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I. SUMMARY

On August 7, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Professional Employees Union, Local 2012, A.F.T., to conduct a Health Hazard Evaluation (HHE) at the Rhode Island Department of Education, 22 Hayes Street, Providence, Rhode Island. The request involved health and comfort complaints including tiredness, irritated eyes, dry throat, and non-specific upper respiratory ailments. The request also stated that employees may be exposed to asbestos. On November 4, 1991, an opening conference and initial walk-through survey were conducted. On January 14, 1992, a return visit was conducted which included environmental air monitoring for asbestos, carbon dioxide, relative humidity and temperature, and collection of bulk paint samples for analysis of inorganic lead. A health symptoms questionnaire was distributed to 65 employees.

Carbon dioxide levels ranged from 500 parts per million (PPM) to 900 PPM in occupied areas. Temperatures were between 73° and 77°F, with relative humidity (RH) between 35% and 42%. The health symptoms questionnaire, returned by 52 of 65 employees, reported that 55% suffer from allergies, and that 59% of the employees frequently experience both headache and fatigue.

Two paint-chip bulk samples obtained from the furnace room in the basement of the facility contained 0.44% and 2.19% inorganic lead by weight.

Three bulk insulation samples from pipe lagging and the furnace surface contained between 30% and 50% chrysotile asbestos. Two of five air samples obtained in the furnace room indicated the presence of airborne asbestos.

The employee health complaints could not be related to any identifiable environmental contaminant. Potential employee exposure to asbestos and lead in the basement area are of concern. Recommendations provided in Section IX of this report address employee comfort issues, and potential exposures to lead and asbestos.

Keywords: SIC 8211 (Educational Facilities) Indoor Air Quality, Asbestos, Carbon Dioxide, Temperature, Indoor Environmental Quality, Relative Humidity, Lead

II. INTRODUCTION

On November 4, 1991, and on January 14, 1992, the National Institute for Occupational Safety and Health (NIOSH) conducted on-site surveys at the Rhode Island Department of Education, Providence, Rhode Island. The Health Hazard Evaluation (HHE), requested by Local 2012, A.F.T., Professional Employees Union, was initially conducted in response to health and comfort complaints including tiredness, irritated eyes, dry throat and possible exposures to inorganic lead, carbon monoxide, and friable asbestos. The study included environmental sampling for carbon dioxide, carbon monoxide, RH, temperature, lead, asbestos, and a health symptoms questionnaire.

III. BACKGROUND

The Department of Education Administrative Building, known as the Roger Williams Building, is located at 22 Hayes Street, Providence, Rhode Island. The building shares its parking lot with the University of Rhode Island Extension Division and abuts the Capitol Center Development Project boundary. The Roger Williams Building also houses the Department of Environmental Management. The structure has three floors above ground and one occupied floor below ground. The building is constructed of concrete and brick with re-enforced structural steel. It is approximately 100 years old and was originally designed as a school. The building became a state office building, approximately 20 years ago, and during subsequent years it has been renovated and structurally converted to accommodate administrative needs.

The Department of Education moved to the building in 1981 when the Family Court moved to new quarters. At the present time, the building houses the Department of Elementary and Secondary Education and the Department of Environmental Management. The building contains approximately 94,000 square feet of which 70,000 are unusable. Fire damage was suffered on two occasions; once in 1967 and again in 1978. The building has not been significantly renovated or improved since the first fire. Following the fires, several offices were relocated. The third floor of the east wing, site of the 1978 fire, is presently gutted as is a significant portion of the second floor.

Recently, life saving improvements to meet minimal fire safety standards, an up-grading of the electrical capacity of the building and additional handicapped accessibility to the building were funded with an insurance settlement and federal/state funds. Approximately one month prior to this survey new lighting was installed throughout all basement areas.

On July 29, 1987, an in-house safety and health survey and review of the print shop area was conducted. Several chemical hazards were identified and hazard communication training was recommended. This was the only health and safety survey conducted at this facility.

IV. WALK-THROUGH OBSERVATIONS

The steam for the heating system is generated in the Veterans Administration Building (an adjacent facility), piped to the Roger Williams building, and stored in two hot water/steam holding tanks. The steam is then piped throughout the facility to radiators located in perimeter offices. Employees use small electric space heaters during the winter to supplement the steam heat in their work areas. Non-functional furnace steam pipes in the basement are encapsulated with asbestos-containing materials (ACMs).

The master control unit regulating temperature for the Roger Williams Building is in the State Capitol Center, located several miles away. Air-conditioning is provided by separate, independent window air-conditioning units located in individual perimeter offices. There is no central ventilation or air handling system. The building has no insulation.

The north side of the structure is adjacent to a heavily travelled interstate highway, and vehicle exhaust emissions have repeatedly been the center of employee complaints. The center part of the building contains a large auditorium/gymnasium, which has been closed as a result of the large fire previously mentioned. Broken furniture, filing cabinets, and numerous other furniture articles are randomly stored here, in addition to combustible paints, and other maintenance materials, creating an extremely hazardous condition.

Many windows are taped shut in an attempt to keep out highway dust/grit and to prevent cold drafts during winter. However, numerous poorly caulked windows still allow entrance of dirt/grime generated from the nearby highway and hot/cold air to freely enter all offices. Employees stated that during the summer, broken or improperly installed air-conditioners fail to adequately maintain comfortable temperatures. The few windows which open are not equipped with screens to prevent insect entrance. The heating system fails to adequately heat all office areas. In the basement there are no radiators to supply heat. The only method for suppling heat to this area is by the transfer of heat from steam pipes located on the ceiling.

Many water-damaged and stained ceiling panels were observed throughout the rooms surveyed. In some office areas ceiling tiles were completely missing (Room B-11). Furthermore, in several offices water-stained, damaged and deteriorating carpeting was observed (Room 126).

In several stairwells there were missing and broken stair treads, creating tripping hazards. In one circumstance a rigid plastic floor mat was placed over several missing floor tiles in stairwell landings. Similarly, ceramic floor tiles are either completely missing or broken in many office areas (Room 222B) and hallways, exposing the sub-floor.

Smoking occurs throughout the facility. Smoking was observed in offices, hallways, restrooms and the cafeteria. Pedestal ashtrays are located on all stairwell landings.

Fleas, cockroaches, silverfish and rodents (mice) are abundant throughout the structure. Spraying or baiting is done by managerial request only and on a very limited basis; however, the abundance of these pests does not indicate any decrease in their population. Pesticide application is performed by Rhode Island State employees from the Department of Administration during employee working hours.

Extensive mold growth was observed in Room B-3 (Law and Education Division Office). The cause was apparently due to this area's air-conditioning unit being mounted into an opening which did not lead to the outside of the building, but rather to the underneath area of an enclosed, external staircase entrance to the facility. Air being drawn in from this confined space created a very humid environment, conducive to mold/fungus growth. Extensive mold growth on perimeter walls was also observed (Room B-7).

When Department of Environmental Management (DEM) employees park DEM vehicles in basement level parking areas, and do not turn-off vehicle engines, exhaust emissions infiltrate several work areas.

Asbestos containing materials (ACMs) are in place around boilers, furnaces, and steam pipes along perimeter walls and the basement ceiling. In many areas this asbestos is friable. Employees must travel through these areas to reach the outside vehicle parking areas. In these same areas, brick walls (perimeter and internal) are painted with lead-containing paint, which is chipping and flaking, accumulating on the floor.

Two employees operate printing presses located on the basement level. There are three, multi-lithe presses and one letter press. There was an extensive oil leak under the Multi-press, Model FR 6427, and numerous flammable liquids both stored and used in this work area. Employees were observed smoking in this room. Employees stated that they had no material safety data sheets (MSDS) on the hazardous chemicals used in their work area, nor had they ever received training on these chemicals addressing personnel protective equipment or the hazards associated with exposure to these chemicals. There was no ventilation available to exhaust chemical vapors from this area.

In the Plate Development Room (B-10), as in the Print Room, hazardous chemicals are used and stored. The employee had not received training on the hazardous chemicals used in that work area.

There was a fire extinguisher sign located at Room B-10, (Dark Room); however, there was no fire extinguisher available at this location.

At Room 313/314 the wall-mounted fire extinguisher was not readily accessible; access was obstructed by unused furniture and boxes.

At Room B-116 the means of egress, and the panic bar are broken on the exit door.

At the foot of the staircase between levels 1 and 2 leading to the basement, there is random storage of paper products, files and numerous cardboard boxes, constituting a potential fire hazard. Adjacent to rooms 313/314 and 201/202, there was miscellaneous and random storage of cardboard boxes, creating a potential fire hazard.

In the basement areas, particularly under each stairwell landing (2 were observed), there was excessive random storage of cardboard boxes, files, paper products and broken furniture, creating a fire hazard.

V. EVALUATION DESIGN AND METHODS

Measurements were obtained for temperature, relative humidity, carbon dioxide and carbon monoxide. Environmental sampling was performed for ACM's and lead.

(A) CARBON DIOXIDE - (CO_2)

Carbon dioxide concentrations were measured in office areas, general work areas and hallways, using a Draeger pump and colorimetric detector tubes. The measurement range for the detector tubes was 0.01-0.3% (100-3000 PPM).

(B) CARBON MONOXIDE - (CO)

Carbon monoxide concentrations were obtained using two different direct reading measurement tools. An Energetics Science, Inc., Model 1735, Series 2000, CO Ecoloyzer was used to assess continuous CO levels at intermittent times during the survey, and CO colorimetric detector tubes were used with a Draeger intermittent bellows pump.

(C) TEMPERATURE AND RELATIVE HUMIDITY

Temperature and RH were measured in employee work areas using a Cole-Parmer LCD Digital Hygrometer, Model 3309-50.

(D) ASBESTOS-CONTAINING MATERIALS (ACMs)

Assessment of ACMs was performed by initially procuring bulk samples of boiler and steam pipe encapsulating materials. General area air samples for friable environmental asbestos were conducted using high volume (2.0 liters/minute) MSA sampling pumps equipped with three stage cassettes.

Three bulk samples, and five 25 mm mixed cellulose ester (MCE) filters were submitted for asbestos analysis by polarized light (PLM), phase contrast (PCM), and transmission electron microscopy (TEM).

NIOSH investigators use phase contrast microscopy (NIOSH Method 7400)[37] to determine airborne asbestos exposures, and electron microscopy (NIOSH Method 7402)[37] to confirm them. The limits of detection and quantitation depend on sample volume and quantity of interfering dust. The limit of detection is 0.01 fiber/cc in a 1,000-liter air sample for atmospheres free of interferences. The quantitative working range is 0.04 to 0.50 fiber/cc in a 1,000-liter air sample.

Bulk samples were submitted for asbestos analysis, and were analyzed for percent and type of asbestos. Samples were examined for homogeneity. Non-homogeneous samples are ground to insure homogeneity. Microscope slides were prepared from each sample using a 1.55 refractive index liquid. The slides are then scanned for the presence of asbestos utilizing polarized light microscopy and dispersion staining techniques. The percentage of fibrous asbestos is estimated by a microscopic examination of the sample.

(E) LEAD

Samples of paint from the walls and ceiling of the boiler room were submitted for lead analysis by means of atomic adsorption spectroscopy according to NIOSH Method 7082 (modified for bulk sample analysis).

A 1.04 gram portion was weighed out and placed in a 125 ml Phillips beaker. The sample was digested with 3 ml nitric acid and 1 ml of a 30% hydrogen peroxide solution. The sample was covered by a watchglass and placed on a hotplate at approximately 150 degrees C until the sample was reduced to 0.5 ml. The beaker was then taken off the hotplate and let cool to room temperature. The sample was then quantitatively transferred to a 25 ml volumetric flask, using double-distilled water. The limit of detection was 4.0 µg/g. The limit of quantitation was 13.0 µg/g.

(F) QUESTIONNAIRE

The NIOSH indoor air quality health and comfort symptoms questionnaire was distributed to 65 Rhode Island Department of Education employees. Responses were received from 52 employees. Questionnaires were designed to evaluate the symptoms normally attributed to complaints associated with building-related illness or comfort. The questionnaire also sought to characterize the type and frequency of reported employee health symptoms.

VI. EVALUATION CRITERIA

(A) GENERAL OVERVIEW

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 adverse 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; thus, such contact may contribute to the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations,[1] 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values[2] (TLVs), and 3) the United States Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards[3] (Permissible Exposure Limits - PELs). The OSHA standards may be required to take into account the economic feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits (RELs), 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, it should be noted that industry is required by the Occupational Safety and Health Act of 1970 (29 CFR 1910) to meet those levels specified by an OSHA standard. A time-weighted average (TWA) exposure refers to the average airborne concentrations of a substance during a normal 8-10 hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures.

(B) INDOOR AIR QUALITY

NIOSH investigators have completed over 1100 investigations of the occupational indoor environment in a wide variety of non-industrial settings. The majority of these investigations have been conducted since 1979.

The symptoms and health complaints reported to NIOSH by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

A number of published studies have reported high prevalence of symptoms among occupants of office buildings.[4-8] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[9,10] Among these factors are imprecisely defined characteristics of heating, ventilating, and air-conditioning (HVAC) systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[11-16] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related than any measured indoor contaminant or condition to the occurrence of symptoms.[17-19] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[19-22]

Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by Legionella bacteria. Sources of carbon monoxide include vehicle exhaust and inadequately ventilated kerosene heaters or other fuel-burning appliances. Exposure to boiler additives can occur, if boiler steam is used for humidification or is released by accident.

Problems NIOSH investigators have found in the non-industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and relative humidity conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, these problems could not be directly linked to the reported health effects.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[23-25] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[26,27] The ACGIH has also developed a manual of guidelines for approaching investigations of building-related complaints that might be caused by airborne living organisms or their effluents.[28]

Measurement of indoor environmental contaminants has rarely proved to be helpful in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proved relationship between a contaminant and a building-related illness. The usual low-level concentrations of particles and variable mixtures of organic materials found are troublesome to understand. However, measuring ventilation and comfort indicators such as carbon dioxide (CO_2), temperature and relative humidity, is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

NIOSH and the Environmental Protection Agency (EPA) jointly published a manual on building air quality, written to help prevent environmental problems in buildings and solve problems when they occur.[29] This manual suggests that indoor environmental quality (IEQ) is a constantly changing interaction of a complex set of factors. Four of the most important elements involved in the development of IEQ problems are: (1) a source of odors or contaminants; (2) a problem with the design or operation of the HVAC system; (3) a pathway between the contaminant source and the location of the complaint; 4) and the building occupants. A basic understanding of these factors is critical to preventing, investigating, and resolving IEQ problems.

The basis for monitoring carbon dioxide, temperature and relative humidity are presented below:

(1) Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of fresh are being introduced into an occupied space. Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2

concentration (range 300-375 PPM). When indoor CO_2 concentrations exceed 1,000 PPM in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased.

(2) Temperature and Relative Humidity

The perception of comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants will find the environment thermally comfortable. The ASHRAE "comfort chart" is presented in Appendix B. The acceptable ASHRAE humidity range for sedentary people is a dew point temperature between 35 and 62 degrees F. This is generally equivalent to a RH between 30% and 50%.

A RH below 30% may be associated with increased discomfort from drying of mucous membranes. High RH (above 70%) may promote fungal growth.[29] If possible, sources are found where biological contaminants may be growing or if visible growth is identified, the sources should be removed as a preventative measure.

(C) TOXICOLOGY

Brief discussions of the toxicological properties of carbon monoxide, asbestos fibers and lead are provided below:

(1) Carbon Monoxide[30-33]

Carbon monoxide (CO) is a colorless, odorless gas, slightly lighter than air. It is produced in the presence of incomplete combustion of carbon-containing compounds. The major sources of human exposure to CO are engine exhausts, tobacco smoke, and inadequately-ventilated combustion products from appliances and heaters that use natural gas, propane, kerosene or similar fuels. The combination of incomplete combustion and inadequate ventilation can result in overexposure to this gas.

The danger from overexposure to this gas arises from its affinity for the hemoglobin (Hb) molecule in red blood cells. Hemoglobin is the oxygen carrier in the blood. On inhalation, CO acts as a metabolic asphyxiant, causing a decrease in the amount of oxygen delivered to the body tissues. CO, upon entering the lungs and diffusing across lung tissue membranes and into the capillary blood network, combines with Hb to form carboxyhemoglobin which, in turn, decreases the amount of free Hb still available for oxygen transfer (or oxygen-carrying capacity) to body tissues. Hb affinity for carbon monoxide molecule is 300 times its affinity for oxygen.[31]

Intermittent exposures to CO are not cumulative in effect and, in general, symptoms occur more acutely only with high exposure concentrations to CO. The hazard of exposure to CO is compounded by the insidiousness with which high concentrations of CO-Hb can be attained without marked physiological symptoms. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness and nausea. These initial symptoms may advance to vomiting, loss of consciousness and collapse, if prolonged or high exposures are encountered. Coma and death may follow if high exposures continue without intervention.[32]

Long-term, low-level exposures to CO can increase the risk of heart attack in some people. The myocardium is more sensitive than any other muscle tissue to the decreased amount of available oxygen in blood, as can be caused by exposure to CO. Not surprisingly, there is substantial evidence of an association between exposure to CO and disturbances of the cardiovascular system, including some limited evidence of an increased risk of myocardial infarction among persons living in environments with high CO levels.[33]

The regulatory criteria used to evaluate occupational exposures to CO are:

OSHA -	Permissible Exposure Limit (PEL)	- 35 PPM - TWA
		- 200 PPM - Ceiling
NIOSH -	Recommended Exposure Limit (REL)	- 35 PPM - TWA
		- 200 PPM - Ceiling
ACGIH -	Threshold Limit Value (TLV)	- 50 PPM - TWA
		- 400 PPM - STEL
US EPA -	Ambient Air Quality Standard	- 9 PPM - 8 hr.

TWA = 8-hour time-weighted average
Ceiling = level not to be exceeded at any time
STEL = short-term exposure limit, a 15-minute TWA which should not be exceeded at any time during a work day

For a non-industrial environment, such as an office building, the criterion most appropriate to evaluate carbon monoxide exposure is the 8-hour ambient air quality standard of 9 PPM.

(2) ASBESTOS-CONTAINING MATERIALS (ACM)[34-37]

(a) Toxicity of Asbestos - Health Effects

Increased health risk resulting from occupational exposure to asbestos has been well documented in the scientific literature. Initially, asbestos was associated with a chronic and debilitating lung disease called asbestosis which normally occurred following long-term exposures to high levels of asbestos fibers. Asbestos has also been linked to several types of cancer, including mesothelioma (a rare cancer of the chest and abdominal lining) and cancers of the lung, esophagus, stomach, and colon. These cancers usually appear many years after the initial contact with asbestos, and sometimes result from short-term and/or low level exposures. This indicates that there may not be a "safe" level of exposure to asbestos for the elimination of all cancer risk. Additionally, cigarette smoking in combination with asbestos exposure greatly increases the risk of developing lung cancer.

(b) Occupational Standards

NIOSH recommends as a goal the elimination of asbestos exposure in the workplace; where it cannot be eliminated, occupational exposure to asbestos should be limited to the lowest possible concentration.[34] This recommendation is based on the proven carcinogenicity of asbestos in humans and on the absence of a known safe threshold concentration.

NIOSH contends that there is no safe concentration for asbestos exposure. Virtually all studies of workers exposed to asbestos have demonstrated an excess of asbestos-related disease. NIOSH investigators therefore believe that any detectable concentration of asbestos in the workplace warrants further evaluation and, if necessary, the implementation of measures to reduce exposures.[34]

The OSHA PEL for asbestos limits exposure to 0.2 fiber/cc as an 8-hour TWA.[35] OSHA has also established an asbestos excursion limit for the construction industry that restricts worker exposures to 1.0 fiber/cc averaged over a 30-minute exposure period.[36,37]

(3) LEAD[38-45]

(a) Toxicity of Lead - Health Effects

Lead has been found to have profound adverse effects on the health of workers in the lead industry.[38] Inhalation, the most important source of lead intake, and ingestion result in damage to the nervous, urinary and reproductive systems.[39] The adverse health effects associated with exposure to lead range from acute, relatively mild, perhaps, reversible stages such as inhibition of enzyme activity, reduction in motor nerve conduction velocity, behavioral changes, and mild central nervous system (CNS) symptoms, to permanent damage to the body and chronic disease.

The signs and symptoms of severe lead intoxication which occur at blood lead levels of 80 micrograms per 100 grams (µg/g) and above are well documented.[39] The symptoms of severe lead intoxication include loss of appetite, metallic taste in the mouth, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pains, fine tremors, numbness, dizziness, hyperactivity, and colic. In lead colic, there may be severe abdominal pain, such that abdominal surgery mistakenly has occasionally been performed.

Evidence accumulated in both adults and children indicates that toxic effects of lead have both central and peripheral nervous system manifestations. The effects of lead on the nervous system range from acute intoxication, coma and cardio-respiratory arrest to mild symptoms, subtle behavioral changes, and electrophysiologic changes associated with lower level exposure. In fact, these effects can occur at blood lead levels of less than 80 micrograms.

With respect to the renal system, it is apparent that kidney disease from exposure to lead is more prevalent than previously believed. The hazard here is compounded by the fact that routine screening is ineffective in early diagnosis. Renal disease may be detected through routine screening only after about two-thirds of kidney function is lost or when manifestation of symptoms of renal failure are present.

Overexposure to lead has profoundly adverse effects on the course of reproduction in both males and females. In the case of male workers, there is evidence of decreased sexual drive, impotence, decreased ability to produce healthy sperm, and sterility.[40]

The blood lead test is one measure of the amount of lead in the body and is the best available measure of recent lead absorption. The free erythrocyte protoporphyrin (FEP) level is a measure of interference with hemoglobin production at the time the red blood cells are made. Lead affects heme synthetase, the last enzyme in heme synthesis. Although some diseases and iron deficiency anemia can cause a rise in FEP, in a healthy individual working with lead, lead absorption is the most likely cause for such an increase. Further, the FEP level becomes elevated when the blood lead level reaches about 40 µg/dl in men and 30 µg/dl in women, and since the average life span of a red blood cell is 120 days, the FEP reflects the blood lead level over the preceding 3 to 4 months. Normal FEP levels are below 50 µg/dl.

Adults not exposed to lead at work usually have a blood lead concentration less than 30 micrograms per deciliter (µg/dl); the average is less than 15 µg/dl.[39] In 1985, the Centers for Disease Control (CDC) recommended 25 µg/dl as the highest acceptable blood level for young children.[41] Since the blood lead concentration of a fetus is similar to that of its mother, and since the fetus's brain is presumed to be at least as sensitive to the effect of lead as a child's, the CDC advised that a pregnant woman's bloodlead level be below 25 µg/dl.[41] Recent evidence suggests that the fetus may be adversely affected at blood lead concentrations well below 25 µg/dl.[42] Furthermore, there is evidence to suggest that levels as low as 10.4 µg/dl affect the performance of children on educational attainment tests, and that there is a dose-response relationship with no evidence of threshold or safe level.[43,44] Lead levels between 40-60 µg/dl in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 - 100 µg/dl represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 µg/dl are considered to be extremely dangerous and often require hospitalization and medical treatment.

(b) HUD Recommendations - Interim Guidelines[45]

Currently, there are no Federal standards governing the level of lead in surface dust in either occupational or non-occupational (i.e., residential) settings. However, lead-contaminated surface dust in either setting represents a potential exposure to lead through ingestion, especially by children. In workers, this may occur either by direct hand-to-mouth contact with the dust, or indirectly from hand-to-mouth contact via clothing, cigarettes, or food contaminated by lead dust. Standards established by HUD as final clearance standards for lead in house dust after lead abatement are an indication of what is "clean": floors, 200 micrograms per square foot (µg/ft^2); walls and window sills, 500 µg/ft^2; and window wells, 800 µg/ft^2. HUD also recommends the standard for floors be applied to exterior porches.[45] These criteria were not based on epidemiology, but were empirically established as feasible limits for clearance following final cleaning during residential lead-based paint abatement. HUD recommends the use of these criteria until they are refined or replaced through additional research.

Paint fines, chips, and dust collected in the bulk samples, obtained in the boiler room in the basement of the facility, were contaminated with lead.

VII. RESULTS

(A) COMFORT PARAMETERS

All environmental measurements for temperature, RH, carbon dioxide and carbon monoxide are presented in Tables I and II. In the employee work areas surveyed on January 14, 1992, air temperatures were between 73^o and 77^{o}F with RH between 35% and 42%.

(B) CARBON DIOXIDE AND CARBON MONOXIDE

Carbon dioxide and carbon monoxide concentrations were measured in all areas where temperature and relative humidity data were obtained. Carbon dioxide concentrations ranged from a low value of 500 PPM to a high value of 900 PPM.

Carbon monoxide values ranged from none detected (ND) to 3 PPM.

(C) QUESTIONNAIRE

Sixty-five indoor air quality questionnaires, which addressed health symptoms, were distributed to employees. Fifty-two questionnaires were returned (80%). Of that number 55% reported that they suffer from allergies and that 59% reported they frequently experience both headache and fatigue. Other reported symptoms included frequent upper respiratory illness (50%), eye irritation (46%) and skin itch, redness or irritation (29%).

During several independent employee-requested interviews, employees stated that they suffered from adverse health symptoms which include allergic reactions to dirt, dust and molds, chronic eye irritations, asthma, sinusitis, headache, fatigue, general malaise, and non-specific upper-respiratory ailments. These adverse health symptoms abated during weekends or when away from the work environment, however, promptly reoccurred upon returning to work.

(D) ASBESTOS

The results of the TEM analysis performed on filters indicated that chrysotile bundles or clusters (1.5 μm x 5.5 μm and 3.5 μm x 4 μm) were detected on two (2) of the five (5) air samples. The results of the PLM analysis on the three (3) bulk samples indicated that chrysotile asbestos was present at between 30% and 50%. Amosite, crocidolite, actinolite/tremolite or anthophyllite asbestos was not detected in any of the samples.

(E) LEAD

Samples of paint from the walls and ceiling of the boiler room were submitted for lead analysis by means of atomic adsorption spectroscopy according to NIOSH Method 7082 (modified for bulk sample analysis).

Inorganic lead was detected in the two bulk samples of paint from the boiler/furnace room. Lead in each of these samples was reported to be 0.44% and 2.19% based on an average percent by weight of the total sample submitted for analysis.

VIII. DISCUSSION

There is no mechanical means for supplying fresh outside air to the building. This lack of air handling units results in a lack of supply air to restroom facilities, which also have no exhaust air systems.

Based on observations, environmental measurements, the lack of a mechanical means for supplying outside air, the lack of immediate control over facility heating capabilities, air-conditioning units which are in disrepair and other identified problems (which have been presented in this report), it appears extensive repair/renovation to this facility seem appropriate.

Carbon monoxide concentrations were below established regulatory standards.

Potential asbestos and lead contaminants present an immediate health concern. Employee exposure to either asbestos or lead may result if the source of these contaminants is disturbed (episodic exposure). The most important route of exposure for lead is hand-to-mouth. Smoking should not occur in any areas where there is potential exposure to lead or asbestos.

NIOSH recommends as a goal the elimination of asbestos exposure in the workplace; where it cannot be eliminated, occupational exposure to asbestos should be limited to the lowest possible concentration.[34] This recommendation is based on the proven carcinogenicity of asbestos in humans and on the absence of a known safe threshold concentration.

NIOSH contends that there is no safe concentration for asbestos exposure. Virtually all studies of workers exposed to asbestos have demonstrated an excess of asbestos-related disease. NIOSH investigators therefore believe that any detectable concentration of asbestos in the workplace warrants further evaluation and, if necessary, the implementation of measures to reduce exposures.[34]

Similarly, inorganic lead, resulting from potentially airborne lead-containing paint particulates which can episodically be distributed, presents an immediate health concern.

Currently there are no Federal standards governing the level of lead in surface dust in either occupational or non-occupational settings. However, lead-contaminated surface dust in either setting represents a potential exposure to lead through ingestion; and, this exposure can occur either by direct hand-to-mouth contact with the dust, or indirectly from hand-to-mouth contact via clothing, cigarettes, or food contaminated by lead dust.

IX. RECOMMENDATIONS

(1) Friable asbestos was observed on furnace structures and steam-pipe lagging in the basement, and should be completely encapsulated or abated. The exposed friable asbestos fibers have resulted from deterioration, poor maintenance operations and general disrepair.

The ACMs covering the steam pipes and boiler should be completely removed as soon as practical. This removal should be performed by a reliable contractor experienced in asbestos abatement.

Prior to removal, the building can be used for normal work activities providing certain interim precautionary measures are taken to minimize the employees exposure to asbestos.

(2) The following guidelines are recommended regarding the asbestos hazards:

a) Employees should be made aware of the health hazards associated with exposure to asbestos and the precautionary actions necessary. NIOSH publication, #81-103, Workplace Exposure to Asbestos, should be made available for employee information and distribution.

An additional recommendation would be to procure training tapes for instructional and informational purposes to inform your employees about asbestos hazards and exposure.

b) Regular housekeeping of accumulated dust on workplace surfaces in the basement area should be performed to reduce any possible employee exposure to asbestos. Only wet janitorial techniques should be employed to prevent the re-dispersion of settled dust, which may contain asbestos fibers. All uncarpeted floors in the basement should be thoroughly damp wiped to remove any previously settled dust. Thereafter, these wet janitorial techniques should be used for routine cleaning purposes. All carpeting and upholstered furnishings in areas where possible asbestos exposure occurs should be cleaned only with a high-efficiency particulate air (HEPA) filter vacuum system.

c) Maintenance activities involving ACM's should not be performed until appropriate abatement has been completed.

d) There are no signs to warn workers of the presence of asbestos on the pipe lagging and boiler insulation. Signs should be posted wherever asbestos insulation is found warning employees of the presence of asbestos and the safety measures required whenever the asbestos is being cut, repaired, or disturbed.

(3) Due to potential lead exposure from lead-containing paints in the boiler room, surface monitoring for employee exposure to inorganic lead should be performed throughout the entire basement, and in all other locations of this facility where lead paint has been used. Depending on these results, it may be necessary to manually clean and vacuum lead-contaminated areas using a high-efficiency particulate air (HEPA) filtering system. (CAUTION - Clean-up, if not properly conducted, may create a worse exposure situation than currently exists.)

The U.S. Department of Housing and Urban Development (HUD) prepared guidelines for removing lead-based paint which were published in the Federal Register, April 18, 1990, pages 14556-14614. All lead-containing paint should be removed from areas where it is located and these areas repainted with a non-lead containing paint. Contractors, hired to remove the lead paint, should be asked about their qualification, experience removing lead-based paints, and the plans to follow Federal and State lead-paint-removal guidelines.

(4) The absence of a source of outside supply air to ventilate this building creates a major ventilation deficiency. A heating, ventilation and air-conditioning (HVAC) system should be installed, which has the capabilities of supplying fresh outside air at the rate of 20 CFM per occupant.

The air handling system should adhere to the following items:

a) The HVAC system should be installed, tested and balanced by a licensed ventilation engineer to insure that all employee occupied work spaces are provided with 20 cubic feet per minute (CFM) per person of outside air and that this supplied air is both properly delivered and properly distributed to these employee work areas.

b) In addition to adherence to ASHRAE ventilation guidelines[26] ASHRAE comfort guidelines[27] for temperature and RH should also be met.

(5) Immediately, and on a continuing basis after installation of the new HVAC system, management should institute and maintain ventilation records which include the following data:

a) Accurate maintenance, and preventative maintenance logs should be kept regarding air-handler filter changing schedules and other related maintenance operations.

b) Institute a regularly scheduled cleaning maintenance protocol for all ceiling supply diffusers.

c) Institute a yearly preventative maintenance schedule to include temperature sensor calibration, and an inspection of all the moving/working parts of the HVAC system.

d) Inform appropriate HVAC personnel when redesigning office space or installing new walls or room dividers. When cubicles are established in office spaces, or when new confining walls or room dividers are introduced, building management and HVAC personnel should be consulted and involved so that the rearrangement of employee work cubicles does not block and/or impede the effectiveness of the HVAC system.

(6) Environmental Monitoring - If HVAC systems are properly maintained as described in the previous paragraphs, periodic environmental monitoring needs should be limited to measuring the concentration of carbon dioxide, temperature and RH to determine whether systems are performing as designed. A reasonable requirement would be to monitor seasonally, perhaps twice per season routinely, or as needed by your staff if deficiencies are suspected.

(7) All restroom facilities throughout the building should be supplied with the ASHRAE recommended rate of 50 cubic feet per minute (CFM) of air per stall. Furthermore, all restrooms should be equipped with a dedicated exhaust system to evacuate odors from the building. Restrooms should also be kept under negative pressure.

(8) Serious consideration should be given to providing a separate and dedicated supply and exhaust ventilation for the print room (Room B-10). Volatile printing chemicals were observed in use and stored during printing operations. A separate local exhaust system with localized collection hoods (using an elephant trunk application) to capture volatile chemicals at their point of origin should also be considered for the printing machines and presses. Localized exhaust ventilation will prevent a buildup of chemical vapors.

(9) Consideration should be given to the establishment of a formal and enforced "NO-SMOKING" policy that permits smoking only in designated areas that are exhausted to the outside. This written "NO-SMOKING" policy should be strictly enforced in all general office work areas.

It is important to recognize that tobacco smoke is potentially a major contributor to indoor air quality problems.[46-50] Tobacco smoke contains several hundred toxic compounds, the more important are: carbon monoxide, nitrogen dioxide, hydrogen cyanide, formaldehyde, hydrocarbons, ammonia, benzene, hydrogen sulfide, benzo(a)pyrene, tars and nicotine. Tobacco smoke can irritate the respiratory system, and in allergic or asthmatic individuals, it often results in eye and nasal irritation, coughing, wheezing, sneezing, headache and other related sinus problems. People who wear contact lenses often complain of burning, itching and tearing eyes when exposed to cigarette smoke.[46-50] The ASHRAE ventilation guidelines for smoking areas and lounges recognize the need to provide additional ventilation (fresh outside air) to maintain air quality. However, eliminating or reducing the contamination of indoor air with cigarette smoke is a better solution. This can be effectively accomplished by restricting smoking only to those areas where indoor air is exhausted directly to the outside and not recirculated.

As a Public Health Agency, NIOSH encourages the prohibition or restriction of smoking in the workplace. Elimination or reducing contamination of the environmental air supply with cigarette smoke is a recognized method of improving the indoor air quality. Restriction of smoking to designated areas (preferably with dedicated exhausts to the outside) is a means to attain this end. By allowing employees in other areas of the Immigration Department work areas to smoke, cross-contamination via the ventilation system and passive environmental air currents within the work space occur, since each office or work area is not specifically isolated from other work areas.

(10) A flammable liquid storage cabinet should be placed in the printing room for storage of flammable and combustible liquids.

(11) A Hazard Communication Program should be developed and implemented which informs employees of the hazards with the chemicals they use or come in contact with when performing printing press operations, such as multi-lithe electrostatic solution, inks, deglazing solutions and padding adhesives. The program should include training (relative to personnel protective equipment usages and limitations), hazardous chemical labeling, and material safety data sheet (MSDS) instruction, as referenced in the Occupational Safety and Health Administration's, (OSHA), 29 CFR 1910.1200 Standard.

It is further recommended that training also be instituted for personnel working in the dark room and performing film processing/developing operations. This training should also be in accordance with OSHA 29 CFR 1910.1200 (h), whereby employees are informed and trained relative to the hazards associated with the chemicals used during film processing and developing procedures and the associated incompatibilities related to these chemicals and their usage.

(12) Oil leaks were observed under printing presses, in particular, multi-press, Model FR-6427. The use of drip pans and dry-it-up granules should only be used as a temporary measure. All leaks should be repaired promptly, as this presents a slip and fall hazard as well as an additional source of combustible materials and volatile organic chemical (VOC) source as an environmental air contaminant.

(13) Employees smoke in the printing press room, where a flammable liquid (#24-2030 spirit fluids, containing 50% methanol) is stored and used. Smoking materials and other ignition sources must be removed from this work area as long as flammable liquids are used and stored there.

(14) Quick wash facilities and eye washing stations were not available in the Print Room or the Development/Dark Room where hazardous chemicals are used and stored.

(15) The damaged or missing ceiling tiles in employee work areas (Rooms 307 and 316) should be repaired or preferably replaced. Damaged ceiling tiles allow debris located above the suspended ceiling to fall on employees or into their work areas.

Water-damaged and water-stained ceiling tiles should be discarded and replaced with new ceiling tiles. Water-damaged ceiling tiles provide an excellent media for mold and fungus growth.

(16) The water-damaged carpeting located in several offices (Room 126) should be discarded. Water-damaged fabric becomes an ideal location for the growth of molds and fungus.

NIOSH recommends removal of water-damaged carpeting from the work environment, once it has been damaged. Replacement of the carpeting with an appropriate tile floor-covering is frequently suggested. Tile floor coverings are available which have absorption qualities for noise reduction, (necessary for quiet work areas), can be easily cleaned, and will not stain.

(17) Large accumulations of dirt, dust and soot were visible on most window sills (Rooms 313, 316 and 215), and housekeeping practices should be increased to eliminate a dispersal potential.

(18) Many employees were observed operating video display terminals (VDT). Many of these VDTs were not equipped with non-glare filters on the screens. Non-glare screens should be provided for employees, since employee complaints of headache and eye irritation were frequent. Also suggested is familiarization by the managerial staff and employees with NIOSH Publication No. 81-119, "Potential Health Hazards of Video Display Terminals" and NIOSH Publications on Video Display Terminals.

(19 Insect and rodent infestations can be controlled or eliminated by routine application of pesticides. Pesticide application should be conducted on weekends or holidays when Department of Education employees are not at work, so that their potential exposure to pesticides and fumigants will be avoided.

(20) Broken stair treads on two stairways should be repaired; level 1 and 2 on the southerly side of the building, located adjacent to Rooms B-10 and B-8, and the northerly stairway in the basement.

This document constitutes the final report of this investigation. In order to comply with our regulations regarding the supplying of this information to affected employees (42 CFR, Part 85.11), this report must be posted in a prominent place, accessible to all employees, for a period of 30 calendar days. If you have any questions or comments regarding the content of this report, or require additional assistance, please feel free to contact this office directly at (617) 565-1440.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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Copies of this report have been sent to:

1. Commission of Education, Department of Education, Room 213, 22 Hayes Street, Providence, Rhode Island 02908

2. A.F.S.C.M.E., Council 94-Local 2872, 1179 Charles Street, North Providence, Rhode Island 02904
3. Professional Employees Union, Local 2012, A.F.T., 22 Hayes Street, Providence, Rhode Island 02908

4. NIOSH, Cincinnati and Regional Offices

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

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TABLE I
Indoor Air Quality Parameters
R.I Department of Education
Providence, Rhode Island
January 14, 1992
HETA 91-349

Work Location	Carbon Dioxide (PPM)	Relative Humidity (%)	Temperature (Degrees F)	Emply. Occupancy on January 14, 1992
Room 316	500	36.5	73	5
Room 313	600	35.4	73	7
Room 307	700	39.2	73	15
Room 215	600	41.4	74	5
Room 213	550	42.7	74	5
Room 202	700	38.8	73	6
Voc. Ed./ Adult Ed.	700	39.2	75	20
Printing Room	900	41.2	76	2
Room B-11	700	39.4	77	11
Room 126	600	38.5	74	4
Outside Air 10:00 AM 1/14/92	200	52.0	46	N/A
Evaluation Criteria: American Society of Heating, Refrigeration, and Air-Conditioning Engineers Standard 55-1981, Revised Standard 62-1989.				
	<1000	20-60	68-78	N/A

PPM - PARTS PER MILLION

TABLE II

Indoor Air Quality Parameters
R.I. Department of Education
Providence, Rhode Island
January 14, 1992

HETA 91-349

Work Location	Carbon Monoxide (PPM) Ecol.	D.Tube
Back Office	2	ND
Main Office	2	ND-1
Outside Hallway	3	1-2

OSHA = PEL-TWA 35 PPM

NIOSH = REL 35 PPM

PPM = PARTS PER MILLION