CDC Workplace Safety and Health

NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA # 2002-0038-2870
26 Federal Plaza, New York, New York

March 2002

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) 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 (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance 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 NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Ronald Hall, Scott Earnest, Erin Snyder, Douglas Trout, Charles Mueller, and Ashok Nimgade of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and Engineering and Physical Hazards Branch, Division of Applied Research and Technology. Joseph Hurrell, Richard Driscoll, and Sherry Baron provided valuable assistance. Analytical support was provided by Data Chem Laboratories. Desktop publishing was performed by Patricia McGraw. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Occupational Exposures and Health Concerns Among Employees at the Federal Building, 26 Federal Plaza, New York City

NIOSH received a request from representatives of the Department of Health and Human Services (DHHS) regarding potential exposures and health effects among Federal Office Building employees related to the attacks on, and subsequent collapse of, the World Trade Center (WTC).

What NIOSH Did

- We met with employees and union and DHHS representatives.
- We checked the work environment for the presence of contaminants by sampling the air and collecting dust and wipe samples.
- We asked DHHS employees at the NYC Federal Building to fill out a questionnaire; we asked DHHS employees in Dallas to fill out the same questionnaire so that we could compare the groups.

What NIOSH Found

- One sample of settled dust out of two had a low level of asbestos. No asbestos fibers were found in the air out of 13 samples.
- Counseling and educational material concerning post-disaster issues were available to employees through the Federal Occupational Health clinic.
- Symptoms of depression and post traumatic stress disorder were reported more frequently among the NYC workers compared to Dallas workers.
- Symptoms related to irritation of eyes, throat, and lungs were reported more frequently among the NYC workers compared to Dallas workers.
- We found no increased use of medical services (doctors or hospitals) among NYC workers compared to those in Dallas.

What DHHS Managers Can Do

- Improve communication with employees concerning post-disaster issues - health and safety committees may be a good way to do this.
- Continue to provide training and education for supervisors concerning ways they can help employees with post-disaster concerns.
- Help employees get medical evaluations if they are having health problems that might be work-related.

What Employees in the Federal Building Can Do

- Participate in educational or other types of sessions in which issues concerning the work environment and post-disaster concerns are discussed.
- Discuss work-related health concerns with your supervisor and your health care provider.

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National Institute for Occupational Safety and Health
NIOSH

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Ronald M. Hall, M.S.
Douglas Trout, M.D., M.H.S.
G. Scott Earnest, Ph.D., P.E., C.S.P.
Charles Mueller, M.S.
Ashok Nimgade, M.D.

SUMMARY

On November 7, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from Department of Health and Human Services (DHHS) representatives regarding indoor environmental quality (IEQ) problems at the Federal Office Building, 26 Federal Plaza, New York City (NYC), New York. This building is located approximately 5 blocks northeast of the World Trade Center (WTC) disaster site. DHHS employees in the building expressed concerns regarding potential exposures and health effects related to the attacks on, and subsequent collapse of, the WTC. Because of the immense impact the WTC attack had on the lives of NYC residents and workers, as well as the concerns of many employees about ongoing security issues, NIOSH investigators included an assessment of mental health symptoms in the HHE. On November 12-15, 2001, NIOSH investigators conducted a site visit at the Federal Office Building to perform an environmental survey and meet with employees. A second site visit for a questionnaire survey was performed on December 4-5, 2001, and a similar questionnaire survey among a comparison group of DHHS employees in Dallas, Texas, was performed on December 12, 2001.

Area air samples in the Federal Office Building were collected to measure concentrations of elements, asbestos, volatile organic compounds (VOCs), total dust, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Bulk samples of settled material were collected at the 44th floor air intake and analyzed for elements and asbestos. Qualitative wipe samples of dust on surfaces were collected in various work areas and analyzed for elements. Carbon monoxide was monitored at various locations, including areas where employees had noted potential health problems, the 44th floor air intake, and near the basement loading dock. Additionally, on approximately every 5th floor, carbon dioxide (CO_2), small particle counts, temperature, and relative humidity measurements were collected.

One of the bulk samples of settled material indicated the presence of chrysotile asbestos (in the range of 1 - <3 percent). No asbestos fibers were found in the air. Many of the air samples collected inside the building indicated that concentrations of contaminants were below the limit of detection (LOD) for the method used. The concentrations of volatile organic compounds we found in our sampling were similar to concentrations we have found in other offices (outside NYC and unrelated to the WTC disaster) evaluated by NIOSH.

One hundred ninety-one (68 percent of the 279 available) NYC Federal Office Building employees completed the questionnaire; 155 (47 percent of the available 328) Dallas DHHS employees completed the questionnaire. A variety of constitutional symptoms, most related to headache, eye, nose, and throat irritation, and irritation of the respiratory tract, were reported more frequently among the workers in NYC compared to those in Dallas. The most

commonly reported symptoms among workers in NYC were eye and nose/throat irritation – both were reported by more than 60 percent of participants, compared to 12 (prevalence ratio [PR] 5.0, 95 percent confidence interval [95 percent CI] 3.2 - 7.7) and 21 percent (PR 3.1, 95 percent CI 2.3 - 4.3) (respectively) in Dallas. Measures of medical care for these constitutional symptoms did not differ between the workers in NYC and Dallas. Workers in NYC were more likely than those in Dallas to experience both depressive (prevalence ratio [PR] 3.4, 95 percent confidence interval [CI] [1.9 - 5.9]) and post traumatic stress disorder (PTSD) (PR 5.7, 95 percent CI [2.5 - 13.1]) symptoms. The prevalence of symptoms varied by agency within DHHS.

Because our HHE was performed more than two months after the WTC disaster, we are unable to document occupational exposures of Federal Office Building employees closer to the time of the WTC disaster. No exploration of an association between exposure to potential air contaminants present at the time of our HHE and reported symptoms was possible because measured concentrations of air contaminants were too low.

We observed that constitutional symptoms (such as headache, eye, nose, and throat irritation, and symptoms affecting the respiratory tract) were more prevalent among NYC Federal Office Building employees than the employees in Dallas. Symptoms associated with depression and stress were also more commonly reported among workers in NYC; the prevalence of both constitutional and mental health symptoms varied by agency within DHHS. Our survey revealed no occupational exposures to substances at concentrations which would explain the reported symptoms; however, we are unable to assess potential occupational exposures of Federal Office Building employees in the time immediately after the WTC disaster. Although our data suggest that an increase in social support might be associated with fewer reported symptoms of depression and stress, an evaluation of all factors which may be related to the reported symptoms was not performed in this HHE. Recommendations are provided in the report to assist DHHS management in addressing these findings.

KEYWORDS: SIC 9199 (General Government, Not Elsewhere Classified) indoor air quality, indoor environmental quality, HVAC systems, World Trade Center recovery activities, post traumatic stress disorder, depression.

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Introduction and Background

On November 7, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from U.S. Department of Health and Human Services (DHHS) representatives regarding indoor environmental quality (IEQ) problems at the Federal Office Building, 26 Federal Plaza, New York, New York. DHHS employees in the building had expressed concerns regarding potential exposures and subsequent health effects from contaminants generated at the World Trade Center (WTC) disaster site; health concerns included chronic sinus infections, allergies, asthmatic bronchitis, and other health problems.

In response to this request, NIOSH representatives conducted an initial site visit on November 12-15, 2001. At the initial site visit, an opening conference was held with DHHS management officials, facility maintenance personnel, and union representatives (the American Federation of Governmental Employees [AFGE] and the National Treasury Employees Union [NTEU] represent DHHS employees). Information was obtained relating to the building, the history of IEQ concerns, relevant events that took place at the time of and after the WTC attack, and other health-related issues. Subsequently, NIOSH investigators conducted an evaluation of the building which included an air sampling survey. A closing conference was held at the Federal Office Building on November 15, 2001, during which preliminary findings and recommendations were discussed. NIOSH investigators made a return site visit to conduct a questionnaire survey among DHHS employees at the Federal Office Building on December 4-5, 2001. Because of the immense impact the WTC attack had on the lives of New York City residents and workers, as well as the concerns of many employees about ongoing security issues, the questionnaire survey included an assessment of mental health symptoms. A similar questionnaire survey among DHHS employees in Dallas, Texas (who served as a comparison group), was performed on December 12, 2001. An interim letter reporting environmental sampling results at the Federal Office Building and preliminary conclusions and recommendations was distributed to management and employee representatives in January 2002.

The extent to which workers and other persons in lower Manhattan have been (and currently are) exposed to potentially hazardous contaminants as a result of the attack which destroyed the WTC towers on September 11, 2001, is an area of active evaluation by NIOSH and other organizations. 26 Federal Plaza is located approximately 5 blocks northeast of the WTC site. The 2.8 million square foot property consists of three inter-connected buildings: the Federal Office Building, the Federal Annex, and the Court of International Trade. The Federal Office Building was built in 1966, the Federal Annex was added in 1974, and the Court of International Trade was built in 1971. Although the Court of International Trade is part of the Federal complex, it is a separate building that is connected by a walk-way and was not evaluated as part of this HHE. Approximately 8,000 employees work in the Federal Office Building and Federal Annex; among those are approximately 400 DHHS employees.

Methods

Industrial Hygiene Evaluation

A walk-through inspection of the Federal Office Building included an overview of the heating, ventilating, and air-conditioning (HVAC) units and fresh air intakes to help guide subsequent evaluation. HVAC units and fresh air intakes are located at the ground level, 15th floor, and the 44th floor. Ventilation to the building is provided by more than 100 air handlers. The fresh air intakes at ground level provided air for the basement and the ground floor. The 15th floor air intakes provided air to floors two through 28 and the air intakes on the 44th floor provided air to the 29th through 41st floors.

Air sampling locations within the Federal Office Building were selected based on the following criteria:(1) areas where DHHS employees expressed concerns about environmental exposures; (2) areas of importance to HVAC system performance (i.e., air intakes on the 44th floor); and (3) unique areas within the building such as the cafeteria, parking garage, and lobby. Additionally, on approximately every 5th floor carbon dioxide (CO_2), small particles, temperature, and relative humidity were measured. Area air samples were collected in the locations listed in Table 1.

Area air samples in the Federal Office Building were collected to measure concentrations of elements, asbestos, volatile organic compounds (VOCs), total dust, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). These samples were collected in part to assess whether compounds present at Ground Zero of the WTC site after September 12, 2001,[1,2] migrated into the Federal Office Building.

Elements

Air, bulk dust, and surface wipe samples for elements were analyzed for silver, aluminum, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus, lead, platinum, selenium, tellurium, thallium, titanium, vanadium, yttrium, zinc, and zirconium using a Perkin Elmer Optima 3000 DV inductively coupled plasma spectrometer according to NIOSH Method 7300.[3] Air samples were collected on 37-millimeter (mm) diameter (0.8–micrometer [µm] pore–size) mixed cellulose ester (MCE) filters, using sampling pumps calibrated at 3 liters per minute (Lpm). Bulk samples of settled material were collected in the air intake area on the 44th floor. Qualitative wipe samples of dust on surfaces were collected in various work areas inside the building.

Asbestos

The bulk samples of settled material collected in the air intake area (prior to air entering the HVAC systems) on the 44th floor were also analyzed for asbestos. Air samples for asbestos were collected on 25–mm diameter cellulose ester membrane conductive cassettes at a calibrated flow rate of 2 Lpm. The samples were analyzed according to NIOSH Method 7400 (phase contrast microscopy [PCM]) and NIOSH Method 7402 (transmission electron microscopy [TEM]).[3] PCM analysis provides a manual count of fibers, but does not differentiate between asbestos and non-asbestos fibers. TEM allows for differentiation between asbestos and non-asbestos fibers.

Total Dust and Particle Size Analysis

Air samples for total dust were collected on tared 37–mm diameter, (5–µm pore–size) polyvinyl chloride (PVC) filters at a calibrated flow rate of 2 Lpm. The filters were gravimetrically analyzed (filter weight) according to NIOSH Method 0500.[3]

In addition, particulate concentration and particle size data were collected with real-time light scattering aerosol spectrometers (Grimm Model 1105 and 1106 dust monitors, Labortechnik GmbH & CoKG, Ainring, Germany). The aerosol spectrometers measure the size distribution of particles in 8 different size ranges. The 1105 model measures particles between 0.5 µm and 15 µm in diameter, and the 1106 model measures particles between 0.3 µm and 6.5 µm in diameter. Particles are sized based upon the amount of light scattered by individual particles. The aerosol spectrometers operate at a flow rate of 1.2 Lpm.[4] The data collected with the aerosol spectrometer was downloaded to an Excel® spreadsheet (Microsoft® Corporation, Redmond, Washington). Because the calibration of the aerosol spectrometer varies with aerosol properties, the output of the instrument is viewed as a measure of relative concentration. Samples for total particulate were collected near the aerosol spectrometer sampling probe. The samples were used for calibration purposes. The calibration sample and aerosol spectrometer data were used to obtain a conversion factor. The conversion factor was obtained by taking the total particulate sample result and dividing it by the integrated aerosol spectrometer concentration result. The conversion factors were then used to adjust the concentration values.

The mass gain, mass fraction (MF), cumulative mass fraction (CMF), CMF less than indicated size, concentration, average respirable fraction, and respirable MF were calculated for each size range. The total percentage of particles in the respirable size range was also calculated as well as the total and respirable concentration values.

Volatile Organic Compounds

Thermal Desorption Tubes

Area air samples were collected on thermal desorption tubes to identify VOCs. The thermal desorption tubes were attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 50 cubic centimeters per minute (cc/min). Each thermal desorption tube contained three beds of sorbent material: a front layer of Carbopack Y™, a middle layer of Carbopack B™, and a back section of Carboxen 1003™. The thermal desorption tubes for low level VOCs were analyzed by the NIOSH laboratory using stainless steel tubes configured for thermal desorption in a Perkin–Elmer ATD 400 automatic thermal desorption system and analyzed using a gas chromatograph with a mass selective detector. Since the sampling and analytical techniques for this method have not been validated for these compounds, all results should be considered semi-quantitative.

Charcoal Tubes

The charcoal tubes were attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 200 cc/min. The charcoal tubes were sent to DataChem Laboratories, Inc. (Salt Lake City, Utah) to be quantitatively analyzed for compounds of interest that were identified on the thermal tubes, including benzene, toluene, xylenes, MTBE (methyl-t-butyl ether), 2-methoxy-1-propanol, MIBK (methyl isobutyl ketone), butyl cellosolve, and total other hydrocarbons, using a Hewlett-Packard model 5890A gas chromatograph equipped with a flame ionization detector.

Polychlorinated Biphenyls (PCBs)

Air samples for PCBs were collected on tenax tubes at a calibrated flow rate of 50 cc/min. The tenax desorption tubes were screened for PCBs. It is not known how efficient these tubes are for trapping and releasing PCBs. For comparison, a stock solution of Arochlor 1254 was prepared in methylene chloride and spiked into blank tennex tubes at levels of approximately 20-200 nanograms (ng) per tube.

Polynuclear Aromatic Hydrocarbons (PAHs)

Air samples for PAHs (a term which describes a large group of organic compounds) were collected on a polytetrafluoroethylene (PTFE) filter (37- mm diameter with a 2 µm pore size) followed by a washed XAD-2 (100 mg/50 mg) sorbent tube at a flow rate of 2 Lpm according to NIOSH method 5506.[3]

Carbon Monoxide (CO)

CO concentrations were measured using ToxiUltra Atmospheric Monitors (Biometrics, Inc.) with CO sensors. ToxiUltra CO monitors were calibrated before and after use according to the manufacturer's recommendations. These monitors are direct-reading with data logging capabilities. The instruments were operated in the passive diffusion mode, with a 30 second sampling interval, with a nominal range from 0 parts per million (ppm) to 999 ppm.

Fine Particle Counts

Particles having an aerodynamic diameter of between 0.01 and 1 µm were counted using a condensation particle counter (CPC) Model 3007 (TSI Inc., St. Paul, Minnesota). The upper concentration limit of this instrument is 5×10^5 particles/cubic centimeter. The sampling flow rate is 100 cubic centimeters per minute.

Medical Evaluation

Initial Site Visit

The NIOSH medical officer met with employees from many of the DHHS agencies in the Federal Office Building in group meetings. In some instances, specific employees preferred confidential meetings; private meetings were held with those individuals. The purpose of the meetings was to answer questions of employees as well as to gain additional information regarding the health concerns of employees in the building. In addition to DHHS employees, Federal employees from other departments also participated in some meetings, including persons from Housing and Urban Development (HUD) and the Food and Drug Administration (FDA). The NIOSH medical officer also met with representatives of the Federal Occupational Health (FOH) clinic on the first floor of the Federal Office Building.

Questionnaire Survey

The primary purpose of the questionnaire survey was to evaluate the prevalence of symptoms among employees in the Federal Office Building. Employees from the DHHS Regional Office in Dallas, Texas, were selected as a comparison group; a comparison group was included in this survey because building occupants, in general, are known to experience a variety of symptoms sometimes attributed to their work environment. DHHS employees in Dallas work at 1301 Young St., an 11-story office building which is approximately 50 years old (a portion is approximately 20 years old). Employees at 1301 Young St. were chosen as a comparison group for the survey because the site was a DHHS Regional Office (similar to the New York City office) and was considered a "typical" office environment. Approximately 1000 employees work in the building, with around 350 of those being employees of DHHS. The building houses a combination of private and cubicle office space.

At both sites the questionnaire was distributed to all HHS employees who were at work the day prior to, or the day of, the survey date (December 4-5 for NYC and December 12 for Dallas). The questionnaire was self-administered and included questions about work duties and location, current symptoms, selected information on past medical history, and questions related to activities directly or indirectly related to the WTC attack. NIOSH representatives were available to answer any questions about specific aspects of the survey or about the survey in general, and to collect the questionnaires at completion. The prevalence of reported symptoms occurring in the four months prior to the survey (including headache, skin problems, and respiratory, mucous membrane, and gastrointestinal symptoms – referred to in this report as constitutional symptoms) was compared between the workers in New York City (NYC) and those in Dallas. The time period of four months was chosen to correspond as closely as practical to the WTC disaster without drawing extra attention to that specific event. The magnitude of the relationships between the two groups of workers was assessed by the prevalence ratio (PR); a 95 percent confidence interval (95 percent CI) which excluded one, or a significance level of $p \leq 0.05$, was considered to indicate a statistically significant finding. The PR represents the prevalence of the symptom in the "exposed" group (workers in NYC) relative to the prevalence in the "unexposed" group (workers in Dallas). A PR of one means there is no association between the symptom/illness and "exposure." A PR of greater than one indicates that there is evidence of an association. For example, a PR of two would mean that a person in the "exposed" group may be two times more likely to have reported the symptom than a person in the "unexposed" group. In this context, "exposure" refers only to working in a building in close proximity to the WTC site (the Federal Office Building).

The questionnaire also included two series of questions (referred to in this report as mental health symptoms) to assess symptoms consistent with depression and symptoms consistent with stress occurring in the month prior to the survey. For depression, an abbreviated set of 11 questions from the Center for Epidemiologic Studies Depression Scale (CES-D)[5,6] was used. Persons were defined as exhibiting depressive symptoms if they scored more than 12 (out of a total possible score of 33). Possible responses included rarely (0), sometimes (1); often (2), and always (3). The cutoff of 12 was picked to approximately correspond to similar cutoffs which have been found useful in assessing depressive symptoms when using a shortened version of the CES-D.[7] The questions related to stress included 17 items derived from diagnostic criteria for post traumatic stress disorder (PTSD), found in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV).[8,9] Persons who provided an affirmative response (defined as an answer of moderately, quite a bit, or extremely) to these questions, following the diagnostic criteria outlined in the DSM-IV, were defined as exhibiting PTSD symptoms.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the 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.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[10] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[11] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[12] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

Indoor Environmental Quality (IEQ)

Standards specifically for the non-industrial indoor environment do not exist; with few exceptions, pollutant concentrations observed in the non-industrial, indoor work environment fall well below published occupational standards or recommended exposure limits. Therefore, along with available occupational exposure criteria, we generally use other guidelines in assessing health complaints and potential occupational exposures of workers in settings such as the Federal Office Building. The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) has published recommended building ventilation and thermal comfort guidelines.[13,14]

NIOSH investigators have completed over 1200 investigations of the indoor environment in a wide variety of settings. Published studies from NIOSH investigators and others have reported on issues related to occupational exposures and symptoms of employees in office buildings.[15,16,17,18,19] The symptoms reported in the literature concerning 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 symptoms. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

Scientists investigating indoor environmental problems believe that multiple factors contribute to building-related occupant complaints.[20,21] 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.[18,19,20,21,22] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts are beneficial.[23] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[24] Design, maintenance, and operation of HVAC systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments. Indoor environmental pollutants can arise from either indoor or outdoor sources.[25]

Occupant perceptions of the indoor environment often are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition.[26] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[27,28]

Asbestos

NIOSH considers asbestos (i.e., actinolite, amosite, anthophyllite, chrysotile, crocidolite, and tremolite) to be a potential occupational carcinogen and recommends that exposures be reduced to the lowest possible concentration. For asbestos fibers >5 micrometers in length, the NIOSH REL is 100,000 fibers per cubic meter of air (100,000 fibers/m^3), which is equal to 0.1 fiber per cubic centimeter of air (0.1 fiber/cm^3), as determined by a 400-liter air sample collected over 100 minutes using NIOSH analytical Method 7400.[3]

As found in 29 CFR 1910.1001 and 1926.1101, the OSHA time-weighted average (TWA) exposure limit for asbestos fibers is an 8-hour time-weighted average airborne concentration of 0.1 fiber/cm^3 (longer than 5 micrometers and having a length-to-diameter ratio of at least 3 to 1), as determined by the membrane filter method at approximately 400X magnification with phase contrast illumination.[29] OSHA has also imposed an excursion limit which requires that no worker be exposed in excess of 1 fiber/cm^3 as averaged over a sampling period of 30 minutes.

Volatile Organic Compounds

VOCs are a large class of organic chemicals (i.e., containing carbon) that have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These compounds are emitted in varying concentrations from numerous indoor sources including, but not limited to, carpeting, fabrics, adhesives, solvents, paints, cleaners, waxes, cigarettes, and combustion sources.

Indoor environmental quality studies have measured widely ranging VOC concentrations in indoor air as well as differences in the mixtures of chemicals which are present. Research suggests that the irritant potency of these VOC mixtures can vary. While in some instances it may be useful to identify some of the individual chemicals which may be present, the concentration of total volatile organic compounds (TVOC) has been used to predict certain types of health effects.[30] The use of this TVOC indicator, however, has never been standardized.

Some researchers have compared levels of TVOCs with human responses (such as headache and irritative symptoms of the eyes, nose, and throat). However, neither NIOSH nor the OSHA currently have specific exposure criteria for VOC mixtures in the nonindustrial environment. Research conducted in Europe suggests that complaints by building occupants may be more likely to occur when TVOC concentrations increase.[31] It should be emphasized that the highly variable nature of complex VOC mixtures can greatly affect their irritancy potential. Considering the difficulty in interpreting TVOC measurements, caution should be used in attempting to associate health effects (beyond nonspecific sensory irritation) with specific TVOC concentrations.

RESULTS

Industrial Hygiene Evaluation

Elements

Bulk and wipe samples of settled material indicated the presence of various elements including aluminum, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus compounds, lead, silver, titanium, vanadium, yttrium, zinc, and zirconium. Qualitative wipe samples also indicated the presence of some elements (i.e., aluminum, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus compounds, lead, silver, titanium, vanadium, yttrium, zinc, and zirconium). The majority of the air samples collected inside the building indicated concentrations of various elements below the LOD for the method; for those samples where detectable levels were found, the concentrations were very low.

Asbestos

One of the two samples of settled material analyzed for asbestos revealed chrysotile asbestos (1 - <3 percent) using the NIOSH analytical Method 9002. The other bulk sample collected in this area had <1 percent chrysotile asbestos. Other forms of asbestos (amosite, crocidolite, actinolite/tremolite, and anthophyllite) were not detected in the bulk samples. Area air sample PCM results indicated low fiber concentrations (0.004 to 0.025 fibers/cc) between the limit of detection (LOD) and the limit of quantification (LOQ) for the method. PCM does not differentiate between asbestos and non-asbestos fibers. Therefore, the samples were also analyzed by TEM which indicated non-specific fiber concentrations between 0.004 and 0.028 fibers/cc. No asbestos fibers were identified on the filters when analyzed by TEM methods (Table 2).

Volatile Organic Compounds

Thermal Desorption Tubes

The compounds identified on the thermal desorption tubes included benzene, toluene, xylenes, MTBE, MIBK, butyl cellosolve, and total other hydrocarbons. The pattern of major compounds detected on the thermal desorption tubes did not appear to match the pattern of major compounds found at the WTC disaster site; however, trace levels of many of the same compounds were detected at the WTC site (samples at the WTC site were taken after September 12, 2001).[1,2] Some of these compounds are common in indoor air environments; the results of the thermal desorption tubes in the Federal Office Building generally are similar to results seen on thermal desorption tubes collected in other indoor air environments.[1,3,26,32] The highest concentrations of VOCs were in the garage area near the loading dock. The increased levels of VOCs in this area are probably a result of the presence of combustion sources (e.g., diesel engines) in the area. The thermal desorption tubes were quantified for several analytes previously reported from NIOSH sampling at the WTC site[1] including 2-methylfuran, benzene, methyl methacrylate, toluene, furfural, xylene, styrene, benzaldehyde, benzonitrile, phenol, a-methylstyrene, naphthalene, methyl naphthlene, biphenyl, and phenanthrene/anthracene. It should be noted that the sampling and analytical techniques for this method have not been validated for these compounds; Appendix A lists results of the thermal desorption tubes.

Charcoal Tubes

The area charcoal tube air samples were quantitatively analyzed for some organic compounds identified on the thermal desorption tubes (benzene, toluene, xylenes, MTBE, 1-methoxy-2-propanol, MIBK, butyl cellosolve, and total other hydrocarbons). Most of the results revealed non-detectable levels; all concentrations were well below occupational evaluation criteria. One sample indicated a benzene concentration at the limit of quantification for the method; all others were non-detectable. This sample was collected in the parking garage near the loading dock and indicated a concentration of 0.002 parts of benzene per million parts of air (ppm). This concentration is well below occupational exposure criteria (NIOSH REL 0.1 parts per million [ppm] [lowest feasible limit], OSHA PEL 1 ppm, and ACGIH TLV 0.5 ppm). The highest detectable concentration of toluene was 0.01 ppm (NIOSH REL 100 ppm, OSHA PEL 200 ppm, and ACGIH TLV 50 ppm). Benzene and toluene are typical components of gasoline, and their presence is probably a result of the presence of fuel or fuel combustion products in the garage area.

Carbon Monoxide

Most of the carbon monoxide concentrations were quite low (Table 3). A peak of 8 ppm, however, was measured near the loading dock when a diesel garbage truck was idling in the area.

Fine Particle Counts

Air sampling results for fine particles (particle diameter< 1µm) are shown in Tables 4 and 5. These results indicate that fine particle concentrations were generally less than 5,000 particles/cc in most offices.

Higher concentrations of fine particles were measured near the elevator shafts on most floors and also in some hallways. Particle concentrations in these areas ranged from approximately 10,000 particles/cc to nearly 40,000 particles/cc. The highest concentrations of fine particles were measured in the parking garage, near the loading dock and in the cafeteria near the grill. Particle concentrations measured in these areas ranged from 160,000 to 340,000 particles/cc. Particle concentrations measured outside the facility were approximately 57,000 particles/cc on the south side of the roof, and 63,000 to 80,000 particles/cc at ground level on the south and north sides of the building, respectively.

The higher particle concentrations measured in the parking garage and near the loading dock were likely a result of diesel engine emissions. Although a local exhaust ventilation system designed to exhaust vehicle emissions was in the parking garage, it did not appear to be functional. The particles near the grill in the cafeteria were likely grease particles generated from the surface of the grill. Subsequent measurements taken in the vicinity of these two areas indicated that there was some particle migration out of these areas into the adjacent hallways. It is likely that some of these particles were transported to other floors of the building via the elevator shafts. It is also likely that particles were able to enter the building via first floor doors. Comparing fine particle concentrations inside and outside of the building suggests that a substantial percentage of particles from the outdoor air was removed from the air by the filtration system in the HVAC units.

HVAC Systems

Of the greater than 100 air handlers, 62 are variable air volume (VAV) with variable frequency drive (VFD) fans capable of flow rates ranging from 8,000 to 80,000 cfm. The remaining units are induction perimeter units which provide no outside air. The Federal Office Building is divided into four VAV zones and three perimeter zones. The returns in unrenovated portions of the Federal Office Building had been ducted to pull air from the corridors. After renovation, most of the exhausts were hard ducted from each space. Stairwell "A" is located outside the building envelope. The other stairwells are enclosed and are not mechanically ventilated. The exhaust system to the loading dock had been disconnected at the ceiling due to continued damage from vehicles hitting the duct work. The elevators located near the loading dock have the potential for pulling engine exhaust up into occupied areas of the building (i.e., a piston effect).

There were no smoke purging systems in this building. However, in the case of a fire or other emergency, the fire safety director, building manager, and facility engineers can shut down any or all HVAC systems. The minimum set point for the HVAC units was 20 percent outside air. Some areas (e.g., all garages and selected areas of the INS and FBI) were supplied 100 percent outside air. The building was under approximately 3 inches of positive pressure and had been as high as 4 inches within the past two years. The air entering the fresh air intakes was filtered by 2- or 4-inch prefilters (Precisionaire Economy) and 11.5-inch pleated filters (Pure Flo-Cell). The manufacturer's specifications state that the prefilter efficiencies are 40 percent @ 1.0 µm, and pleated filter efficiencies 80-85 percent @ 1.0 µm. A comparison of fractional collection efficiencies of American Society of Heating, Refrigeration and Air-conditioning Engineers [ASHRAE] filter media are presented in Figure 1. Pressure drop across the final filters are measured with an inclined manometer and with an electronic micromanometer which is wired to the building ventilation monitoring system. The pressure drop measurements are used as an indicator for when the filters need to be changed.

Total Dust and Particle Size Analysis

The results of the particle size data collected on September 13-14 indicated that the total and respirable particle concentrations were well below any established occupational criteria. These data also indicated that the particulate concentrations were below the Environmental Protection Agency (EPA) ambient standards for air particulate with diameters of 10 µm or less (150 $\mu g/m^3$) and particulate with 2.5 µm or less (65 $\mu g/m^3$). Appendix B has a further discussion of this sampling.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAH compounds consisting of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthrcene, fluoranthene, pyrene, benzo(a)anthrcene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(ghi)perylene, and indeno(1,2,3-cd)pyrene were sampled for during this evaluation. The majority were non-detectable. Trace amounts of anthracene and fluoranthene (between the LOD and LOQ for the method) were detected on a few of the samples in the building. There is no occupational criterion for fluoranthene, and anthracene has an OSHA PEL of 0.2 mg/m^3 (200 $\mu g/m^3$). The indicated concentrations of anthracene and fluoranthene were below 0.14 $\mu g/m^3$ and 1.2 $\mu g/m^3$, respectively. One other compound (benzo(a)anthrcene) was detected at trace amounts (between the LOD and LOQ for the method). The indicated concentrations for benzo(a)anthrcene were below 0.24 µg/m^3. There are no occupational exposure criteria for benzo(a)anthrcene; however, the ACGIH recommends exposure be controlled to levels as low as possible.

PCBs

PCBs were not detected on any of the Tenax-TA thermal desorption tubes.[1]

Medical Evaluation

Initial Site Visit

On September 11, 2001, DHHS employees at the Federal Office Building had varying experiences regarding exposure to potential contaminants released after the attacks on the WTC; many walked long distances through various parts of the NYC area as they left work. After September 11, 2001, most of the DHHS employees employed at the Federal Office Building did not return to work at the building until September 24 - September 25. During the time most employees were away from the building, cleaning of the building and the immediate environment was conducted under the supervision of the US EPA. Among the services provided to DHHS employees after building re-occupancy was counseling provided as part of the FOH employee assistance program (EAP). Initially six EAP counselors were available for employee consultation; at the time of the NIOSH site visit, one full-time counselor was present. In addition, numerous information sheets related to post-disaster issues were made available to employees via the FOH services.*

The FOH clinic in the Federal Office Building provides occupational health services for all DHHS employees in the building and for approximately 70 percent of all employees in the building. FOH representatives reported that irritation of the respiratory tract and mucous membranes and unusual taste in the mouth were the most commonly reported symptoms among persons coming to the clinic after employees returned to work. FOH reported that the number of reports was greatest in the month after the WTC attack. Approximately 5-6 persons reporting to the FOH clinic in the month after the attack required transfer to a local emergency department for treatment (indicating presentation with an apparently more serious health problem).

The interviews conducted during the initial site visit revealed concerns related to working in the Federal Office Building. These concerns included issues related to: (1) poor air quality in the building and outdoors after the WTC attack; (2) constitutional symptoms experienced by employees after the WTC attack – the most commonly reported symptoms included upper respiratory and mucous membrane irritation, bad taste in the mouth, and headaches; (3) symptoms of feeling increased stress at work; (4) workers' concerns that there had been inadequate communication between management and employees concerning health-related issues; and (5) feelings of inadequate safety at work in the Federal Office Building. Management and worker representatives generally agreed that most persons had experienced at least transient symptoms related to the altered air quality after the WTC attack – for the most part these symptoms were reported to have lessened with time.

Questionnaire Survey

Questionnaires were completed by 191 (68 percent of the 279 employees at work at the time of questionnaire administration) Federal Office Building employees (employees in NYC) during the December 4-5, 2001, site visit. Questionnaires were completed by 155 (47 percent of the 328 DHHS employees working at the time of the questionnaire administration) employees in Dallas. Participants are

* Information sheets included the following: "Wellness Tips: the bereaved employee returning to work," "Grief," "Children and disasters," "Wellness Tips: fear of flying," "For managers: how to help your employees," and "How family members can be supportive."

grouped by agency in Table 6. In NYC, Centers for Medicare/Medicaid Services (CMS) (70 employees; 37 percent of the 189 respondents in NYC) and Administration for Children and Families (ACF) (40 employees; 21 percent of the 189 respondents in NYC) made up the two largest groups of participants. In Dallas, the same agencies had the greatest number of participants; 34 CMS employees (22 percent of the 152 respondents in Dallas) and 31 ACF employees (20 percent of the 152 Dallas respondents) participated. Other characteristics of the two groups of participants are presented in Table 7. Of note, the groups were similar in terms of age, gender, and race. Both NYC and Dallas groups had high percentages of employees with at least some college education.

To evaluate the potential role of residential exposure to contaminants from the WTC site, the survey included a question concerning zip code of residence since the WTC disaster. Among the workers in NYC, four persons (2 percent of the 191) reported living in lower Manhattan (defined by a northern boundary of zip codes 10013 and 10002 – approximately corresponding to Charlton St. and Broome St.); further analysis of the data based on location of residence was not performed.

Constitutional Symptoms

Table 8 presents a summary of symptoms reported occurring within the four months prior to the survey. All of the symptoms/conditions included in the questionnaire, except for diarrhea, indigestion, and head/sinus congestion were reported significantly more frequently among the workers in NYC compared to those in Dallas. The most commonly reported symptom among workers in NYC were nose/throat and eye irritation. Nose/throat irritation was reported by 66 percent of participants in NYC and by 21 percent of participants in Dallas (PR 3.1; 95 percent CI 2.3 - 4.3). Eye irritation was reported by 62 percent of participants in NYC and by 12 percent of participants in Dallas (PR 5.0; 95 percent CI 3.2 - 7.7). "Bad taste in mouth" was the symptom with the greatest prevalence ratio (12.3). Information on past medical history collected in the questionnaire indicated that the background prevalence of asthma and other respiratory conditions was similar among the two groups of workers; the background prevalence of asthma reported among both groups was higher than that found in general population studies. Dallas workers reported a higher prevalence of history of allergies (such as hay fever). Prevalence ratios and confidence intervals were similar after adjusting for gender, race, education, age, and current cigarette smoking. Results of the unadjusted analyses are included in this report.

Among workers in the two survey locations, the prevalence of symptoms varied by agency within DHHS. For example, among agencies with eight or more participants, the prevalence of eye irritation among workers in NYC ranged from 27 percent to 81 percent, and that among workers in Dallas ranged from 0 percent to 21 percent.

There were no significant differences between participating workers in NYC and Dallas in percentages of persons seeing a physician, being prescribed medications, or reporting going to the emergency room after September 11 up to the time of the survey. No workers from NYC reported being hospitalized after September 11 up to the time of the survey.

Table 9 includes additional information pertaining to symptoms reported more frequently among workers in NYC compared to those in Dallas, including whether the symptom was still present at the time of the survey and whether exposure to the worksite made the symptom worse. Nose/throat irritation, cough, and eye irritation were the symptoms reported as still present among the largest number of participants, reported by 52 (42 percent of those reporting the symptom within the 4 months prior to the survey), 43 (41 percent), and 40 (34 percent) persons, respectively. Overall, 31 percent - 50 percent of the NYC participants experiencing symptoms in the 4 months prior to the survey reported that symptoms were still present at the time of the NIOSH survey. Table 9 also shows that a high percentage (ranging from 37 percent - 81 percent) of participants with symptoms in the 4 months prior to the survey reported that their symptoms were made worse by exposure at their worksite after September 11, 2001.

Mental Health Issues

Among workers in NYC, 131 (69 percent) reported personally witnessing some part of the WTC attack, including the collapse of the WTC or someone seriously injured or killed. Seventy-six (41 percent) reported knowing someone who was injured or killed during the attack. Sixteen (8 percent) persons reported participating in rescue/recovery efforts after the WTC attack.

Among workers in NYC, 49 (26 percent) reported having two or more sessions of supportive counseling (such as counseling as part of an EAP or from a private therapist) since the WTC attack up to the time of the survey, 36 (19 percent) reported having one such session, and 104 (55 percent) reported not receiving any supportive counseling. Three (2 percent) of the Dallas workers reported receiving supportive counseling in the time after the WTC attack. Among workers in NYC, 53 (31 percent) of respondents reported that they thought they would benefit from additional supportive counseling. Among these 53, 19 (36 percent) had reported not receiving any counseling up to the time of the survey, while 34 (64 percent) reported that they had received one or more counseling sessions.

Workers in NYC were more likely than those in Dallas to experience depressive symptoms (60 [32 percent] versus 14 [10 percent]; PR 3.2, 95 percent CI [1.9 - 5.5]). Workers in NYC were also more likely than those in Dallas to experience PTSD symptoms (47 [25 percent] versus 6 [4 percent]; PR 5.7, 95 percent CI [2.5 - 13.1]). Selected characteristics of workers in NYC are summarized in Table 10 regarding the presence of reported depressive and PTSD symptoms. No consistent relationship was observed between race (non-white versus white) or education level (high school education or less versus at least some college) and the presence of depressive and PTSD symptoms. Women (compared to men) and persons who reported knowing someone who was injured or killed in the WTC attack (compared to those who did not) were more likely to report depressive and PTSD symptoms, although the differences were not statistically significant. Persons who reported that they had two or less people with whom they could confide concerning matters on their mind (compared to those reporting three or more) were more likely to report both depressive (PR 2.5, 95 percent CI [1.7 - 3.7]) and PTSD (PR 2.3, 95 percent CI [1.4 - 3.8]) symptoms.

Among workers in NYC, those persons meeting our definition for PTSD symptoms were significantly more likely to report experiencing all the individual constitutional symptoms over the 4 months prior to the survey compared to those who did not meet our definition (PR ranged from 1.5 - 5.3, $p<.05$). Those persons meeting our definition for depressive symptoms were significantly more likely to report all the individual constitutional symptoms (PR ranged from 1.3 - 3.3, $p<.05$) except four (shortness of breath, congestion, skin irritation, and indigestion).

Among workers in the two survey locations, the prevalence of mental health symptoms varied by agency within DHHS. Among agencies with 7 or more participants, the prevalence of employees in NYC meeting our definitions of having depressive symptoms and PTSD symptoms ranged from 0 percent to 45 percent for depressive symptoms and from 0 percent to 38 percent for PTSD symptoms. The prevalence of employees in Dallas meeting our definitions for depressive and PTSD symptoms also varied by agency; the prevalence ranged from 0 percent to 29 percent for depressive symptoms and from 0 percent to 20 percent for PTSD symptoms. When evaluating the prevalence of the mental health symptoms by agency between the locations (NYC and Dallas), it was noted that one agency had the highest percentages of participants with PTSD symptoms in both locations. Participants from that agency made up 5 percent of the total 346 survey participants; 5 employees (9 percent of the total number of 53 participants who had PTSD symptoms) within the agency were determined to have PTSD symptoms.

Discussion

The questionnaire survey indicates that workers in NYC were more likely than those in Dallas to report a wide variety of constitutional and mental health symptoms occurring in the 4 months prior to the survey. Additionally, approximately one-third to one-half of workers in NYC reported that constitutional symptoms were still present at the time of the NIOSH survey. Our questionnaire assessed the presence of illness requiring medical care by evaluating physician and emergency room visits, hospitalizations, and use of prescribed medications; none of those measures differed between workers in NYC and Dallas.

At the time of our survey no measurable indices of air contamination suggested specific sources for the ongoing symptoms. Specifically, results of air sampling conducted by NIOSH for volatile organic compounds, CO, total and respirable dust (respirable dust refers to smaller dust particles), PAHs, and PCBs indicated that these substances were not present at concentrations indicative of an occupational health hazard at the time of our survey. Our air sampling results are not surprising given the time of the sampling after the disaster, the distance of the Federal Office Building from the WTC site, and the fact that air sampling performed **on** the WTC debris pile in the weeks after the disaster revealed air concentrations of potential contaminants which were generally below relevant occupational exposure criteria.[2] We are not able to directly address the potential role of past exposures (environmental [outdoors], occupational [inside the Federal Office Building], or both) which may be related to the symptoms being reported in our survey.

The questionnaire survey revealed that workers in NYC as a group reported more symptoms consistent with depression and PTSD when compared with those in Dallas. It is important to note that the questions we used to assess these symptoms are screening instruments which are not diagnostic of any specific medical disorder. These findings are not surprising given the immense impact the WTC attack had on the lives of residents and workers in NYC and concerns of many employees about security issues. A recent survey found that persons across the US are experiencing symptoms of stress related to the terrorist attacks,[33] and other studies have documented mental health symptoms among persons indirectly affected by terrorist attacks.[34]

We observed that the prevalence of many of the reported symptoms (both constitutional and mental health) varied by agency at both sites. Although the small number of workers in some of the agencies may limit our ability to accurately assess differences between them, studies in the literature have shown that many factors aside from measurable concentrations of air contaminants, including workplace psychosocial factors, may be related to symptoms reported by building occupants.[35,36] A comprehensive evaluation of such potential factors was not performed as part of this HHE. The above, combined with the fact that we found no current airborne exposures in the workplace, suggests that other factors which may differ between agencies may be important in understanding the reported symptoms among DHHS employees. Some of the other factors which may be important may include job duties and organizational factors; organizational factors refers to such things as the design of the work environment, the manner in which work schedules and roles/duties are determined, career development issues, and the nature of social support within an organization.[37] Regarding this last factor, our data suggest that an increase in the number of persons an employee can talk to regarding issues on their mind might lead to a decrease in depression and PTSD symptoms.

Limitations

Our evaluation has several limitations. First, participants in our survey from both NYC and Dallas may not be representative of the entire workforces at those locations because participation rates were 68 percent (NYC) and 47 percent (Dallas). Second, our questionnaire asked participants to report symptoms which are non-specific and could potentially be affected by many factors (including various types of both work-related and non work-related factors) which we did not assess but which may have differed between the two work locations. Regarding work-related factors, we are limited in our ability to assess whether work-related symptoms reported among workers in NYC are related to contaminants in the air directly related to the WTC attack or some other pre-existing problems (such as inadequate ventilation in the garage). And third, our environmental survey in NYC was conducted more than two months after the WTC attack; it is possible that changing outdoor environmental conditions (such as changes in the wind and changes in the type or quantity of contaminants being produced at the WTC site) would alter the type and concentration of contaminants present in the Federal Office Building.

Portable Air Cleaners (PACs)

Portable air cleaners (PACs) were observed in a number of offices. PACs can be used to supplement the general ventilation system of buildings to improve air quality in localized areas such as small offices. PACs are available in a wide variety of makes and models. They utilize many different collection mechanisms to remove particles, gases, and vapors from the ambient air. Collection mechanisms may include HEPA filtration, negative ion generation, carbon adsorption, electret filtration, and ultraviolet germicidal irradiation (UVGI) to name a few.

For particle removal, it is important that the PAC utilize HEPA filters (99.97 percent efficient for collecting particles having a diameter of 0.3 µm) and have an airflow capacity appropriate to the size of the room. PACs should also be properly maintained. Proper maintenance procedures involve periodic replacement of filter media. Particulate filters generally increase in efficiency with loading (when they get dirty); however, pressure drop across the filter will increase and adversely effect air flow. Carbon filters will degrade with loading. There is limited evidence that PACs are associated with a reduction in asthma symptoms.[38]

HVAC Filtration

Collection efficiency ratings of HVAC filters are commonly based upon the ASHRAE Standard 52.1 entitled, "Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter." This standard specifies a method for testing the collection efficiency of filters based upon synthetic dust arrestance or the mass fraction of dust removed. This test provides a single arrestance value to describe the ability of a filter to remove particles from the air.

Because atmospheric dust contains a wide variety of particle types and sizes, ranging from less than 0.01 microns to greater than 100 µm, it is useful to understand how a filter performs based upon particle size. Figure 1 provides a graph of the collection efficiency of four different ASHRAE rated filters tested at a face velocity of 250 feet per minute. As can be seen in the figure, there are dramatic differences between a filter's collection efficiency based upon particle size. Typically, the most penetrating particle size is in the range of 0.1 to 0.3 microns.

Cleaner air can be provided to a building by installing filters with higher collection efficiencies. Several issues must be considered when this is done: the capacity of the HVAC system to handle higher efficiency filters and the ability of the filters to form a tight seal with the filter housing. Some HVAC systems simply may not be able to handle the increased pressure drop associated with higher efficiency filters. Additionally, the new filters must form a tight seal with the filter housing to prevent leakage around the filter. Small areas of leakage can dramatically reduce the actual collection efficiency of a filter.

Dallas Workers

As mentioned previously, many studies have shown that employees of "non-problem" buildings frequently report symptoms that are thought to be related to the workplace. Although we did not perform an environmental evaluation at the Dallas building, we have no reason to believe that there are specific factors at the Dallas office building which are responsible for the symptoms reported among participating employees at that site. Implementation of standard recommendations to address indoor environmental quality issues on a continual basis should be considered by those responsible for maintaining the work environment in the Dallas building.[39,40]

CONCLUSIONS

In response to a request for assistance in evaluating concerns of NYC Federal Office Building DHHS employees regarding potential exposures and health effects related to the attacks on, and subsequent collapse of, the WTC, we found that constitutional symptoms (such as headache, eye, nose, and throat irritation, and symptoms affecting the respiratory tract) were more prevalent among the employees in NYC than among a comparison group of DHHS employees in Dallas. Symptoms associated with depression and PTSD were also more commonly reported among the employees in NYC; and the prevalence of both constitutional and mental health symptoms varied by agency within DHHS. Our survey revealed no occupational exposures to substances at concentrations which would explain the reported symptoms; however, we are unable to assess potential occupational exposures of Federal Office Building employees around the time of the WTC disaster because our HHE was performed more than two months after that event. Although our data suggest that an increase in social support might be associated with fewer reported symptoms of depression and PTSD, an evaluation of all factors which may be related to the reported symptoms was not performed in this HHE.

RECOMMENDATIONS

1. DHHS management and appropriate consultants (such as Federal Occupational Health [FOH]) should continue efforts to address symptoms experienced by employees and concerns about work in the Federal Office Building. These efforts should include the following:
- employees with work-related health concerns should be encouraged to report these concerns to the FOH clinic. FOH should keep a log of appropriate information (such as symptoms, work location, etc.) and periodically provide summaries to appropriate management personnel;
- training of managers and supervisory personnel at all levels should be conducted to insure that each agency is responding appropriately to health and safety concerns of employees;
- information about how to access employee assistance programs (such as counseling services) should be readily available to all employees, and the availability of an adequate level of counseling for employees should be maintained.

2. Employees with possible work-related symptoms should be evaluated by their health care provider (such as FOH and/or their personal physician) to determine, if possible, the etiology of reported symptoms. Individuals with definite or possible occupational illnesses should be protected from exposures to presumed causes or exacerbators of the illness. In general, this can often be accomplished by using engineering (e.g., maintaining appropriate ventilation systems in a proper manner) and/or administrative (e.g., work and hygiene practices, and housekeeping) controls. Because we found no elevations in the concentrations of air or surface contaminants, the use of personal protective equipment (such as gloves or respirators) is not recommended for DHHS employees and is not likely to be effective in preventing the reported symptoms. One type of administrative control that may be

considered for employees who remain symptomatic despite the absence of an identifiable cause of illness includes reassignment. In such cases, the reassigned worker should retain wages, seniority, and other benefits that might otherwise be lost by such a job transfer.

3. Communication between management and employees should be improved to facilitate the exchange of concerns about environmental conditions and security issues in the building. Employees should be made aware of current issues with the building and decisions made by building managers to address those issues. A health and safety committee made up of workers and managers should be used to facilitate these communication efforts.

4. Industrial hygiene consultants should be used to perform environmental sampling and evaluations in the Federal Office Building if new issues or problems are identified. The Federal Occupational Health program employs industrial hygienists that are qualified and capable of performing these assessments.

5. We identified two primary sources of ongoing fine particulate exposure – vehicles in the parking garage and activities occurring in the cafeteria. Exposure to fine particles may result in some respiratory irritation and therefore, exposure should be reduced where feasible.[41,42] All trucks should be shut off when parked in the parking garage or while being used at the loading dock. However, if the trucks can not be turned off, dedicated exhaust systems for the parked trucks could be installed to remove exhaust gases and particulate. General exhaust in this area should also be enhanced to remove combustion products generated from traffic moving in and out of the garage area and loading dock. Similarly, particles generated in the cafeteria can be removed with local exhaust ventilation systems. Both areas should also be kept under negative pressure in relation to the rest of the building to avoid cross contamination.

6. If used, portable room air cleaners should be properly maintained and should be HEPA filtered; these air cleaners may also contain charcoal filters to assist in the removal of volatile organic compounds. Ozone-generating air cleaners should not be used.

7. Settled dust in the air intake areas (prior to air entering the HVAC systems) in the building should be removed and the areas cleaned. New York City law requires that it be cleaned up by licensed asbestos handlers.[43]

8. Dust inside the building should be minimized by frequent vacuuming of carpets and cubicle upholstery with a HEPA-filtered vacuum (to avoid dust particles becoming airborne during the cleaning process, vacuums that are not HEPA filtered should not be utilized). Dust distributed on non-porous surfaces (i.e., wood, metal, etc.) should be cleaned with wet (damp) methods to avoid entraining settled particles into the air.

9. The facility engineers should evaluate the feasibility of using more efficient filters for the HVAC systems. Care must be taken to assure that more efficient filters do not create more static pressure than the system can handle.

10. The information provided on general IEQ and mold in Appendix C of this report should be used to address work environment issues as they arise. This information should be provided to the maintenance staff responsible for maintaining the building and any person responsible for health and safety. References regarding a written program to deal with IEQ issues include the "Building Air Quality Action Plan,"[39] and the "Building Air Quality – A Guide for Building Owners and Facility Managers."[40] The "Building Air Quality Action Plan" is particularly useful for the implementation of an effective IEQ management program. These documents contain some of the best practical advice available regarding the prevention, evaluation, and correction of IEQ problems.

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TABLE 1
LOCATIONS OF AREA AIR SAMPLES COLLECTED IN THE BUILDING
HETA 2002-0038, FEDERAL OFFICE BUILDING

LOCATION	DESCRIPTION
SOUTH SIDE AIR INTAKES (SERVE THE 29TH TO 41ST FLOORS–ALL DHHS FLOORS)	PRIOR TO AIR ENTERING THE HVAC SYSTEMS
GENERAL AREA IN THE ADMINISTRATION FOR CHILDREN AND FAMILIES	NEAR COMPUTER ROOM 4112H
GENERAL AREA IN THE ADMINISTRATION FOR CHILDREN AND FAMILIES	CENTRAL AREA OF OFFICE NEAR CONFERENCE ROOM A
GENERAL AREA IN THE ADMINISTRATION FOR CHILDREN AND FAMILIES	SOUTH SIDE OF OFFICE AREA NEAR EXIT
GENERAL AREA IN THE CENTER FOR MEDICARE AND MEDICAID SERVICES	NEAR OFFICE AREAS # 180 AND #179
HOUSING AND URBAN DEVELOPMENT	OFFICE OF THE ASSISTANT GENERAL (3500)
PARKING GARAGE	LOADING DOCK AREA
OFFICE OF THE INSPECTOR GENERAL	OFFICE AREA 3900 B
DIVISION OF FINANCIAL MANAGEMENT FINANCIAL CONTROLS BRANCH	NEAR OFFICE AREA 38-130 E
CAFETERIA	GENERAL AREA
GENERAL OFFICE AREA IN THE FOOD AND DRUG ADMINISTRATION	34TH FLOOR
LOBBY AREA OF THE FEDERAL BUILDING	IN FRONT OF FED KIDS DAYCARE CENTER

TABLE 2
PCM AND TEM FIBER CONCENTRATION RESULTS
HETA 2002-0038, FEDERAL OFFICE BUILDING

SAMPLE #	LOCATION	PCM[1] FIBER CONCENTRATION (FIBERS/CC)	TEM[2] FIBER CONCENTRATION (FIBERS/CC)
ASB-112	34TH FLOOR FDA GENERAL OFFICE AREA	0.007	0.004
ASB-114	CAFETERIA FLOOR 6 GENERAL AREA	ND	0.011
ASB-111	LOBBY OF 26 FEDERAL BUILDING (IN FRONT OF DAYCARE CENTER)	0.025	0.028
ASB-106	3900B-OFFICE OF THE INSPECTOR GENERAL	0.006	0.007
ASB-102	PARKING GARAGE NEAR LOADING DOCK	OVERLOADED WITH PARTICULATE (COULD NOT ANALYZE)	OVERLOADED WITH PARTICULATE (COULD NOT ANALYZE)
ASB-108	CMS-DFM FINANCIAL CONTROLS BRANCH (GENERAL OFFICE AREA)	ND	0.006
ASB-103	44G SOUTH SIDE AIR INTAKE	0.004	0.004
ASB-105	HUD 3500 OFFICE OF ASSISTANT GENERAL COUNSEL	0.043	0.04
ASB-113	3805 FOB CMS GENERAL OFFICE AREA	0.008	0.009
ASB-107	44G SOUTH SIDE AIR INTAKE	0.009	0.02
ASB-110	ACF- 41-14 FOB GA GENERAL OFFICE AREA (NORTH SIDE OF GENERAL OFFICE AREA)	ND	0.005
ASB-101	ACF- 41-14 FOB GENERAL OFFICE AREA (SOUTH SIDE NEAR EXIT)	ND	0.01
ASB-104	ACF- 41-14 FOB NEAR CONFERENCE ROOM A	ND	0.006

ND = NON-DETECTED
NO ASBESTOS FIBERS WERE IDENTIFIED WITH TEM ANALYSIS
[1] PHASE CONTRAST MICROSCOPY
[2] TRANSMISSION ELECTRON MICROSCOPY

TABLE 3
CARBON MONOXIDE SAMPLES (PPM)[1] AT VARIOUS LOCATIONS
HETA 2002-0038, FEDERAL OFFICE BUILDING

SAMPLE LOCATION (SAMPLE #)	MEAN, PPM	STANDARD DEVIATION	PEAK AND SAMPLE NUMBER
SOUTH-SIDE AIR INTAKE (#1)	1.9	0.5	PEAK = 3.0 SAMPLE # = 346
ACF NEAR COMPUTER RM (#2)	0.1	0.3	PEAK = 1.0 SAMPLE # = 3017
ACF NEAR CONF. ROOM (#3)	0.8	0.5	PEAK = 2.0 SAMPLE # = 484
ACF NEAR SOUTH SIDE (#4)	0.3	0.5	PEAK = 1.0 SAMPLE # = 480
LOADING DOCK IN BASEMENT (#5)	1.7	1.5	PEAK = 8.0 SAMPLE # = 382

[1] NIOSH REL FOR CARBON MONOXIDE: 35 PPM AS A TIME WEIGHTED AVERAGE, 200 PPM AS A CEILING.

TABLE 4
FINE PARTICLE COUNTS (PARTICLES/CUBIC CENTIMETER) IN VARIOUS OFFICES AND HALLWAYS
HETA 2002-0038, FEDERAL OFFICE BUILDING

SAMPLE LOCATION	MEAN, PARTICLES/CC	STANDARD DEVIATION	SAMPLE NUMBER
38TH FLOOR HHS, HQ	1974.8	96.6	6
41ST FLOOR, ACF NEAR COMPUTER ROOM	3581.0	156.3	4
41ST FLOOR, ACF IN COMPUTER ROOM	2848.5	29.8	4
41ST FLOOR, ACF NEAR CONF. ROOM	2915.4	52.8	5
41ST FLOOR, ACF CONFERENCE ROOM	3249.1	87.4	7
41ST FLOOR, ACF NEAR WINDOW	2547.7	56.4	7
41ST FLOOR, ACF SOUTH SIDE	2183.6	170.9	9
5TH FLOOR, HALLWAY NEAR INS, FBI	27198.8	170.54	5
20TH FLOOR, SOUTH HALLWAY	10927.2	125.8	5
30TH FLOOR, SOUTH HALLWAY	23066.2	706.1	5
35TH FLOOR, SOUTH HALLWAY	22597.2	135.8	5
44TH FLOOR, SOUTH HALLWAY	37843.8	268.5	5
HUD, CORNER OFFICE	1661.0	55	6

TABLE 5
FINE PARTICLE COUNTS (PARTICLES/CUBIC CENTIMETER) AT VARIOUS LOCATIONS
HETA 2002-0038, FEDERAL OFFICE BUILDING

SAMPLE LOCATION	MEAN, PARTICLES/CC	STANDARD DEVIATION	SAMPLE NUMBER
41ST FLOOR, ELEVATORS	14839.0	427.7	5
38TH FLOOR, EEVATORS	17231.2	487.0	6
1ST FLOOR, ELEVATORS	27820.0	240.4	5
1ST FLOOR OUTSIDE (SOUTH)	63074.7	2023	11
1ST FLOOR OUTSIDE (NORTH)	80221.5	15634.4	12
5TH FLOOR, ELEVATORS	26202.8	317.7	6
10TH FLOOR, ELEVATORS	18104.4	254.3	5
20TH FLOOR, ELEVATORS	14914.8	143.5	5
30TH FLOOR, ELEVATORS	22799.4	214.3	5
35TH FLOOR, EEVATORS	21924.6	774.8	5
6TH FLOOR, CAFETERIA	21167.6	2735.5	5
6TH FLOOR CAFETERIA, GRILL	163124.2	40392.2	5
BASEMENT LOADING DOCK	229603.8	21483.0	5
BASEMENT, GARAGE	335923.5	15241.9	6
BASEMENT, HALLWAY	7277.6	207.6	7
BASEMENT, X-RAY ROOM	284103.8	16698.3	5
BASEMENT, ELEVATOR	21914.8	2632.0	5
ROOF, SOUTH-SIDE	57204.8	604.0	8
44TH FLOOR, SOUTH-INLET	56439.8	1688.1	6

TABLE 6
AGENCIES OF SURVEY PARTICIPANTS
HETA 2002-0038, FEDERAL OFFICE BUILDING

AGENCY	NYC - # (PERCENT OF 189 PROVIDING THIS INFORMATION)	DALLAS - # (PERCENT OF 152 PROVIDING THIS INFORMATION)
CENTERS FOR MEDICARE/MEDICAID SERVICES	70 (37)	34 (22)
ADMINISTRATION FOR CHILDREN AND FAMILIES	40 (21)	31 (20)
DIVISION OF COST ALLOCATION	2 (1)	4 (3)
OFFICE OF THE GENERAL COUNSEL	8(4)	10 (7)
OFFICE OF CIVIL RIGHTS	9 (5)	14 (9)
OFFICE OF THE SECRETARY	15 (8)	8 (5)
OFFICE OF ENGINEERING	10 (5)	-[1]
ADMINISTRATION ON AGING	2 (1)	1 (1)
HEALTH RESOURCES AND SERVICES ADMINISTRATION	11 (6)	14 (9)
PSC/ADMINISTRATIVE OPERATIONS	-[1]	10 (7)
OFFICE OF PUBLIC HEALTH AND SCIENCE	-[1]	7 (5)
INDIAN HEALTH SERVICE	-[1]	15 (10)
OTHER	22 (12)	4 (3)

[1] AGENCIES NOT PRESENT AT THIS REGIONAL OFFICE

TABLE 7
DESCRIPTION OF SURVEY PARTICIPANTS
HETA 2002-0038, FEDERAL BUILDING

LOCATION	# OF PARTICIPANTS (PARTICIPATION RATE)	# (PERCENT) FEMALE	MEAN AGE (YEARS)	# (PERCENT) HIGH SCHOOL EDUCATION[1]	RACE # (PERCENT)			# (PERCENT) CURRENT CIGARETTE SMOKERS
					WHITE	BLACK	HISPANIC	
NYC	191 (68 PERCENT)	126 (66)	46	30 (16)	103 (59)	36 (20)	38 (22)	14 (7)
DALLAS	155 (47 PERCENT)	90 (59)	48	10 (7)	100 (65)	34 (22)	17 (11)	18 (12)

[1] # (PERCENT) OF PARTICIPANTS REPORTING AT MOST A HIGH SCHOOL EDUCATION

TABLE 8
SYMPTOMS AND ILLNESSES REPORTED ON QUESTIONNAIRE
HETA 2002-0038, FEDERAL BUILDING

SYMPTOM/ILLNESS[1]	NUMBER OF WORKERS IN NYC (PERCENT) REPORTING SYMPTOM/ILLNESS	NUMBER OF WORKERS IN DALLAS (PERCENT) REPORTING SYMPTOM/ILLNESS	PREVALENCE RATIO [95 PERCENT C I]
HISTORY OF ALLERGY OR HAYFEVER	86 (46)	93 (60)	0.8 [0.6–0.9]
HISTORY OF ASTHMA	18 (9)	12 (8)	1.2 [0.6–2.5]
BAD TASTE IN MOUTH	59 (32)	4 (3)	12.3 [4.6 - 33.2]
SHORTNESS OF BREATH	51 (28)	7 (5)	6.1 [2.9 - 13.1]
CHEST TIGHTNESS	51 (27)	7 (5)	6.0 [2.8 - 12.9]
NAUSEA/VOMITING	37 (20)	6 (4)	5.2 [2.2 - 11.9]
EYE IRRITATION	117 (62)	19 (12)	5.0 [3.2 - 7.7]
WHEEZING	38 (21)	9 (6)	3.5 [1.8 - 7.1]
NOSE/THROAT IRRITATION	125 (66)	33 (21)	3.1 [2.3 - 4.3]
SEVERE HEADACHE	70 (38)	21 (14)	2.8 [1.8 - 4.3]
RASH OR SKIN IRRITATION	27 (14)	9 (6)	2.4 [1.2 - 5.0]
DIARRHEA	19 (10)	7 (5)	2.2 [1.0 - 5.1]
COUGH	104 (56)	41 (27)	2.1 [1.6 - 2.8]
HEAD OR SINUS CONGESTION	95 (52)	65 (42)	1.2 [1.0 - 1.6]
INDIGESTION	20 (11)	17 (11)	1.0 [0.5 - 1.8]

[1] QUESTIONS CONCERNING SYMPTOMS REFERRED TO SYMPTOMS EXPERIENCED IN THE 4 MONTHS PRIOR TO THE SURVEY.

Table 9
Current Symptoms Among Workers in NYC
HETA 2002-0038, Federal Building

Symptom[1]	Number of Workers in NYC (percent) reporting symptoms	Number (percent of those reporting symptom) Currently with Symptom[2]	Number (percentof those reporting symptom) Reporting Worksite Exposure Making Symptom Worse[3]
Nose/throat Irritation	125 (66)	52 (42)	92 (74)
Cough	104 (56)	43 (41)	68 (65)
Eye Irritation	117 (62)	40 (34)	95 (81)
Severe Headache	70 (38)	31 (44)	46 (66)
Shortness of Breath	51 (28)	25 (49)	34 (67)
Wheezing	38 (21)	19 (50)	25 (66)
Chest Tightness	51 (27)	19 (37)	35 (69)
Bad Taste in Mouth	59 (32)	18 (31)	41 (69)
Nausea/vomiting	37 (20)	13 (35)	25 (68)
Rash or Skin Irritation	27 (14)	10 (37)	10 (37)

[1]Symptoms reported as occurring in the 4 months prior to the survey that were found to have an increased prevalence among workers in NYC compared to Dallas workers (Table 12)

[2] Number (percent) of workers in NYC reporting symptom in the 4 months prior to the survey that reported having symptom at time of NIOSH survey

[3] Number (percent) of workers in NYC reporting symptom in the 4 months prior to the survey that reported their symptom was made worse with exposure to worksite after September 11, 2001.

Table 10 - Prevalence of Mental Health Symptoms Among NYC Participants by Selected Characteristics HETA 2002-0038, Federal Building

		# (percent) With Depressive Symptoms[1]	Prevalence Ratio (95 percent CI)	# (percent) With PTSD Symptoms[2]	Prevalence Ratio (95 percent CI)
Gender	Female	45 (37)	1.7 (1.0 - 2.9)	36 (29)	1.7 (0.9 - 3.0)
	Male	14 (22)		11 (17)	
Race	Nonwhite	26 (38)	1.4 (0.9 - 2.2)	14 (19)	0.8 (0.5 - 1.5)
	White	27 (26)		24 (23)	
Education	Education - High School or less	9 (31)	1.0 (0.5 - 1.7)	9 (30)	1.3 (0.7 - 2.4)
	Education - Some college or more	48 (32)		35 (23)	
Know Victim[3]	Yes[3]	28 (37)	1.3 (0.9 - 2.0)	24 (32)	1.5 (0.9 - 2.5)
	No	31 (29)		23 (21)	
# Confidants[4]	2 or less[4]	27 (56)	2.5 (1.7 - 3.7)	21 (42)	2.3 (1.4 - 3.8)
	>2	31 (23)		25 (18)	

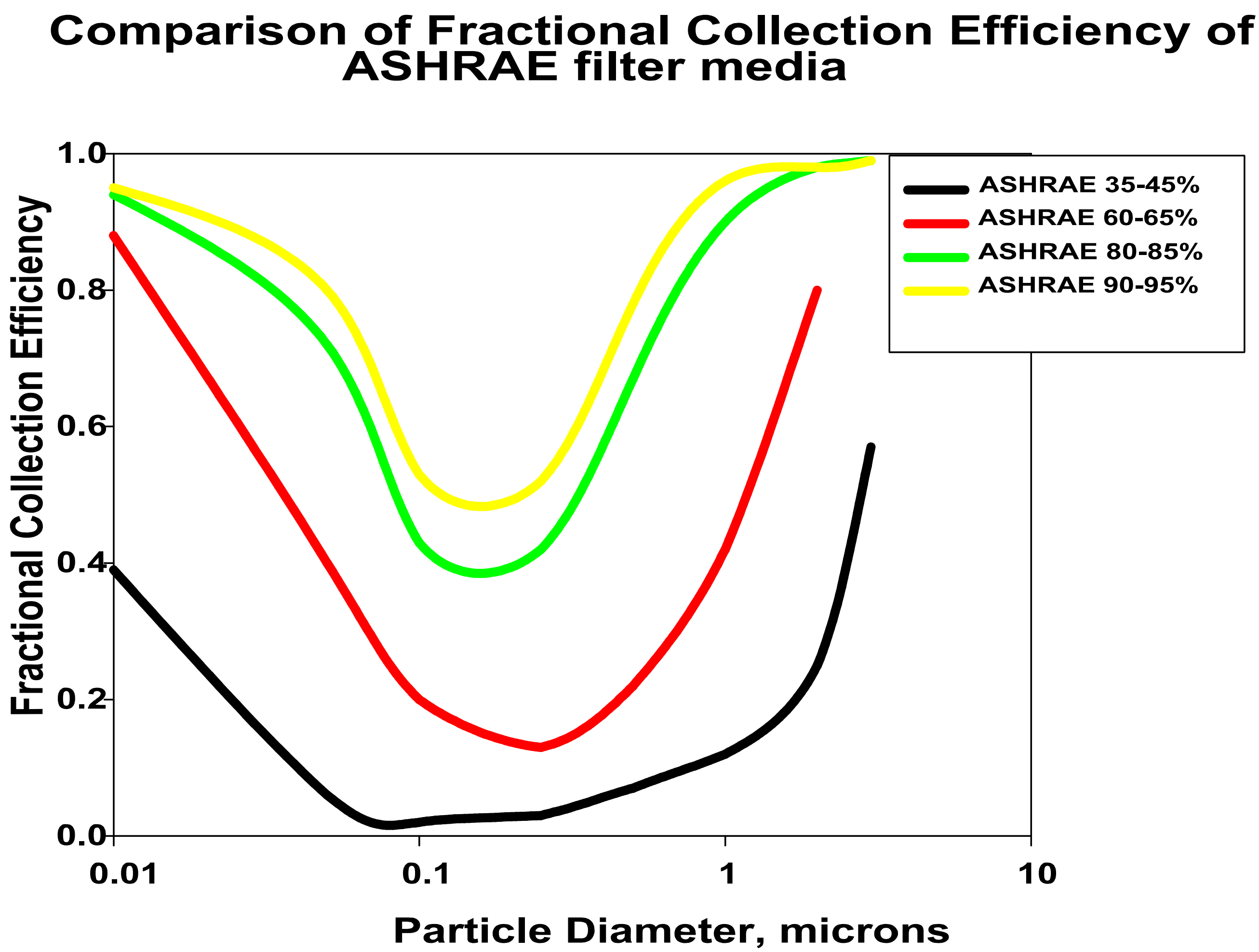
[1] 'Depressive symptoms' were defined as a score of 12 or more (out of a total possible score of 33) for the 11 questions in the questionnaire taken from the modified CES-D scale.

[2] 'PTSD symptoms' were defined by affirmative responses (answers of 'moderately,' 'quite a bit,' or 'extremely') to those questions defining PTSD according to DSM-IV criteria.

[3] An affirmative response to the question "Did you know anyone who was seriously injured or killed during the attack."

[4] A response of 'none' or '1 or 2' to the question "How many people (friends or relatives) do you feel at ease with and can talk to about what is on your mind."

FIGURE 1
FRACTIONAL FILTER COLLECTION EFFICIENCIES FOR DIFFERENT ASHRAE FILTER MEDIA



APPENDIX A

Appendix A--HHS BUILDING THERMAL DESORPTION TUBE RESULTS

SAMPLE ID		Location	2-methylfuran	benzene	Methyl Methacrylate	toluene	furfural
			ppm	ppm	ppm	ppm	ppm
11/13/01 SAMPLES							
A03879		44G air intake south side	ND	0.0004	ND	0.0006	ND
A05090		ACF 41-14 FOB general office	ND	0.0005	ND	0.0009	ND
A04448		CMS 3805 FOB general office	ND	0.0007	ND	0.0017	ND
A03941		ACF 41-14near conf. Room A	ND	0.0008	ND	0.0019	ND
11/14/01 SAMPLES							
A39629		HUD 3500 office of assistant general councel	0.00011	0.0009	ND	0.0018	ND
A39703		HUD 3500 office of assistant general councel	0.00010	0.0008	ND	0.0024	ND
A40989		CMS - DFM Floor 38 Financial controls Branch	0.00005	0.0007	ND	0.0014	ND
A04210		Parking garage at loading dock	0.00017	0.0030	ND	0.0078	ND
A39910		Parking garage at loading dock	0.00019	0.0023	ND	0.0058	0.00014
A05635		44G air intake south side	ND	0.0009	ND	0.0013	ND
A03074		44G air intake south side	ND	0.0005	ND	0.0012	ND
11/15/01 SAMPLES							
A05417		Cafeteria Floor 6 General Area	0.00011	0.0008	ND	0.0013	ND
A39809		Lobby of federal building in front of Daycare	0.00018	0.0012	ND	0.0026	ND
A03231		34th floor FDA general office area	0.00013	0.0010	ND	0.0019	ND
A39611FB		Field blank	ND		ND		ND
A04082FB		Field blank	ND		ND		ND
					* MDC = 0.00006 ppm		* MDC = 0.0001 ppm
NIOSH REL	**TWA**		**no established criteria**	**0.1 ppm**	**100 ppm**	**100 ppm**	**no established criteria**
OSHA PEL	**TWA**		**no established criteria**	**1 ppm**	**100 ppm**	**200 ppm**	**5 ppm**
ACGIH TLV	**TWA**		**no established criteria**	**0.5 ppm**	**50 ppm**	**50 ppm**	**2 ppm**
SAMPLE ID			**xylene/etbenz**	**styrene**	**benzaldehyde**	**benzonitrile**	**phenol**
			ppm	ppm	ppm	ppm	ppm
11/13/01 SAMPLES							
A03879		44G air intake south side	0.0005	0.00002	ND	ND	ND
A05090		ACF 41-14 FOB general office	0.0007	0.00004	0.00006	ND	ND
A04448		CMS 3805 FOB general office	0.0014	0.00007	0.00011	ND	ND
A03941		ACF 41-14near conf. Room A	0.0015	0.00008	0.00010	ND	0.00013
11/14/01 SAMPLES							
A39629		HUD 3500 office of assistant general councel	0.0013	0.00010	0.00014	ND	0.00007
A39703		HUD 3500 office of assistant general councel	0.0014	0.00010	0.00017	ND	0.00021
A40989		CMS - DFM Floor 38 Financial controls Branch	0.0010	0.00009	0.00011	ND	0.00010
A04210		Parking garage at loading dock	0.0061	0.00019	0.00020	0.00013	ND
A39910		Parking garage at loading dock	0.0054	0.00020	0.00027	0.00014	0.00014
A05635		44G air intake south side	0.0010	0.00006	ND	ND	ND
A03074		44G air intake south side	0.0009	0.00005	0.00006	ND	ND
11/15/01 SAMPLES							
A05417		Cafeteria Floor 6 General Area	0.0011	0.00006	0.00008	ND	ND
A39809		Lobby of federal building in front of Daycare	0.0022	0.00011	0.00016	0.00006	0.00006
A03231		34th floor FDA general office area	0.0016	0.00010	0.00014	ND	0.00025
A39611FB		Field blank	ND	ND	ND	ND	ND
A04082FB		Field blank	ND	ND	ND	ND	ND
NIOSH REL	**TWA**		**100 ppm**	**50 ppm**	**no established criteria**	**no established criteria**	**5 ppm**
OSHA PEL	**TWA**		**100 ppm**	**100 ppm**	**no established criteria**	**no established criteria**	**5 ppm**
ACGIH TLV	**TWA**		**100 ppm**	**20 ppm**	**no established criteria**	**no established criteria**	**5 ppm**

APPENDIX A CONTINUED

SAMPLE ID			a-methylstyrene	naphthalene	methyl naphthalene	biphenyl	phenanthrene/anthracene
			ppm	ppm	ppm	ppm	ppm
11/13/01 SAMPLES							
A03879		44G air intake south side	ND	0.00005	ND	ND	ND
A05090		ACF 41-14 FOB general office	ND	0.00010	0.00002	ND	ND
A04448		CMS 3805 FOB general office	ND	0.00018	0.00003	ND	ND
A03941		ACF 41-14near conf. Room A	ND	0.00017	0.00003	ND	ND
11/14/01 SAMPLES							
A39629	HUD 3500 office of assistant general councel		ND	0.00015	0.00003	ND	ND
A39703	HUD 3500 office of assistant general councel		0.00003	0.00017	0.00005	ND	ND
A40989	CMS - DFM Floor 38 Financial controls Branch		0.00004	0.00016	0.00003	ND	ND
A04210		Parking garage at loading dock	ND	0.00043	0.00022	ND	ND
A39910		Parking garage at loading dock	0.00004	0.00073	0.00054	0.00003	ND
A05635		44G air intake south side	ND	0.00008	ND	ND	ND
A03074		44G air intake south side	ND	0.00009	0.00002	ND	ND
11/15/01 SAMPLES							
A05417		Cafeteria Floor 6 General Area	ND	0.00018	0.00003	ND	ND
A39809	Lobby of federal building in front of Daycare		0.00004	0.00035	0.00011	ND	ND
A03231		34th floor FDA general office area	ND	0.00021	0.00007	ND	ND
A39611FB		Field blank	ND	ND	ND	ND	ND
A04082FB		Field blank	ND	ND	ND	ND	ND
						* MDC =0.00001	* MDC =0.0001 ppm
NIOSH REL	**TWA**		**50 ppm**	**10 ppm**	**no established criteria**	**0.2 ppm**	**no established criteria**
OSHA PEL	**TWA**		**Ceiling 100 ppm**	**10 ppm**	**no established criteria**	**0.2 ppm**	**no established criteria**
ACGIH TLV	**TWA**		**50 ppm**	**10 ppm**	**no established criteria**	**0.2 ppm**	**no established criteria**
* MDC's = minimal detectable concentration based on the limit of detection and a volume of 12 liters							

APPENDIX B

Total Dust and Particle Size Analysis

The aerosol spectrometer was used to obtain the mass gain, MF, CMF, CMF less than indicated size, concentration, average respirable fraction, and respirable MF for particle size analysis conducted in the 44th floor air intakes (the outside air intakes that supply air to the HHS floors), the HUD office space area, and the Center for Medicare and Medicaid Services general office area.

Tables B-1 and B-2 list the results of the aerosol spectrometer particle size evaluation conducted on 11/13/01 inside the building (Center for Medicare and Medicaid general office space), and in the 44th floor south side air intakes (prior to the air entering the HVAC systems). The particulate air sample in the Center for Medicare and Medicaid general office space was non-detected; therefore, a minimum detectable concentration was calculated using the limit of detection for the analytical method. The minimum detectable concentration of 0.046 mg/m^3 was used with the total integrated aerosol spectrometer concentration of 0.092 mg/m^3 to obtain a conversion factor of 0.5 for the particle size data. The particulate air sample collected in the 44th floor air intake area indicated a total particulate concentration of 0.034 mg/m^3. The aerosol spectrometer indicated a total integrated particulate concentration of 0.079 mg/m^3. These results provided a conversion factor of 0.43. The conversion factors were used to adjust the aerosol spectrometer particle size data.

Tables B-3 and B-4 list the results of the aerosol spectrometer particle size evaluation conducted on 11/14/01 inside the building (HUD general office space), and in the 44th floor south side air intakes (prior to the air entering the HVAC systems). The particulate air sample in the HUD general office space was non-detected; therefore, a minimum detectable concentration was calculated using the limit of detection for the analytical method. A minimum detectable concentration of 0.02 mg/m^3 was used with the total integrated aerosol spectrometer concentration of 0.044 mg/m^3 to obtain a conversion factor of 0.45 for the particle size data. The particulate air sample collected in the 44th floor air intake area indicated a total particulate concentration of 0.067 mg/m^3. The aerosol spectrometer indicated a total integrated particulate concentration of 0.128 mg/m^3. These results provided a conversion factor of 0.52. The conversion factors were used to adjust the aerosol spectrometer particle size data.

Table B-1

Particle size analysis results collected in the general office area of the Center for Medicare and Medicaid Services on 11/13/01

Stage Number	Effective Cut Diameter	Size Range lower	Size Range upper	Size Interval Dp	Final Weight (mg)	Initial Weight (mg)	Net Gain (mg)	Mass Fraction	CMF	CMF< Indicated Size	Concentration (mg/m^3)	Average Respirable Fraction	Respirable Mass Fraction
1	6.5	6.5	50	43.5	0.003665	0	0.00366	0.319	1.000	0.681	0.01468	0.07	0.0223164
2	5	5	6.5	1.5	0.005818	0.003665	0.00215	0.187	0.681	0.494	0.00863	0.22	0.04121
3	3.5	3.5	5	1.5	0.00839	0.005818	0.00257	0.224	0.494	0.270	0.01030	0.455	0.10179
4	2	2	3.5	1.5	0.009703	0.00839	0.00131	0.114	0.270	0.156	0.00526	0.775	0.08851
5	1	1	2	1	0.010159	0.009703	0.00046	0.040	0.156	0.116	0.00183	0.97	0.03853
6	0.75	0.75	1	0.25	0.01036	0.010159	0.00020	0.017	0.116	0.099	0.00080	1	0.01743
7	0.5	0.5	0.75	0.25	0.010654	0.01036	0.00029	0.026	0.099	0.073	0.00118	1	0.02563
8	0.3	0.3	0.5	0.2	0.011495	0.010654	0.00084	0.073	0.073	0.000	0.00337	1	0.07318
Totals							0.011495				0.046		0.4086
Total Aerosol Concentration 0.046 mg/m^3													
Respirable Mass Fraction 0.409 or 41%													
Respirable Mass Concentration 0.019 mg/m^3													

Table B-2

Particle size analysis results collected in the south side 44th floor air intakes (prior to air entering the HVAC systems) on 11/13/01

Stage Number	Effective Cut Diameter	Size Range lower	Size Range upper	Size Interval Dp	Final Weight (mg)	Initial Weight (mg)	Net Gain (mg)	Mass Fraction	CMF	CMF< Indicated Size	Concentration (mg/m^3)	Average Respirable Fraction	Respirable Mass Fraction
1	15	15	50	35	0.00112	0	0.00112	0.243	1.000	0.757	0.00833	0	0
2	10	10	15	5	0.00209	0.00112	0.00097	0.211	0.757	0.546	0.00721	0.005	0.00105
3	7.5	7.5	10	2.5	0.00281	0.00209	0.00072	0.157	0.546	0.389	0.00538	0.0425	0.00668
4	5	5	7.5	2.5	0.00357	0.00281	0.00076	0.165	0.389	0.224	0.00565	0.1875	0.03093
5	3.5	3.5	5	1.5	0.00416	0.00357	0.00059	0.129	0.224	0.095	0.00443	0.455	0.05882
6	2	2	3.5	1.5	0.00444	0.00416	0.00028	0.060	0.095	0.034	0.00207	0.775	0.04681
7	1	1	2	1	0.00455	0.00444	0.00011	0.024	0.034	0.010	0.00081	0.97	0.02300
8	0.5	0.5	1	0.5	0.00460	0.00455	0.00005	0.010	0.010	0.000	0.00036	1	0.01039
Totals							0.0046011				0.0342		0.1777

Total Aerosol Concentration 0.034 mg/m^3

Respirable Mass Fraction 0.178 or 18%

Respirable Mass Concentration 0.0061 mg/m^3

Table B-3
Particle size analysis results collected in the general office area of HUD on 11/14/01

Stage Number	Effective Cut Diameter	Size Range lower	Size Range upper	Size Interval Dp	Final Weight (mg)	Initial Weight (mg)	Net Gain (mg)	Mass Fraction	CMF	CMF< Indicated Size	Concentration (mg/m^3)	Average Respirable Fraction	Respirable Mass Fraction
1	6.5	6.5	50	43.5	0.004355	0	0.00435	0.434	1.000	0.566	0.00870	0.07	0.03037
2	5	5	6.5	1.5	0.006217	0.004355	0.00186	0.186	0.566	0.381	0.00372	0.22	0.04082
3	3.5	3.5	5	1.5	0.00817	0.006217	0.00195	0.195	0.381	0.186	0.00390	0.455	0.08854
4	2	2	3.5	1.5	0.008999	0.00817	0.00083	0.083	0.186	0.103	0.00166	0.775	0.06396
5	1	1	2	1	0.009235	0.008999	0.00024	0.024	0.103	0.080	0.00047	0.97	0.02281
6	0.75	0.75	1	0.25	0.009325	0.009235	0.00009	0.009	0.080	0.071	0.00018	1	0.00904
7	0.5	0.5	0.75	0.25	0.009496	0.009325	0.00017	0.017	0.071	0.054	0.00034	1	0.01705
8	0.3	0.3	0.5	0.2	0.010037	0.009496	0.00054	0.054	0.054	0.000	0.00108	1	0.05385
Totals							0.010037				0.020		0.3265

Total Aerosol Concentration 0.02 mg/m^3

Respirable Mass Fraction 0.326 or 33%

Respirable Mass Concentration 0.0065 mg/m^3

Table B-4

Stage Number	Effective Cut Diameter	Size Range lower	Size Range upper	Size Interval Dp	Final Weight (mg)	Initial Weight (mg)	Net Gain (mg)	Mass Fraction	CMF	CMF< Indicated Size	Concentration (mg/m³)	Average Respirable Fraction	Respirable Mass Fraction
1	15	15	50	35	0.008929	0	0.00893	0.269	1.000	0.731	0.01811	0	0
2	10	10	15	5	0.01548	0.008929	0.00655	0.198	0.731	0.533	0.01328	0.005	0.00099
3	7.5	7.5	10	2.5	0.020639	0.01548	0.00516	0.156	0.533	0.378	0.01046	0.0425	0.00661
4	5	5	7.5	2.5	0.02597	0.020639	0.00533	0.161	0.378	0.217	0.01081	0.1875	0.03015
5	3.5	3.5	5	1.5	0.030136	0.02597	0.00417	0.126	0.217	0.091	0.00845	0.455	0.05716
6	2	2	3.5	1.5	0.032161	0.030136	0.00203	0.061	0.091	0.030	0.00411	0.775	0.04735
7	1	1	2	1	0.03289	0.032161	0.00073	0.022	0.030	0.008	0.00148	0.97	0.02132
8	0.5	0.5	1	0.5	0.033157	0.03289	0.00027	0.008	0.008	0.000	0.00054	1	0.00805
Totals							0.033157				0.067		0.1716

Total Aerosol Concentration 0.067 mg/m³

Respirable Mass Fraction 0.172 or 17%

Respirable Mass Concentration 0.012 mg/m³

Particle size analysis results collected on 11/14/01 in the south side 44th floor air intakes (prior to air entering the HVAC systems)

Appendix C

Indoor Environmental Quality (IEQ) and Mold Exposure

During our evaluation of the Federal Office Building, there were signs of water incursion (i.e., water damaged ceiling tiles) in different locations throughout the building. In addition, some individuals expressed concerns regarding mold in the building and mold-related illnesses. The following information is provided to help the building managers address mold-related IEQ issues.

There are no exposure guidelines for mold in air. Therefore, it is not possible to distinguish between "safe" and "unsafe" levels of exposure. We do know, however, that moisture intrusion along with nutrient sources such as building materials or furnishings allows mold to grow indoors. It is important, therefore, to keep the building interior and furnishings dry to prevent unwanted mold growth. The potential for health problems is an important reason to prevent indoor mold growth and to remediate any indoor mold contamination. Remediation guidelines are available; it is important to protect cleanup workers, the building occupants, and the surrounding indoor environment during remediation activities.

The key to preventing indoor mold contamination is to control interior moisture. Each of the following should be considered.

- Repair leaks in the building envelope and plumbing/sewage systems.
- Prevent condensation through insulation, increasing surface temperature, or increasing air circulation.
- Vent any moisture-producing equipment or appliances to the outdoors.
- Maintain interior relative humidity below 60 percent (ideally between 30 percent and 50 percent to minimize mold growth). Dehumidify as necessary to achieve this level.
- Ensure that air conditioning systems are adequately drained to prevent standing water.
- Clean up and dry any wet or damp spots within 48 hours.
- Ensure that water drains away from the building foundation.
- Routinely inspect and maintain the building and building systems.

References:

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EPA [2001]. Mold Remediation in Schools and Commercial Buildings. Washington, D.C.: Environmental Protection Agency.

New York City Department of Health. Guidelines on Assessment and Remediation of Fungi in Indoor Environments. Available: www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html (2000).

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