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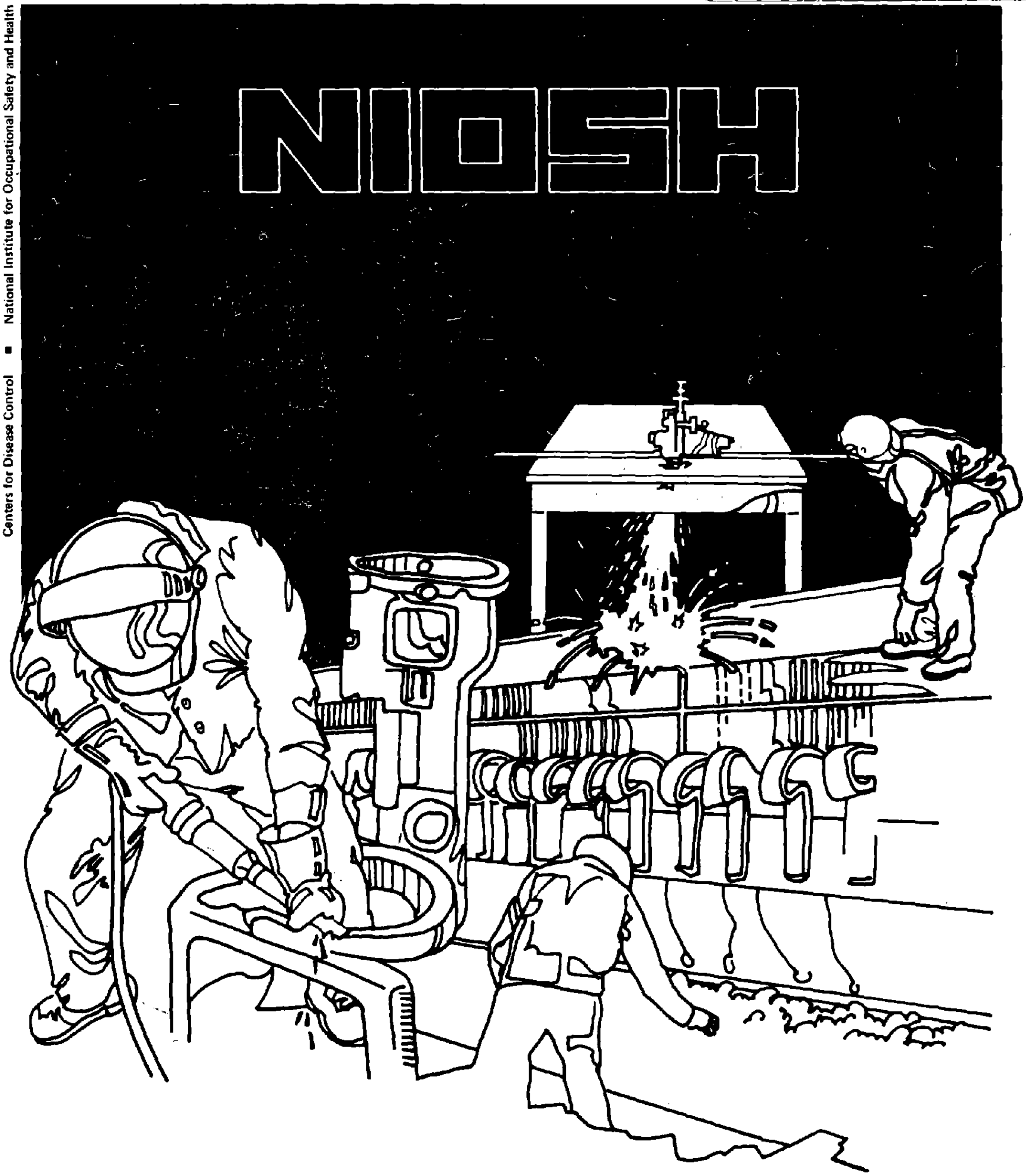

Health Hazard Evaluation Report

HHE 80-199-948
AMERICAN STANDARD, INC.
LOUISVILLE, KENTUCKY

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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American Standard, Inc.
Louisville, Kentucky

NIOSH Investigators:
Andrew D. Lucas, IH
John Horan, MD

I. SUMMARY

On July 8, 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request from employees for a health hazard evaluation at American Standard Incorporated in Louisville, Kentucky. The requestor was concerned about the enameling department where employees coat bathtubs and sinks with enameling powder, then bake the enamel in furnaces. Symptoms reported by employees in the enameling department included nausea, vomiting, chills, and difficulties in eating. The requestor was also concerned about a report that the man-coolers used in the enameling department had been associated with outbreaks of Legionnaires Disease. NIOSH was asked to investigate this report and the symptoms reported by the employees.

NIOSH investigators conducted an initial survey on July 14-16, 1980. A follow-up survey was conducted on September 22-24, 1980.

Personal and general area air measurements were made for metal fumes, respirable dust and silica, carbon monoxide and heat stress. Medical questionnaires were administered and blood samples for lead analysis were obtained.

Analyses of air samples indicated that concentrations of lead in the breathing zone of enamelers and heaters ranged from 26 to 162 ug/M^3, with a mean concentration of 77 ug/M^3. The calculated 8-hr TWA ranged from 20 to 122 ug/M^3 with a mean of 58 ug/M^3 of inorganic lead. The NIOSH and OSHA recommended standard for inorganic lead is 50 ug/M^3 as an 8-hour TWA. Heat stress measurements with a wet bulb globe thermometer (WBGT) ranged from 86^{o}F to 102^{o}F WBGT. The NIOSH recommended criteria for occupational exposure to hot environments requires that certain work practices be initiated when the exposure is continuous for one hour and the TWA WBGT exceeds 79 F for men or 76 F for women. Carbon monoxide and silica levels were not found in toxic concentrations.

The clinical presentation of employee symptoms was not typical of legionellosis; and there is no evidence that any particular type of air-conditioning system is more likely than others to disseminate Legionella pneumophila bacteria and contribute to outbreaks of legionellosis. Eight enamelers had blood lead levels greater than 39 ug/100 ml (highest - 48), but they were not associated with a statistically significant difference in physical signs or symptoms. The 116 other employees all had blood lead levels below 40 ug/100 ml (the upper limit of "normal"). The clinical presentation of symptoms suggests that the principal cause of employee symptoms is the extremely hot working environment.

There is no evidence to suggest that legionellosis is a problem in the enameling department or that employees are at increased risk of acquiring the disease due to occupational exposures. Environmental and biological sampling indicate that elevated lead levels in the department have contributed to increased blood lead in some long-term enamelers. Environmental measurements and personal interviews indicate that heat stress is a significant problem and may be the major cause of symptoms among employees in the department. Recommendations for control and monitoring of excessive lead levels and for amelioration of symptoms due to heat stress are contained in Section VII of this report.

KEYWORDS: SIC 3479, enameling, foundry, lead, heat stress, "Legionnaires Disease", legionellosis

II. INTRODUCTION

On July 8, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from an authorized representative of employees for a health hazard evaluation of American Standard Incorporated in Louisville, Kentucky. The area of concern was the enameling department where employees coat bathtubs and sinks with enameling powder, then bake the enamel in furnaces. Symptoms reported by employees in the enameling department included nausea, vomiting, chills, and difficulties in eating.

The requestor was concerned about a report that the man-coolers used in the enameling department had been associated with outbreaks of Legionnaire's Disease. NIOSH was asked to investigate this report and the symptoms reported by the employees.

NIOSH industrial hygienists and a medical officer met with management and union representatives for the opening and closing conferences, walk-through survey and environmental sampling on July 14, 15, and 16, 1980.

A follow-up survey consisting of environmental sampling and medical testing was conducted on September 22, 23, and 24, 1980. Interim Report #1 was issued in September, 1980; Interim Report #2 was issued in April 1981.

III. BACKGROUND

In the enameling department at American Standard Incorporated workers apply enamel to cast iron bathtubs and small wares (sinks) which provides an aesthetic, hygienic and anti-corrosive coating.

The enameling department has 24 furnaces that operate at 1800°F. Furnaces 42-49 are designed for small wares; furnaces 50-65 are designed to accommodate bathtubs. Each furnace has two sides: the left hand side is utilized for "burn in"; the right hand side is the "working side" and two metal doors on wheels move laterally, providing access to each side of the furnace. Two people work at each furnace, the heater and the enameler. The process begins in the sludge booth where the bare cast iron pieces are sprayed with a wet base coat. This is dried in an oven at 100°-110°F for 8-9 minutes, and the bathtubs and sinks are then transported to the furnace area by a conveyor system.

The pieces for enameling are prepared by covering imperfections in the base coat with "mud", then heated for nine minutes and placed in the "burn in" side of the furnace. Following this, they are placed on a hydraulic pivoting system at the enameling station where the operator (enameler) can rotate or tilt the pieces by means of foot controls. The enameler applies the enameling powder using a vibrating sieve which enables uniform distribution of the powder. The heater usually assists in applying the first coat to the bathtub, after which the piece is returned to the working side of the furnace until the enamel melts. The enameler then applies second and third coats in the same manner. After the third coat melts, the pieces are removed from the furnace, trimmed, placed on carts, and rolled to a cooling area. An enameling team averages 25 regular bathtubs in a 6-hour shift.

Each enameling station has a man-cooler next to it. Man-coolers are supplied to provide comfort ventilation at the enameling stations. The cooling towers for the man-coolers are located outside the building. Each cooling tower has a bank of water sprinklers which are designed to spray water. As the water drops in the tower, it evaporates and cools the air around it. This cooled, humidified air is then blown through a ventilation system with outlets near the enameling stations. The duct outlets are covered with filters to prevent foreign objects from being blown onto the pieces which are being enameled.

All enamelers and heaters in the bathtub area work 6-hour shifts. Heaters in the small ware (sinks) area work 8-hour shifts.

IV. EVALUATION DESIGN AND METHODS

Information concerning process description, engineering controls, composition of the enameling powder, personal protective equipment and clothing, work practices, training programs and monitoring for the areas in question were obtained from management. Employee interviews focused on the job description, work practices, training programs, and associated health problems.

A. Environmental Sampling

Twenty personal breathing zone air samples were taken to determine the concentration of metals in the breathing zone of the enamelers. One area sample was also obtained. The samples were collected on mixed cellulose ester membrane filters (0.8 um pore size) using portable pumps at a flow rate of 1.5 liters per minute (lpm). These samples were analyzed by atomic absorption spectroscopy according to NIOSH Method P & CAM 173 for lead, chromium, iron, antimony, cobalt, copper and titanium. They were also analyzed for lithium by atomic emission spectroscopy. Eleven personal air samples were taken to determine the concentration of respirable silica in the breathing zone of the enamelers. The samples were collected on pre-weighed FWSB filters equipped with nylon cyclones using portable pumps set at a flow rate of 1.7 lpm. These samples were analyzed for respirable silica by X-ray diffraction according to NIOSH Method P & CAM 259. In addition, the samples were analyzed gravimetrically to determine the concentration of respirable dust.

Air sampling for carbon monoxide was performed by the use of a direct reading Ecolyzer.

Factors contributing to heat stress were measured with the Reuter-Stokes RSS-211D and RSS-211A (Wibget), a portable electronic instrument which is capable of determining dry bulb temperature (DB), natural wet bulb temperature (WB) and the 6" Vernon Globe temperature (GB). Environmental measurements were also taken with a standard heat stress setup composed of a dry bulb thermometer, wet bulb thermometer and 6" globe thermometer. The Wet Bulb Globe Temperature (WBGT) index used as the parameter in determining the environmental conditions for implementation of work practices is calculated by the following equation:

$$WBGT = 0.7\ WB + 0.3\ GT$$

The time-weighted average (TWA) WBGT is determined by the following equation:

$$\text{Av. WBGT} = \frac{(WBGT_1) \times (t_1) + (WBGT_2) \times (t_2) + (WBGT_n) \times (t_n)}{(t_1) + (t_2) + \text{------------------} (t_n)}$$

where $WBGT_1$, $WBGT_2$, $WBGT_n$, are calculated values of WBGT for the various work and rest areas occupied during total time period; t_1, t_2, t_n are the elapsed times in minutes spent in the corresponding areas which are determined by a time study.

Air flow patterns were determined by igniting smoke candles and observing the movement of the smoke. Ventilation measurements were obtained with a Kurtz air flow meter.

B. Medical Evaluation Methods

The medical investigation addressed three concerns:

1) The unconfirmed report that the man-coolers used in the enameling department were the same type as those used in the Philadelphia hotel where an outbreak of "Legionnaires' Disease" (legionellosis) had occurred in 1976 and the subsequent concern that symptoms of enameling department employees were due to legionellosis;

2) The possiblity that elevated environmental lead levels could be causing lead toxicity in the employees;

3) The possibility that the hot work environment could be causing heat stress problems in the employees.

To address the problem of possible legionellosis, the NIOSH physician contacted the Special Pathogens Branch of the Bacterial Diseases Division at the Centers for Disease Control in Atlanta, Georgia to obtain information about any potential association between outbreaks of legionellosis and specific types of air-conditioning or cooling devices. He also contacted the Kentucky State Department for Human Resources to obtain information about occurrence of the infection in Louisville and in the state of Kentucky. During the first site visit to the American Standard plant in July 1980, he conducted informal non-directed interviews of employees in the enameling department to determine whether they were experiencing symptoms that suggested an outbreak of legionellosis.

The problems of possible lead toxicity and heat stress were addressed during the second NIOSH site visit in September 1980. On September 22-24, NIOSH medical personnel performed physical examinations, conducted questionnaire interviews, and obtained blood samples from 122 employees in the enameling department.

The physical examinations performed to evaluate possible lead toxicity included observation for tremor, testing the biceps deep tendon reflexes, and quantifying the strength of wrist extensor and plantar extensor muscle groups.

The questionnaires were administered by a NIOSH interviewer. They included directed questions about symptoms that might be related to either heat stress or lead toxicity, directed questions about washing before eating, drinking or smoking at work, directed and non-directed questions about possible sources of lead exposure outside the workplace, and demographic questions concerning age, race, sex, job category, and duration of employment.

Blood samples were obtained for hematocrit and blood lead levels. Hematocrit was determined by the microcentrifuge technique. Analysis for blood lead levels was performed by the laboratories of Environmental Science Associates, Inc., using anodic stripping voltammetry.

V. EVALUATION CRITERIA

The sources of criteria used to assess workroom concentrations of air contaminants were: (1) Recommended Threshold Limit Values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1980; (2) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), November, 1978; (3) NIOSH criteria for recommended standards for hot environments, 1972; and (4) NIOSH Recommendations for Occupational Health Standards. These standards/criteria are summarized in Table I.

Lead Toxicity

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from lead dust contamination on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood-forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or neurological disorder. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 micrograms/100 milliliters (ug/100 ml) of whole blood are considered to be normal levels which may result from daily non-occupational exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100 ml. Lead levels between 40-60 ug/100 ml in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/100 ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100 ml are considered dangerous and often require hospitalization and medical treatment.

The applicable OSHA standard for exposure to airborne inorganic lead is 50 ug/M^3. An action level of 30 ug/M^3 has been set as the concentration at which an environmental monitoring and medical surveillance program must be instituted (see Recommendations, page 15). The proposed OSHA regulation on lead absorption will eventually require blood lead levels to average less than 50 ug/100 ml.

Heat

Environmental heat (or resistance to removal of metabolic heat) leads to well-documented reactions in human beings: increased cardiovascular and respiratory activity, increased body heat temperature, and sweating. If the heat load is excessive or prolonged, then frank heat disorders result. Other clinical entities from heat effects are heat syncope, heat rash, and heat fatigue.

The three major clinical disorders resulting from excessive heat stress on susceptible workers are: (1) heat stroke, from failure of the thermoregulatory center; (2) heat exhaustion, from depletion of body water and/or salt; (3) heat cramps, from salt loss and dilution of tissue fluid.

A. Heat Stroke

Heat stroke (the term sunstroke is obsolete) is the most serious of the heat disorders, and must be treated as a medical emergency.

The three cardinal signs of heat stroke are: (1) hot, dry skin: red, mottled, or cyanotic; (2) hyperthermia: a body temperature usually of 106^{o} F. or higher and rising; (3) brain disorders: mental confusion, that progress to delirium, loss of consciousness, convulsions, and coma.

Heat stroke is uniformly fatal unless treated promptly and adequately. Treatment consists of rapid cooling of the body preferably by immersion in chilled water accompanied by vigorous massage of the skin or by wrapping the unclothed body of the patient in wet sheets and fanning with cool dry air. First aid treatment of the victim should always be initiated immediately and not delayed while waiting for transportation to a medical facility. The victim should be moved to a cool area, soaked with cold water and fanned to increase convective cooling while awaiting transportation to an appropriate medical facility.

B. Heat Exhaustion

The symptoms and signs of heat exhaustion are chiefly weakness or extreme fatigue, giddiness, nausea, and headache in persons who may be working in the heat or resting between bouts of work. The skin may be clammy and moist, indicating that sweating remains active. The complexion may be pale, muddy, or flushed. Oral temperature may be normal or low, but rectal temperature is usually elevated (99.5^{o}-101^{o} F.). The victim may faint on rising from the sitting position and have a weak, thready pulse and low blood pressure. The underlying disorder in heat exhaustion is depletion of the volume of body fluids and salts, and follows when intake of water or salt or both is insufficient to replenish excessive losses. Treatment is based on correcting volume depletion, which is the underlying disorder common to both types of heat exhaustion. Many mild cases recover spontaneously following rest in a cool area and taking water. The severe case of heat exhaustion should be removed to a treatment facility. Volume depletion is corrected by administering salted fluids by mouth.

C. Heat Cramps

Heat cramps is a disorder characterized by painful spasms of the skeletal muscles of workers who sweat profusely in the heat and drink large volumes of water without replacing salt losses. The muscles involved may be in the arms, legs, or abdomen, those used in performing the job being chiefly affected. Onset may be during or after work hours. Treatment is based on replacing the salt losses by drinking salted liquids.

Heat syncope (or faintness) may be observed in unacclimatized workers standing erect and immobile in the heat. Pooling of blood in dilated vessels of the skin and lower part of the body results in inadequate venous return to the heart and may lead to fainting. Intermittant movement to assist venous return helps prevent this occurrence.

Heat rash, which is commonly known as prickly heat, follows the absorption of water by keratin and plugs the orifices of sweat ducts. This leads to inflammation of the glands, and is manifested as tiny red, raised vesicles in the affected area. It results from unrelieved exposure to humid heat with the skin being continuously wet with unevaporated sweat. It is important because if extensive, or complicated by infection, discomfort from heat rash may not only interfere with restful sleep and impair efficient performance, but can result in temporary total disability. Heat rash is prevented by providing cooled recovery or sleeping quarters to allow the skin to dry between heat exposures.

VI. RESULTS AND DISCUSSION

A. Environmental

Table II depicts the results of air sampling for metals on July 14 and 15, 1980. Fifteen of the twenty personal samples for metal exposure were found to have lead concentrations above 50 ug/M^3 with a maximum of 162 ug/M^3. The mean (average) concentration for these airborne measurements was 77 ug/M^3. The OSHA airborne lead standard is 50 ug/M^3 based on an eight-hour time weighted average (TWA). Since enamelers work 6-hr shifts, the TWA may be calculated by adding 120 minutes of non-exposure to lead. This results in 12 of 20 personal lead exposures which are above 50 ug/M^3 for an 8-hr TWA. The highest 8-hr TWA is 122 ug/M^3 with a mean concentration of 59 ug/M^3. Chromium, iron and lithium concentrations were well within environmental standards/criteria. Antimony, copper, cobalt and titanium were below detectable levels.

Table III indicates the results of air sampling for respirable dust and silica on July 14 and 15. The results for quartz and cristobalite were below 0.03 mg per filter, which is the lower limit of quantitation, and well within existing standards/criteria. The highest concentration of respirable nuisance dust was 2.45 mg/M^3. The OSHA standard is 5 mg/M^3.

A carbon monoxide survey of the area on July 15, 1980, detected levels at less than 3 parts per million parts of air (ppm). The NIOSH recommended criteria for carbon monoxide is 35 ppm.

A heat monitoring survey was performed on July 14 and 15 and September 23 and 24, 1980. On July 14 and 15, outdoor temperatures rose to over 100°F. September 23 and 24 were mild days, with outdoor temperatures no higher than the mid-60's (°F). Table IV indicates spot measurements of WBGT on July 14 and 15. Nearly every area, with the exception of the foreman's air-conditioned office, qualifies as an area where NIOSH recommends compliance with the work practice standard described in criteria for a recommended standard...Occupational Exposure to Hot Environments (see Appendix 1). This standard states that ... "When exposure of an employee is continuous for one hour or intermittent for a period of two hours and the time-weighted average WGBT exceeds 79° for men or 76°F for women, then any one or combination of the following practices shall be initiated to insure that the employee's body care temperature does not exceed 100.4°F:". An area where environmental conditions are 86°F WBGT or above should be posted, warning that it is a heat stress area.

During the third shift on July 15, the aisleway area, which was used as a spell or rest area by the employees, registered a WBGT of 95°F. Temperatures at the enameling station in the chest region of the enameler ranged up to 125°F WBGT. A face measurement of one of the man-coolers indicated a WBGT of 84°F.

On September 23 and 24, further heat measurements were taken with the Reuter-Stokes and standard setups. The heat monitoring instruments were placed in the areas where work is performed, that is, the enameling station, the enamelers' workbench, and the aisleway. The amount of time spent is each area was recorded. Observations on September 23 of the enamelers at furnaces 56 and 59 on the 12:00 P.M. to 6:00 P.M. shift indicated that they spent 61% of their time at the enameling station, and 39% of their time at their workbench, preparing bathtubs. The heater was observed to spend 21% of his time at the enameling station, and 79% of his time at the aisleway, patching bathtubs with "mud". Table A in the appendix indicates spot measurements taken at 15-minute intervals of WBGT values at furnaces 56 and 58. Table V depicts the time-weighted WBGT values for these heat stress measurements. The time-weighted WBGT values were obtained by multiplying the average WBGT in an area by the percentage of time spent in that area.

A strip chart was connected to a Reuter Stokes to develop an even more precise profile of the WBGT at furnace 59, in conjunction with the time study which was conducted there. The results are summarized in Table B in the Appendix. The average WBGT was 102°F. The results also indicate that each succeeding layer of enamel reduced the WBGT; this is most likely due to shielding of the radiant heat from the bathtub caused by the progressively thicker enamel coatings.

Strip chart recordings of WBGT at furnace 45 (small wares) on September 23, from 12:20 to 3:30 ranged from 78°F WBGT to 90°F WBGT.

Finally, on September 24, the enameler at furnace 60 was observed, and heat stress measurements were taken at the enameling station and workbench areas from 7:22 A.M. to 10:54 A.M.

The time-weighted WBGT was 89°F during the observation times. Table V summarizes the time-weighted wet bulb globe temperatures recorded on September 23 and 24.

Enamelers are provided with limited protective clothing by American Standard Inc. An aluminized reflective cloth sleeve and heavy gloves are supplied to protect the arms and hands while enameling. Enamelers fashion aprons from rolls of aluminized cloth. They have also devised aluminum masks which attach to their hard hats and protect their faces while enameling.

When the bathtubs are removed from the furnace, they are sources of intense radiant heat. Globe temperature measurements (indicative of radiant heat) were as high as 199°F at the chest zone of the enameler. Protection from radiant heat is best provided by reflective shielding which intercepts the heat. Man-coolers, which function by blowing cooled air over the worker, provide comfort by accelerating the evaporation of sweat. Man-coolers alone are not sufficient to provide relief from the heat stress conditions encountered in the enameling department. It is worth pointing out that on July 15, a day when the ambient outdoor temperatures exceeded 100°F, the function of the man-coolers seemed to be impaired, as evidenced by the face measurement of the man-cooler at furnace 55 1/2 which had a WBGT of 84°F. Many workers complained of the high heat and humidity. The lowest WBGT recorded in any working area on July 15 was 95°F at the aisleway in front of furnace 56. There was no spell area readily available where the enamelers and heaters could find relief. Management at American Standard Inc. reported that production drops precipitously during the summer months. The company provides drinks containing electrolytes to replace those lost from sweating, and allows workers to take breaks as required during periods of heat stress.

Smoke candles were ignited in different areas of the enameling department to determine air flow patterns. The smoke tended to hang fairly low in the air, diffusing slowly up to about 12 to 14 feet above the shop floor before spreading out, indicating a lack of air movement in the area. Air velocity and smoke tube measurements at the entrances and doorways to the enameling department demonstrated that air was being drawn into the enameling department from every entrance, thus illustrating that the enameling department is under negative pressure.

During the initial visit, the man-cooler system was inspected and showed signs of inadequate maintenance. Water sprayers were rusted and corroded, some were inoperative. One of the man-cooler fans was severely rusted, with segments of the fan blades missing due to severe corrosion. Filters at the face of the man-coolers were soiled and needed replacement.

General housekeeping in the enameling department was deficient, particularly during the follow-up visit. Enameling powder had accumulated on the floor throughout the department. Employees reported that regular floor sweeping in this area had been terminated.

The shower room and locker areas were poorly maintained, and not conducive to personal hygiene.

B. Medical

1. Report of Possible Legionellosis

In response to NIOSH inquiries, personnel at the Special Pathogens Branch of the Bacterial Diseases Divison of CDC reviewed their files and found no copies of correspondence with the American Standard Corporation. They do have a form letter which they use in reply to questions concerning environmental aspects of legionellosis (Appendix I), but there is no record that a copy of this letter was sent to the American Standard Corporation.

The man-coolers used in the enameling department are capillary air washers. There were no capillary air washers at the Bellevue Hotel in Philadelphia during the 1976 outbreak of legionellosis there. There is currently no evidence that any particular brand or type of air-conditioning system is more likely than others to be responsible for disseminating Legionella pneumophila bacteria and contributing to outbreaks of legionellosis. There is also, as yet, no preventive maintenance procedure for air-conditioning or cooling systems that has been proven to prevent outbreaks of legionellosis.

The Kentucky State Department for Human Resources reported that there have been some sporadic cases of legionellosis in Kentucky, but no clusters of cases. In Louisville, there had been about ten cases in the previous four years, and there was no evidence of a common source.

Legionellosis (formerly called Legionnaires' Disease), has two typical clinical presentations. In the more severe form, the patient generally first notes headache, malaise, and myalgia (muscle aches). Sometimes these symptoms are accompanied by diarrhea. After several days these non-specific symptoms are followed by high fever, non-productive cough, and pneumonia. This severe form of legionellosis can occur in isolated cases or in an outbreak similar to the one that occurred in Philadelphia in 1976. When the disease does occur as a common source outbreak, generally only about 5% or fewer of the people exposed to the common source develop the disease.

A less severe form of legionellosis is sometimes called Pontiac fever. This form of the disease usually presents with fever, headache, malaise, and muscle aches. These symptoms generally last only two to five days, and the disease resolves regardless of whether any therapy is begun. Common-source outbreaks of this milder form of the disease often have much higher attack rates, with illness occurring in 90% or more of the exposed population.

Informal interviews of about two dozen enameling department employees during the first NIOSH site visit in July 1980 revealed a common pattern of symptoms. These included dizziness or light-headedness, loss of appetite, nausea, abdominal cramps, and muscle cramps. Headache and vomiting were also reported. The symptoms were chronic, generally lasting for the entire duration of employment in the enameling department, and were more intense and more frequent in the summer months. The workers had found through experience that they could generally achieve relief by taking a break from work when they felt the onset of symptoms. Some workers also obtained relief by drinking the oral electrolyte replacement fluid supplied at work or solutions or beverages they supplied themselves. Several of the long-term employees of the enameling department reported that these symptoms occurred prior to the installation of the man-coolers and that the mancoolers, if anything, helped to alleviate the symptoms.

Although some of the symptoms reported by the employees could be caused by legionellosis, these non-specific symptoms are found in many other diseases, including lead toxicity and heat stress. The whole clinical picture of symptoms that are chronic, worse in hot weather, and partly relieved by work breaks, fluid replacement, and partial cooling by the man-coolers suggests that the symptoms are more likely related to the hot working environment than to infection by the L. pneumophila bacterium or other microorganisms.

2. Lead Toxicity

The 122 employees who participated in the medical survey on September 22-24 ranged in age from 19 to 61 years, with a mean of 39. They worked at their current job for 1 to 34 years, with a mean of 12. All but one were men, and 109 (89%) were White (the other 13 were Black). There were 53 enamelers, 64 heater/helpers, and 5 other employees.

Analysis of the blood samples from the 122 employees revealed that 116 samples (95.1%) had lead levels within the normal range of less than 40 ug/100 ml. The eight other samples had lead levels between 40 and 48 ug/100 ml. The eight individuals who had elevated blood lead levels had normal hematocrits. In addition, there were eight individuals with normal lead levels but slightly decreased hematocrits. The 16 persons who had abmormal blood test results, either elevated lead level or decreased hematocrit, were notified of the abnormal results by private letter.

The eight persons with elevated blood lead levels were all enamelers. The information from their questionnaire interviews was compared with that from all other enamelers interviewed to determine if they experieced any risk factors that may have contributed to their elevated blood lead levels.

The race and sex distributions of the two groups were similar, as were their mean ages (Table VI). The groups were compared for several factors that might lead to increased lead exposure and increased absorption, including eating, drinking, or smoking at work and washing up before any of these activities (Table VI). They were also compared for possible exposures to lead outside the work place, such as soldering. For each of these potential exposures, the percentages of the two groups involved were similar, and there were no statistically significant differences in comparing the two groups for any of these categories of increased exposure.

Analysis of physical examination results revealed that none of the enamelers in either group had diminished strength of the wrist extensor or plantar extensor muscle groups. Biceps deep tendon reflexes were considered abnormal if they were absent, diminished, or asymmetrical. Six of the eight enamelers (75.0%) with elevated blood lead levels versus 16 of 45 enamelers (35.5%) with normal blood lead levels had abnormal biceps deep tendon reflexes. This difference is not statistically significant (Table VI).

Six of the eight enamelers (75.0%) with elevated blood lead levels versus 22 of 45 enamelers (48.9%) with normal blood lead levels had a tremor. The presence of this physical sign is probably not a reliable indicator of lead toxicity in this population. Tremor can occur following strenuous physical activity, and it can also be induced by the salt and water depletion that occurs in heat stress.

There were seventeen employees who participated in personal sampling for breathing zone concentrations of lead in August and who also had blood lead levels drawn in September. When the personal air sample lead levels for these employees are compared to their blood lead levels by linear regression analysis, there is no statistically significant correlation between these two variables ($p = 0.53$). This lack of correlation is probably due to the fact that air sampling represents a one day exposure, which may not reflect the chronic long-term exposures that contribute to a blood lead level.

The most striking difference between enamelers with elevated blood lead level and other enamelers was average duration of employment as an enameler (Table VI). The average duration of work as an enameler for the group with elevated lead levels was 21.1 years, compared to only 13.4 years for the other group. Although the difference between these two means does not reach statistical significance, duration of work as an enameler is the only factor that appears to be strongly associated with an elevated blood lead level. It is possible that chronic, low-level exposure to leaded enamel powder for many years may be contributing to the mildly elevated blood lead levels that were found in some of the workers.

Another factor that may contribute to elevated blood lead levels is the amount of lead in the enamel powder which an individual enameler uses. If there is a substantial difference in the amount of lead contained in the various enamels, and if individual enamelers routinely work with the same enamel powders for extended periods, then this may be an important factor contributing to elevated lead levels in some of the enamelers.

3. Heat Stress

Our medical investigations were not designed to include extensive physiologic evaluations for signs of heat stress. The questionnaire interviews conducted on September 22-24 included questions about symptoms that could be related to either heat stress or lead toxicity. Table VII shows the total number of symptoms reported by the employees and the frequency with which individual symptoms were reported. Of the 17 symptoms listed, only "diarrhea" is not common to either heat stress or lead toxicity (it can be a symptom of legionellosis); and only "fever" is common to heat stress but not to lead toxicity. Both of these were among the least common symptoms reported.

The 122 employees reported a total of 594 symptoms, or 4.9 symptoms per person. Results of the initial survey in July 1980, as noted above, suggested that legionellosis was an unlikely cause of the symptoms occurring in the workers. The normal blood lead levels in 116 of the 122 employees tested

(95.1%) suggests that lead toxicity was not the primary cause of reported symptoms. It seems likely that heat stress from hot working conditions is a probable cause of the reported symptoms, although these symptoms are relatively non-specific and could also be related to a variety of other, non-occupational, illnesses.

Susceptibility to heat stress is partly a function of the hot environment to which a person is exposed and partly a function of individual variables. In general, heat stress symptoms are more likely to occur and are likely to be more severe in individuals who are not acclimatized.

To determine whether there was any change in the prevalence of symptoms as a function of acclimatization, we asked each interviewee about presence of symptoms during the week prior to the NIOSH survey (the week of September 15) and during the first week back to work following the annual three-week summer shut down (the week of August 18). Table VIII shows that, for the total population interviewed, the prevalence of symptoms in August was actually slightly less than that in September, suggesting no beneficial effect from a period of acclimatization. Several factors may explain this phenomenon. The summer shut down occurred during an intense heat wave, and employees may have experienced little change in hot environmental conditions outside of work. Because they were experienced in adjusting to work in hot environments, they may also have allowed themselves to acclimatize gradually when they returned to work in August by taking more frequent breaks and by slowly working up to their usual level of productivity.

In addition to inadequate acclimatization, other individual factors that are likely to render a person more susceptible to heat stress include old age, obesity, and chronic illness. We did not evaluate for either of the latter two factors in our survey, but the "healthy worker effect" would make it unlikely that people with chronic diseases would comprise a large portion of this population.

Table IX shows a breakdown of the total population to analyze for prevalence of symptoms in enamelers and non-enamelers. The groups of enamelers and non-enamelers are further broken down into age groups to determine if there is any change in the prevalence of symptoms as a function of age. The enamelers have the greatest exposure to the intense radiant heat from the furnaces and from the bathtubs when they are removed from the furnaces, and therefore are experiencing the hottest working conditions. The 64 heaters and five others (Forklift Driver, Machinist, Scrap Hauler, 2 Sand Blasters) are included together as non-enamelers. The employees with elevated lead levels are considered as a separate group because some of their symptoms could be related to lead toxicity.

Table X shows the most frequent symptoms reported in each group. In general, those symptoms reported most frequently by the whole group (including "trouble sleeping," "unusually tired," and "muscle cramps") are also among the most frequently reported symptoms for each sub-group.

Table IX shows that symptoms were more prevalent in older than in younger workers, and in the older age groups, symptoms were more prevalent in enamelers (who have the hottest working environment) than in non-enamelers. This pattern of symptom prevalence is what one would expect if the symptoms are related to heat stress. It would have been useful to compare questionnaire results with employees of similar age groups from a department where heat stress was not a problem, but such a control group was not part of this survey.

In spite of the extremely hot working environnment in the enameling department, the employees appear to tolerate the conditions fairly well. One indicator of this is the long average duration of employment in the department (12 years). In addition, the blood tests of 122 employees (which were obtained before, during, and after the work shifts) revealed only one elevated hematocrit (53%, upper normal limit was 52%), suggesting that, through frequent breaks and adequate fluid replacement, the workers were probably able to avoid severe dehydration. Although the reported symptoms suggest a high prevalence of heat cramps and heat exhaustion, review of company medical records and recall of management personnel and long-term employees did not reveal a single instance of a case of heat stroke in an enameling department employee.

VII. RECOMMENDATIONS

1. Provide an easily accessible rest or spell area which is supplied with cool, dehumidified air for recovery from the heat stress conditions which exist during the summer months. Instituting this measure could also address the problem of decreased productivity during the summer months, as a cool rest area should enable faster recovery from the heat stress conditions and a quicker return to the work stations.

2. Install barriers to protect the enamelers from the radiant heat given off by the bathtubs and furnaces. The most efficient barriers are covered with aluminum to reflect the radiant heat.

3. Provide better personal protective clothing to protect the enamelers from radiant heat.

4. New employees should be instructed in the hazards associated with hot environments and allowed to acclimatize over a period of 6 days. The acclimatization schedule shall begin with 50 percent of the anticipated total work load and time exposure on the first day, followed by daily 10 percent increments building up 100 percent total exposure on the sixth day.

5. Regular acclimatized employees who return from 9 or more consecutive calendar days of leave, shall undergo a four day acclimatization period. The acclimatization schedule shall begin with 50 percent of the anticipated total exposure on the first day, followed by daily 20 percent increments building up to 100 percent total exposure on the fourth day. Regular acclimatized employees who return from four consecutive days of illness should have medical permission to return to the job, and should undergo a four day re-acclimatization period as defined above.

6. A variety of saccharin-free fluids containing electrolytes should be made available to replace body fluids lost in heat stress conditions.

7. Clean up the showers and locker rooms. Install scales and instruct employees in the importance of weighing themselves before and after the day's work to prevent excessive water loss and dehydration.

8. Reduce dust levels in the air through engineering controls aimed at the source, that is, the vibrating seives used to spread the enamel powder.

9. Institute regular maintenance procedures for the man-coolers. Replace or repair all rusted out or corroded parts.

10. Implement good housekeeping procedures in the enameling department. Routine floor cleaning will reduce airborne levels of dust.

11. Institute medical surveillance, including periodic biological monitoring and medical examinations, according to the criteria set forth in the OSHA standard for occupational exposure to lead (CFR Section 1910.1025), Section j.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared and Submitted By:

Andrew D. Lucas, M.S.
Project Officer
Industrial Hygienist
Industrial Hygiene Section

John Horan, M.D.
Medical Officer
Medical Section

Environmental Assistance Provided By:

Richard Hartle, M.S.
Industrial Hygienist
Industrial Hygiene Section

Richard Costello,, P.E., C.I.H.
Industrial Hygienist
Industrial Hygiene Section

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies
Cincinnati, Ohio

Report Typed By: Odessa Brown
Clerk-Typist
Industrial Hygiene Section

IX. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH at the Cincinnati address.

Copies of this report have been sent to:

1. International Molders and Allied Workers Union Local #8
2. American Standard Inc., Louisville, Kentucky
3. NIOSH, Region IV
4. OSHA, Region IV

X. REFERENCES

1. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1980. Cincinnati, Ohio: ACGIH, 1980.

2. Occupational Safety and Health Administration Standards, Code of Federal Regulations 29 CFR 1910 July, 1980.

3. National Institute for Occupational Safety and Health. Criteria for a recommended standard...occupational exposure to hot environments. 1972, HSM 72-10269.

4. National Institute for Occupational Safety and Health. Criteria for a recommended standard...occupational exposure to carbon monoxide. 1972, HSM 73-11000.

Table I
Environmental Standards/Recommended Criteria

American Standard, Inc
Louisville, Kentucky
HE 80-199

Substance	OSHA Standard	NIOSH Recommended Criteria	ACGIH TLV
Inorganic Lead	0.05 mg/M^3*	0.05 mg/M^3	0.5 mg/M^3
Chromium Metal	1 mg/M^3	1 mg/M^3	-----
Iron Oxide Fume	10 mg/M^3	10 mg/M$_3$	5 mg/M^3
Lithium Hydride	0.025 mg/M^3	0.025 mg/M^3	0.025 mg/M^3
Carbon Monoxide	50 ppm**	35 ppm	50 ppm
Heat Stress	-----	Begin instituting work work practices when continuous 1 hr. or intermittent 2 hr. time weighted average (TWA) WBGT*** measurements exceed 79^{O}F for men or 76^{O}F for women. An area which exceeds 86^{O}F should be posted as a heat stress area	See Below****
Respirable Nuisance Dust	5 mg/M^3	-----	5 mg/M^3

* mg/M^3 = milligrams of substance per cubic meter of air
** ppm = parts per million parts of air
*** WBGT = wet bulb globe temperature

****

Permissible Heat Exposure Threshold Limit Values
(Values are given in ^{O}C. WBGT)

Work - Rest Regimen	Work Load: Light	Moderate	Heavy
Continuous work	30.0	26.7	25.0
75% Work - 25% Rest, Each hour	30.6	28.0	25.9
50% Work - 50% Rest, Each hour	31.4	29.4	27.9
25% Work - 75% Rest, Each hour	32.2	31.1	30.0

Higher heat exposures than shown in this Table are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceedsd 38.0^{O}C.

Table II

Air Sampling for Metals

American Standard, Inc
Louisville, Kentucky
HE 80-199

July 14 and 15, 1980

Job/Location	Date of Sample	Time of Sample	Sample Volume (liters)	Type of Sample	Lead Concentration (ug/M3)	Lead Concentration 8 hr. TWA (ug/M3)	Chromium Concentration (ug/M3)	Iron Concentration (ug/M3)	Lithium Concentration (ug/M3)
Enameler, Furnace #60	7/14/80	5:57p-10:44p	430	Personal	100	75	ND	ND	7
" " #62	"	6:03p-10:46p	420	"	71	53	ND	ND	2
" " #53	"	5:45p-10:56p	470	"	103	77	ND	24	4
" " #49	"	6:07p-10:57p	430	"	37	28	ND	23	ND
" " #55	"	5:47p-10:55p	470	"	26	20	ND	ND	ND
" " #58	"	5:49p-10:49p	450	"	100	75	ND	ND	4
" " #57	7/15/80	5:53a-10:46a	440	"	32	24	30	35	ND
Heater, Furnace #56	"	6:32a-10:44a	380	"	48	48	ND	42	ND
Enameler, Furnace #61	"	6:06a-10:48a	420	"	78	59	ND	17	2
" " #44	"	6:27a-10:35a	370	"	65	49	ND	13	ND
" " #60	"	5:57a-10:53a	440	"	83	62	ND	ND	5
" " #58	"	5:49a-10:47a	450	"	98	74	ND	11	9
" " #55	"	5:45a-10:42a	450	"	99	74	ND	14	5
Gen'l Area, Furnace #62	"	6:18a-10:54a	410	Area	70	70	ND	12	5
Enameler, Furnace #61	"	11:50a-4:53p	450	Personal	90	68	ND	13	2
" " #57	"	11:44a-4:59p	470	"	43	32	55	49	2
" " #59	"	11:40a-4:57p	480	"	112	84	ND	11	2
" " #65	"	11:55a-4:55p	450	"	162	122	ND	ND	4
" " #62	"	11:51a-4:52p	450	"	62	47	ND	20	2
" " #56	"	11 35a-4:56p	480	"	54	41	ND	15	2
" " #53	"	11:30a-2:40p	280	"	81	61	ND	ND	ND

ND = Not Detectable

NOTE: All the above samples were also analyzed for antimony, cobalt, copper and titanium. They were found to be below the detectable limits for these substances.

Table III

Air Sampling For Respirable Dust and Silica

American Standard, Inc.
Louisville, Kentucky
HE 80-199

July 14 and 15, 1980

JOB/LOCATION			DATE OF SAMPLE	TIME OF SAMPLE	SAMPLE VOLUME (liters)	RESPIRABLE NUISANCE DUST(mg/M3)
Enameler,	Furnace	#61	7/14/80	5:59p-10:45p	490	0.31
"	"	#46	"	6:17p-11:01p	480	0.89
"	"	#47	"	6:13p-11:00p	490	0.27
"	"	#56	"	5:49p-10:53p	520	1.12
"	"	#53	7/15/80	6:21a-10:40a	440	2.45
"	"	#65	"	6:31a-10:55a	480	1.94
"	"	#49	"	6:24a-10:37a	430	0.37
"	"	#46	"	12:01p- 4:50p	490	0.83
"	"	#49	"	11:27a- 1:15p	180	0.22
"	"	#47	"	11:25a- 4:50p	550	0.25
"	"	#58	"	11:47a- 4:50p	500	1.53

mg/M^3 = milligrams of substance per cubic meter of air.

NOTE: All of the above are personal samples. Each sample was also analyzed for quartz and cristobalite and found to be below the limit of detection (0.03 mg/M^3).

Table IV
Heat Stress Measurements
American Standard, Inc.
Louisville, Kentucky
HE 80-199

Location	Time	Wet Bulb Globe Temperature
July 14, 1980		
Foreman's Office	6:30p	67
Furnace #56, immediately behind enameler	6:40p	102
Aisleway, 4' from an enameled tub just removed from furnace	6:55p	108
Furnace #58, 4' behind enameler	8:45p	88
Furnace #60, 3' behind enameler	8:55p	86
Furnace #60, enameler's chest zone	9:15p	116
" " " " "	9:18p	114
Furnace #56 " " "	9:30p	118
" " " " "	9:31p	115
" " " " "	9:33p	114
Furnace #58 " " "	9:40p	105
" " " " "	9:44p	103
" " " " "	9:47p	99
" " " " "	9:49p	99
July 15, 1980		
Foreman's office	8:25a	68
4' from a recently finished bathtub	8:41a	102
Furnace #59, enameler's chest zone	8:52a	108
" " " " "	8:54a	99
" " " " "	9:00a	111
" " " " "	9:03a	112
" " " " "	9:05a	103
Furnace #56, enameler's chest zone	9:12a	113
" " " wrist "	9:12a	150
" " " chest "	9:22a	119
" " " " "	9:25a	109
" " " " "	9:27a	115
" " " " "	9:30a	120
Outside of plant, near foreman's office	12:01p	90
Aisleway in front of furnace #56	4:20p	95
Furnace #56, Enameler's chest zone	4:23p	125
" " " " "	4:26p	114
" " " " "	4:30p	107
" " " " "	4:35p	118
Furnace #59 " " "	4:38p	110
" " " " "	4:40p	113
Face measurement of man-cooler at furnace #55 1/2	4:45p	84
Washroom in enameling department	5:10p	97

Table V

Heat Stress Measurements Time-Weighted WBGT Values

American Standard, Inc.
Louisville, Kentucky
HE 80-199

September 23-24, 1980

Job Title	Date	Sampling Time	Time-weighted WBGT (oF)
Enameler, Furnace #56	9/23/80	12:30p- 1:15p	86
Heater, Furnace #56	"	12:30p- 1:15p	79
Enameler, Furnace #58	"	2:05p- 3:00p	93
Enameler, Furnace #59	"	2:00p- 4:00p	102
Enameler, Furnace #60	9/24/80	7:22a-10:54a	89

Table VI
Compare Employees with Elevated Blood Lead to All Other Enamelers.
AMERICAN STANDARD INCORPORATED
LOUISVILLE, KENTUCKY
SEPTEMBER 22-24, 1980

	Enamelers with ↑ Pb (n = 8)	Enamelers with Normal Pb (n = 45)
Race	7W 1B	43W 1B
Sex	All Male	44M 1F
Age (yrs)		
Range	26 -54	23 - 61
Mean	42.1	39.2
Current Job (yrs)		
Range	5 - 33	1 - 34
Mean	21.1	13.4
S.D.	12.5	10.14

$t = 1.92$
$0.5 < p < 0.6$

	#	%	#	%	p value (Fisher's Exact Test)
Eat at Work	6	75.0%	25	55.6%	0.27
Wash Before	3	50.0%	10	40.0%	0.50
Drink at Work	8	100.0%	45	100.0%	0.99
Wash Before	1	12.5%	3	6.7%	0.49
Smoke (cigarettes)	6	75.0%	33	73.3%	0.65
Smoke at Work	6	75.0%	32	71.1%	0.60
Wash Before	0	---	0	---	---
Other Exposure*	1	12.5%	6	13.3%	0.72
Examination					
DTR	6	75.0%	16	35.5%	0.08
Tremor	6	75.0%	22	48.9%	0.16

"Other Exposure" included non work-related exposures such as soldering, melting bullets, and drinking home-made whiskey.

Table VII
AMERICAN STANDARD INCORPORATED
LOUISVILLE, KENTUCKY
SEPTEMBER 22-24, 1980

Symptoms	# Reported	% of Total Reported Symptoms
Unusually Tired	79	13.2%
Trouble Sleeping	72	12.1
Muscle Cramps	70	11.7
Headache	54	9.0
Muscle Weakness	49	8.2
Irritability	37	6.2
Tremor (Shakes)	34	5.7
Poor Appetite	34	5.7
Weight Loss	31	5.2
Nausea	28	4.7
Dizziness	26	4.4
Poor Memory or Concentration	18	3.0
Diarrhea	18	3.0
Constipation	13	2.2
Abdominal Cramps	13	2.2
Vomiting	11	1.8
Fever	10	1.7
TOTAL	597	100.0

Each symptom was counted once if it was reported by an employee in either August or September, and it was counted twice if it was reported by an employee in both August and September.

Table VIII

AMERICAN STANDARD INCORPORATED
LOUISVILLE, KENTUCKY
SEPTEMBER 22-24, 1980

Questionnaire Results

	Symptoms Reported					
Employee Group	Total	(per person)	8/80	(per person)	9/80	(per person)
Total (n = 122)	597	(4.9)	289	(2.4)	308	(2.5)
Enamelers with Pb (n = 8)	44	(5.5)	24	(3.0)	20	(2.5)
Enamelers with N Pb (n = 45)	230	(5.1)	114	(2.5)	116	(2.5)
Others (n = 69)	323	(4.7)	151	(2.2)	172	(2.5)

Table IX

AMERICAN STANDARD INCORPORATED
LOUISVILLE, KENTUCKY
SEPTEMBER 22-24, 1980

Symptom Prevalence in Different Groups of Employees.

Employee Group	Symptoms Reported Total	(per person)
Total (n = 122)	594	(4.9)
Enamelers ≥55 y/o (n = 6)	56	(8.0)
Non-Enamelers ≥55 y/o (n = 12)	73	(6.1)
Enamelers with ↑ Pb (n = 8)	44	(5.5)
Enamelers 26-54 y/o with Normal Pb (n = 32)	168	(5.3)
Non-Enamelers 26-54 y/o with Normal Pb (n = 44)	230	(5.2)
Enamelers ≤25 y/o (n = 6)	6	(1.0)
Non-Enamelers ≤25 y/o (n = 13)	13	(1.5)

Table X

AMERICAN STANDARD INCORPORATED
LOUISVILLE, KENTUCKY
SEPTEMBER 22-24, 1980

Most Common Symptoms in Different Employee Groups*

Total (n = 122)

1. Unusually Tired
2. Trouble Sleeping
3. Muscle Cramps

All Enamelers with Normal Pb (n = 45)

1. Unusally Tired
1. Muscle Cramps
2. Trouble Sleeping
3. Headache

All Non-Enamelers (n = 69)

1. Trouble Sleeping
2. Unusually Tired
3. Muscle Cramps

Enamelers with ↑Pb (n = 8)

1. Unusually Tired
1. Muscle Cramps
1. Muscle Weakness

Enamelers ≥55 y/o (n = 7)

1. Unusually Tired
2. Trouble Sleeping
2. Headache
2. Nausea

Non-Enamelers ≥55y/o (n = 12)

1. Trouble Sleeping
2. Muscle Cramps
2. Poor Appetite

Enamelers 26-54y/o with Normal Pb (n = 32)

1. Muscle Cramps
2. Unusually Tired
3. Trouble Sleeping

Non-Enamelers 26-54 y/o (n = 44)

1. Unusually Tired
2. Trouble Sleeping
3. Muscle Cramps
3. Headache

Enamelers ≤25 y/o (n = 6)

1. Headache
2. Muscle Cramps
2. Muscle Weakness
2. Tremor
2. Trouble Sleeping

Non-Enamelers ≤25 y/o (n = 13)

1. Weight Loss
2. Unusually Tired
3. Trouble Sleeping

---

*Symptoms are listed in order of frequency. Two or more symptoms reported in equal frequency by a group are given the same numerical listing.

APPENDIX A

Heat Stress Measurements

American Standard, Inc.
Louisville, Kentucky
HE 80-199

September 23, 1980

Location	Sample Time	Wet Bulb Globe Temperature (oF)
Furnace #56 enameling station, enameler's side	12:30p	99
" " " " " "	12:45p	89
" " " " " "	1:01p	92
" " " " " "	1:15p	95
Furnace #56 enameling station, heater's side	12:30p	103
" " " " " "	12:45p	90
" " " " " "	1:01p	98
" " " " " "	1:15p	98
Aisleway in front of furnace #56	1:45p	74
" " " " " "	1:55p	74
Furnace #58 enameling station, enameler's side	2:05p	101
" " " " " "	2:15p	101
" " " " " "	2:33p	104
" " " " " "	2:50p	103
" " " " " "	3:00p	99

APPENDIX B

Summary of Strip Chart Recordings of WBGT at
Furnace #59 from 2:00-4:00 p.m.

American Standard, Inc.
Louisville, Kentucky
HE 80-199

September 23, 1980

Activity	Average Wet Bulb Globe Temperature (°F)	% of Time at The Activity
1st Coating of Enamel	124	22.1
2nd Coating of Enamel	112	18.9
3rd Coating of Enamel	107	11.4
Trimming Bathtub	104	8.7
Preparing Bathtubs at Workbench	82	39.0

NOTE: Average WBGT is 102°F from 2:00-4:00 for enameler at furnace #59.

APPENDIX I

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

Thank you for your recent inquiry regarding Legionnaires' disease.

In 19 outbreaks of legionellosis (Legionnaires' disease or Pontiac fever) investigated by staff of the Center for Disease Control (CDC), evidence has been found in 4 that cooling towers or evaporative condensers from air-conditioning systems may have disseminated bacteria and caused the outbreaks. Three outbreaks clearly were not related to air-conditioning systems; they occurred in areas that were not air conditioned. The role of air-conditioning systems in the other outbreaks is unknown. No association has been found between the occurrence of sporadic cases of Legionnaires' disease (unassociated with outbreaks) and direct occupational exposure to air-conditioning cooling towers or evaporative condensers nor has an association been found between legionellosis and air-conditioning systems that have no cooling tower or evaporative condenser. Although much remains to be learned, it seems that air-conditioning cooling towers and evaporative condensers may be an important source for some, but not all, outbreaks of legionellosis and may possibly be responsible for some sporadic cases.

The techniques for demonstrating that an air-conditioning cooling tower or evaporative condenser contains the Legionnaires' disease bacterium (Legionella pneumophila) are slow and complex. Water samples are examined by immunofluorescence microscopy and inoculated into guinea pigs and embryonated eggs and then onto agar media. Using these techniques, L. pneumophila has been recovered from several cooling towers, including some associated and some not associated with outbreaks. The fact that the bacterium is found in an air-conditioning cooling tower or evaporative condenser does not indicate per se that the air-conditioning system is responsible for disease. Because cooling towers and evaporative condensers are efficient "scrubbers" of air and because L. pneumophila is spread through the air, it may be possible for air-conditioning cooling towers or evaporative condensers to collect the bacterium passively from the air.

As a first step in determining whether preventive maintenance or decontamination of air-conditioning cooling towers or evaporative condensers might be effective in preventing cases of Legionnaires' disease or Pontiac fever, we had to determine what available chemical agents were effective against L. pneumophila.

To this end, representatives of CDC met on October 3, 1978 with representatives from the United States Environmental Protection Agency (EPA) and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Six classes of EPA-registered disinfectants were identified which might be useful against the bacterium. Representatives of these 6 classes--a chlorinated phenol, a quaternary ammonium, an isothiazolin, a dithiocarbamate, 2, 2-dibromo-3-nitrilopropionamide, and calcium hypochlorite--have been tested in a CDC laboratory for their effect on L. pneumophila. Fixed concentrations of L. pneumophila were exposed in hypochlorite-free, sterile tap water to several concentrations of each compound; aliquots of this water were then inoculated at various time periods on artificial media and in yolk sacs of embryonated eggs for growth of L. pneumophila. A compound with 50% didecyl dimethyl ammonium chloride (a quaternary ammonium compound), 20% isopropanol, and 30% inert ingredients was effective at concentrations of 70, 140, and 630 ppm, respectively, in preventing recovery of L. pneumophila from aliquots of water taken after 3, 6, 24, and 168 hours' exposure. Calcium hypochlorite and 2, 2-dibromo-3-nitrilopropionamide also appeared effective, but testing is not complete. The other 3 compounds appeared to be less rapidly effective in inhibiting recovery of L. pneumophila in laboratory tests.

These studies have identified certain commercially available water disinfectants that are being or will be tested for their ability to decontaminate evaporative condensers and cooling towers implicated in the transmission of L. pneumophila. However, the efficacy of any such decontamination procedures in actually inhibiting growth of L. pneumophila in cooling tower or evaporative condenser water and preventing transmission of the organism remains to be demonstrated.

These findings also do not address the problem of long-term preventive maintenance of evaporative condensers and cooling towers. Although CDC, EPA, ASHRAE, and the Cooling Tower Institute advise that routine preventive maintenance measures may be effective in controlling slime, scale, algae, and bacterial growth in such air-conditioning units, they have no information about the utility of such procedures in preventing legionellosis.

Sincerely yours,

Jeffrey D Band MD

Special Pathogens Branch
Bacterial Diseases Division
Bureau of Epidemiology

Suggested reading:

1. Miller RP. Cooling towers and evaporative condensers. Ann Intern Med 1979; 90:667-70.

2. Morris GK, Patton CM, Feeley JC, Johnson SE, Gorman G, Martin WT, Skaliy P, Mallison GF, Politi BD, Mackel DC. Isolation of the Legionnaires' disease bacterium from environmental samples. Ann Intern Med 1979;90:664-6.

I. RECOMMENDATIONS FOR A STANDARD FOR WORK IN HOT ENVIRONMENTS

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to heat in the workplace be controlled by requiring compliance with the work practice standard set forth in the following sections. Adherence to the precautionary procedures prescribed will prevent acute or chronic heat disorders and illnesses and heat induced unsafe acts, and will reduce the risk of harmful effects due to the interactions between excessive heat and toxic chemicals and physical agents. The standard is amenable to techniques that are valid, reproducible, and presently available. It will be reviewed and revised as necessary.

Section 1 - Definitions

(a) Acclimatization to heat means a series of physiological and psychological adjustments that occur in an individual during his first week of exposure to a hot environment so that thereafter the individual is capable of working in a hot environment without excessive strain.

(b) Unimpaired mental performance means the ability of an employee to cope with conditions where safety and health depend on constant alertness because he has to make critical decisions, fine discriminations, or fast and skillful actions.

(c) Intermittent heat exposure means exposure to hot environmental conditions which continues no longer than fifteen minutes without an interrupting interval spent either spontaneously or according to a prescribed schedule in a cooler environment.

(d) Continuous heat exposure means any exposure to hot environmental conditions which is not an intermittent exposure.

(e) Hot environmental condition means any combination of air temperature, humidity, radiation and wind speed that exceeds a Wet Bulb Globe Temperature (WBGT) of 79°F.

Section 2 - Applicability

The provisions of this standard are applicable to all places of employment, indoors and outdoors, and to all employees except those who are required to wear impermeable protective clothing.

Section 3 - Work Practices

(a) For sedentary jobs where continuous unimpaired mental performance is required, no employee shall be exposed to conditions which exceed the limits set forth in Figure I-1.

(b) No employee should be permitted to work without protective observation at high heat stress levels.

(c) When exposure of an employee is continuous for one hour or intermittent for a period of two hours and the time-weighted average WBGT exceeds 79°F for men or 76°F for women, then any one or combination of the following practices shall be initiated to insure that the employee's body care temperature does not exceed 100.4°F:

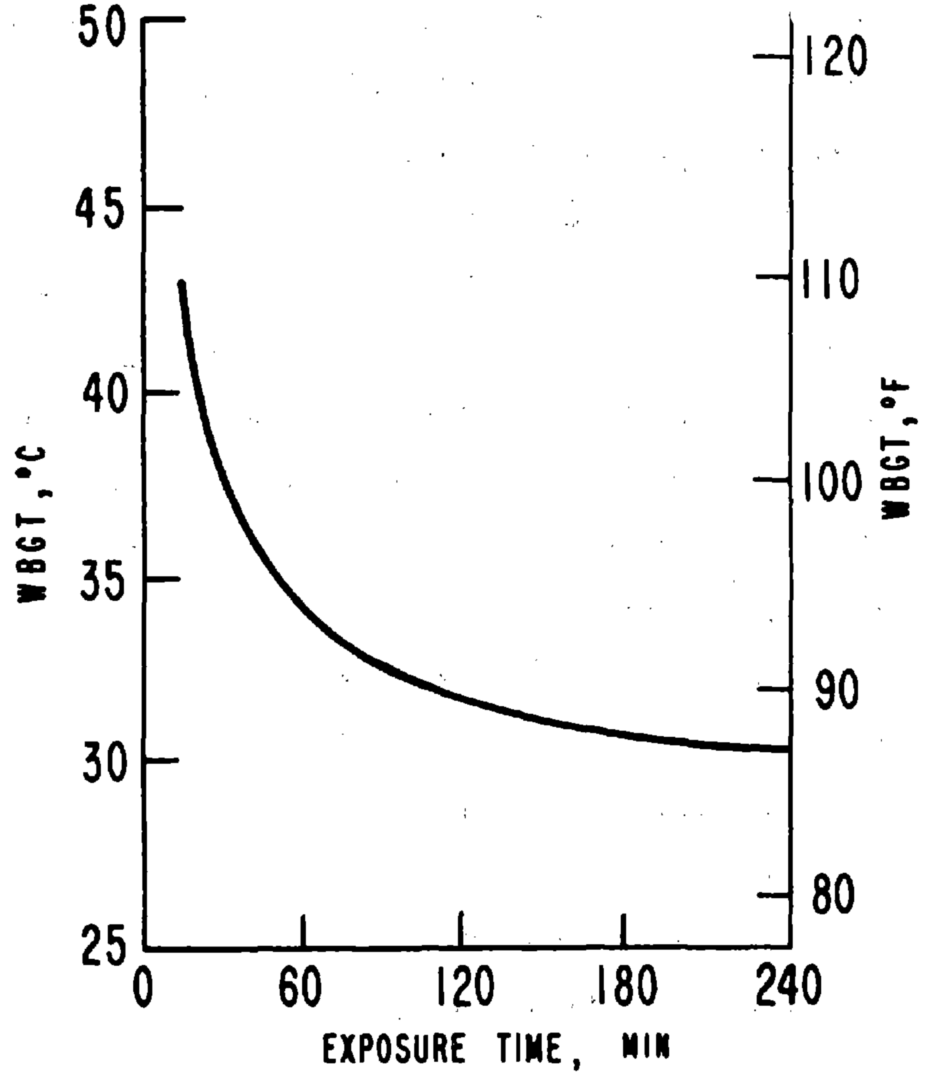

FIGURE I-1. UPPER LIMITS OF EXPOSURE FOR UNIMPAIRED MENTAL PERFORMANCE

(i) Acclimatization

(1) Unacclimatized employees shall be acclimatized over a period of 6 days. The acclimatization schedule shall begin with 50 percent of the anticipated total work load and time exposure on the first day, followed by daily 10 percent increments building up 100 percent total exposure on the sixth day.

(2) Regular acclimatized employees who return from nine or more consecutive calendar days of leave, shall undergo a four day acclimatization period. The acclimatization schedule shall begin with 50 percent of the anticipated total exposure on the first day, followed by daily 20 percent increments building up to 100 percent total exposure on the fourth day.

(3) Regular acclimatized employees who return from four consecutive days of illness should have medical permission to return to the job, and should undergo a four day re-acclimatization period as defined in (2) above.

(ii) A work and rest regimen shall be implemented to reduce the peaks of physiological strain and to improve recovery during rest periods.

(iii) The total work load shall be evenly distributed over the entire work day when possible.

(iv) When possible hot jobs shall be scheduled for the coolest part of the work shift.

(v) Regular breaks, consisting as a minimum of one every hour, shall be prescribed for employees to get water and replacement salt. The employer shall provide a minimum of 8 quarts of cool potable 0.1 percent salted drinking water or a minimum of 8 quarts of cool potable water and salt tablets per man per shift. The water supply shall be located as near as possible to the position where the employee is regularly engaged in work, but never further than 200 feet* therefrom.

(vi) Appropriate protective clothing and equipment shall be provided and used.

(vii) Engineering controls to reduce the environmental heat load shall be utilized.

Section 4 - Environmental Measurements

(a) The WBGT index used as the parameter in determining the environmental conditions for implementation of work practices shall be calculated by the following equations:

For indoor exposure, or outdoor exposure with no solar load:

WBGT = 0.7 WB + 0.3 GT

For outdoor sunlit exposure:

WBGT = 0.7 WB + 0.2 GT + 0.1 DB,

where WB = the natural wet-bulb temperature obtained with a wetted sensor exposed to the natural air movement (unaspirated)

GT = globe thermometer temperature

DB = dry-bulb temperature

*Except where a variance had been granted.

(b) The time-weighted average WBGT shall be determined by the equation:

$$\text{Av. WBGT} = \frac{(\text{WBGT}_1) \times (t_1) + (\text{WBGT}_2) \times (t_2) + \text{---} (\text{WBGT}_n) \times (t_n)}{(t_1) + (t_2) + \text{-------------} (t_n)}$$

where WBGT_1, WBGT_2, WBGT_n, are calculated values of WBGT for the various work and rest areas occupied during total time period; t_1, t_2, t_n are the elapsed times in minutes spent in the corresponding areas which are determined by a time study.

(i) Where exposure to environmental conditions is continuous for several hours or the entire work day, the WBGT shall be calculated as an hourly time-weighted-average.

(ii) Where exposure is intermittent, the WBGT shall be calculated as a two-hour time-weighted average.

Section 5 - Medical

(a) All employees who are 45 years of age and older and who have not had previous occupational exposure to heat shall not be assigned to jobs where the environmental conditions equal or exceed 79°F WBGT for men and 76°F WBGT for women, until they are acclimatized.

(b) All personnel who are to be assigned to hot jobs for the first time shall be evaluated by a physician prior to assignment to assure that the individual can cope with the hot environment. In the examination special emphasis should be on the cardiovascular, renal, hepatic, endocrine, and respiratory system and the skin. The examination should also include a complete medical history of the worker with specific emphasis on previous heat-related disorders or illnesses.

(c) All employees exposed to hot environmental conditions should be given a periodic physical examination every 2 years for employees under age 45, and every year for employees 45 years of age or older, that should include all components of the preplacement examination.

(d) There shall be a person available during working hours, who shall have had first aid training in recognizing the signs and symptoms of any heat disorder or illness.

Section 6 - Apprisal of Employees of Hazards from Exposure to Excessive Heat

Each employee who may be exposed to environmental conditions that exceed the prescribed limits shall be given training in health and safety procedures through a program that shall include the following as a minimum:

(a) Information as to water intake for replacement purposes.

(b) Information as to salt replacement.

(c) Importance of weighing each day before and after the day's work.

(d) Instruction on how to recognize the symptoms of heat disorders and illnesses, including dehydration, exhaustion, heat syncope, heat cramps, salt deficiency exhaustion, prickly heat, and heat stroke.

(e) Information as to special caution that shall be exercised in situations where employees are exposed to toxic agents and/or other stressful physical agents which may be present in addition to and simultaneously with heat.

(f) Information concerning heat acclimatization. The information shall be kept on file and readily accessible to the worker at all places of employment where he may be exposed to excessive heat.

Section 7 - Warning Sign

The following warning sign shall be appropriately located at one or more places to be noticed by any one entering an area where environmental conditions are 86°F WBGT or above.

W A R N I N G

HEAT STRESS AREA

Section 8 - Monitoring

(a) A WBGT profile shall be established for each work place for winter and summer seasons to serve as a guide for deciding when work practices shall be initiated to conform with the requirements of the standard. The first profile shall be established within 3 months of the effective date of this standard.

(b) After the WBGT profiles have been established, monitoring shall be conducted once during July and August of each year.

Section 9 - Recordkeeping

(a) The following records shall be maintained:

(i) Medical records for each employee.

(ii) Records of acclimatization as required by Section 3(c)(i).

(iii) Records of the WBGT for each work area as specified in Section 8.

(b) Records required by provisions (i) and (ii) above shall be maintained for a period of the employee's employment and for one year thereafter.

(c) Records of the WBGT as specified in (iii) above shall be maintained for a period determined by the Secretary of Labor with consultation with the Secretary of Health, Education, and Welfare.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

On July 8, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from employees at American Standard, Incorporated, Louisville, Kentucky. The requestors were concerned about the enameling department where employees coat bathtubs and sinks with enameling powder, then bake the enamel in furnaces. Symptoms included nausea, vomiting, chills, and difficulties in eating. The requestor was also concerned that the man-coolers used in the enameling department had been associated with outbreaks of Legionnaires Disease. The NIOSH investigation was conducted on July 14 to 16, 1980, and on September 22 to 24, 1980. Personal and general area air measurements were made for metal fumes, respirable dust and silica, carbon monoxide, and heat stress. Medical questionnaires were administered and blood samples for lead analysis were obtained. The clinical presentation of employee symptoms was not typical of legionellosis, and there is no evidence that any particular type of air conditioning system is more likely than others to disseminate Legionella pneumophila bacteria and contribute to outbreaks of legionellosis. Symptoms suggested that the principal cause of employee symptoms was the extremely hot working environment. Elevated lead levels in the department had contributed to increased blood lead in some long-term enamelers. Heat stress was a significant problem and may have been the major cause of symptoms among employees in the department. Recommendations for control and monitoring of excessive lead levels and for amelioration of symptoms due to heat stress are contained in the body of the full report.

17. Document Analysis a. Descriptors

KEYWORDS: SIC 3479 (Coating, Engraving, and Allied Services, Not Elsewhere Classified); enameling; foundry; lead; heat stress; "Legionnaires Disease;" legionellosis.

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