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OTIS ELEVATOR COMPANY
ALEXANDRIA, VIRGINIA

NIOSH INVESTIGATORS:
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SUMMARY

On August 7, 1992, the National Institute for Occupational Safety and Health (NIOSH), received a request for a Health Hazard Evaluation (HHE) from the Otis Elevator Company regional office in Alexandria, Virginia. The request asked NIOSH to investigate health problems experienced by some building occupants including headache, fatigue, nausea, burning eyes, and congestion. In response to this request, NIOSH investigators conducted a site visit on November 30 - December 1, 1992. The objectives for this visit were to inspect the facility, distribute a self-administered questionnaire, and to review the building's heating, ventilating and air-conditioning (HVAC) system. Environmental monitoring for standard indoor environmental parameters (temperature, relative humidity [RH], carbon dioxide [CO_2]) was conducted for comparison with guidelines developed by the American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE). Measurements were taken to estimate the quantity of outside air (OA) provided to occupied areas.

Visual inspection indicated that all air-handling units (AHUs) were in good condition, draining properly, and had clean filters. OA dampers on both systems were open. The OA rates greatly exceeded those recommended by ASHRAE. Temperature monitoring was skewed, as AHU-2 was inadvertently shut down the previous day and was not turned back on until 10:00 AM on the day of the evaluation. RH levels were within acceptable ranges in all areas monitored throughout the day. The CO_2 levels were all below the 1000 part per million (ppm) guideline recommended by ASHRAE Standard 62-1989, confirming measurements that indicated more than adequate OA intake. Housekeeping was generally good in the office areas. Housekeeping was in need of improvement in the warehouse, where many uncovered oil/solvent cans and uncovered containers filled with oil-soaked rags were observed. Monitoring data revealed several sources of volatile organic compounds (VOCs) in the basement, however, VOC concentrations in the office areas were typical of levels found in many non-industrial buildings.

Twenty-five of the 37 people who were employed at this regional office completed and returned a questionnaire which dealt with health symptoms and perceptions of working conditions. Analysis of the questionnaire data revealed that the most common health-related complaints were tired or strained eyes, and stuffy/runny nose or sinus congestion. Eight employees noted these symptoms occurring at least once per week. Headache and unusual tiredness, fatigue or drowsiness were each noted by six persons as occurring at least once per week. The most commonly reported employee concern regarding workplace conditions, reported by 13 employees, was that the temperature was too cold at least once per week. Other concerns included too little air movement, temperature too high, dry air, and the presence of tobacco and chemical odors.

Ongoing health concerns and complaints associated with the working environment have been experienced by some employees at the Otis Elevator regional office in Alexandria, Virginia. No environmental contaminant or condition that would explain the reported symptoms was found. Recommendations to address the IEQ issues at this office include eliminating smoking in the basement, improving housekeeping in the basement, repairing the basement overhead door, informing building occupants regarding the proper operation and function of the HVAC system, and establishing a pro-active IEQ management program. In addition, the company should consider relocating contaminant-generating activities outside of the basement and should ensure that personnel who perform these activities are aware that contaminant-generating activities in the basement may affect other areas of the office.

KEYWORDS: SIC 8211 indoor environmental quality, ventilation, carbon dioxide, relative humidity, temperature, volatile organic compounds, indoor air quality.

INTRODUCTION

On August 7, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from management for a Health Hazard Evaluation (HHE) at the Otis Elevator Company regional office in Alexandria, Virginia. The request concerned employees' symptoms and their suspected relationship to the workplace environment. On November 30 - December 1, 1992, investigators from NIOSH conducted a site visit, which began with an opening conference attended by NIOSH, Otis Elevator management, and employee representatives. Background information regarding the facility and prior indoor environmental quality (IEQ) problems were obtained during this meeting. Following the opening conference, a building inspection was conducted to identify potential IEQ issues, and a self-administered questionnaire was distributed to all employees. On December 1, 1992, a closing conference was held to discuss preliminary findings, recommendations, and future actions. This letter will present our observations, findings, and recommendations.

BACKGROUND/FACILITY INFORMATION

Otis Elevator representatives indicated that IEQ problems have been an ongoing issue for approximately 2 years. There was no single or unique event which prompted the request for a HHE, but rather a general realization among workers that many of them were experiencing health symptoms which improved upon leaving the building. The symptoms included headache, fatigue, nausea, burning eyes, and congestion.

The Otis Elevator Regional Headquarters facility in Alexandria was constructed in 1969 and originally housed federal government employees. The building was leased by Otis Elevator in 1986 and is currently occupied by 35-40 marketing and field employees. The 13,500 square-foot facility has two floors plus a basement, with enclosed stairwells at the front and back of the building. The top two floors serve as offices, and the basement functions as a warehouse and maintenance area. A firewall separates the building from a sister facility that is owned by the same building management company. The top floor was converted 3 years ago from a storage and training area to offices. The office layout is primarily open (cubicle), with some private offices/conference rooms along the exterior walls. A project to replace the carpet was underway during our site visit. The exterior walls have windows which can be opened by occupants. According to building management, smoking is not allowed in the office areas, but is permitted in the basement/warehouse.

There are two full-time employees in the basement/warehouse area. In addition to storage of elevator parts and lubricating fluids, used containers are cleaned with a commercially available hydrocarbon solvent in a cleaning tank provided by the solvent vendor. Approximately 1 hour a day is spent cleaning containers. A propane-powered fork lift is used once or twice a week, but except for parking, it is only operated outside.

The facility is serviced by two roof-mounted, constant-volume air-handling units (AHUs). Both units have forced-air gas heating with electric Freon® cooling. AHU-1 is a 15 ton downflow system with a nominal total air flow capacity of 6000 cubic-feet per minute (CFM). This system supports the first floor office and basement/warehouse area. AHU-2 is a 12.5 ton system that was added in the spring of 1992 to support the second floor office area. AHU-2 has a nominal total air flow capacity of 5000 CFM. Supply air is delivered via ductwork through ceiling grilles. The return air (RA) path is through grilles into the common space above the false ceiling (first floor and basement), to a central RA shaft for AHU-1, and above the false ceiling on the second floor to the RA inlet for AHU-2. Both systems have fixed outside air (OA) louvers opening into a mixing chamber (RA and OA) prior to filtration and further conditioning (heating or cooling). Design OA volumes are 1200 CFM for AHU-1 and 1000 CFM for AHU-2. According to the building owners, the AHUs are inspected every 2 months and the filters (disposable coarse) are changed at this time.

At one time the AHUs were cycled, but at the request of Otis Elevator representatives, they are now operated continuously. Thermostat sensors and AHU controls are located in the center of the first (AHU-1) and second floors (AHU-2).

EVALUATION PROCEDURES

Industrial Hygiene

A. Carbon Dioxide (CO_2)

Instantaneous measurement of CO_2 concentrations were obtained using a Gastech Model RI-411A Portable (direct reading) CO_2 monitor. The principle of detection is non-dispersive infrared absorption. The instrument was zeroed (zero CO_2 gas source) and calibrated prior to use with a known CO_2 source (span gas). The monitor provides CO_2 concentrations in 25 parts per million (ppm) increments with a range of 0 - 4975 ppm. Measurements were obtained at various intervals and locations throughout the building. Outdoor readings were taken to determine baseline CO_2 levels.

B. Temperature and Relative Humidity (RH)

Dry bulb temperature and RH levels throughout the building were determined at various intervals. Outdoor readings were obtained for comparison purposes. Instrumentation consisted of a TSI, Inc. model 8360 VelociCalc® meter with a digital readout. This unit is battery-operated and has humidity and temperature sensors on an extendable probe. The temperature range of the meter is 14 to 140°F and the humidity range is 20 to 95%. Temperature and RH as determined via standard dry bulb, wet bulb, and psychometric chart, correlated well with levels determined via the VelociCalc® meter.

C. VOC/CO Monitoring

Instantaneous measurements to assess relative levels of VOCs were obtained in various indoor and outdoor locations. This monitoring was done with an Hnu® Systems Model PL 101 analyzer. This portable, non-specific, direct-reading instrument uses the principle of photoionization for detection. The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many compounds. These ions are driven to a collector electrode where the current (proportional to concentration) is measured. A 10.2-electron-volt lamp was utilized. This lamp will ionize a wide variety of organic compounds, yet exclude normal constituents of air such as nitrogen, oxygen, and carbon dioxide. Measurements were obtained with the instrument set on maximum sensitivity. This sampling was conducted to identify potential sources of solvent emissions or material that may be emitting VOC's.

Integrated air samples were obtained using standard charcoal tubes (100 milligrams front section/50 milligrams backup) as the collection medium. The samples were collected using constant-volume SKC model 223 low-flow sampling pumps, at flow rates of 100 cc/min. Sampling times ranged from 3 to 5 hours. Pump calibration was checked prior to sampling using the soap bubble/buret technique. The pumps are equipped with a pump stroke counter and the number of strokes necessary to pull a known volume of air was determined. This information was used to calculate a cubic centimeter's (cc) air-per-pump-stroke "K" factor. The pump stroke count was recorded before and after sampling, and the difference was used to calculate the total volume of air sampled.

Charcoal tube samples were collected in the basement and first floor of the Otis Elevator facility and analyzed via gas chromatography/mass spectroscopy (GC/MS) to identify major compounds. A field blank was submitted with the samples. All samples were analyzed by a NIOSH contract analytical laboratory.

An integrated area sample for CO was collected at the first floor reception area using a direct-reading long-term calorimetric detector tube manufactured by Dräger (67 28741). These tubes contain a chemically impregnated media which will change color in proportion to the concentration of CO. The sample was collected with a constant-volume SKC model 223 low-flow sampling pump. A flow rate of 15-20 cubic centimeters per minute (cc/min) was used to collect the sample over a 4-hour period. According to Dräger, the relative standard deviation for this particular sampling method is 10-15%. CO sampling was conducted to determine if emissions from the propane-powered fork-lift resulted in elevated CO levels.

D. Ventilation Monitoring

The TSI, Inc. model 8360 VelociCalc® meter was used to measure air velocity at the outside air intake vent for subsequent determination of outside air volume. This is an electronic meter with a digital readout. Velocity is measured by the cooling effect of air as it passes over a heated (hot-wire) sensor at the end of the probe.

Medical

An indoor air quality and work environment symptoms survey was distributed to all 37 employees. The questionnaire was self-administered and returned to NIOSH investigators in a confidential manner. The questionnaire included questions concerning work and medical history, current symptoms, and feelings about the workplace environment.

EVALUATION CRITERIA

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 a high prevalence of symptoms among occupants of office buildings.[1-5] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[6,7] 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.[8-13] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.[14]

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.[15-17] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[17-20]

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.[21-23] 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.[24,25] 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 effluent.[26]

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.

A. Carbon Dioxide (CO_2)

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 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, 15 cfm/person for reception areas, and 60 CFM/person for smoking lounges, and provides estimated maximum occupancy figures for each area.[24]

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.

B. 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.[25] ASHRAE has developed a chart which includes a "comfort zone" considered to be both comfortable and healthful for the majority of the building occupants. This zone lies between 68° and 77°F and 20 to 60% relative humidity. Note, however, that some scientists feel that RH levels below 30% may produce discomfort from dryness.[27] Because the feeling of comfort is subjective, the range is wide.

FINDINGS AND DISCUSSION

Industrial Hygiene

A. Building Inspection

No obvious signs of moisture-damaged carpet, ceiling tile or insulation were detected during a visual inspection of the facility. Housekeeping was generally good in the office areas and the building appeared clean. Inspection of the enclosed offices on the first and second floors showed that one office on each floor did not have a return air grille.

Housekeeping in the warehouse was in need of improvement. The solvent degreasing tank lid was open, and numerous waste solvent/oil containers were not covered. (Open containers of volatile material result in increased evaporation of solvents, increasing airborne concentrations.) Oil-soaked rags were improperly stored in an uncovered metal drum. Similarly, the funnel used to dispose of waste oil into a pipeline leading to the outside waste storage tank was uncovered. Workers commented that noticeable emissions (visible vapors/mists) are periodically detected backing up from this disposal system. Workers also indicated that spray painting (aerosol spray can) occasionally takes place in the basement, and odors from this activity can be detected on the first floor.

One of the overhead doors in the basement was broken, necessitating the use of the fork-lift to open it. Because of this broken door, the fork-lift was started and operated inside the basement with the outside door closed, resulting in an increased build-up of vehicle exhaust emissions.

During the building inspection it was noted that many occupants were unfamiliar with how the HVAC system was operated. For instance, several employees were unaware that the AHUs were operated continuously.

B. HVAC Inspection

Visual inspection of AHU-1 and AHU-2 showed that both systems appeared to be in good shape and were operating properly. The filters had recently been changed and the coils were clean. The condensate drain pan was dry and showed no evidence of standing moisture or microbiological growth. The OA intakes on both systems were open. A bathroom exhaust vent was within 2-3 feet of the OA intake on AHU-1. This could potentially result in emissions reentraining into the building.

The RA shaft serving AHU-1 was inspected; the dampers were open on both the first floor and the basement. These dampers are spring-loaded with fusible links for rapid closure in the event of a fire. The RA inlet was open on AHU-2.

OA quantities were determined at each AHU and are shown in Table 1. A minimum of 12 velocity measurements were obtained at the face of each OA intake louvre. These measurements were used to calculate an average flow rate in cubic-feet per minute (CFM) for each AHU. Because each OA intake was equipped with a cross-hatch grille, an area correction factor of 0.88 was used to adjust the final result. These measurements show that sufficient OA is provided to occupants, as the OA rates greatly exceed those recommended by ASHRAE.

C. Environmental Monitoring

CO^2 measurements (Table 2) also indicated that sufficient OA is provided to occupied areas; all CO_2 concentrations were below the 1000 ppm guideline. Serial measurements obtained at 8:00 AM, 11:00 AM, and 3:00 PM did not show an increase in CO_2 levels as the day progressed. On the day of the monitoring, building occupancy was 2 persons in the basement, 15 persons on the first floor, and 8 persons on the second floor.

RH levels were within acceptable ranges in all areas monitored throughout the day. Temperature monitoring was skewed as AHU-2 was inadvertently shut down the previous day and was not turned back on until 10:00 AM. Therefore, the AM temperature levels were low, and on the first floor and basement were below levels generally considered comfortable. On the first floor, the temperature rose to a more comfortable level as the day progressed. In the basement, however, the temperature never exceeded 66° F. (Employees wore extra clothing and used a space heater in the office.) It is likely that these lower temperatures in the basement were due to the open overhead doors, which allowed infiltration of colder outside air.

The CO monitoring, conducted at the receptionist desk on the first floor, showed a trace level of CO that was below the monitoring instrument's manufacturers lower quantitation limit of 2.5 ppm. These results do not suggest a CO hazard.

Measurements to assess relative levels of VOCs were made in various locations (Table 3). The data indicate that there are several sources of VOC emissions in the basement. The results of the integrated air samples collected to identify VOCs in the basement and first floor show that the levels detected were low and not indicative of a health hazard. The total VOC concentration detected in the basement adjacent the cleaning tank was 0.91 milligrams/cubic meter (mg/m^3), with the primary contributor being C_7 - C_{11} alkanes (0.4 mg/m^3). The source of these hydrocarbons is likely the oils or cleaning solvent in this area. The total VOC concentration detected on the first floor (reception area) was 0.47 mg/m^3, approximately one-half the level detected in the basement. There are no specific standards for total VOCs in non-industrial environments, but the measured levels are orders of magnitude lower than occupational exposure criteria for workplaces in general[28], and are typical of levels found in many non-industrial buildings.[29,30]

D. Miscellaneous

No unusual janitorial or pesticide treatment practices were identified during the survey. The carpet is not shampooed and is routinely vacuumed. Pesticide inspection is conducted by a licensed commercial operator on a monthly basis. Only crevice treatment is used and the building is not fogged.

Medical

At the time of the investigation, 37 people were employed at this regional office. Twenty-five questionnaires were completed and returned (a participation rate of 68%). The most common health complaints which employees related to the workplace were tired or strained eyes, and stuffy/runny nose or sinus congestion. Eight employees noted these symptoms occurring at least once per week. Headache and unusual tiredness, fatigue, or drowsiness were each noted by six persons as occurring at least once per week.

The most commonly reported employee concern regarding workplace conditions, reported by 13 employees, was that the temperature was too cold at least once per week. Other concerns included too little air movement, too high a temperature, dry air, and the presence of tobacco and chemical odors. These concerns, including the concerns over tobacco and chemical odors, were reported by workers from all floors of the building.

CONCLUSIONS

Measurement of the standard IEQ parameters indicated that the HVAC system was delivering sufficient conditioned outside air to occupants. Temperature levels in the morning, however, were below those generally considered comfortable. This may have been influenced by open doors, which allowed colder unconditioned air to enter the building, and by the temporary shut-down of AHU-2.

No source of microbiological growth was identified during the survey. Standing water or moisture-damaged porous materials were not found in the building or HVAC system. Housekeeping appeared to be good in the office areas.

No environmental contaminant or condition that would explain the reported symptoms was found during this survey. A potential source of VOC emissions is, however, present in the basement. Because they have a common ventilation system, contaminants generated in the basement (e.g., smoking, paint spraying) cannot be isolated from the first floor.

RECOMMENDATIONS

1. Eliminate smoking in the basement. As the basement is on a common ventilation system with the first floor, there is no mechanism to isolate environmental tobacco smoke. In addition to the health concerns, smoking poses a potential fire hazard as there are numerous combustible materials (solvents, oils) used in the basement.

2. Ensure all sources of emissions in the basement are contained. Oil-soaked rags should be maintained in sealed containers (safety can with self-closing lid) pending proper disposal. All containers, even if there is only residual material present, should be kept shut until cleaned. A lid should be obtained and used for the waste-oil disposal system (funnel). The degreasing tank lid should be kept closed unless the tank is in use.

3. Consider relocating contaminant generating activities outside of the basement/warehouse areas. These activities include spray painting and oil container cleaning.

4. Ensure that personnel are aware that any contaminant-generating activities in the basement/warehouse may affect other areas, and that precautions should be taken to control emissions. First floor occupants should be advised of any odor/contaminant generating activity that takes place in the basement.

5. Repair the overhead door and ensure it is open prior to starting the forklift.

6. Inform building occupants regarding the proper operation and function of the HVAC system.

7. Ensure that all interior changes account for the impact on the HVAC system.

Implement an IEQ management plan to ensure that issues are proactively addressed (e.g., painting, new carpet, construction, etc.). Reference #28 (EPA/NIOSH Building Air Quality) provides excellent guidelines regarding an IEQ management plan. Resolution of IEQ problems generally involves a cycle of hypothesis generation and testing. As questions or plausible causes are suggested, they should be considered and evaluated. This serves to narrow down the possibilities as potential explanations are ruled out, or improvements are implemented.

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1. Otis Elevator Company
2. NIOSH Atlanta Region

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
Outside Air Quantities
Otis Elevator: Alexandria, VA
HETA 92-350: December 1, 1992

AHU#	Area Served	# Occupants[1]	OA Rate (CFM)	CFM OA/P[2]
1	First Floor/Basement	22	682	31
2	Second Floor Office	13	791	61

[1] Maximum number of occupants
[2] CFM OA/P = Cubic-feet per minute of outside air per person

Table 2
Temperature, Relative Humidity (RH) and Carbon Dioxide (CO_2) Monitoring
Otis Elevator: Alexandria, VA
HETA 92-350: December 1, 1992

Location	CO_2 (ppm)			RH %			Temperature		
	8:00	11:00	3:00	8:00	11:00	3:00	8:00	11:00	3:00
Outside	425	400	375	NA	NA	NA	48.0	42.6	44.2
B. Stairwell	525	650	550	42	34	39	59.0	66.2	63.6
C. Warehouse	575	575	450	39	34	34	62.3	65.4	66.6
W.house Off.	575	575	425	37	34	34	64.3	66.0	66.6
F. Stairwell	650	675	600	36	34	33	62.0	64.6	67.0
Receptionist	750	725	675	36	34	35	66.0	68.8	71.8
1st. Floor NE	675	700	650	35	34	34	66.8	68.4	70.3
1st. Floor C.	675	675	650	34	35	34	67.2	67.3	70.1
1st. Floor SE	650	650	625	34	34	33	67.4	67.5	69.4
1st. Floor SW	675	675	625	33	34	33	67.4	67.6	69.1
1st. Floor W	725	725	675	33	34	34	67.9	68.9	70.6
2nd. Floor NW	675	775	775	32	37	34	62.5	67.5	73.7
2nd. Floor W	650	750	725	34	37	34	62.0	68.1	73.2
2nd. Floor SW	625	825	625	34	35	34	61.1	68.3	71.7
2nd. Floor SE	625	875	600	34	35	33	60.4	68.5	72.4
2nd. Floor C.	650	750	675	35	35	33	61.8	68.7	72.3
2nd. Floor NE	625	775	650	36	35	33	61.7	68.7	72.7
2nd. Floor N	625	750	675	36	35	35	62.0	68.8	74.0

NOTES:

A space heater was used in the warehouse office
ppm = parts of gas or vapor per million parts air

Air handler unit serving the second floor shut down the previous evening. The system was not repaired and turned back on until 10:00 AM.

Table 3
Measurement of Volatile Organic Compounds
Otis Elevator: Alexandria, VA
HETA 92-350: December 1, 1992

Location	Hnu® Reading (ppm)[1]
Outside Front Entrance	0.5-1
Second Floor Offices	1.5-2
Copying Machine and Printer, Second Floor	1.5-2
Warehouse Office	2
Above Waste Rags, Warehouse	4-5
Above Containers near degreasing sink in Warehouse	>20
Oil Room, Warehouse	5-10
First Floor Offices	1.5-2

[1] PPM is used here as a relative scale only, and is not indicative of a true concentration of any one contaminant.

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HEALTH HAZARD EVALUATION REPORT

HETA 92-350-2292
OTIS ELEVATOR COMPANY
ALEXANDRIA, VIRGINIA