HETA 93-0351-2413
APRIL 1994
GOODWILL INDUSTRIES OF AMERICA, INC.
BETHESDA, MARYLAND

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I. SUMMARY

On April 19-20, 1993, National Institute for Occupational Safety and Health (NIOSH) representatives conducted a health hazard evaluation (HHE) at the Goodwill Industries of America, Inc. facility in Bethesda, Maryland. The HHE resulted from a confidential employee request which concerned indoor environmental quality (IEQ) issues, including potential exposures to print shop solvents, second-hand smoke, and water-damaged carpeting.

On April 20, 1993, temperature, relative humidity, and carbon dioxide (CO_2) measurements were made at 25 locations inside and at one location outside the building twice during the day. The heating, ventilating, and air-conditioning (HVAC) units that serviced the facility were opened and visually examined. Information was gathered about building characteristics and questionnaires were distributed to the 70 employees in the office to obtain information regarding employees' symptoms and perceptions of the building environment.

Twenty-three of the 25 indoor CO_2 concentrations (range: 400 to 975 parts per million [ppm]) were less than 1000 ppm, a guideline suggested by American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). An office on the first floor in the east wing and a cubicle area on the first floor of the west wing had CO_2 concentrations of 1100 and 1000 ppm, respectively, in the morning. Temperature (69°F to 80°F) and relative humidity (33% to 45%) measurements during the site visit were within comfort ranges recommended by ASHRAE.

At the time of the NIOSH site visit, the HVAC units seemed well maintained; however, the recirculating HVAC units (heat pumps) were operated in an automatic mode, which resulted in no supply air delivery when temperature setpoints were satisfied. Chemicals from the print shop and environmental tobacco smoke (ETS) were identified as potential contaminants in the recirculating ventilation systems. There was some evidence of water damage.

All of the organic solvent sample concentrations measured for toluene, 1,1,1-trichloroethane, or xylene/ethyl benzene isomers (range: 0.21 to 11 ppm) in the print shop, were below the respective evaluation criteria for occupational exposures. Perchloroethylene concentrations (0.61 and 1.66 ppm) were below the Occupational Safety and Health Administration standard of 100 ppm, however, NIOSH recommends that exposures to perchloroethylene be reduced to the lowest feasible concentration.

Fifty-seven out of 70 questionnaires (81%) were returned and analyzed. The most commonly-reported environmental concerns were thermal comfort, lack of air movement, and smoke odors. The four most frequently-reported symptoms were pain or stiffness in back, shoulders, or neck; stuffy nose or sinus congestion; dry, itching, or irritated eyes; and tired or strained eyes.

Environmental tobacco smoke (ETS) was identified as a health hazard in this building. ETS and chemicals used in the print shop had the potential to enter the recirculating ventilation system. The ventilation systems turned off when not calling for heating or cooling. Recommendations for improving the work environment can be found in Section VIII of this report.

KEYWORDS: SIC 8399 (Social Services, Not Elsewhere Classified), indoor environmental quality, IEQ, environmental tobacco smoke, ETS, carbon dioxide, temperature, relative humidity, organic solvents, trichloroethane, perchloroethylene, toluene, print shop.

II. INTRODUCTION

On December 1, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request to investigate indoor environmental quality (IEQ) at the Goodwill Industries of America, Inc. facility in Bethesda, Maryland. The confidential employee request expressed concern over IEQ issues, including potential exposures to print shop solvents, "second-hand" smoke, and water-damaged carpeting in the office areas. The employees reported symptoms of headache, sore throat, eye irritation, and upper respiratory irritation which they associated with the worksite. In response to this request, a NIOSH site visit was conducted on April 19 and 20, 1993, at this facility. An interim letter with preliminary results was sent to the company and employee representatives in May 1993.

III. BACKGROUND

The Goodwill Industries of America, Inc. facility in Bethesda, Maryland was a brick building, which consisted of a basement and three above grade floors, located in a suburban area. Figures 1-4 are diagrams of each floor, starting with the basement (not to scale). The original structure was built as a summer home in the 1920s, an east addition was added in 1982, and an west addition was added in 1991. Also in 1991, the attic dormers were raised and office space was added on the third floor of the main structure. At the time of the NIOSH site visit, there were approximately 70 employees who occupied the building between 7:30 a.m. and 1:00 a.m.

The building was served by seven recirculating heating, ventilating, and air-conditioning (HVAC) package units with heat pumps. A fixed amount of outside air entered these units from outside intakes on three sides of the building. Outside air mixed with the return air and passed through fiberglass panel filters with a rated efficiency of approximately 30%. Filtered, mixed air then passed through the heating/coiling coils, the fan, supply air ductwork, and was delivered to the occupied space through ceiling and floor diffusers.

The basement (Figure 1) contained the reception area, print shop, mailroom, darkroom, and computer areas. The print shop had its own HVAC system and a wall exhaust fan that led directly outside. It was equipped with three presses which used rubber-based ink and one press which used oil-based inks. The computer room in the basement floor had a separate air-conditioning humidification system that used supply air from one of the package units. The first floor (Figure 2) and second floor (Figure 3) floors contained office space. The second floor also had a film editing area. The third floor (Figure 4) contained office space and the employee lounge. The offices and the hallways were carpeted and the print shop area had tile and concrete floors. The majority of the office staff had access to windows that could be opened. All of the windows had blinds or curtains for shading.

According to management, smoking was allowed in private offices throughout the building if occupants kept the office doors closed and used a portable filtering device. These offices were served by the recirculating ventilation systems.

IV. METHODS

Questionnaire Evaluation

On April 19, 1993, questionnaires were distributed to all 70 employees working in the building. The questionnaire asked if the employee had experienced, while at work on the day of the survey, any of the symptoms (irritation, nasal congestion, headaches, etc.) commonly reported by occupants of "problem buildings." The questionnaire also asked about the frequency of occurrence of these symptoms while at work in the building during the four weeks preceding the survey, and whether these symptoms tended to get worse, stay the same, or get better when they were away from work. The final section of the questionnaire asked about environmental comfort (too hot, too cold, unusual odors, etc.) experienced while the employees were working in the building during the four weeks preceding the questionnaire administration.

Environmental Evaluation

During the environmental evaluation of the building, information was collected using standardized checklists and inspection forms. These forms were grouped to address the whole building, the evaluation area, and the HVAC system. Descriptive information for the building (age, size, construction, location, etc.), the area to be evaluated (size, type of office space, cleaning policies, furnishings, pollutant sources, etc.), and the HVAC systems (type, specifications, maintenance schedules, etc.) was gathered. Inspections of the evaluated area and HVAC systems were conducted to determine current conditions. The purpose of the environmental investigation was to obtain information required to characterize the building, determine the condition of building ventilation systems, and document its current indoor environmental status.

In addition, indicators of IEQ were measured. These indicators were carbon dioxide (CO^2) concentration, temperature (T), and relative humidity (RH). These measurements were collected at 25 locations and outside the building as shown in Figures 1-4. Measurements were made at each location between 10:02-11:42 a.m. and 3:13-5:15 p.m. Smoke tubes were used to visualize airflow in the evaluated area and to determine potential pollutant pathways into this building.

Real-time CO_2 concentrations were measured using a Gastech Model RI-411A, portable CO_2 indicator. This portable, battery-operated instrument uses a non-dispersive infrared absorption detector to measure CO_2 in the range of 0-4975 parts per million (ppm), with an accuracy of ±25 ppm. Instrument zeroing and calibration were performed prior to use with zero air and a known concentration of CO_2 span gas (800 ppm).

Real-time temperature and humidity measurements were made using a Vaisala, Model HM 34, battery-operated meter. This meter is capable of providing direct readings for dry-bulb temperature and RH, ranging from -4 to 140°F and 0 to 100%, respectively. Instrument calibration is performed monthly using primary standards.

Organic Solvent Monitoring

One personal breathing zone (PBZ) sample and one area air sample were collected in the print shop on charcoal tubes at a flowrate of 0.2 liters per minute (l/min). One additional

sample was used for qualitative analysis to identify major constituents by gas chromatography/mass spectroscopy (GC/MS) analysis. The charcoal tubes were desorbed with carbon disulfide and screened by gas chromatography/flame ionization detector (GC-FID), according to NIOSH Methods 1003, 1500 and 1501.[1,2,3] Bulk samples of oil-based ink, rubber-based ink, and cleaning solvent were also collected and analyzed for organic component identification. The material safety data sheets (MSDSs) for the compounds used on the print shop were reviewed.

The PBZ and area samples were quantitatively analyzed for the major organic constituents identified in the qualitative sample: toluene, 1,1,1-trichloroethane (TCE), perchloroethylene (PCE), xylene/ethyl benzene isomers, and limonene. Total C_7 - C_{10} hydrocarbons were quantitated against n-octane. The laboratory-assigned limits of detection (LODs) and limits of quantitation (LOQs), and calculated minimum detectable concentrations (MDCs) and minimum quantifiable concentrations (MQCs), assuming a sample volume of 38 liters, are as follows:

Analyte	LOD µg/sample*	LOQ µg/sample*	MDC ppm	MQC ppm	Minimum Volume (liters)
TCE	2	7	0.01	0.03	38
Toluene	1	4	0.007	0.03	38
PCE	2	6	0.008	0.02	38
Xylene/ Ethyl Benzene	30	120	0.18	0.73	38
Limonene	11	30	0.05	0.14	38

* = micrograms per sample (µg/sample)

The analytical LOD and LOQ for C_7 - C_{10} hydrocarbons were 9 micrograms (µg) and 25 µg per sample, respectively. These values equate to a MDC of 0.24 milligrams per cubic meter (mg/m^3) and a MQC of 0.66 mg/m^3, assuming a sampling volume of 38 liters.

V. EVALUATION CRITERIA

To assess the hazards posed by workplace exposures, industrial hygienists use a variety of environmental evaluation criteria. These criteria propose exposure levels to which most employees may be exposed for a normal working lifetime without adverse health effects. These levels do not take into consideration individual susceptibility, such as pre-exiting medical conditions, or possible interactions with other agents or environmental conditions.

Evaluation criteria for chemical substances are usually based on the average PBZ exposure to the airborne substance over an entire 8- to 10-hour workday, expressed as a time-weighted average (TWA). To supplement the 8-hr TWA where there are recognized adverse effects from short-term exposures, some substances have a short-term exposure limit (STEL) for 15-minute peak periods; or a ceiling limit, which is not to be exceeded at any time. Additionally, some chemicals have a "skin" notation to indicate that the substance may be absorbed through direct contact of the material with the skin and mucous membranes.

The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),[4] the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs),[5] and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[6] Evaluation criteria change over time with the availability of new toxicologic data.

The OSHA PELs reflect the economic feasibility of controlling exposures in various industries, public notice and comment, and judicial review; whereas the NIOSH RELs are based primarily on concerns related to the prevention of occupational disease. An additional complication is due to the fact that a Court of Appeals decision vacated the OSHA 1989 Air Contaminants Standard in *AFL-CIO v OSHA,* 965F.2d 962 (11th cir., 1992); and OSHA is now enforcing the previous 1971 standards (listed as Transitional Limits in 29 CFR 1910.1000, Table Z-1-A).[6] However, some states which have OSHA-approved State Plans will continue to enforce the more protective 1989 limits. NIOSH encourages employers to use the 1989 limits or the RELs, whichever are lower.

Indoor Environmental Quality

Indoor environmental quality (IEQ) is affected by the interaction of a complex set of factors which are constantly changing. Four elements involved in the development of IEQ problems are:

- sources of odors or contaminants,
- problems with the design or operation of the HVAC system,
- pathways between contaminant sources and the location of complaints,
- and the activities of building occupants.

A basic understanding of these factors is critical to preventing, investigating, and resolving IEQ problems.

The symptoms and health complaints reported to NIOSH by non-industrial 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. Usually, 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 prevalences of symptoms among occupants of office buildings.[7-11] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[12,13] Among these factors are imprecisely defined characteristics of 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.[14-19] 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 to the occurrence of symptoms than any measured indoor contaminant or condition.[20-22] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[23-25]

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 identified in the non-industrial indoor environment include poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and RH 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 at the present time. With few exceptions, pollutant concentrations observed in non-industrial indoor environments 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] 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 been helpful in determining the cause of symptoms and complaints except where there are strong or

unusual sources, or a proven relationship between contaminants and specific building-related illnesses. The low-level concentrations of particles and mixtures of organic materials usually found are difficult to interpret and usually impossible to causally link to observed and reported health symptoms. However, measuring ventilation and comfort indicators such as CO_2, temperature, and RH has proven useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems. The basis for measurements made during this evaluation are listed below.

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and, if monitored, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, and 15 cfm/person for reception areas, and provides estimated maximum occupancy figures for each area.[26]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 ppm). When indoor CO_2 concentrations exceed 1000 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.

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 55-1992, specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[27]

Environmental Tobacco Smoke

Environmental tobacco smoke (ETS) consists of exhaled mainstream smoke from the smoker and sidestream smoke which is emitted from the smoldering tobacco. ETS consists of between 70 and 90% sidestream smoke. More than 4000 compounds have been identified in laboratory-based studies, including many known human toxins and carcinogens such as carbon monoxide, ammonia, formaldehyde, nicotine, tobacco-specific nitrosamines, benzo(a)pyrene, benzene, cadmium, nickel, and aromatic amines.[29,30] Many of these toxic constituents are more concentrated in sidestream than in mainstream smoke.[31] In studies conducted in residences and office buildings with tobacco smoking, ETS was a substantial source of many gas and particulate polycyclic aromatic compounds.[32]

ETS has been shown to be causally associated with lung cancer and cardiovascular disease in adults, and respiratory infections, asthma, middle ear effusion, and low birth weight in children.[33-35] It is also a cause of annoying odor and sensory irritation. The U.S. Environmental Protection Agency (EPA) has classified ETS as

a known human (Group A) carcinogen.[36] NIOSH considers ETS to be a potential occupational carcinogen and believes that workers should not be involuntarily exposed to tobacco smoke.[37]

Worker exposure to ETS is most efficiently and completely controlled by simply eliminating tobacco use from the workplace. To facilitate elimination of tobacco use, employers should implement smoking cessation programs. Management and labor should work together to develop appropriate nonsmoking policies that include some or all of the following:

- Prohibit smoking at the workplace and provide sufficient disincentives for those who do not comply.
- Distribute information about health promotion and the harmful effects of smoking.
- Offer smoking-cessation classes to all workers.
- Establish incentives to encourage workers to stop smoking.

The most direct and effective method of eliminating ETS from the workplace is to prohibit smoking in the workplace. Until this measure can be achieved, employers can designate separate, enclosed areas for smoking, with separate ventilation. Air from this area should be exhausted directly outside and not recirculated within the building or mixed with the general dilution ventilation for the building. Ventilation of the smoking area should meet general ventilation standards, such as ASHRAE Standard 62-1989, and the smoking area should have slight negative pressure to ensure airflow into the area rather than back into the airspace of the workplace.[37]

Organic Solvents

A list of selected organic solvents along with a brief summary of their primary health effects and respective evaluation criteria for occupational exposures to these contaminants are presented in Table 1.

VI. QUESTIONNAIRE RESULTS

Questionnaires were distributed to the 70 employees working in the building on April 19, 1993. Fifty-seven employees (21 males and 35 females [one respondent did not answer that question]) returned the questionnaires. The average age of the respondents fell in the 30 to 39 years old category. Eleven currently smoked cigarettes, 17 were former smokers, and 11 had never smoked. Respondents had worked in the building for an average of 5.8 years and worked an average of 40 hours per week (range: 9-55). They used a computer for an average of 5.2 hours per day.

The questionnaire results are shown in Table 2. The first column of Table 2 shows the percentage of the 57 respondents who reported the occurrence of symptoms while at work on the day of the survey. Pain or stiffness in back, shoulders, or neck; stuffy nose or sinus congestion; dry, itching, or irritated eyes; and tired or strained eyes are the most commonly reported symptoms.

The second column shows the percentage of employees who reported experiencing the respective symptom once a week or more often while at work during the four weeks preceding the survey. With a few exceptions, these symptom prevalences are more than those for symptoms experienced on the day of the survey.

The third column shows the percentage of employees who reported experiencing the respective symptom once a week or more often while at work during the four weeks preceding the survey and also reported that the symptom tended to get better when they were away from work. This latter criterion has, in some studies of indoor air quality, been used to define a "building related" symptom, but it is possible that a symptom which does not usually improve when away from the building could also be due to conditions at work.

The reported "building-related" frequent symptom prevalences shown in column three, are somewhat lower than the corresponding symptom prevalences over the last four weeks shown in the second column, and were highest for tension, irritability, or nervousness; dry, itching, or irritated eyes; and tired or strained eyes. Overall, twelve of the 57 respondents (21%) reported having one or more symptoms that had occurred at work one or more days a week during the preceding four weeks and tended to get better when away from work.

Table 3 shows results of employee reports regarding environmental conditions at their workstations on the day of the survey and during the four weeks preceding the survey. Column one shows the results for the day of the survey. It shows that 30% of the respondents perceived that the ventilation system was not providing sufficient air movement, 21% thought it was too hot, 18% detected tobacco smoke odors, and 12% felt the air was too dry during at least part of their work day.

The second column shows the responses to the questions about environmental comfort conditions experienced in the facility during the four weeks preceding the survey. Adverse environmental conditions (too hot, too cold, odors, etc.) were considered "frequent" if they were reported to occur at work once a week or more often. The results are generally somewhat higher than those shown in the first column for workstation environmental conditions experienced during the day of the survey. Thirty-seven percent of the respondents reported too little air movement, 28% frequently were too hot, 7% were frequently too cold, 14% felt the air was too dry, and 30% frequently sensed tobacco smoke odors.

VII. ENVIRONMENTAL RESULTS AND OBSERVATIONS

Indoor Environmental Quality

Environmental measurements are presented in Figures 5-7. Indoor CO_2 concentrations (Figure 5) at the 25 monitoring locations ranged from 400 to 1100 ppm. The outdoor CO_2 concentration was 375-400 ppm throughout the day. Twenty-three of the 25 CO_2 concentrations were lower than 1000 ppm, a guideline suggested by ASHRAE.[23] The Accounting Office on the first floor in the east wing had a morning concentration of 1100 ppm. The cubicle area on the first floor of the west wing had a concentration of 1000 ppm in the morning. The windows were closed in those areas during the time of the monitoring. Carbon dioxide measurements over 1000 indicate a potential problem with air circulation and distribution within those offices.

Indoor temperatures (Figure 6) ranged from 69 to 80°F across all areas measured throughout the day. Outside temperatures were 76 to 78°F. Inside RHs (Figure 7) ranged from 33 to 45% and outside RHs were 35%. The temperature and RH measurements were within the acceptable seasonal ranges of operative temperature and humidity suggested by ASHRAE.[24] In general, acceptable temperature and RHs are 74°F-80°F (summer) and 69°F-76°F (winter) at 30%-40% RH. The temperature increased and relative humidity remained stable during the workday in the office areas.

The HVAC systems that serve the building were opened and visually examined. There was no standing water or signs of microbial growth except in one unit that had reportedly been water-damaged in the past from a clogged condensate pan. The unit had flooded the ceiling and carpet on the second floor of the east wing; the damage had not totally been repaired. Fiberglass filters (30% efficiency) were used in all the units, and reportedly changed every 6-8 weeks. Six of the units had outside air intakes with fixed louvers which provided unconditioned fresh air. Preventive maintenance was reportedly performed on each unit biannually by a contractor. The HVAC systems ran only when heating or air-conditioning was called for, otherwise, there was no air flow. Smoke tube patterns showed areas had little or no air movement when the HVAC systems were not running. The thermostats in the office areas are pre-set. According to management, smoking was allowed in private offices throughout the building if occupants kept the doors closed and used a filtering device. These offices were on the recirculating ventilation systems which allowed smoke to be carried throughout the building.

The print shop has its own HVAC system and a wall exhaust fan that led directly outside. The thermostat for the unit in the print shop could be adjusted by print shop staff. The use of the exhaust fan, at high speeds in its current location, interfered with the operation of two presses. Smoke tube flow patterns indicated that air from the print shop flowed into the main corridor of the building and into a recirculating system that served part of the basement and first floors when the exhaust fan was not used. This result was obtained when the basement/recirculating system was running and the print shop HVAC unit was off, when both HVAC units were off, and when both HVAC units were off and the outside door for the print shop was open. The air flow patterns indicated that print shop solvents have the potential to migrate into other work areas.

The furniture, carpeting, and walls for the enclosed and partitioned areas were in good condition. The office areas were well lighted with fluorescent lights with incandescent desk lamps used for auxiliary lighting. Most of the employees had computers on their desks. Two photocopiers and several laser printers were located in the building. The lunch room on the third floor housed two coffee pots and one microwave oven. Personal fans were observed in 4 offices. One office, on the first floor, had a separate air conditioning unit. The three bay offices had electric heaters.

Organic Solvent Monitoring Results

The print shop organic solvent monitoring results are presented in Table 4. The PBZ sample for the printer was collected for the length of time that the employee was running one of the presses. All of the PBZ and area concentrations for TCE (11.1 and 5.1 ppm), toluene (0.49 and 0.21 ppm), and xylene/ethyl benzene (1.39 and 0.83 ppm) were well below the respective occupational exposure evaluation criteria, assuming that the activities in the print shop were consistent throughout the day. Perchloroethylene

concentrations (0.61 and 1.66 ppm) were well below the OSHA standard of 100 ppm, however, NIOSH recommends that exposures to perchloroethylene be reduced to the lowest feasible concentration which could be accomplished by using the exhaust fan in the print shop. Limonene concentrations were 0.16 ppm for both samples. Total C_7-C_{10} hydrocarbons were 20.4 and 14.7 mg/m^3.

The rubber-based and oil-based inks contained mostly aliphatic hydrocarbons (C_{13} and above). The solvent used for cleaning the presses contained mostly C_9H_{12} alkyl benzenes, xylenes, dipropylene glycol methyl ether, and limonene. There was not a MSDS available on site for this cleaning solvent.

VIII. DISCUSSION/CONCLUSIONS

The questionnaire results showed that many employees had frequently experienced symptoms (e.g., pain or stiffness in back, shoulders, or neck; stuffy nose or sinus congestion; dry, itching, or irritated eyes; and tired or strained eyes) while in the building. A substantial proportion of the symptomatic employees reported that their symptoms tended to get better when they were away from the building. These symptom prevalences are similar to other NIOSH investigations. Thermal comfort, lack of air movement, and smoke odors were significant concerns among the employees.

Most of the CO_2 concentrations measured were lower than the ASHRAE guideline of 1000 ppm. Two areas in the morning had CO_2 measurements over 1000 ppm, which indicated a potential problem with air circulation and distribution within those offices. The measured temperatures and RHs were within acceptable comfort ranges. The mechanical ventilation systems were in good condition, but the HVAC units turned off when not calling for heating or cooling. Air flow patterns showed that print shop solvents could potentially enter the basement reception area, and that tobacco smoke could enter the common areas of the building and the recirculating ventilation systems. ETS was identified as a potential health hazard in this building. However, sampling of specific organic compounds found relatively low levels.

Reports of building related health complaints have become increasingly common in recent years; unfortunately the causes of these symptoms have not been clearly identified. As discussed in the criteria section of this report, many factors are suspected (e.g., volatile organic compounds, formaldehyde, microbial proliferation within buildings, inadequate amounts of outside air, etc.). While it has been difficult to identify concentrations of specific contaminants that are associated with the occurrence of symptoms, it is felt by many researchers in the field that the occurrence of symptoms among building occupants can be lessened by providing a properly maintained interior environment.

IX. RECOMMENDATIONS

Although there were no clear environmental causes for the symptoms reported by the Goodwill Industries of America employees, the NIOSH evaluation identified some areas which could be changed to improve employee comfort and health. ETS and print shop solvents may have attributed to the reported symptoms. Based on the results and observations of this evaluation, the following recommendations are offered.

1. Based on the adverse health effects associated with ETS, smoking should not be allowed in the building. Until that is achieved, a separate smoking area should be designed to meet the current ASHRAE guidelines of negative pressure with respect to the rest of the building, 60 cfm of supply air per person, and direct exhaust to the outside to prevent smoke from entering the ventilation system.[26] Suggestions to eliminate or restrict smoking in the workplace are found in the references listed in the evaluation criteria.

2. To reduce exposures to perchloroethylene and other potentially hazardous substances, the print shop should use the exhaust fan on a low setting whenever the presses are operating. The print shop should be maintained under negative air pressure with respect to surrounding areas to prevent

migration of contaminants to other building areas. If use of the exhaust fan at its present location interferes with the two presses, an additional exhaust fan could be installed at a different location in the print shop.

3. Based on smoke tube airflow pattern results and high CO_2 measurements in two offices, HVAC package unit fans should remain on continuously during periods of building occupancy to provide better air movement throughout the building instead of turning off when not cooling or heating the office areas.

4. Material safety data sheets should be available for all hazardous compounds that used in the print shop. According to the OSHA Standard 1910.1200 "Hazard Communication," employers should have copies of MSDSs available for all chemicals used in their workplace and employees should be informed about the hazard compounds they work with.[40]

5. Water-damaged ceiling tiles and carpeting cannot be effectively disinfected and, therefore, should be replaced on the second floor to prevent possible microbial growth.

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1. Administrative Services Manager, Goodwill Industries of America, Inc., Bethesda, Maryland.
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3. Confidential Requestors

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

TABLE 1

ORGANIC SOLVENT HEALTH EFFECTS AND EVALUATION CRITERIA
GOODWILL INDUSTRIES OF AMERICA, INC.
BETHESDA, MARYLAND
HETA 93-0351

ORGANIC SOLVENT	MAJOR HEALTH EFFECTS[4,38,39]	OSHA PEL (PPM)*	NIOSH REL (PPM)	ACGIH TLV (PPM)
1,1,1 - TRICHLOROETHANE (TCE)	CENTRAL NERVOUS SYSTEM EFFECTS, LIVER AND CARDIOVASCULAR EFFECTS	350	350	350
TOLUENE	CENTRAL NERVOUS SYSTEM DEPRESSION, IRRITATION OF THE EYES, RESPIRATORY TRACT, AND SKIN.	200 (100 - 1989)	100	50
PERCHLOROETHYLENE (PCE)	CENTRAL NERVOUS SYSTEM EFFECTS, LIVER TUMORS IN ANIMAL STUDIES	100 (25 - 1989)	LOWEST FEASIBLE CONC.**	25
XYLENES	CENTRAL NERVOUS SYSTEM DEPRESSION, IRRITATION OF THE EYES AND RESPIRATORY TRACT	100 (100 - 1989)	100	100
ETHYL BENZENE	IRRITATION OF THE EYES, UPPER RESPIRATORY TRACT, AND SKIN.	100 (100 - 1989)	100	100
LIMONENE	SKIN IRRITATION AND SENSITIZATION			

* = PART PER MILLION (PPM)
** = LOWEST FEASIBLE CONCENTRATION - POTENTIAL HUMAN CARCINOGEN
PARENTHESES INDICATE VACATED 1989 OSHA PELS.

TABLE 2

SYMPTOMS EXPERIENCED AT WORK GOODWILL INDUSTRIES OF AMERICA, INC.
BETHESDA, MARYLAND
HETA 93-0351

SYMPTOMS OF 57 WORKERS	EXPERIENCED ON DAYS OF SURVEY WHILE AT WORK	FREQUENTLY EXPERIENCED LAST FOUR WEEKS WHILE AT WORK	HAVE FREQUENT SYMPTOMS THAT IMPROVE WHEN AWAY FROM WORK
DRY, ITCHING, OR IRRITATED EYES	16 %	14 %	11 %
TIRED OR STRAINED EYES	16 %	19 %	11 %
STUFFY NOSE, OR SINUS CONGESTION	18 %	16 %	0 %
SNEEZING	14 %	16 %	5 %
SORE OR DRY THROAT	9 %	7 %	5 %
DRY OR ITCHY SKIN	9 %	11 %	4 %
UNUSUAL FATIGUE OR DROWSINESS	11 %	12 %	5 %
HEADACHE	12 %	16 %	5 %
TENSION, IRRITABILITY OR NERVOUSNESS	14 %	23 %	16 %
DIFFICULTY WITH MEMORY OR CONCENTRATION	0 %	2 %	0 %
NAUSEA OR UPSET STOMACH	4 %	4 %	2 %
FEELING DEPRESSED	0 %	2 %	2 %
PAIN OR STIFFNESS IN BACK, SHOULDERS, OR NECK	21 %	14 %	5 %
DIZZINESS OR LIGHTHEADEDNESS	2 %	2 %	2 %
COUGH	4 %	5 %	2 %
CHEST TIGHTNESS	2 %	4 %	4 %
WHEEZING	0 %	2 %	0 %
SHORTNESS OF BREATH	4 %	4 %	0 %

TABLE 3

DESCRIPTION OF WORKPLACE CONDITIONS
GOODWILL INDUSTRIES OF AMERICA, INC.
BETHESDA, MARYLAND
HETA 93-0351

CONDITIONS	EXPERIENCED AT WORK DURING DAYS OF THE SURVEY 57 WORKERS	FREQUENTLY EXPERIENCED WHILE AT WORK DURING PREVIOUS FOUR WEEKS 57 WORKERS
TOO MUCH AIR MOVEMENT	0 %	0 %
TOO LITTLE AIR MOVEMENT	30 %	37 %
TEMPERATURE TOO HOT	21%	28 %
TEMPERATURE TOO COLD	4 %	7 %
AIR TOO HUMID	4 %	5 %
AIR TOO DRY	12 %	14 %
TOBACCO SMOKE ODORS	18 %	30 %
CHEMICAL ODORS (E.G., PAINT, CLEANING FLUIDS, ETC.)	7 %	12 %
OTHER UNPLEASANT ODORS (E.G., BODY ODOR, FOOD ODOR, PERFUME)	9 %	4 %

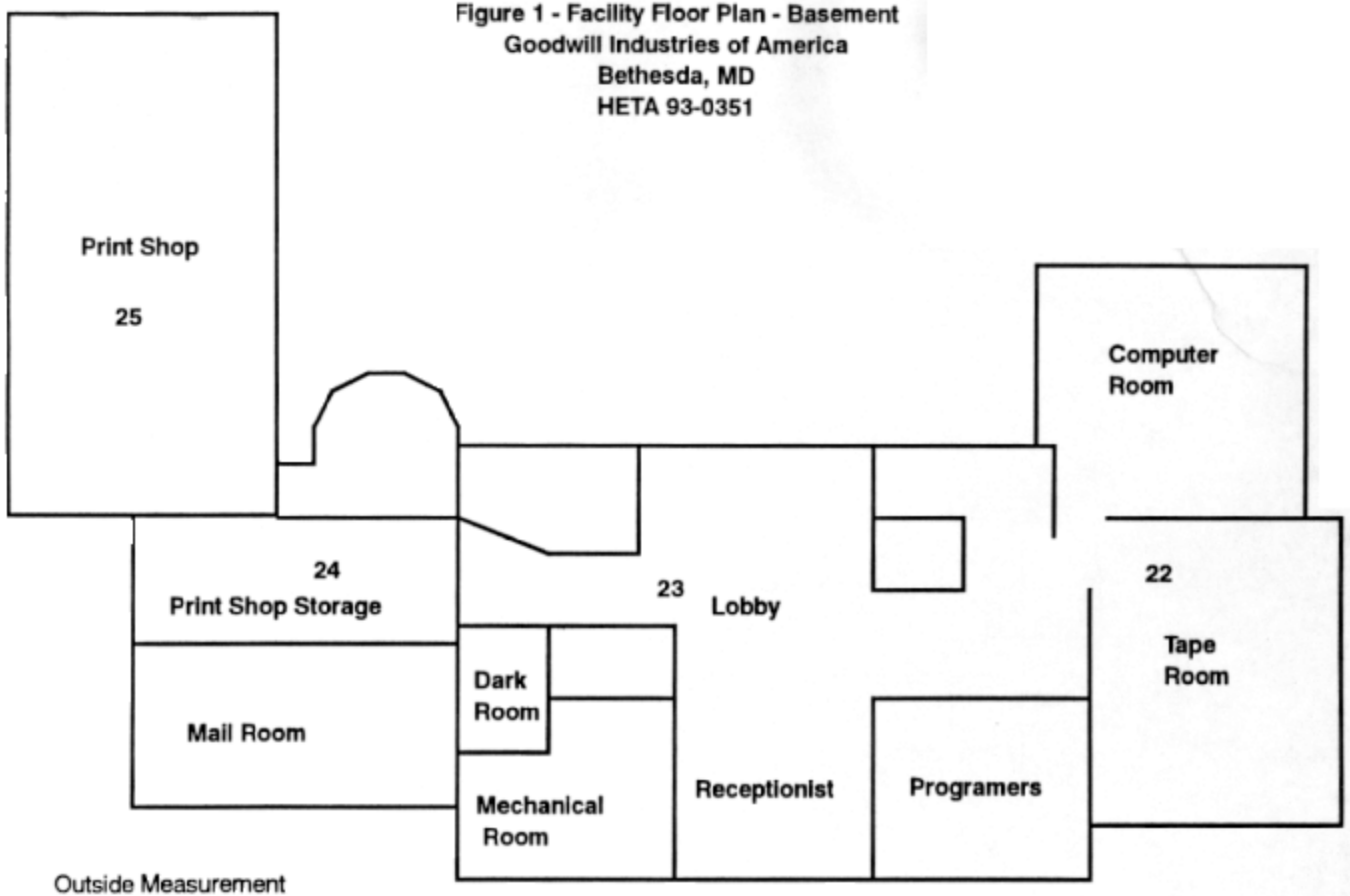
TABLE 4

ORGANIC SOLVENT SAMPLING RESULTS
PRINT SHOP
GOODWILL INDUSTRIES OF AMERICA, INC.
BETHESDA, MARYLAND
HETA 93-0351
APRIL 20, 1993

	SAMPLE TIME	SAMPLE VOLUME (LITERS)	TCE-PPM*	TOLUENE-PPM	PCE-PPM**	XYLENE/ETHYL BENZENE-PPM	LIMONENE-PPM	C_7-C_{10} HYDROCARBONS MG/M^3***
PRINTER-PBZ	9:05-12:15	38	10.9	0.49	1.66	1.39	0.16	20.4
PRINT SHOP	12:39-5:17	56	5.0	0.21	0.61	0.83	0.16	14.7
MDC#			0.01	0.007	0.008	0.18	0.05	0.24
MQC##			0.03	0.03	0.02	0.73	0.14	0.66
OSHA PEL			350	200	100	100/100		
NIOSH REL			350	100	LFC@	100/100		
ACGIH TLV			350	50	25	100/100		

* = 1,1,1-TRICHLOROETHANE-PARTS PER MILLION (TCE-PPM)
** = PERCHLOROETHYLENE-PARTS PER MILLION (PCE-PPM)
*** = MILLIGRAMS PER CUBIC METER (MG/M^3)
\# = MINIMUM DETECTABLE CONCENTRATION BASED ON SAMPLE VOLUME OF 38 LITERS (MDC)
= MINIMUM QUANTIFIABLE CONCENTRATION BASED ON SAMPLE VOLUME OF 38 LITERS (MQC)
@ = LOWEST FEASIBLE CONCENTRATION, POTENTIAL HUMAN CARCINOGEN (LFC)

Figure 1 - Facility Floor Plan - Basement
Goodwill Industries of America
Bethesda, MD
HETA 93-0351

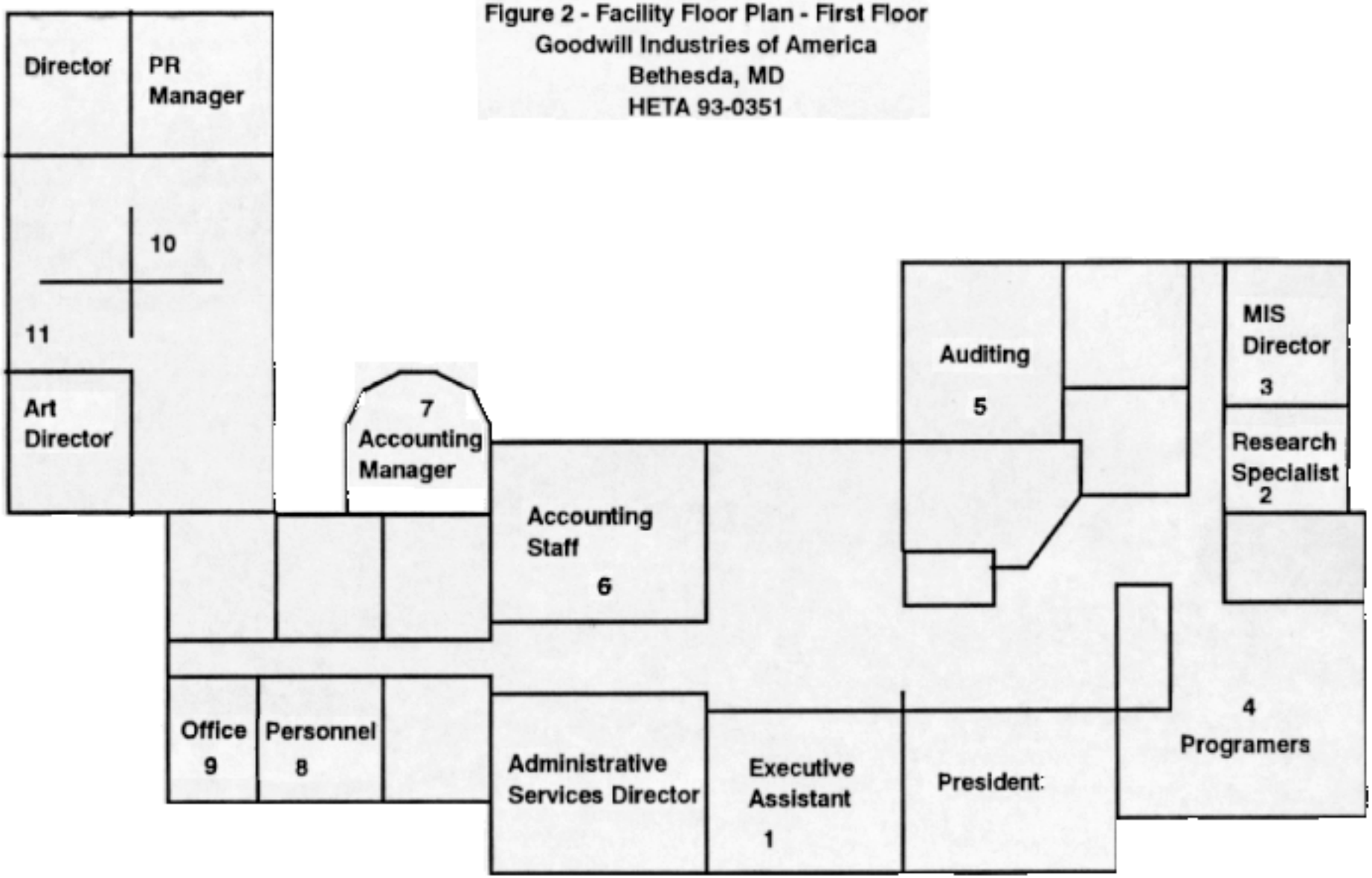


Outside Measurement

North

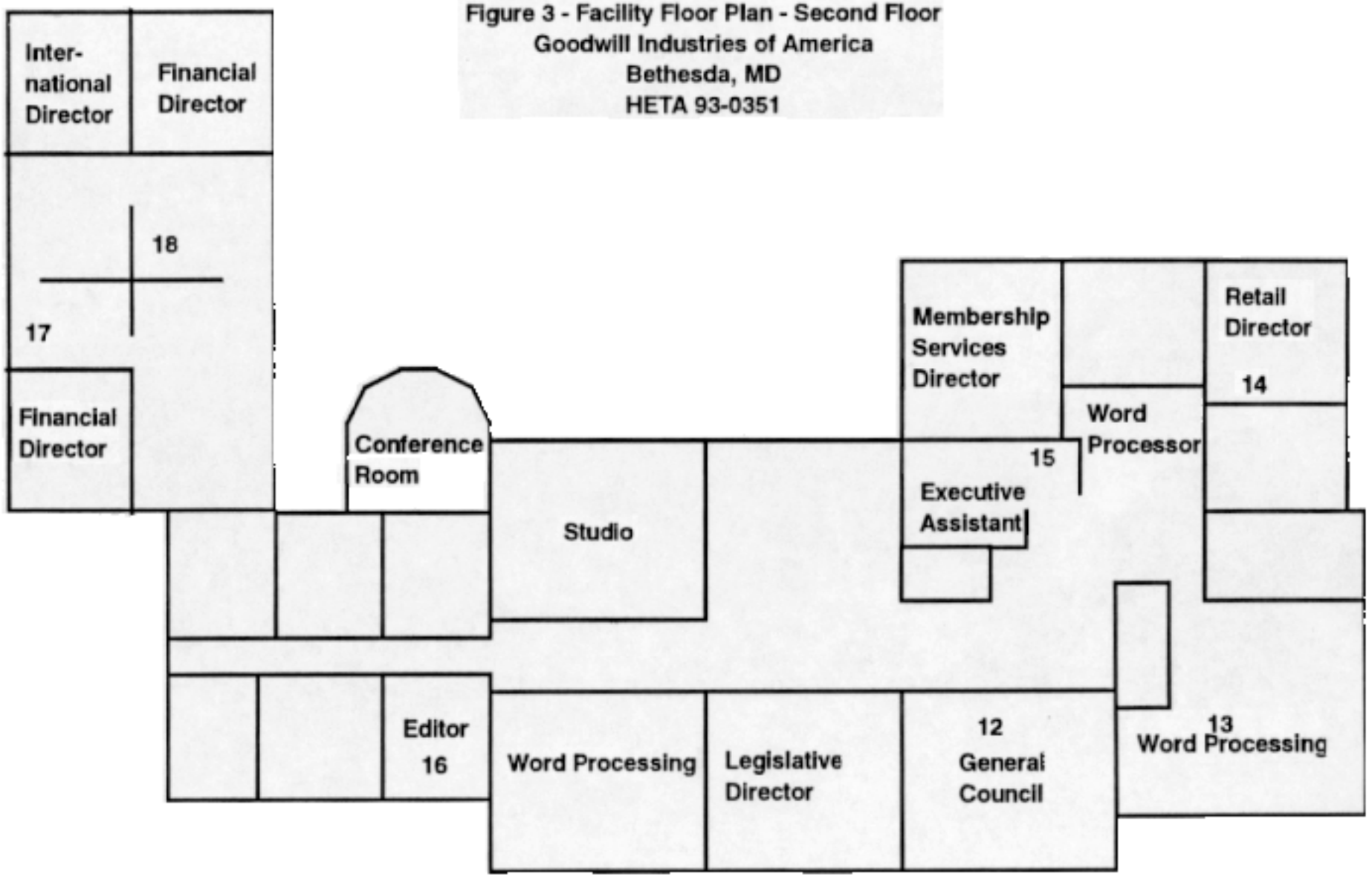
Not to Scale
Numbers indicate sampling locations.

Figure 2 - Facility Floor Plan - First Floor
Goodwill Industries of America
Bethesda, MD
HETA 93-0351



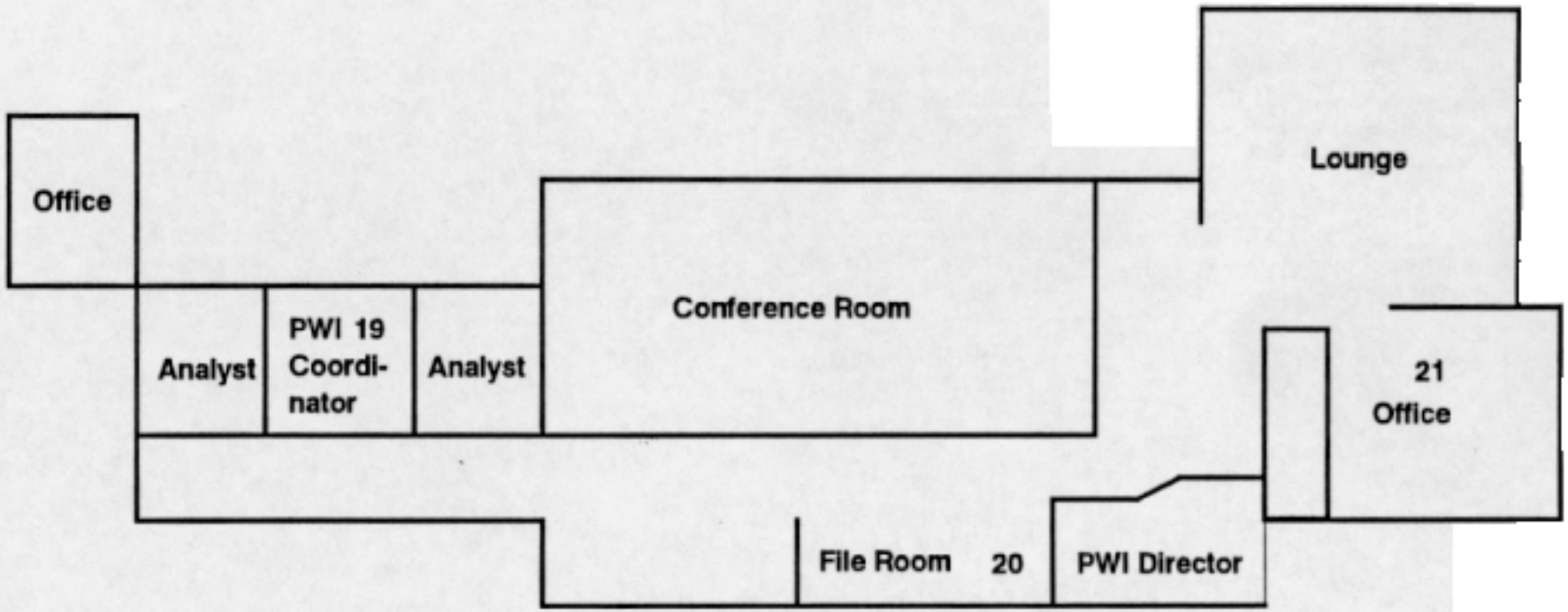
Not to Scale
Numbers indicate sampling locations

Figure 3 - Facility Floor Plan - Second Floor
Goodwill Industries of America
Bethesda, MD
HETA 93-0351



Not to Scale
Numbers indicate sampling locations.

Figure 4 - Facility Floor Plan - Third Floor
Goodwill Industries of America
Bethesda, MD
HETA 93-0351



North

Not to Scale
Numbers indicate sampling locations.

Figure 5 Carbon Dioxide Measurement Results

Goodw ndustr es Bethesda MD HETA 93-0351

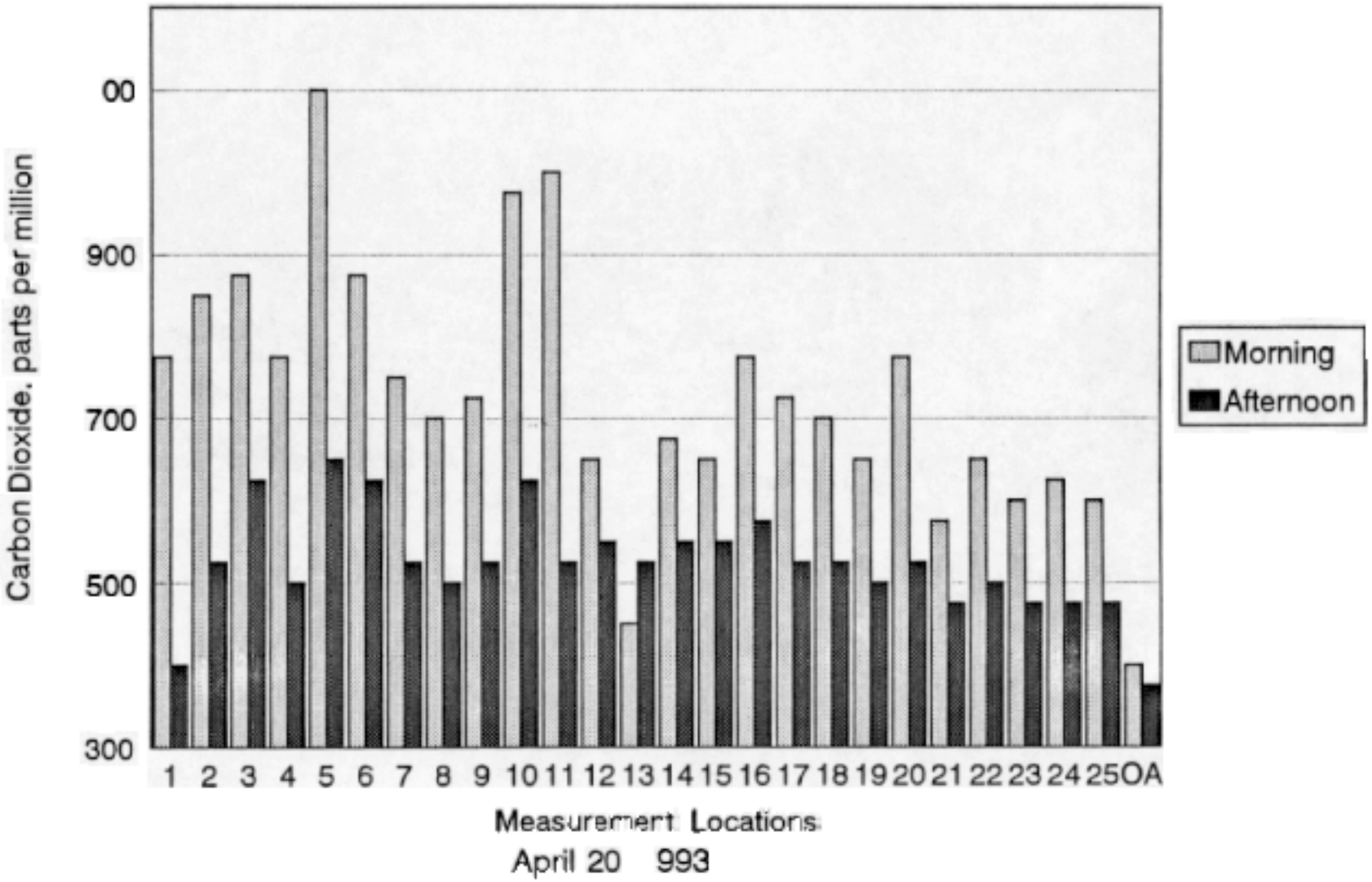
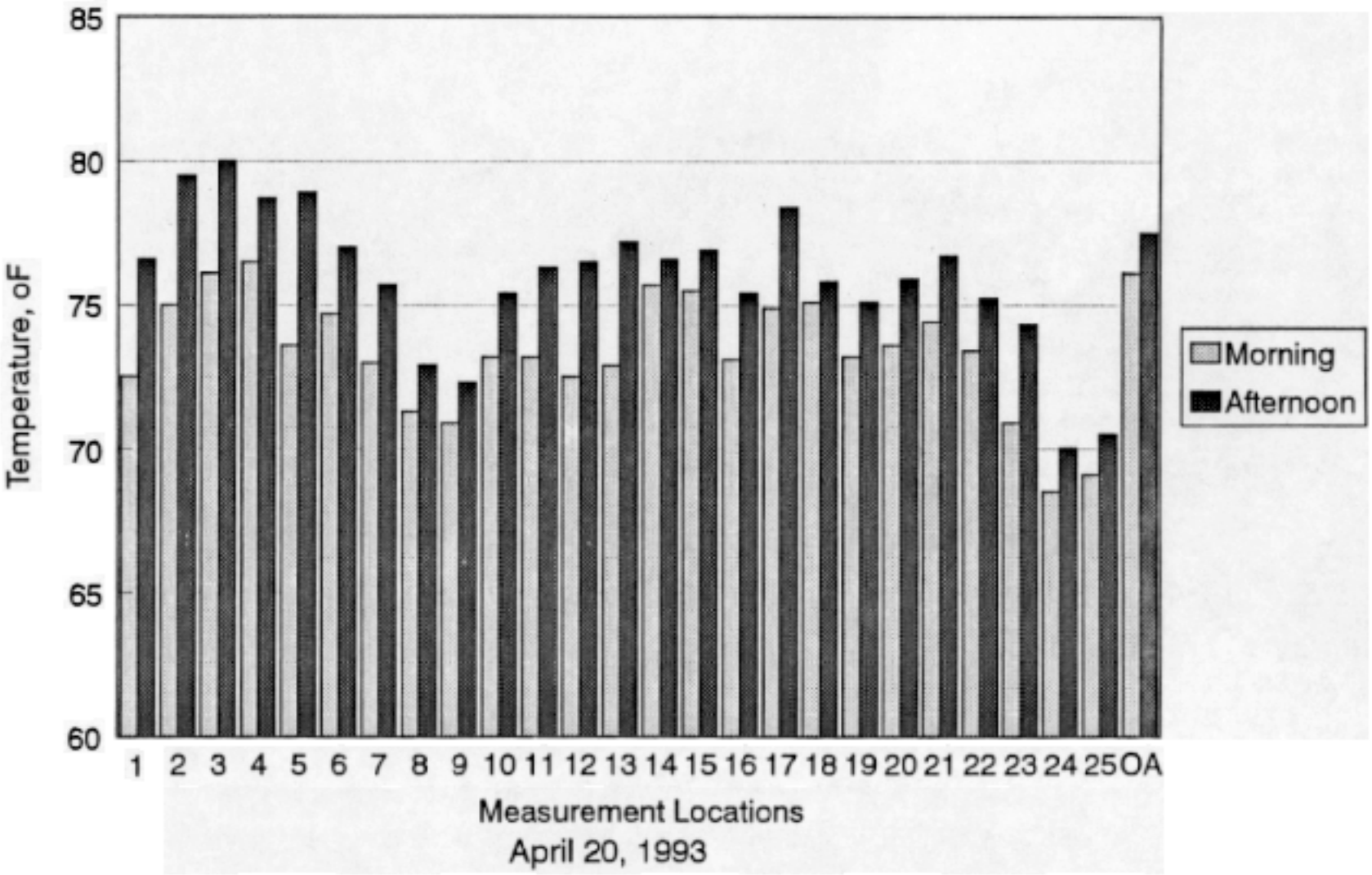


Figure 6 - Temperature Measurement Results

Goodwi l Industries, Bethesda, MD HETA 93-0351



F gure 7 Re ative Hum idity Measurement Results

Goodw ndustries Bethesda, MD HETA 93-0351