HEALTH HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT

HETA 94-0373

Suffolk County Courthouse
Boston, Massachusetts

November 1994

Preface

The Hazard Evaluation and Technical Assistance Branch of the National Institute for Occupational Safety and Health (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.

Mention of Company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation (HHE) at the request of the Massachusetts Department of Public Health. This request asked NIOSH to determine if a health hazard existed for employees at the Suffolk County Courthouse, Boston, Massachusetts, from exposure to isocyanates and volatile organic compounds resulting from an ongoing renovation and waterproofing project.

On August 23-25, 1994, five industrial hygienists from NIOSH conducted an environmental evaluation at the Suffolk County Courthouse. During that evaluation, air samples were collected throughout the facility for methylene biphenyl diisocyanate (MDI), 2,4-toluene diisocyanate (2,4-TDI), 2,6-toluene diisocyanate (2,6-TDI), and volatile organic compounds.

The samples taken from the Suffolk County Courthouse revealed no measurable quantities of isocyanates and only low quantities of volatile organic compounds (VOCs). The delay between the last application of the waterproofing chemicals and the NIOSH evaluation could account for the low results. However, this does not mean that a health hazard from these chemicals did not exist prior to this investigation.

Now that the waterproofing project has stopped, with no future plans of using isocyanate based products, there is little threat of seeing any new cases of individuals sensitized to isocyanates. The risk to previously sensitized workers appears low, although difficult to quantitate. For those employees who were reported to have become sensitized to isocyanates, their biological responsiveness and sensitivity may be at levels lower than the analytical detection limit for the sampling method. Any decision to return sensitized workers to this building should be made by the individual employee's health care providers. If sensitized employees return to the building, a medical surveillance program should be established to monitor the respiratory condition of those employees.

Even though VOCs were below the industrial exposure criteria, the levels measured may still account for health related problems experienced by some employees. A small percentage may still experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). However, most employees may just experience an unpleasant odor from the asphalt based waterproofing compounds, with no health problem. Therefore, management needs to be sensitive to that small percentage of employees who may still experience health problems, by relocating those individuals to other work locations within the building or off-site.

No isocyanates were detected on the 147 samples collected throughout the Suffolk County Courthouse. However, low quantities of volatile organic compounds were detected on area air samples. The results of this investigation do not imply that a health hazard from low level exposure to isocyanates and VOC does not still exist for some employees. A small percentage may still experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

Until an effective ventilation system is operational which meets ASHRAE criteria, management should be sensitive to that small percentage of employees which may still experience health problems from low levels VOC exposure, by either relocating those individuals to other work locations within the building or off-site. Even with an operational ventilation system, and independent of exposure measurements, individuals who were reported to have been medically documented as developing isocyanate sensitization from the waterproofing chemical may be at continued risk and may be unable to return to the building to work.

Keywords: SIC 9199 (General Government, Not Elsewhere Classified), methylene biphenyl diisocyanate, MDI, toluene diisocyanate, TDI, volatile organic compounds, VOCs, Duramem, Bituthane, respiratory irritant, sensitization, asthma.

INTRODUCTION

On August 5, 1994, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the Massachusetts Department of Public Health. This request asked NIOSH to determine if a health hazard existed for employees at the Suffolk County Courthouse, Boston, Massachusetts, from exposure to isocyanates and volatile organic compounds resulting from an ongoing renovation and waterproofing project. As a result of the waterproofing project, a number of Courthouse employees have reported to have experienced or filed a complaint of health symptoms that include cough, wheezing, chest tightness, exacerbation of pre-existing asthma, new onset of asthma, burning eyes with tearing, sore throat, shortness of breath, fatigue, headache, and nausea.

On August 8, 1994, a medical officer and an industrial hygienist from NIOSH attended an informational meeting at the Commonwealth of Massachusetts, Division of Capital Planning and Operations (DCPO) office in Boston, Massachusetts. The purpose of that meeting was to meet with the requestors, discuss the background information pertaining to the waterproofing project at the courthouse, review intervention strategies by DCPO to control chemical exposures and odors at the courthouse, and to briefly tour the courthouse.

On August 23-25, 1994, five industrial hygienists from NIOSH conducted an environmental evaluation at the Suffolk County Courthouse. During that evaluation, air samples were collected throughout the facility for methylene biphenyl diisocyanate (MDI), 2,4-toluene diisocyanate (2,4-TDI), 2,6-toluene diisocyanate (2,6-TDI), and volatile organic compounds. Sampling was conducted during normal business hours while the building was occupied. The temporary ventilation fans installed on the roof and using the stairways to distribute outside air to each floor was operational during this investigation.

This report presents the results of the NIOSH environmental investigation, along with recommendations for corrective actions. This report will serve to close out this technical assistance request.

BACKGROUND

The following background information has been extracted from numerous documents, letters, and reports pertaining to the renovation project at the Suffolk County Courthouse. The "new" Suffolk County Courthouse was constructed in the 1930s, and is located in the downtown Boston area. At any given time, there could be as may as 2,000 employees and court visitors within the facility.

This 17-story structure is constructed of concrete frame with masonry infill and a brick exterior cladding over the upper 80 percent of the building envelope. A stone exterior

cladding is installed over the lower 20 percent of the building envelope. The building is connected to a neighboring building (the old Courthouse) between the ground and the fourth floors. Several of the floors contain mezzanine levels with interior localized stairwells connecting the mezzanine levels to the main floors. Two main stairwells extend the entire height of the facility. A mechanical/elevator penthouse floor is located immediately below the roof. A mechanical "half" story is located between the eighth floor mezzanine level and the ninth floor. Two mechanical rooms located on the opposite ends of the eighth floor mezzanine level provide access to this "half" story. The space heating system consists of a piped radiator system connected to fuel fired boilers located in the sub-basement levels. The radiators are located at building perimeters under windows. The windows all contain operable/openable units, many of which contain unit air conditioners. Many of the radiators are of the "ventilating" type with integral fans that draw exterior air directly into the facility.[1]

Early on in this investigation, it was reported that there was no central ventilating system within the building. However, subsequent surveys by independent building technology consultants discovered a central ventilation system. They found two supply air fans located on the seventeenth floor. These fans appeared capable of supplying preconditioned outside air at rate of approximately 100,000 cubic feet per minute (cfm). In addition, four exhaust fans were also found in the seventeenth floor elevator penthouse. Those fans are connected to ventilation shafts which were sealed. It has been hypothesized that the ventilation system was shut down in the early 1970's due to the energy crisis/oil embargo, and has not been activated since. Also, as a result of many previous renovation projects conducted over the years at the Courthouse, many of the individual room supply and exhaust grills have either been sealed or removed .

Because of leaks in the new Suffolk County Courthouse building, DCPO undertook a project of external renovation in 1993. This renovation project consisted of removing the old exterior brick facade, waterproofing the exterior wall, and caulking around the windows, and installing a new brick facade. The waterproofing material used was Duramem V-500, manufactured by Percore Corporation. Duramem V-500 is a urethane waterproofing material whose principal components are aromatic hydrocarbons, xylene, methylene bisphenyl diisocyanate (MDI) and toluene diisocyanate. The volatile fraction is composed of polycyclic aromatic hydrocarbons (40%), xylene (10%), and MDI (7%).[2]

The caulking material used was Bituthane, manufactured by W.R. Grace & Company. Bituthane is a rubberized asphalt/aromatic isocyanate polyol liquid waterproofing material. It was used to seal the interface between the window edge flashing and the Duramem V-500. The chemical components of the Bituthane, by weight, are asphalt (30%), naphthenic oil (15%), and MDI (4%).[2]

Information supplied to NIOSH indicate that employees began experiencing health related symptoms almost immediately after the waterproofing project started in October 1993. These health complaints have continued, even though the last application of Duramem V-500 and Bituthane was in June 1994. In November 1993, DCPO retained

the services of an industrial hygiene firm to collect air samples within the Courthouse. Air samples were collected for aromatic hydrocarbons and MDI. In November 1993, sampling results collected from various offices within the Courthouse during waterproofing application showed MDI levels from 0, or not detected, to 23.5 parts per billion (ppb). During the subsequent months, up until the last application of the waterproofing, MDI and aromatic hydrocarbons levels were lower than previously measured; however, they were still present within the facility.

In July 1994, DCPO retained the services of a second industrial hygiene firm to monitor the chemical exposures within the facility and to provide technical assistance for reducing the chemical and odor problems. The approach was to positively pressurize the building to prevent the water proofing chemical compounds from infiltrating through pipe chases, windows, and other wall openings. Two large supply air fans were placed on the roof to introduce outside air into the facility. Since there was no duct distribution network accessible, the two common stairways were used to distribute the air throughout the facility. This required that the fire door on each floor had to be kept open. In addition, offices where odors were more prevalent were targeted for depressurization of the exterior wall cavity. This was accomplished by covering the windows and piped radiators with a polyethylene film. Exhaust fans were placed on the window ledges between the poly film and windows. These fans were connected via flexible duct between the radiator vents and window. The fans created a negative pressure within specific wall cavity around pipe chases and exhausted out the window. This exhaust configuration was present in a number of offices throughout the facility. Even with this extensive effort, odors and employee health complaints continued.

During this period of odor abatement, a number of offices and employees were moved out of the building. Also, employees that had medically documented cases of pre-existing asthma, new cases of asthma, or any other pre-existing medical condition which appeared to be exacerbated by the chemicals within the facility were given administrative leave.

On August 5, 1994, NIOSH was asked to conduct an independent evaluation of the chemical exposures within the facility. During August 23-25, 1994, NIOSH conducted an industrial hygiene evaluation at the Suffolk County Courthouse.

METHODS

On August 23-25, 1994, environmental air samples were collected throughout the Courthouse to evaluate potential exposures to methylene biphenyl diisocyanate (MDI), 2,4-toluene diisocyanate (2,4-TDI), 2,6-toluene diisocyanate (2,6-TDI), and volatile organic compounds.

Isocyanates

Area air samples for potential exposure to MDI, 2,4-TDI and 2,6-TDI monomers were collected using impingers containing 20 milliliters (ml) of an 80:20 solution of dimethylsulfoxide (DMSO) and acetonitrile containing tryptamine. The air to be sampled was drawn through the impinger solution at a constant flow rate of 1.0 liter per minute (lpm). Isocyanate samples were collected for approximately 6 hours.

The collected isocyanate samples were analyzed according to NIOSH Analytical Method 5522[3]. Analysis consisted of injecting a 25 microliter (µℓ) aliquot of each sample into a high performance liquid chromatograph (HPLC), equipped with a fluorescence detector and then measuring the fluorescent peaks of the tryptamine derivatives of isocyanates.

Volatile Organic Compounds

Area air samples for volatile organic compounds (VOCs) were collected on both thermal desorption and coconut shell, charcoal sorbent tubes. Thermal desorption tubes are very sensitive and are extremely useful for sampling VOCs when chemical concentrations are expected to be very low. Each thermal desorption tube contained three beds of sorbent material, a front layer of Carbotrap C (≃ 350 milligrams, mg) a middle layer of Carbotrap (≃ 175 mg) and a back layer of Carboxen 569 (≃ 150 mg), all housed in a stainless steel tube. Prior to field sampling, each tube was conditioned for 2 hours at 375 °C. Air was drawn through each thermal desorption tube at a constant flow rate of 50 cubic centimeters per minute (cc/min) for a maximum of 2 hours. Thermal desorption samples were collected from each floor of the new Courthouse and were submitted for qualitative, or screening analysis of VOCs using gas chromatography / mass spectrometry (GC/MS).

Standard coconut shell, charcoal tubes (150mg/50mg) were used to collect area air samples for quantitative analysis of VOCs according to NIOSH Analytical Methods 1400 and 1501.[3] Air was drawn through each charcoal tube at a constant flow rate of 50 cc/min for approximately 6 hours. The quantitative analysis of the charcoal tubes are dependent upon the qualitative analysis of the thermal desorption tubes. If no hydrocarbon peaks are detected on the thermal desorption samples during the initial screening, then no peaks would be expected to be detected on the charcoal tubes samples. If hydrocarbon peaks are identified from the screening, then that screening is used to direct the quantitative analysis of the charcoal tubes by focusing on particular chemical compounds.

EXPOSURE CRITERIA

General Guidelines

As a guide to the evaluation of the hazard 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. In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

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.[4-6] With few exceptions, pollutant concentrations observed in non-industrial indoor environments fall well below these published occupational standards or recommended exposure limits (REL). It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. These evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling (C) values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Isocyanates

Within industries where isocyanates are used, the prevalence of isocyanate-related symptoms may reach 10%. A recent study reported a 10.3% prevalence of MDI asthma in a foundry with 78 employees.[7] Among workers with respiratory symptoms, the predominant clinical diagnosis is bronchial asthma. Rhinitis (runny nose), conjunctivitis (inflamed eyes), chronic obstructive lung disease, and skin lesions are also observed.[8]

Isocyanates can induce immediate, late, and dual (combined intermediate and late) asthmatic responses; the late asthmatic reaction predominates on inhalation challenge testing.[9] In a study of 29 workers referred for specific inhalation challenges with isocyanates, 7 had an immediate response, 15 had an early or late response, and 7 had dual reactions. Late asthmatic reactions were seen with exposure to MDI as well as to toluene diisocyanate (TDI) and hexamethylene diisocyanate (HDI).[10] Delayed asthmatic reactions may be missed by cross-shift spirometry, but should be detected by serial measurements of peak expiratory flow rates. In one study, workers currently exposed to MDI had cross-shift changes in forced expiratory volume in one second (FEV_1) that were not significantly different from zero. However, the comparison population of workers with no history of MDI exposure had a mean cross-shift increase in FEV_1, so there was a significant difference between the two groups.[11]

The role of immunologic testing in diagnosing cases of isocyanate-induced asthma is still under investigation. Estimates of the percentage of symptomatic individuals with isocyanate-induced asthma who have immunoglobulin-E (IgE) antibodies directed against isocyanates conjugated to human serum albumin have ranged from 14%[7] to 80%.[12] Isocyanates, including MDI[13], can also cause hypersensitivity pneumonitis, characterized by shortness of breath and fever for several hours after exposure and the presence of isocyanate-specific immunoglobulin-G (IgG) antibodies. In a study of 29 individuals with positive inhalation challenges to isocyanates, 10 of whom had positive challenge tests to MDI, none had isocyanate-specific IgE alone. Twenty of these subjects had isocyanate-specific IgG only, while nine had both IgE and IgG.[10] Recent evidence suggests that a hypersensitivity pneumonitis-type of reaction may be a more frequent consequence of MDI exposure than previously recognized, approaching 5%.[14]

Studies of the natural history of occupational asthma[15] indicate that, although improvement is often noted after exposure to the precipitating agent is terminated, symptoms and bronchial hyperreactivity may persist for many years or indefinitely. Persistence of chronic asthma appears to be related to the duration of an individual's exposure following onset of the disease and may also be related to the severity of the asthmatic reaction. In a follow-up study of 50 workers with isocyanate-induced asthma, 16 of whom were sensitized to MDI, 82% continued to have respiratory symptoms, and approximately half of these required inhaled or oral medications for asthma at least once per week. All of these individuals had avoided isocyanate exposure for at least 4 years.[16] Death has been reported in an isocyanate-sensitized worker who continued to work with polyurethane paint containing toluene diisocyanate.[17]

Both the ACGIH threshold limit value (TLV) and NIOSH REL for industrial exposures to MDI are a TWA of 5 parts MDI per billion parts air (ppb) [equivalent to 50 micrograms per cubic meter of air (ug/m^3)] for an 8-hour workday (ACGIH) or up to a 10-hour workday (NIOSH). NIOSH also recommends a 10-minute TWA ceiling of 20 ppb (200 ug/m^3). The OSHA permissible exposure limit (PEL) for MDI is a 20 ppb ceiling level that should not be exceeded during any part of the workday. Both the ACGIH TLV and OSHA PEL for an industrial exposure to TDI is 5 ppb for an 8 hour TWA exposure. NIOSH considers TDI a carcinogen, and recommends that exposures be reduced to the lowest feasible limit using state of the art engineering controls. Some studies have suggested that exposure to MDI levels below the exposure criteria may produce isocyanate-induced respiratory sensitization in some workers.[18,19]

The NIOSH recommendations apply to diisocyanate monomers only, and not to the higher polymers of these compounds. Little is known about the toxicological effects of polymeric isocyanates. However, it is thought that the inhalation of any species having multiple unreacted isocyanate groups may impair respiratory function or give rise to sensitization.[21,22] In 1983, the United Kingdom Health and Safety Commission set a "common control limit" for workplace exposure to all isocyanates. This new control limit is 20 ug/m^3 of isocyanate group (NCO) expressed as an 8-hour TWA, and 70 ug/m^3 NCO as a 10-minute TWA. This new control limit requires that the analytical methods be applicable to "total isocyanate," that is, the sum of all isocyanate species, including monomers and prepolymers.[22]

Volatile Organic Compounds

Volatile organic compounds describe a large class of chemicals which are organic (i.e, containing carbon) and have sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. Not all hydrocarbons exhibit the same toxicological effects; therefore, exposure criteria are dependent on the particular hydrocarbon and toxic effect. Generally, overexposure to these substances may cause irritation of the eyes, respiratory tract, and skin. Since they are central nervous system depressants, overexposure may also cause fatigue, weakness, confusion, headache, dizziness, and drowsiness.

RESULTS

The purpose of this environmental investigation was to characterize through integrated air sampling the potential for chemical exposures to the waterproofing chemicals within the Courthouse. Area air sampling was accomplished for total isocyanates and volatile

organic compounds on fifteen floors a day, for 3 consecutive days. The location for sampling on each floor was left up to the industrial hygienist assigned to particular floors. The decision on sampling location was based on personal observation, discussions with occupants, and noticeable odors. Using this method of site selection, the possibility existed that some rooms or areas might be sampled more than once and others not at all. Over that 3 day period , 150 area air samples for isocyanates, 15 thermal desorption tubes for qualitative VOC screening and 150 charcoal tube samples for quantitative VOC analysis were collected throughout the new and old Courthouses. Appendix 1 outlines the relevant sampling information and locations, sorted by floor, where each isocyanate and charcoal tube sample was collected within the Courthouse. When possible, the room number is listed where the sample was collected. If no room number was available, a general description of the area where the sample was collected is provided. The following outlines the results from the environmental evaluation conducted at the Suffolk County Courthouse.

Isocyanates

Of the 150 isocyanate samples collected, three were voided due to sample tampering. The remaining 147 samples were submitted for quantitative analysis of total monomeric isocyanates, including methylene biphenyl diisocyanate (MDI), 2,4-toluene diisocyanate (2,4-TDI), and 2,6-toluene diisocyanate (2,6-TDI).

No isocyanates were detected on any of the 147 samples collected within the Courthouse. The Limit of Detection (LOD) for the isocyanate analysis was 0.05 parts per billion (ppb) for MDI, 0.28 ppb for 2,4-TDI, and 0.41 ppb for 2,6-TDI. The Limit of Quantitation for the isocyanate analysis was 0.15 ppb for MDI, 0.67 ppb for 2,4-TDI and 1.2 ppb for 2,6-TDI. The LOD is defined as the smallest amount of analyte which can be distinguished from background. The Limit of Quantitation (LOQ) is defined as the lowest amount of analyte that can be reported with acceptable precision. Results falling between the LOD and LOQ can only be interpreted as a semi-quantitative estimate.

Volatile Organic Compounds

Qualitative Analysis

Fifteen thermal desorption area air samples were randomly placed throughout the new Courthouse. The purpose of collecting the thermal desorption tube samples was to determine what chemical compounds were present in the air, and not to determine their relative amounts. Those screening air samples were then used to direct the quantitative analysis of the long-term integrated charcoal tube samples.

The total ion chromatograms showing individual volatile organic compound peaks detected by thermal desorption are presented in Appendix 2. Each peak detected on each sample is numbered 1-39. The table which accompanies Appendix 2 lists each peak number with its corresponding chemical identification. Each chromatogram has the same scale for comparison (same time and abundance axes).

Only low amounts of contaminants were detected on the samples. The highest amount was detected on sample CX-34 which contained a series of branched aliphatic hydrocarbons. Many of the samples contained a series of aromatic hydrocarbons including alkyl benzenes (trimethylbenzenes, etc.), naphthalene, and various alkyl naphthalenes (methyl-, dimethyl-, trimethyl-). Other compounds present on some samples included siloxane compounds, p-dichlorobenzene, limonene, toluene, xylene, and butyl cellusolve. Acetone was detected at higher levels on one sample (CX-43) and on one of the control (blank) samples. Dimethylsulfoxide (DMSO) was detected on several samples but its source is suspected to be from the impinger sampling for isocyanates being conducted at the same time.

Quantitative Analysis

Since the qualitative analysis of the thermal desorption tubes revealed low amounts, it was unlikely the quantitative analysis of the standard charcoal tubes would detect any VOCs. Initially, 6 of the 150 charcoal tube samples were selected to be quantitatively analyzed for organic solvents, primarily xylene and ethanol. The six samples were selected because they were collected in areas were the industrial hygienist observed chemical odors.

The analysis of those six samples, shown in Table 1, revealed only trace amount of xylene and ethanol. All concentrations detected fell below or between the LOD and LOQ of the analytical method.

The LODs of this analysis for xylene and ethanol were 0.01 parts per million (ppm) and 0.03 ppm, respectively. The LOQs of this analysis for xylene and ethanol were 0.02

and 0.12 ppm, respectively. Values falling between the LOD and LOQ are indicated in parentheses and can only be considered as semi-quantitative estimates.

The quantitative analysis of those six charcoal tube samples confirmed that any VOCs collected would be low, and therefore difficult to detect. Considering the results of the first six samples analyzed, and the fact that the samples were collected in areas observed to have chemical odors, it was felt that additional analysis of the remaining 144 samples would most likely provide similar results.

Table 1.
Results of quantitative analysis of selected charcoal tubes.

Sample Number	Sample Location	Xylene (ppm)	Ethanol (ppm)
8101-030	Room 702 - Video Room	not detected	(0.1)
8101-045	Justice Dreben's Office	not detected	(0.05)
8101-049	Justice Perretta's Office	(0.015)	(0.05)
8101-140	Room 702 - Above Ceiling	(0.019)	(0.04)
8101-147	Supreme Court Conf. Rm. (Behind wall heater)	not detected	not detected
8101-150	Justice Perretta's Office	(0.017)	not detected
	Limit of Detection (LOD)	*0.01*	*0.03*
	Limit of Quantitation (LOQ)	*0.02*	*0.12*

Instead of analyzing all the remaining charcoal tube samples, it was decided that only 12 additional samples would be selected for analysis. Those 12 samples were analyzed for xylene, and toluene . The results of that analysis are shown in Table 2.

The LOD of this analysis for toluene and xylene was 0.03 parts per million (ppm) and 0.02 ppm, respectively. The LOQ of this analysis for toluene and xylene was 0.11 and 0.10 ppm, respectively. Values falling between the LOD and LOQ are indicated in parentheses and can only be considered as semi-quantitative estimates.

As anticipated, the results of the quantitative analysis showed low concentrations of toluene, with xylene not detected. Therefore, it was decided that the remaining charcoal tube samples would not be analyzed.

Table 2.
Quantitative Analysis for Toluene and Xylene

Sample Number	Sample Location	Toluene (ppm)	Xylene (ppm)
8101-005	Room 206 - Jury Pool Room	ND	ND
8101-014	Floor 6 - DA Conference Room	ND	ND
8101-018	Room 630 - Attorney's Office	0.15	ND
8101-020	Room 604 - Jim Larkins Office	(0.09)	ND
8101-024	Room 815 - Superior court	(0.09)	ND
8101-060	Room 414 - Jury Room	0.16	ND
8101-077	Room 702 - Video Room	0.15	ND
8101-097	Justice Perretta's Office	0.12	ND
8101-099	Room 1400 - Barbara Diamond's Office	(0.07)	ND
8101-101	Room 100 - Old Courthouse	0.13	ND
8101-133	Room 702 Video room	0.21	ND
8101-148	Thorndike Library	(0.07)	ND
	Limit of Detection	***0.03***	***0.02***
	Limit of Quantitation	***0.11***	***0.10***

DISCUSSION AND RECOMMENDATIONS

Some of the most important information gathered during this investigation were sampling results obtained by the consultant during, or directly after, the waterproofing applications. Those results did show that concentrations of isocyanates and VOCs

within the facility did approach or exceed industrial exposure criteria. In November 1993, sampling results collected from various offices within the Courthouse during waterproofing application showed MDI and TDI levels from nondetected to 23.5 parts per billion (ppb) and nondetected to 1.8 ppb, respectively. During the subsequent months up until the last application of the waterproofing, MDI and aromatic hydrocarbons levels were lower than previously measured; however, they were still present within the facility.

The samples collected by NIOSH during this investigation at the Suffolk County Courthouse revealed no detectable quantities of isocyanates and low quantities of VOCs. The delay between the last application of the waterproofing chemicals and the NIOSH investigation could account for the sampling results. However, this does not mean that a health hazard from these chemicals did not exist prior to this investigation.

Now that the waterproofing project has stopped, with no future plans of using isocyanate based products, there is little threat of developing new cases of isocyanate sensitization. The risk to previously senstized wokers appears low, although difficult to quantitate. For those employees who were reported to have become sensitized to isocyanates, their biological responsiveness and sensitivity may be at levels lower than the analytical detection limit for the sampling method. Any decision to return sensitized workers to this building should be made by the individual employee's health care providers. If sensitized employees return to the building, a medical surveillance program should be established to monitor the respiratory condition of those employees.

Even though VOCs were below the industrial exposure criteria, the levels measured may still account for health related problems experienced by some employees. A small percentage may still experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). However, most employees may just experience an unpleasant odor with no health problem. Therefore, management needs to be sensititive to that small percentage of employees which may still experience health problems, by relocating those indivduals to other work locations within the building or off-site.

Documentation provided by DCPO reveals that although 6 months has passed since the last waterproofing application, employees continue to complain of chemical odors in their workplace. This may be a direct result of the low odor thresholds for many of the VOCs used in the waterproofing materials and the lack of an adequate central ventilation system to provide sufficient dilution air. Until the waterproofing material totally off-gases (which could depend on several environmental variables), it is possible that the chemical odors may persist in the building for a long period.

Finally, the investigators noted the lack of restrictions regarding cigarette smoking within the facility. The open policy on smoking, compounded by the lack of an adequate ventilation system, may cause additional complaints and health related

problems for employees. The health hazards associated with exposure to environmental tobacco smoke (ETS) have been well documented in the scientific literature.

Based on the sampling results and observations made during this investigation, the following recommendations are offered:

1. It is recommended that an engineering study be commissioned to determine the most appropriate way of ventilating the building according to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) criteria. ASHRAE has published recommended building ventilation design criteria and thermal comfort guidelines.[23,24] The ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute (cfm) per person for office environments. Once adequate outside air per occupant load is achieved, it must be evenly distributed to the occupied spaces. Proper indoor ventilation, according to ASHRAE, not only provides for sufficient dilution air, but also increases employee comfort.

2. A medical surveillance program should be instituted to monitor and assess the health of those effected employees. This will be an especially important program should these individuals return to work in this building. Until an effective ventilation system is operational which meets ASHRAE criteria, management should be sensititive to that small percentage of employees which may still experience health problems from low levels VOC exposure, by either relocating those indivduals to other work locations within the building or off-site.

   Even with an operational ventilation system, and independent of exposure measurements, individuals which have been reported to have been medically documented as developing isocyanate sensitization from the waterproofing chemical may be at continued risk and may be unable to return to the building to work.

3. The smoking policy should be reviewed and revised based on the most current literature available on the health affects from exposure to environmental tobacco smoke (ETS).

   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. NIOSH and the Association of Schools of Public Health (ASPH) have recommended the following strategy for smoking cessation. Specifically, 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.

If smoking is to continue within the Courthouse, then designated smoking areas should be established. A designated smoking lounge should be equipped with a separate ventilation system that does not allow for recirculation of air. Currently, ASHRAE recommends that 60 cfm of outside air be provided for smoking lounges.

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3. General Counsel, Division of Capital Planning and Operations, The Commonwealth of Massachusetts.

4. Director of Administration and Finance, Suffolk county District Attorney's Office, The Commonwealth of Massachusetts.

5. Court Administrator, Trial Court, Boston Municipal Court Department, The Commonwealth of Massachusetts.

6. Office of Environmental Affairs, City of Boston, Department of Health and Hospitals.

7. OSHA Region I

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.

Appendix 1.

Sampling Information

HETA 94-0373
Sufflok County Courthouse
Boston, MA

October 1994

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

HETA 94-0373

Sampling Information

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
23-Aug	1	102	Donovens Clerks Office	8101-001	18	8101-373-001	356
23-Aug	1	100	Trail Court Room	8101-002	18	8101-373-002	357
23-Aug	1	104	Sheriff's Office	8101-003	18	8101-373-003	355
23-Aug	1	Lobby	Guard/Security Area	8101-004	18	8101-373-004	355
24-Aug	1	Garage	Van Room	8101-060	18	8101-373-060	353
24-Aug	1	Lobby	Adjacent to Entrance	8101-059	18	8101-373-059	356
24-Aug	1	104	Sherriff's Office (Conf. Rm.)	8101-058	18	8101-373-058	357
25-Aug	1	100-Old	Superior Court Docket Rm.	8101-101	19	8101-373-101	374
25-Aug	1	117-Old	Civil Clerk's Office	8101-105	19	8101-373-102	370
25-Aug	1	117-Old	Document Vault	8101-102	19	8101-373-103	372
23-Aug	2	206	Jury Pool Room	8101-005	18	8101-373-005	359
23-Aug	2	213	Civil Court Clerks Office	8101-006	18	8101-373-006	359
23-Aug	2	210	Boston Juv. Court Clinic	8101-007	18	8101-373-007	359
24-Aug	2	215	Clerk Magistrates Office	8101-057	18	8101-373-057	350

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
24-Aug	2	214	Donoven's Clerks Office	8101-056	18	8101-373-056	354
24-Aug	2	210	Director, Juv. Court Clinic	8101-055	18	8101-373-055	366
24-Aug	2	206	Jury Pool Room	8101-054	18	8101-373-054	367
25-Aug	2	215	Magistrates Clerks Office	8101-104	19	8101-373-104	370
25-Aug	2	210	Juv. Court Clinic (Grad. Off.)	8101-103	18	8101-373-105	368
25-Aug	2	206	Jury Pool Room	8101-106	18	8101-373-106	363
23-Aug	3	313	Superior Court Room	8101-008	18	8101-373-008	357
23-Aug	3	300	Att. Office Supreme Court	8101-009	18	8101-373-009	355
23-Aug	3M	Hallway	Near Jury/Court Officers Office	8101-010	18	8101-373-010	void
24-Aug	3	313	Superior Court Anti- Room	8101-053	18	8101-373-053	void
24-Aug	3M	349M	Juvenile Department	8101-052	18	8101-373-052	363
24-Aug	3M	Hallway	Jury Deliberation Area	8101-051	18	8101-373-051	363
25-Aug	3	318	Civil Court Records Dept.	8101-107	18	8101-373-107	336
25-Aug	3	316	Judges Chambers	8101-108	18	8101-373-108	366
25-Aug	3	314	Superior Court Room	8101-109	18	8101-373-109	366
25-Aug	3	Ladies Rm.	Across from Rm. 314	8101-110	19	8101-373-110	369
25-Aug	3-Old	371	Court Room	8101-115	18	8101-373-117	360

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
23-Aug	4	413	Court Room	8101-019	20	8101-373-018	389
23-Aug	4	411	Court Clerk's Office	8101-013	19	8101-373-020	382
23-Aug	4	408	Docket Office	8101-017	19	8101-373-012	378
24-Aug	4	403	Court Room	8101-068	19	8101-373-068	382
24-Aug	4	404	Court Room	8101-061	19	8101-373-063	381
24-Aug	4	418	Magistrate's Office	8101-064	19	8101-373-062	378
24-Aug	4	414	Jury Room	8101-060	19	8101-373-065	372
25-Aug	4		Probation Room (Women)	8101-119	18	8101-373-118	360
25-Aug	4		Probation Room (Men)	8101-116	18	8101-373-119	363
23-Aug	5	500	Near Doorway	8101-015	18	8101-373-019	367
23-Aug	5	508	Cashier's Office	8101-012	18	8101-373-016	366
23-Aug	5	507	Middle of Room	8101-016	18	8101-373-014	362
23-Aug	5	504	Clerk's Office	8101-011	18	8101-373-017	360
24-Aug	5	512	Court Clinic	8101-069	19	8101-373-061	388
24-Aug	5	504	Clerk's Office	8101-067	16	8101-373-064	321
24-Aug	5		File Room	8101-070	16	8101-373-066	319
25-Aug	5	505G	Admin. (probation) Office	8101-114	18	8101-373-114	360

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
25-Aug	5	509	Cashier's Office	8101-113	18	void	
23-Aug	6	604	Jim Larkin's Office	8101-020	19	8101-373-013	373
23-Aug	6	630	Attorney's Office	8101-018	17	8101-373-011	345
23-Aug	6		Conference Room	8101-014	17	8101-373-015	345
24-Aug	6		Exec. Asst. DA's Office	8101-068	19	8101-373-068	382
24-Aug	6	602	Office	8101-062	19	8101-373-069	369
24-Aug	6	612	Appelate Library	8101-065	19	8101-373-067	369
25-Aug	6		Grand Jury Room	8101-118	22	8101-373-111	445
25-Aug	6	604	Jim Larkin's Office	8101-111	18	8101-373-116	361
25-Aug	6	630	Attorney's Office	8101-117	18	8101-373-115	360
25-Aug	6		Conference Room	8101-112	18	8101-373-120	360
23-Aug	7	703	Judges Chambers	8101-022	18	8101-373-027	362
23-Aug	7	702	Video Room	8101-030	18	8101-373-026	350
23-Aug	7	712	Poleaski Clerks Office	8101-026	18	8101-373-030	353
23-Aug	7	707	Probation Clerk	8101-025	18	8101-373-021	352
24-Aug	7M	751M	Locker room	8101-076	21	8101-373-080	410
24-Aug	7	704	Court room	8101-074	20	8101-373-074	406

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
24-Aug	7	702	Video Room	8101-077	20	8101-373-076	400
25-Aug	7	702	Video Room (window)	8101-133	19	8101-373-132	375
25-Aug	7	702	Video Room	8101-138	19	8101-373-137	375
25-Aug	7	702	Video Room (above false ceiling)	8101-140	19	8101-373-138	375
25-Aug	7	714	Superior Court Clerk	8101-135	19	8101-373-139	370
25-Aug	7	707	Superior Court Probation	8101-131	19	8101-373-140	370
25-Aug	7M	763M	Superior Criminal Court	8101-139	19	8101-373-135	370
23-Aug	8	802	Homicide	8101-021	19	8101-373-028	372
23-Aug	8	817	Superior Court	8101-028	19	8101-373-024	370
23-Aug	8	815	Superior Court	8101-024	18	8101-373-029	396
24-Aug	8M	859M	Court Reporter's	8101-080	21	8101-373-071	412
24-Aug	8	806	Superior Court	8101-079	21	8101-373-075	415
24-Aug	8	815	Superior Court	8101-075	21	8101-373-072	410
25-Aug	8	802	Homicide	8101-136	19	8101-373-134	370
25-Aug	8M	850M	Jury Room	8101-132	19	8101-373-133	370
23-Aug	9	909	Richard Dimeo's Office	8101-023	19	8101-373-025	380
23-Aug	9	906	Superior Court	8101-029	19	8101-373-022	380

Sufflolk County Courthouse
Boston, MA
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				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
23-Aug	9	916	Superior Court	8101-027	19	8101-373-023	375
24-Aug	9	916	Superior Court	8101-073	21	8101-373-077	425
24-Aug	9	902	Drug Unit	8101-071	21	8101-373-079	425
24-Aug	9M	959M	Jury Room	8101-078	21	8101-373-073	411
24-Aug	9	909	Richard Dimeo's Office	8101-072	20	8101-373-078	399
25-Aug	9	902	Drug Unit	8101-137	18	8101-373-136	358
25-Aug	9M	951M	Notary	8101-134	18	8101-373-131	355
23-Aug	10	1017	East Wall	8101-039	18	8101-373-034	354
23-Aug	10	1016	West Wall	8101-035	18	8101-373-033	349
23-Aug	10	1015	West Wall	8101-038	17	8101-373-038	347
24-Aug	10	1001	South Wall	8101-081	18	8101-373-087	348
24-Aug	10	1004	East Wall	8101-085	18	8101-373-084	349
24-Aug	10	1007	West Wall	8101-082	18	8101-373-086	348
24-Aug	10	1000	Housing Court Office	8101-087	16	8101-373-082	322
25-Aug	10	1010	Northwest Wall	8101-128	18	8101-373-123	352
25-Aug	10	1012	North Wall	8101-127	18	8101-373-124	352
25-Aug	10	1014	Northeast Wall	8101-130	18	8101-373-121	356

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
23-Aug	11	1100	Southwest Wall	8101-040	17	8101-373-032	338
23-Aug	11	1121	South Wall	8101-031	17	8101-373-040	336
23-Aug	11	1103	South Wall	8101-032	17	8101-373-031	333
24-Aug	11		Library	8101-089	17	8101-373-085	347
24-Aug	11		Hallway	8101-088	18	8101-373-088	348
24-Aug	11		Office (NW corner of Bldg.)	8101-090	18	8101-373-090	351
25-Aug	11	1114	Copying room	8101-126	18	8101-373-126	357
25-Aug	11	1112	Exec. Sect. to Chief Justice	8101-124	18	8101-373-128	357
25-Aug	11		Elevator Lobby (east side)	8101-129	18	8101-373-122	354
25-Aug	11	1123	Law Clerk's Office	8101-125	18	8101-373-125	354
23-Aug	12		Admin. Services	8101-033	17	8101-373-037	341
23-Aug	12		Library	8101-037	18	8101-373-036	353
23-Aug	12	1205	Technical Services	8101-034	17	8101-373-035	346
23-Aug	12	1204	Trustees Room	8101-036	17	8101-373-039	343
24-Aug	12		Library (SW Wall)	8101-086	18	8101-373-083	350
24-Aug	12		Library (NW Wall)	8101-084	18	8101-373-081	351
24-Aug	12		Library (Center)	8101-083	18	8101-373-089	350

Sufflolk County Courthouse
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				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
25-Aug	12		Staff Room	8101-121	18	8101-373-127	355
25-Aug	12		Membership Services	8101-122	18	8101-373-130	352
25-Aug	12	1206	Technical Services	8101-123	18	8101-373-129	349
23-Aug	13M	1350M	Fiscal Office	8101-050	17	8101-373-050	348
23-Aug	13M	1351M	Fiscal Office	8101-043	17	8101-373-048	346
23-Aug	13M	1362M	Office	8101-046	17	8101-373-046	346
24-Aug	13	1304	Justice Graney's Office	8101-100	18	8101-373-097	394
24-Aug	13	1316	Office	8101-095	18	8101-373-098	366
24-Aug	13		Supreme Court's Conf. Room	8101-094	18	8101-373-095	356
25-Aug	13	1304	Justice Graney's Office	8101-142	19	8101-373-150	365
25-Aug	13		Thorndike Library	8101-148	19	8101-373-149	379
25-Aug	13		Supreme Court's Conf. Room	8101-147	19	8101-373-147	374
23-Aug	14	1400	Barbara Diamond's Office	8101-047	17	8101-373-049	348
23-Aug	14	1412	Supereme Court Clerks Office	8101-048	18	8101-373-047	361
23-Aug	14	1404	Clerk Rouse's Offices	8101-044	18	8101-373-042	360
24-Aug	14	1400	Barbara Diamond's Office	8101-099	20	8101-373-094	394
24-Aug	14	1407	Reporter of Court Discisions	8101-091	20	8101-373-093	394

Sufflolk County Courthouse
Boston, MA
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				Charcoal Tubes		*Isocyanate Impingers*	
Date	**Floor**	**Room**	**Location**	**Sample Number**	**Volume (liters)**	**Sample Number**	**Volume (liters)**
24-Aug	14	1404	Clerk Rouse's Office (Records)	8101-092	20	8101-373-092	366
25-Aug	14	1400	Barbara Diamond's Office	8101-143	19	8101-373-144	371
25-Aug	14	1410	Supreme Court Clerks Office	8101-141	19	8101-373-146	374
25-Aug	14		Outside between Durmen and brick	8101-145	20	8101-373-142	393
25-Aug	14		SE Stairwell	8101-149	18	8101-373-148	365
23-Aug	15		Justice Dreben's Office	8101-045	19	8101-373-045	372
23-Aug	15		Justice Perretta's Office	8101-049	18	8101-373-044	366
23-Aug	15		Conference Room	8101-041	19	8101-373-043	374
23-Aug	15		Justice Gillerman's Office	8101-042	19	8101-373-041	371
24-Aug	15		Justice Dreben's Office	8101-093	22	8101-373-100	429
24-Aug	15		Justice Perretta's Office	8101-097	21	8101-373-096	423
24-Aug	15		Chief Justice Warner's Office	8101-098	18	8101-373-099	367
25-Aug	15		Justice Perretta's Office	8101-150	18	8101-373-143	362
25-Aug	15		Conference room	8101-144	18	8101-373-141	352
24-Aug	16		Staff Attorney's Library	8101-096	21	8101-373-091	419
25-Aug	16		Office of Doc. Preservation	8101-146	18	8101-373-145	351

Sufflolk County Courthouse
Boston, MA
August 23-25, 1994

Appendix 2.

Thermal Desorption Tube Chachromatograms

HETA 94-0373
Sufflok County Courthouse
Boston, MA

October 1994

SEQ 8101
THERMAL DESORPTION TUBES
PEAK IDENTIFICATION

1)Air*/CO_2*24)Aromatic hydrocarbons, C_9H_{12}
2)SO_2*alkyl benzenes (trimethyl-
3)C_4H_{10} butanesethylmethyl benzenes, etc.)
4)Ethanol25)Aliphatic hydrocarbons,
5)Acetone*mostly branched alkanes,
6)C_5H_{12} pentanesC_{10}-C_{12} range
7)C_5H_8 pentadiene26Octamethylcyclotetrasiloxane
8)Dimethyl sulfide**27)p-Dichlorobenzene/decane
9)Acetic acid28)Limonene
10)t-Butanol29)$C_{10}H_{14}$ alkyl benzenes
11)n-Hexane(tetramethyl-, diethyl-,
12)Methylcyclopentanedimethyl ethyl benzenes, etc.)
13)1,1,1-Trichloroethane30)Aliphatic aldehydes*
14)Benzene*31)C_{10}-C_{14} n-alkanes
15)Propylene glycol?32)Decamethylcyclopentasiloxane
16)Methylcycohexane33)Naphthalene
17)Dimethyl disulfide**34)Caprolactam
18)Toluene35)Methyl naphthalenes
19)Dimethylsulfoxide (DMSO)**36)Biphenyl
20)Perchloroethylene37)Dimethyl naphthalenes
21)Ethyl benzene/xylenes38)$C_{12}H_{10}$, acenaphthene
22)Cellosolve acetate*39)Trimethyl naphthalenes
23)Butyl cellosolve

*Also present on some media/field blanks.
**DMSO was present as a sampling media for isocyanates; other sulfides may be present as impurities of DMSO.

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