0.4 for fly ash and <3 for coal dust. If the percentages are consistent on personal samples, the highest concentration for any specific metal on any fly ash or coal dust sample would be <1 ug/m^3.

h. Grab Samples

Table IX presents the results of grab sampling for oxides of nitrogen (NO_x) and sulfur dioxide (SO_2). The highest concentrations were obtained for SO_2 and ranged from nondetected to >25 parts SO_2 per one million parts of air (ppm). The highest concentrations were obtained on the third level of the scrubber and at a pipe sticking out of the ground near the base of the scrubber. The current NIOSH recommended standard for SO_2 is 0.5 ppm. Six of the 14 grab samples for SO_2 exceeded the NIOSH criteria. Concentrations for three NO_x samples ranged from a trace (not sufficient for quantitation) to 2 ppm. The tubes used for NO_x collect both NO plus NO_2 simultaneously. It is not possible to distinguish either material separately.

Certified direct-reading indicator tubes are certified to an accuracy of $\pm$35% at one-half the test gas concentration and $\pm$25% at 1, 2, and 5 times the test gas concentration. The test gas concentration usually corresponds to the OSHA PEL. In addition, some of the criteria for 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 for exposure to high levels of SO_2 on and near the scrubber.

i. Noise Measurements

Table X presents the results of noise monitoring using electronic passive dosimeters. Time-weighted average values determined over the sample time ranged from 80 to 91.8 dB for 17 personal sample, and two area samples had values of 81.5 and 91.3 dB (dosimeters sample for up to a maximum of 480 minutes). Seven of the 17 personal samples exceeded 85 dBA, which represents the criteria established by NIOSH and ACGIH. The OSHA PEL requires that continuing effective hearing conservation programs must be conducted if employee's TWA exposures equal or exceed 85 dBA.

j. Heat Stress

Table XI represents the results of heat stress measurements collected using a WBGT meter. WBGT values ranged from 70°F in the lunchroom to 94°F in the penthouse on Level 10 (near the steam drum). The criteria for heat stress are variable, ACGIH recommends WBGT values ranging from 77 to 86°F depending on the work-rest regiment and the work load (light, moderate, or heavy). NIOSH considers a hot environment as one in which the WBGT value exceeds 79°F.

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 potable water, work load, age, 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 the boiler.

k. General Observations

There were sources of SO_2 exposure located near the scrubber. One source was a leak in the bottom of a duct running into the S-2 scrubber. A second source was an open pipe located near the smoke stack. These and any other sources should be eliminated or reduced through maintenance/engineering controls as needed.

The lighting in the coal transfer house may need to be increased to ensure safe working conditions. A missing wall panel located on the upper floor of the coal transfer house should be replaced. A rope used as a barrier accross the opening is not a suitable safeguard against someone falling through the opening. There was a lot of visible airborne dust created when motor vehicles such as dump trucks moved throughout the yard area. This was probably due to the speed of the vehicle and the buildup of dust in the yard area and on roads leading to the ash pond.

The dewatering building was posted as a hearing protection area. Some employees were observed not wearing the required hearing protection.

During this survey, the dewatering crew were not observed spending long periods of time in the fly ash silo. Employees spent no more than 1 to 2 minutes in the silo. However, they reported that it was sometimes necessary to remain in the fly ash silo for longer periods of time while cleaning out fly ash blockages.

The eye wash stations and/or first aid kits were not clean. This may be due in part to the fine airborne dust in various areas of the plant. First-aid kits were all located inside protective outer cabinets. In general, dust had accumulated on the inside of the cabinets and in some instances inside the kits themselves.

There were a number of contract employees working on the scrubber. They were involved in sandblasting and spray painting activities. It was not feasible to add these individuals to the environmental characterization of the power plant workforce. Their activities could involve exposure to hazardous levels of airborne contaminants (i.e. label on sand used for sandblasting stated that it contained crystalline silica)

B. Medical

Of the total of 87 male workers in the power plant, 75 completed the respiratory questionnaire and had pulmonary function tests (86% participation rate). All the participants had chest X-rays. In addition, two workers had chest X-rays but did not complete the questionnaire. The characteristics of the 75 participants are as follows: 1) Age = 35.3 ± 9 years (mean ± S.D.); 2) duration of employment in the power plant = 3.7 ± 2 years (mean ± S.D.); 3) Smoking status: current smoker = 20 (27%); 4) smoking status: nonsmoker and ex-smoker = 55 (73%).

1) Questionnaire responses

The American Thoracic Society definition of chronic bronchitis is "A clinical disorder characterized by excessive mucous secretion in the bronchial tree.[21] 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 for chronic bronchitis, three participants (4%) had chronic bronchitis. They have worked at the power plant for a duration of three years, four years, and eight years respectively. None of them used a respirator at work. All three were cigarette smokers.

Respirator use: Of all the workers in the plant, only six workers (8%) said that they were required to wear a respirator at work. Ten participants (13%) nevertheless used a respirator while working. Forty-one workers (55%) have been trained in respiratory protection, but only six persons said that they had ever been fit-tested for a respirator.

2) Chest X-rays

Forty-eight (62%) of the chest X-rays reviewed showed no abnormalities. Chest X-rays with positive findings include 18 (24%) showing calcified foci consistent with old healed tuberculosis, histoplasmosis, or ther hilar calcification, with no evidence of active disease. The rest included two with an elevated left diaphragm, one with features of previous thoracic surgery, one with pleural thickening, and five with questionable lung markings who were referred to their personal physicians for comparison with previous X-ray films and follow-up. One of the X-rays showed a linear fibrotic strand in the left lower lung, and one showed features consistent with pneumoconiosis (category 't' opacities with category 1/1 profusion) in the upper and middle zones of both lung fields. Category 't' refers to medium-sized irregular opacities, and profusion 1/1 refers to opacities definitely present but few in number and not obscuring the lung markings.[22] No large opacities nor pleural abnormalities were noted. The worker concerned had a duration of employment in the power plant of less that three years, which is less than the mean duration of employment for all workers interviewed (3.7 + 2 years). He had no significant previous exposures to dusts and fumes, and had no respiratory symptoms. His pulmonary function test results were within normal limits.

3) Pulmonary function tests (PFTs)

Results of PFTs are considered abnormal 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 FEV_1/FVC% is less than 70%.[23]

Using these criteria, ten participants (13%) 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. The group with abnormal PFTs included eight with obstructive airways disease (with 5/8 smokers) and two with restrictive lung disease (both smokers).

TABLE 1

GROUP	NO.	AGE (years)	DURATION OF EMPLOYMENT IN POWER PLANT (years)	SMOKING HISTORY
ABNORMAL PFTs	10	39.6 ± 10.5 (Mean ± S.D.)	3.6 ± 1.9 (Mean ± S.D.)	70% smokers (7/10)
NORMAL PFTs	65	34.6 ± 8.6 (Mean ± S.D.)	3.9 ± 2.1 (Mean ± S.D.)	20% smokers (13/65)

The 10 workers with abnormal PFTs include two operators, four maintenance men, and four supervisors or other staff. Eight of the ten individuals with abnormal PFTs had a reduced FEV_1 and/or a reduced $FEV_1/FVC\%$ (indicative of an obstructive lung disorder). Two of the eight with features of airways obstruction gave a past history of asthma and/or bronchitis. These conditions can cause the PFT abnormalities seen. The differences between those with abnormal PFTs and those with normal PFTs with regards duration of employment in the plant and age are minimal (see Table 1). There were however significantly more smokers in those with abnormal PFTs (Chi-square = 8.67; $p < 0.01$). Of those with features of obstructive airways disease, five were cigarette smokers.

VII. DISCUSSION AND CONCLUSION

Seven of 17 personal noise samples were over the current criteria of 85 dBA. Many employees wore ear muffs or ear plugs. In some instances such as in the dewatering building, employees were observed not wearing ear protection, and some employees stated that they wore ear plugs in the "noisy" areas only.

The majority of airborne samples were below current environmental criteria. All personal samples for coal dust, fly ash, crystalline silica, nitrogen dioxide, nitric oxide, and sulfuric acid were below the lowest current criterion. Four personal sulfur dioxide samples were above the NIOSH recommended criterion. In addition, crystalline silica and the three subject metals (As, Ni, and Pb) were found at concentrations far exceeding the current criteria on area samples collected in the fly ash silo. If employees were to remain in the fly ash silo with concentrations as high as those found on two separate samples, they would be exceeding the corresponding TWA (8- or 10-hour) criterias very quickly. For example, the arsenic criteria (2 ug/m^3) would be exceeded in approximately 12 to 15 minutes, and the nickel criteria (15 ug/m^3) in approximately 1.5 hours.

The fly ash and coal dust concentrations measured during this survey are relatively low. However, an important consideration in evaluating these levels is the potential for crystalline silica and metals to be present at significant concentrations. The silica content was 1.8% for fly ash and 4.4 to 4.8% for coal dust. All 12 coal dust samples are below 0.35 mg/m^3 and all 10 fly ash samples are at or below 0.88 mg/m^3 and most (9) are below 0.63 mg/m^3. In addition, crystalline silica concentrations were below the lower laboratory limit of quantitation for all personal coal dust and fly ash samples. Assuming the percentage of crystalline silica remains constant, employees exposed to coal dust concentrations in excess of 1.0 mg/m^3 would be at or above the NIOSH recommended standard. Exposure to metals could present a serious hazard, but due to the relatively low percentages found on area samples (Table VIII) probably only in extremely high dust concentrations such as in the fly ash silo.

Medical

The group of workers surveyed are relatively young (mean age of 35 years) with a short mean duration of employment at the power plant (3.7 years). As such, it may be a little early to detect any significant chronic effect of dust and fume exposures. The results of the group evaluation did not indicate abnormalities that may be related to duration of employment in the power plant. Chest X-rays showed one individual with X-ray features in the upper and middle lung zones consistent with pneumoconiosis. The category 't' pattern of opacities seen on the X-ray can occur in asbestosis and in diffuse interstitial fibrosis.[22] However the abnormal appearances of asbestosis and diffuse interstitutial fibrosis usually predominate in the lower lung fields. Upper and middle lung zones are more often the areas involved in silicosis and coal pneumoconiosis.[22] In these conditions though, the commonly encountered opacities are usually of category 'p', 'q', or 'r' (i.e. pinpoint, micronodular, or nodular) and not category 't' (i.e. irregular, small opacities). The environmental monitoring did not indicate any excessive exposure to coal dust or silica. There was also no indication that silica or coal dust exposure was any different in the short duration that the worker concerned was employed at the power plant. In the absence of any other cases of similiar X-ray abnormalities in the 75 workers surveyed, it is uncertain why this individual with a short duration of employment in the plant, and no previous history of exposure to asbestos or other fibrogenic dusts, should have the X-ray abnormalities seen. Clinical assessment and follow-up was recommended to further evaluate this.

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.[24-29]

VIII. RECOMMENDATIONS

1. Doors on the fly ash silo should be kept closed to help reduce fugitive emissions.

2. Employees entering the fly ash silo while it is operating should be equipped with full-facepiece respirators that have high-efficiency cartridges, and full-body protective clothing such as disposable coveralls. In addition, time spent by employees in the fly ash silo should be kept to a minimum.

3. Management should conduct a more extensive analysis of airborne crystalline silica and metals when the fly ash silo is operating. The results reported herein were collected on one day. There may be considerable variation in airborne concentrations on different days.

4. Management should develop a written respiratory protection program as outlined in the NIOSH Guide to Industrial Respiratory Protection.[28] In addition, the selection of available respirators should be increased to include respirators suitable for protection against sulfur dioxide. These respirators should be issued to employees working on the scrubber.

5. Sources of SO_2 exposure should be eliminated or reduced through maintenance and/or engineering controls.

6. Employee training programs should be initiated, by management, to emphasize the health problems associated with chemical exposures (boiler gases, particulates, crystalline silica, etc.) in coal-fired power plants.

7. 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.

8. The missing wall panel on the top floor of the transfer house should be replaced. The rope currently in place is not sufficient to ensure the safety of employees working in the area.

9. The lighting in the coal transfer house should be evaluated.

10. Wearing of hearing protection in areas where it is required should be better enforced.

11. A heat stress survey should be conducted to evaluate the potential hazard for employees working in hot areas, such as near the steam drum on Level 10.

12. Management should ensure that all employers including contract employees use proper techniques and personal protective equipment while working at this facility.

13. A program for pre-placement medical examinations and periodic pulmonary function tests should be established.

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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. Southwest Power Station, 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

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

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
Sulfuric Acid	1.5	Cellulose Ester Membrane Filter	P&CAM No. 268	1	1	1
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]

(continued)

TABLE I (continued)

Chemical or Physical Agent	Flow Rate (LPM)	Sampling Method	Analytical Method	Environmental Criteria, mg/m³ (unless otherwise noted)		
				OSHA PEL	NIOSH Recommendation	ACGIH TLV
Quartz*	**	PVC Filter Loaded Into 10 mm Nylon Cyclone	P&CAM No. 259	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$	0.05	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$
Metals	1.5	AA Filter	ICP - AES	--------- ---Variable------------		
Boiler Gases (CO, NO_x, SO_2)	-	Certified Direct Reading Indicator Tubes	Direct Reading, Visual	-------Used TWA Criteria------		
Noise	-	Electronic Dosimeters	Printout, Visual	90 dBA***	85 dBA	85 dBA
Heat Stress	-	WBGT Meter	Visual, Direct Reading	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 For Coal Dust and Crystalline Silica
Personal Samples

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Job/Location	Sample Time	Volume (Liters)	Date	Concentration (mg/m^3) Dust	Quartz*
Coal Crew - Operating Front End Loader In Coal Yard	0736-1552	992	7-26-82	0.23	LLQ
Coal Crew - Operating Front End Loader In Coal Yard	0734-1558	1008	7-27-82	0.13	--
Coal Crew - Coal Distribution Floor	0811-1554	926	7-27-82	0.31	--
Coal Crew - Coal Distribution Floor	0741-1544	966	7-27-82	0.32	LLQ
Maintenance - Working On Coal Distribution Floor	0744-1541	954	7-28-82	0.13	--
Operator - Heater Floor	0800-1441	802	7-27-82	0.30	--
Operator - Pit	0729-1507	916	7-28-82	0.16	--
Operator - Pit	0733-1449	872	7-27-82	0.18	--
Maintenance - Working on Exhaust Fan No. 3	0739-1540	962	7-26-82	0.22	LLQ
Maintenance - Working on Conveyor No. 4	0741-1540	958	7-26-82	0.19	--
Janitor - Sweeping In Lunch Room, Shop, 2nd Floor	0747-1540	966	7-26-82	0.08	--

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

Environmental Criteria (mg/m^3): Dust = OSHA = 2.4** (based on an 8.0-hour TWA)
NIOSH = none
ACGIH = 2** (based on an 8.0-hour TWA)

Quart = $\frac{10\ mg/m^3}{\%\ SiO_2+2}$ (OSHA,ACGIH)

0.05 (NIOSH)

** Less than 5% quartz

TABLE III

Airborne Concentrations For Fly Ash and Crystalline Silica
Personal Samples

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Job/Location	Sample Time	Volume (Liters)	Date	Concentration (mg/m^3) Dust	Quarts*
Janitor - Part Of Shift In Dewater Building	0736-1552	836	7-26	0.17	
Janitor - Part Of Shift In Dewater Building	0734-1548	839	7-29	0.27	LLQ
Maintenance - Dewater Building Crew	0804-1546	785	7-26	0.46	LLQ
Maintenance - Dewater Building Crew	0806-1545	780	7-26	0.29	
Maintenance - Dewater Building Crew	0811-1545	772	7-26	0.30	
Maintenance - Dewater Building Crew	0733-1550	845	7-28	0.54	LLQ
Maintenance - Dewater Building Crew	0813-1549	775	7-28	0.88	LLQ
Maintenance - Dewater Building Crew	0736-1548	836	7-28	0.62	LLQ
Maintenance - Dewater Building Crew	0737-1545	829	7-29	0.27	
Maintenance - Dewater Building Crew	0740-1546	826	7-29	0.55	

NOTE: Fly ash was not being run in the Dewater Building on July 26
LLQ = Below the lower laboratory limit of quantitation (0.03 mg)
Sensitivity of analytical balance = 0.01 mg.

Environmental Criteria (mg/m^3): Dust = OSHA = 5** (based on an 8-hour TWA)
NIOSH = none

Quart = OSHA = ACGIH = $\frac{10\ mg/m^3}{\%\ SiO_2+2}$

NIOSH = 0.05 for up to a 10-hour TWA

* Quarts was the only polymorph of crystalline silica found on any sample
** Nuisance particulate

TABLE IV

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

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 29, 1982

Job/Location	Sample Time	Volume (Liters)	Type Of Sample	Concentration mg/m^3 NO	Concentration mg/m^3 NO_2
Scrubber - Maintenance*	1200-1548	5.4	P	LLD	LLD
Scrubber - Operator**	0732-1413	7.4	P	0.41	LLD
Scrubber - Top Level	0850-1555	9.9	A	LLD	LLD
Scrubber - Level 3	0842-1602	9.2	A	2.05	LLD

* Sample for first portion of shift invalid, hose came loose from pump for unknown period.
** Hose came loose from pump for 10-15 minute period during morning.
P = Personal
A = Area
LLD = Below the laboratory limit of detection (NO = 2 ug/sample, NO_2 = 3 ug/sample).

Environmental Criteria (mg/m^3): Nitric Oxide = OSHA - 30 (based on an 8-hour TWA)
NIOSH - 30 (based on an 8-hour TWA)
Nitrogen Dioxide = OSHA - 9 (ceiling value that should not be exceeded)
NIOSH - 1.8 (ceiling value which should not be exceeded during any 15-minute period)

TABLE V

Airborne Concentrations For Sulfur Dioxide

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Job/Location	Sample Time	Volume (Liters)	Date	Type Of Sample	Concentration mg/m^3
Scrubber - Operator	0739-1532	710	7-28-82	P	0.05
Scrubber - Maintenance	0740-1548	732	7-28-82	P	0.13
Scrubber - Maintenance	0740-1552	738	7-27-82	P	1.26
Scrubber - Maintenance	0743-1554	737	7-27-82	P	1.76
Scrubber - Maintenance	0743-1542	719	7-29-82	P	4.87
Scrubber - Maintenance	0744-1541	716	7-29-82	P	1.82
Scrubber - Auxillary Pit Operator	0738-1505	671	7-27-82	P	0.72
Scrubber - Electrician	0751-1553	723	7-29-82	P	2.35
Scrubber - Top Level	0850-1554	535	7-29-82	A	0.93
Scrubber - 3rd Level	0925-1602	660	7-29-82	A	13.30

P = Personal
A = Area

Environmental Criteria (mg/m^3): OSHA = 13 (based on an 8-hour TWA)
NIOSH = 1.3 (for up to a 10-hour TWA)

TABLE VI

Airborne Concentrations For Sulfuric Acid

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 29, 1982

Job/Location	Sample Time	Volume (Liters)	Type Of Sample	Concentration mg/m^3
Scrubber - Maintenance	0743-1542	719	P	0.18
Scrubber - Maintenance	0746-1541	713	P	0.13
Scrubber - Operator	1035-1533*	448	P	0.13
Scrubber - Top Level	0850-1554	636	A	0.08
Scrubber - Level 3	0842-1602	660	A	1.25

* Sample for first portion of shift invalid, hose came off pump for unknown period.

Environmental Criteria (mg/m^3): 1 (NIOSH, OSHA, ACGIH) as a TWA

TABLE VII

Results Of Area Sampling For Respirable Crystalline Silica
Samples Collected With High-Volume Cyclone

Southwest Power Station
City Utilties
Springfield, Missouri
HETA 82-093

July 1982

Location	Type Of Sample	Date	Sample Time	Volume (Liters)	% Crystalline Silica	Concentration (mg/m^3)
Fly Ash Silo	Fly Ash	7-28-82	1432-1451	171	1.8	0.25
Fly Ash Silo	Fly Ash	7-28-82	1013-1230	1233	1.8	1.97
Coal Distribution Floor, End Of Middle Conveyor	Coal Dust	7-29-82	0838-1614	4058	4.8	0.80
Coal Distribution Floor, 10" Above Conveyor Near East Wall, 4" Above Exhaust Hood	Coal Dust	7-27-82	1005-1622	3393	4.4	0.40

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

NIOSH = 0.05 mg respirable SiO_2/m^3 (for up to a 10.0-hour TWA)

* Quartz was the only polymorph of crystalline silica present.

TABLE VIII

Airborne Concentrations For Metals
Area Samples

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Location	Sample Time	Volume (Liters)	Date	Metal	% Of Total Weight On Filter	Concentration (ug/m^3)
Fly Ash Silo - Sample Of Fly Ash	1232-1239	10	7-28	As	.1	110
				Ni	.1	110
				Pb	.4	390
Fly Ash Silo - Sample Of Fly Ash	1016-1230	201	7-28	As	.08	85
				Ni	.11	107
				Pb	.35	351
Coal Distribution Floor - Coal Dust Sample End Of Middle Conveyor	1012-1638	579	7-27	As	<3	LLD
				Ni	<3	LLD
				Pb	<3	LLD
Coal Distribution Floor - Coal Dust Sample End Of Middle Conveyor	0848-1614	669	7-29	As	<2	LLD
				Ni	<2	LLD
				Pb	<2	LLD

LLD = Below the laboratory limit of detection.

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

TABLE IX

Airborne Concentrations Of Boiler Gases
Measured Using Certified Direct-Reading Indicator Tubes

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Location	Sample Time	Date	Contaminant	Concentration (ppm)
Fly Ash Silo - Ground Level	1442	7-28-82	SO_2	ND
Scrubber - 3rd Level, 4' From Instrument Shed	1528	7-28-82	SO_2	ND
Scrubber - Top Level	1010	7-29-82	SO_2	ND
	1233	7-29-82	SO_2	Trace
Scrubber - Top Level	1014	7-29-82	NO_x	Trace
Scrubber - 3rd Level. On Right Side Of Platform (As You Face Precipitator) On Side Of Platform Closest To Precipitator	1538	7-28-82	SO_2	25
	1320	7-29-82	SO_2	ND
	1606	7-29-82	SO_2	15
	1612	7-29-82	NO_x	2
	1542	7-28-82	NO_x	0.8
Scrubber - On Platform Below Duct That Runs Into The S-2 Scrubber, One Nearest The Dewater Building	1545	7-29-82	SO_2	2.5
2' From Pipe At Base of Smokestack. Pipe Located Near Scrubber Building and Red Silo	1200	7-26-82	SO_2	5
8' From Pipe	1205	7-26-82	SO_2	ND

(continued)

TABLE IX (continued)

Location	Sample Time	Date	Contaminant	Concentration (ppm)
12' From Pipe	1427	7-26-82	SO_2	ND
12" From Pipe	1435	7-26-82	SO_2	>25
Ground Level, Between Legs Of Scrubber	1440	7-26-82	SO_2	ND
Top Of Precipitator West Side	1457	7-26-82	SO_2	5

* These detector tubes collect both NO and NO_2 and cannot distinguish the amount of either material individually.

Environmental Criteria (ppm): SO_2 = OSHA - 5 (based on an 8-hour TWA
NIOSH - 0.5 (based on an 8-hour TWA)

$NO_x(NO+NO_2)$* = OSHA = NO - 25 (based on an 8-hour TWA)
NO_2 - 5 (ceiling value, not to be exceeded)
NIOSH = NO - 25 (based on an 8-hour TWA)
NO_2 - 1 (ceiling value, not to be exceeded during any 15-minute period)

TABLE X

Results Of Noise Measurements
Personal And Area Samples

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-093

July 1982

Job/Location	Sample Time	Date	Range Of Hourly dB Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Maintenance - Working On Exhaust Fan No. 3	0739-1542	7-26-82	74.0-85.8	1	0	80.6	
Maintenance - Working On Conveyor No. 4	0741-1542	7-26-82	74.4-87.1	1	0	80	
Maintenance - Sweeping Turbine Floor And Burner Floor	0748-1542	7-26-82	68.4-85.9	2	0	81.2	
Maintenance - Sweeping 2nd Floor, Shop, Lunch Room	0747-1550	7-26-82	66.5-86.7	1	0	81.4	
Maintenance - Sweeping	0732-1549	7-29-82	76.0-93.3	2	2	86	2nd Highest Hourly TWA Was 92.4 dBA, 3rd Highest Was 84.8 dBA.
Maintenance - Dewatering Building	0804-1547	7-26-82	82.4-92.4	6	1	88	
Maintenance - Dewatering Building	0811-1547	7-26-82	80.6-95.3	6	5	91.8	

(continued)

TABLE X (continued)

Job/Location	Sample Time	Date	Range Of Hourly dB Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Maintenance - Dewatering Building	0808-1546	7-26-82	80.5-92.3	5	2	87.9	
Maintenance - Dewatering Building	0736-1545	7-29-82	82.6-89.1	6	0	86.4	2nd Highest Hourly TWA Was 87.9 dBA, 3rd Highest Was 86.9 dBA.
Maintenance - Scrubber	0743-1558	7-28-82	78.5-90.9	1	1	84.2	2nd Highest TWA Was 85.0 dBA.
Maintenance - Scrubber	0854-1551	7-28-82	77.3-86.3	1	0	81.8	
Coal Crew - D7 Operator Coal Yard	0736-1553	7-26-82	83.3-91.3	6	2	87.7	
Operator - Heater Floor	0800-1445	7-27-82	76.2-84.8	0	0	81.2	7-hour sample
Operator - Heater Floor	0731-1518	7-28-82	74.7-90.2	2	1	83.8	
Operator - Pit	0733-1449	7-27-82	81.2-94.4	6	3	89.1	
Operator - Pit	0729-1508	7-28-82	72.3-87.7	6	0	84.6	
Operator - Scrubber	0739-1531	7-28-82	76.2-84.3	0	0	81.3	

(continued)

TABLE X (continued)

Job/Location	Sample Time	Date	Range Of Hourly dB Levels	Number Of Hours Exceeding 85 dBA	Number Of Hours Exceeding 90 dBA	TWA (dBA)	Comments
Dewater Building Sample On Side Of Slurry Conveyor	0920-1603	7-29-82	83.2-95.0	6	3	91.3	Area sample, 7-Hour Sample, 6 Hourly TWA's Exceeded 88 dBA.
Scrubber - Top Level	0850-1554	7-29-82	77.2-85.2	1	0	81.5	Area sample

Environmental Criteria: 85 dBA (NIOSH, ACGIH)
90 dBA (OSHA, but if employees are exposed to over 85 dBA as a TWA, the company must have a hearing conservation program)

TABLE XI

Heat Stress Measurement
Collected Using WBGT Meter

Southwest Power Station
City Utilities
Springfield, Missouri
HETA 82-0[illegible]

July, 1982

Location	Time	Date	WBGT (°F)
Auxillary Storage Room - On Top Of Table	0855	7-27-82	72
Lunchroom - On Table	0857	7-27-82	70
	1146	7-26-82	75
	1500	7-26-82	73
Hopper Pit - Under Coal Pile	1157	7-26-82	81
	1452	7-26-82	79
Basement - Meter Setting On Side Piece Of 1-C Primary Air Fan	0934	7-27-82	92
	1133	7-26-82	92
	1443	7-26-82	93
Control Room - On Table Located Behind Boiler Control Board	0943	7-27-82	74
Coal Distribution Floor - Meter Setting On Top Of Housing, End Of Middle Conveyor	0951	7-27-82	80
	1122	7-26-82	87
	1435	7-26-82	89
Level 10, On Platform At End Of Steam Drum	1005	7-27-82	91
	1105	7-26-82	94
	1427	7-26-82	92
Level 10, 10' From Elevator Door At Aisle Beside Penthouse	1055	7-26-82	82
	1420	7-26-82	82
Dewatering Building	1021	7-27-82	81

Environmental Criteria: WBGT readings are only one component of a heat stress evaluation. Other factors include, age, sex, work regiment, work load, and availability of potable water.