NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2002–0136–2880
United States Senate and House of Representatives
Washington, D.C.

July 2002

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

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

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This report was reviewed by the United States Capital Police. For security reasons, the Capital Police redacted certain portions of the report. The redacted portions of the report have been blacked out. Copies of this report have been sent to the Sergeant at Arms of the United States Senate, and the Chief Administrative Officer of the United States House of Representatives. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

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

Highlights of the NIOSH Health Hazard Evaluation

Irradiated Mail Handling and Opening at the Capitol Office Buildings

The National Institute for Occupational Safety and Health (NIOSH) is the federal agency responsible for doing research in workplaces and making recommendations intended to prevent occupational illnesses and injuries. NIOSH is part of the Centers for Disease Control and Prevention. Researchers from the NIOSH health hazard evaluation program evaluate occupational health concerns of workers, worker representatives, and employers. On February 8, 2002, NIOSH received a joint request from the Sergeant at Arms of the United States Senate and the Chief Administrative Officer of the United States House of Representatives related to health concerns regarding handling and opening irradiated mail at the Capitol office buildings in Washington, D.C.

What NIOSH Did

- We measured the air for contaminants that could potentially come from irradiated mail. These were carbon monoxide, volatile organic compounds, formaldehyde, ozone, particulate, polynuclear aromatic hydrocarbons, and toluene diisocyanate. Samples were collected in ten buildings (Cannon, Capitol, Dirksen, Ford, Hart, House Post Office screening facility, Longworth, Rayburn, Russell, and the Senate Post Office screening facility) over three days. We chose sampling sites in each building using symptom reports and mail volume information.
- We also measured carbon dioxide, temperature, and relative humidity. These indicators are used to assess indoor environmental quality.
- We interviewed 389 employees in 120 offices regarding symptoms related to handling mail.
- We met with and reviewed information collected by the Office of the Attending Physician (OAP).

What NIOSH Found

- Sampled substances were either not detected or were found at low levels below those known to cause health problems. Low levels of many substances are typical in office buildings.
- Small particulate counts indoors were generally much lower than outdoors. Exceptions were noted in two small offices in the Hart Senate Office Building which indicated adjustments were needed to the ventilation system. These adjustments have been made.
- The most commonly reported symptoms were headache, skin irritation, eye irritation, skin rash, dry hands, nausea, and nose or throat irritation. We believe it is likely that multiple factors are responsible for the reported symptoms. These factors are described below:
  - Because the irradiation process heats and dries out paper, handling of the treated mail can lead to dry skin and skin irritation in some employees.
  - Irradiated mail may produce odors, which some individuals can smell at levels below occupational guidelines and in some cases below air monitoring detection limits. The response to odor varies among individuals, and odors can potentially trigger symptoms such as headaches, mucous membrane irritation, eye irritation, and nausea in some individuals.
  - Humidity levels in most buildings were not optimal. Sub-optimal humidity levels can lead to eye and skin irritation.
  - Heightened awareness and resultant employee stress from recent terrorist attacks may have contributed to workers' symptoms.
- We did not find evidence suggesting the potential for long term health effects from handling irradiated mail.
- We worked with the Legislative Task Force, the OAP, and the General Services Administration to develop recommendations for handling irradiated mail in Capitol Hill offices

and offsite mail handling facilities. The recommendations are summarized on the following page; full text is in the complete report.

What Employees Can Do

- If you experience symptoms you feel are associated with a specific work activity such as handling irradiated mail, report them to the OAP. This will help the OAP understand when and where problems are occurring.
- Continue to wash hands with lotion-based soap, but liberally apply water-based hand cream or lotion after each hand washing and throughout the day to minimize drying your skin.
- If you experience eye or nose dryness or irritation, use over-the-counter saline eye drops or saline nose spray to help alleviate symptoms. If symptoms do not improve, see your health care provider.
- Handle mail in well ventilated areas.
- Avoid touching mouth, eyes, or face when handling mail.
- If you choose to use gloves while handling irradiated mail, consider using gloves made of breathable material. Change gloves when they are grossly dirty or have perforations in them, and remove gloves when eating, drinking, or smoking. Wash hands after removing gloves. *Additional information on gloves is included in the full report.*

What Legislative Offices Can Do

- Encourage employees experiencing health symptoms to see their health care provider and report symptoms to the OAP.
- Provide gloves made of breathable material to individuals who choose to wear them.
- Encourage employees handling irradiated mail to liberally apply water-based hand cream or lotion after washing hands.
- Share all information about mail changes and mail handling procedures with employees.

What Capitol Support Services Can Do

- Track symptoms reported to the OAP to identify patterns that suggest a work-related cause.
- If symptoms suggest a work-related cause in specific areas, conduct an environmental evaluation.
- Continue current efforts to maintain optimal humidity levels.
- Provide mild lotion based soaps at employee wash stations.
- Provide timely communication of information about ongoing changes in mail and mail handling procedures with legislative offices and employees.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, contact the Office of the Senate Sergeant at Arms (4-2341) or the Office of the Chief Administrative Officer for the House of Representatives (6-5155) or call NIOSH at 1-513-841-4252 and ask for HETA Report # 2002-0136-2880

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SUMMARY

On February 8, 2002, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from the Sergeant at Arms Office at the United States Senate and the Chief Administrative Officer at the United States House of Representatives regarding health concerns related to handling and opening irradiated mail at the United States Senate and House office buildings in Washington, D.C.

In response to the request, NIOSH representatives conducted environmental and epidemiologic evaluations at the Russell, Dirksen, Hart, Cannon, Longworth, Rayburn, and Ford Buildings, the Senate Post-Office Screening Facility, the House Mail Processing Facility, the Capitol building, and Postal Square on February 13-15, 2002. The environmental evaluation included air sample collection for carbon dioxide, temperature, and relative humidity as well as for contaminants potentially derived from heated mail as a result of irradiation, including small and total particulate, volatile organic compounds, formaldehyde, ozone, carbon monoxide, toluene diisocyanate, and polynuclear aromatic hydrocarbons. In addition, bulk samples of irradiated mail and mail that had not gone through the irradiation process were analyzed for anions, metals, and pH. The epidemiologic evaluation consisted of interviews with individual employees who handled or had concerns about the mail, meetings with the Senior Medical Officer from the Office of the Attending Physician (OAP), and review of data collected by the OAP.

Air samples indicated non-detectable or low concentrations of sampled contaminants. The types and levels of airborne substances we measured in areas where irradiated mail was handled were not distinguishable in a meaningful way from those measured in areas where irradiated mail was not handled. This comparison was hindered in a few cases where employee interviews revealed that mail volumes and/or mail opening activities were lower on the day that samples were collected. We do not suspect that daily variability of the mail load will have an effect on the results of our environmental evaluation based on the number of buildings and offices evaluated, the number of samples collected, and the low concentrations of any detectable compounds. Many of the volatile organic compounds that were detected are common in indoor air, and the results of the sampling for these compounds generally are similar to results seen by NIOSH in other indoor environments. The bulk sample analysis did not provide information that could link irradiated mail to the reported health effects. [redacted].

Among the 389 Congressional staff employees interviewed, the most common symptoms were headache, skin irritation, eye irritation, skin rash, dry hands, nausea, and nose or throat irritation. We believe that it is likely that multiple factors are responsible for the reported symptoms. The added dryness of the mail from the irradiation process can lead to dryness and skin irritation from repeated handling of the mail. This is due to the absorptive

effect of the damaged cellulose fibers from the irradiated paper drawing moisture off the skin. This drying effect can cause the outer layer of the skin to dry out and fissure, causing chapped and irritated skin. Individuals with a history of atopy (allergies) may have been particularly vulnerable. The [redacted] we observed in our environmental survey can also exacerbate the symptoms of eye and skin irritation that were seen.

In general, established guidelines for occupational exposures are based on the goal of preventing and minimizing measurable adverse effects in healthy populations. They are not based on avoidance of odors, and many chemical odors can be detected by smell at levels below exposure guidelines. Some odors can be detected by humans at levels below those detectable using industrial hygiene techniques. There is evidence that irritation can be produced from volatile organic compounds at very low levels—levels which would trigger the activation and amplification of the neurosensory mechanisms for an odor threshold (activating the sense of smell), but potentially below levels that we could measure for some compounds. Thus, odors could potentially trigger irritant symptoms experienced by the employees, including some of the mucous membrane irritation and headaches.

Adding to the unfamiliar and unpleasant odors causing headaches and irritation, skin irritation, and mucous membrane irritation, was the fact that these occurrences happened in a climate of heightened awareness and unusual anxiety in these Government Buildings due to recent terrorist acts. It is possible that this heightened awareness and resultant employee stress, while not a root cause of the problem, may have contributed to problems caused by the handling of the very dry irradiated mail.

Environmental samples collected across several Capitol Hill building locations over a three day period did not reveal any exposures exceeding any existing occupational guidelines. In addition, exposures in irradiated mail locations were not demonstrably higher than exposures in control locations where no mail was opened. These findings are similar to what has been found in other recent investigations of irradiated mail. Medical interviews did result in finding a fairly high number of individuals reporting symptoms of irritation. As noted above, the absorptive effect of the irradiated paper drawing moisture off the skin could account for some of the symptoms, other irritant symptoms may be due to odors associated with the mail, still others due to the [redacted] and heightened awareness. Therefore, it is likely that a number of causes were responsible for the reported symptoms. Recommendations are provided in the report.

Keywords: SIC 9121 Legislative Bodies. Irradiated Mail, Indoor air quality, Indoor environmental quality, headache, skin irritation, eye irritation, skin rash, dry hands, nausea, and nose or throat irritation.

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INTRODUCTION

On February 7, 2002, the National Institute for Occupational Safety and Health (NIOSH) received a joint request for a Health Hazard Evaluation (HHE) from the Sergeant at Arms of the United States Senate and the Chief Administrative Officer of the House of Representatives regarding health concerns related to handling and opening irradiated mail at the United States Senate and House of Representatives office buildings in Washington, D.C. Employees expressed concerns about symptoms such as nose bleeds, eye irritation, and headaches. From February 13-15, 2002, NIOSH representatives conducted environmental and epidemiologic evaluations at multiple Federal Office Buildings. This report presents the results of our evaluations, including conclusions and recommendations.

METHODS

On February 8, a preliminary strategy describing NIOSH plans for selecting sampling locations, selecting contaminants for evaluation, and collecting medical information on symptoms was presented to the U.S. Capitol Legislative Mail Task Force for comment and discussion. Agreement on the general approach was provided by members of the Task Force, including representatives of the U.S. Environmental Protection Agency (EPA), the U.S. Postal Service, the Defense Advanced Research Projects Agency (DARPA), the Armed Forces Radiobiology Research Institute (AFRRI), the Lawrence Livermore National Laboratory, and the White House Office of Science and Technology Policy. Agreement was also reached to encourage collaboration on sampling, with AFRRI agreeing to perform concurrent sampling over the three days of the HHE. AFRRI's independent report is attached as Appendix B.

Industrial Hygiene Methods

The environmental and epidemiological evaluations were conducted on February 13-15, 2002. On February 13, environmental sampling was conducted in the Russell, Cannon, and Longworth buildings, and in the Senate Post-Office Screening Facility. On February 14, environmental sampling was conducted in the Hart, Dirksen, and Rayburn buildings, and in the House Post-Office Screening Facility. On February 15, sampling was conducted in the Russell, Hart, Dirksen, Capitol, and Ford buildings. Senators' and Representatives' offices were chosen for evaluation based either on health complaints attributed to mail handling, or because the office handles a relatively high volume of mail. Air samples were collected in areas where workers handled and opened irradiated mail. Samples were also collected where no irradiated mail was stored or handled and outdoors for comparison.

We sampled for contaminants that may be derived from heated mail as a result of irradiation and that could be associated with worker symptoms including small particulate, volatile organic compounds (VOCs), formaldehyde, ozone, carbon monoxide, toluene diisocyanate (TDI), polynuclear aromatic hydrocarbons (PAHs), and total particulate. We also measured typical indoor air environmental parameters such as carbon dioxide (CO_2), temperature, and relative humidity (RH).

Volatile Organic Compounds (VOCs)

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 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. The typical desorption procedure for thermal desorption

tubes is suited for most common organic solvents with a molecular weight below 300 and boiling points around 200 °C or less. The thermal desorption tubes collected during this evaluation were desorbed in the ATD at 300°C for 10 minutes. Samples were analyzed according to NIOSH analytical method 2549.[1] Some of the compounds identified on thermal desorption tubes were selected for further scrutiny via charcoal tube analysis, a better 'quantitative' method than thermal desorption tube analysis. They were selected because of their greater relative abundance, compared to other compounds detected on the thermal desorption tubes, or because of their known irritating or toxic properties.

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, UT) to be quantitatively analyzed for compounds of interest (identified on the thermal tubes) using a Hewlett-Packard model 5890A gas chromatograph equipped with a flame ionization detector.

Direct Reading

A MiniRAE 2000 (RAE Systems Inc., PGM-7600, Sunnyvale, California) portable VOC monitor (photoionization detector [PID]) equipped with a 10.6 electron volt lamp was used to give a direct reading indication of the non-specific total volatile organic compound (TVOC) concentration.

Formaldehyde

Mail sent through the irradiation process may include products (i.e., paper, photographic film, etc.) in which formaldehyde was used in the manufacturing process. Therefore, air samples were collected during this evaluation to identify if irradiated mail released formaldehyde at concentrations that could be linked with worker symptoms.

Air samples were collected on silica gel sorbent tubes (containing a cartridge coated with 2,4–dinitrophenylhydrazine) at a calibrated flow rate of 0.2 liter per minute (lpm). The tubes were analyzed at Datachem Laboratories, Inc. (Salt Lake City, UT) by high pressure liquid chromatography (HPLC) with an ultraviolet (UV) detector according to NIOSH Method 2016.[1]

Ozone

Monitoring for ozone (O_3) (detection range of 0.05 to 0.7 parts of ozone per million parts [ppm] of air) was conducted with colorimetric detector tubes. The detector tubes are used by drawing air through the tube with a bellows-type pump. The resulting length of the stain in the tube (produced by a chemical reaction with the sorbent) is proportional to the concentration of ozone.

Carbon Monoxide

Carbon monoxide (CO) concentrations were measured using real-time ToxiUltra Atmospheric Monitors (Biometrics, Inc.) with CO sensors. These monitors are direct-reading instruments with data logging capabilities. The instruments were operated in the passive diffusion mode, with a 30-second sampling interval, and a nominal range from 0 parts of CO ppm to 999 ppm.

Toluene Diisocyanate

Air samples for 2,4- and 2,6-toluene diisocyanate (TDI) were collected according to NIOSH Method 5525,[1] using 37 millimeter reagent-coated quartz fiber filters. Personal sampling pumps calibrated to a nominal flow rate of 1.5 lpm were used to draw air through the impregnated filters. Samples were stored cold until analysis at the NIOSH laboratory via pH-gradient high performance liquid chromatography with ultraviolet and fluorescence detection. Analysis of TDI-reagent standards in the appropriate concentration range were interspersed with the sample analysis. Calibration curves were constructed for 2,6- and 2,4-TDI using fluorescence peak height as a function of concentration. In this

method, the instrumentation limit of detection (LOD) is generally much lower that the method LOD, which is determined by the level of interferences in the samples near the retention time of the analytes. Based on the highest interferences observed in this sample set near the retention time of TDI isomers, this is estimated to be 50 nanograms (ng) per sample. This yields a minimum detectable concentration of 18 parts per trillion, based on a sample volume of 400 liters of air.

Polynuclear Aromatic Hydrocarbons

Air samples for polynuclear aromatic hydrocarbons (PAHs) (a term which describes a large group of organic compounds) were collected on a polytetrafluoroethylene (PTFE) filter (37-millimeter [mm] diameter with a 2 micrometer [μm] pore size) followed by a washed XAD-2 (100 milligrams [mg]/50 mg) sorbent tube at a flow rate of 2 lpm according to NIOSH method 5506.[1] Samples were analyzed at Datachem Laboratories, Inc. (Salt Lake City, UT) for the following PAHs: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, and indeno(1,2,3-c,d)pyrene.

Direct Reading–Temperature, RH, CO, and CO_2

A TSI® Q Trak™ (Model 8551, TSI Incorporated, St. Paul, Minnesota) was used to give a real time indication of temperature, RH, CO, and CO_2 in the various locations within the government buildings on Capitol Hill.

Total Particulate 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) at Datachem Laboratories, Inc. (Salt Lake City, Utah) according to NIOSH Method 0500.[1]

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.[2] 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. Results for the particle size analysis are presented in Appendix A.

Small Particulate

Particles having an aerodynamic diameter 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 x 10^5 particles/cubic centimeter (cc). The sampling flow rate is 100 cc/min.

Bulk Samples

Pieces of irradiated and non-irradiated mail were collected and sent to Data Chem laboratories in Salt Lake City, Utah, to be analyzed for anions (a negatively charged ion; indicates acidity). The non-irradiated mail consisted of a manila envelope, a white envelope, and a colored page from a catalog; these were obtained from office stock at NIOSH offices in Cincinnati, Ohio. The mail samples were analyzed for fluoride, chloride, nitrite ion, bromide, nitrate ion, phosphate ion, and sulfate ion, by ion chromatography according to NIOSH Method 7903.[1] The method was modified for bulk matrix; no recovery or stability data are available. Therefore, the results should be considered semi-quantitative.

Three irradiated mail samples and three non-irradiated mail samples were analyzed for metals and pH. One gram of each sample was weighed into a graduated centrifuge tube and extracted with 25.0 milliliters de-ionized water by sonicating for 15 minutes. Aliquots of each sample solution were analyzed for trace metals by Inductively Coupled Argon Plasma-Atomic Emission Spectroscopy according to NIOSH method 7300,[1] and pH using an Mettler/Toledo Model MP 225 pH meter at the NIOSH Laboratories in Cincinnati, Ohio.

Portions of irradiated and non-irradiated bulk samples were extracted with a solvent mixture. The extracts were analyzed by infusion-electrospray-mass spectrometry and liquid chromatography-electrospray-mass spectrometry at the NIOSH laboratory. This analysis was intended to identify chemical changes in the mail as a result of the irradiation process.

MEDICAL METHODS

The NIOSH medical officers conducted informal interviews on February 13-15, 2002, with individual employees, and groups of employees, who work in House and Senate office buildings around Capitol Hill. NIOSH representatives sought to interview all employees who handled mail as part of their work duties, as well as all employees who had questions or concerns about the mail. Interviews consisted of questions regarding work duties and current symptoms experienced while opening, handling or working with irradiated mail. During the interviews the medical officers also discussed preliminary conclusions from other NIOSH evaluations of irradiated mail. Employees were given the opportunity to ask questions and voice additional concerns. A NIOSH medical officer interviewed the Senior Medical Officer from the Office of the Attending Physician (OAP), US Capitol, who was responsible for evaluating House and Senate workers experiencing symptoms they related to irradiated mail exposure. Data collected by the OAP were also reviewed.

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

increases 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),[3] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[4] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[5] 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 environments 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 Senate and House office buildings. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation and thermal comfort guidelines.[6,7]

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.[8,9,10,11,12] 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.[13,14] Among these factors are imprecisely defined characteristics of heating, ventilating, and air-conditioning (HVAC) systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[11,12,13,14,15] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts are beneficial.[16] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[17] 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.[18]

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.[19] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[20,21]

Temperature and RH

The American National Standards Institute (ANSI)/ASHRAE Standard 55-1992 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[6] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-74ºF in the winter, and from 73-79ºF in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends that RH be maintained between 30 and 60% RH.[7] Upper and lower humidity limits are based on the maintenance of acceptable thermal conditions based solely on comfort considerations including thermal sensation, skin wettedness, skin dryness, and eye irritation.[6] Some studies have suggested low humidity levels may be associated with symptoms of eye and skin irritation.[22,23,24,25,26]

Carbon Monoxide (CO)

CO is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials such as gasoline or propane fuel. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, or nausea. Symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. If the exposure level is high, loss of consciousness may occur without other symptoms. Coma or death may occur if high exposures continue.[27,28,29,30,31,32] The display of symptoms varies widely among individuals, and may occur sooner in susceptible individuals such as young or aged people, people with preexisting lung or heart disease, or those living at high altitudes.

Exposure to CO limits the ability of the blood to carry oxygen to the tissues by binding with the hemoglobin to form carboxyhemoglobin (COHb). Blood has an estimated 210-250 times greater affinity for CO than oxygen, thus the presence of CO in the blood can interfere with oxygen uptake and delivery to the body. Once absorbed into the bloodstream, the half-life of bloodborne CO at sea level and standard pressure is approximately five hours. This means that an initial COHb level of 10% could be expected to drop to 5% in five hours, and then to 2.5% in another five hours. If oxygen is administered to the exposed person, as happens in emergency treatment, the COHb concentration drops more quickly. Once exposed, the body compensates for the reduced bloodborne oxygen by increasing cardiac output, thereby increasing blood flow to specific oxygen-demanding organs such as the brain and heart. This ability may be limited by preexisting heart or lung diseases that inhibit increased cardiac output.

The NIOSH REL for CO is 35 ppm for full shift time-weighted average (TWA) exposure, with a ceiling limit of 200 ppm which should never be exceeded.[32] The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with COHb levels in excess of 5%.[27] The ACGIH® recommends an 8-hour TWA TLV® of 25 ppm based upon limiting shifts in COHb levels to less than 3.5%, thus minimizing adverse neurobehavioral changes such as headache, dizziness, etc, and maintaining cardiovascular exercise capacity.[4] The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure.[5] The US Environmental Protection Agency (EPA) National Ambient Air Quality Standard (NAAQS) for CO requires that ambient air contains no more than 9 ppm CO for an 8-hour TWA, and 35 ppm for a one-hour average.[33] The NAAQS for CO was established to protect "the most sensitive members of the general population" by maintaining increases in carboxyhemoglobin to less than 2.1%.

Carbon Dioxide (CO_2)

CO_2 is a normal constituent of exhaled breath, and if monitored at equilibrium concentrations in a building, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, 15 cfm/person for reception areas,

classrooms, libraries, and auditoriums, and 60 cfm/person for smoking lounges. Maintaining the recommended ASHRAE outdoor air supply rates when the outdoor air is of good quality, and there are no significant indoor emission sources, should provide for acceptable indoor air quality.

CO_2 is not considered a building air pollutant, but CO_2 concentration is used as an indicator of the adequacy of outside air supplied to occupied areas. Indoor CO_2 concentrations are normally higher than the generally constant outdoor ambient CO_2 concentration. ASHRAE Standard 62-2001 recommends 700 ppm above that measured outdoors as the upper limit for comfort (odor) reasons.[7] Based on NIOSH experience, when indoor CO_2 concentrations exceed 800 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. It is important to note that CO_2 is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual level when the measurements are made.

Volatile Organic Compounds (VOCs)

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.

IEQ 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.[34] 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.[35] 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.

Formaldehyde

At room temperature, formaldehyde is a colorless, flammable gas that has a distinct, pungent smell. Formaldehyde is used in the production of fertilizer, paper, photographic film, plywood, and urea-formaldehyde resins. It is also used as a preservative in some foods and in many products used around the house, such as antiseptics, medicines, and cosmetics. Sources of formaldehyde include smog, cigarettes and other tobacco products, gas cookers and open fireplaces, manufactured wood products and household sources such as fiberglass, permanent press fabrics and some cleaners.

Levels of formaldehyde in the environment have been well characterized and will vary depending on the area of the country and whether it is a rural or urban environment (combustion processes account for the majority of the formaldehyde entering the environment). One large study found that formaldehyde concentrations measured in the ambient environment ranged from 0.001 to 0.068 ppm, with an average of 0.0028 ppm. Generally, indoor formaldehyde concentrations are much higher than outdoor concentrations.[36]

Exposure can occur through inhalation and skin absorption. The acute effects associated with formaldehyde are irritation of the eyes and respiratory tract and sensitization of the skin. The first symptoms associated with formaldehyde exposure, at concentrations ranging from 0.1 to 5 ppm, are burning of the eyes, tearing, and general irritation of the upper respiratory tract. There is variation among individuals, in terms of their tolerance and susceptibility to acute exposures of the compound.[37]

Formaldehyde exposure has been identified as a possible causative factor in cancer of the upper respiratory tract in a proportionate mortality study of workers in the garment industry.[38] NIOSH has identified formaldehyde as a suspected human carcinogen and recommends that exposures be reduced to the lowest feasible concentration. The OSHA PEL is 0.75 ppm as an 8-hour TWA and 2.0 ppm as a STEL.[39] ACGIH has designated formaldehyde to be a suspected human carcinogen and therefore, recommends that worker exposure by all routes should be carefully controlled to levels "as low as reasonably achievable" below the TLV.[4] ACGIH has set a ceiling limit of 0.3 ppm.

Note: NIOSH testimony to DOL on May 5, 1986, stated the following: "Since NIOSH is not aware of any data that describe a safe exposure concentration to a carcinogen, NIOSH recommends that occupational exposure to formaldehyde be controlled to the lowest feasible concentration; 0.1 ppm in air by collection of an air sample for any 15-minute period as described in NIOSH analytical method 3500 which is the lowest reliably quantifiable concentration at the present time." NIOSH also lists a REL for formaldehyde of 0.016 ppm for up to a 8-hour TWA exposure (again using NIOSH analytical method 3500 and indicating that this is the lowest reliably quantifiable concentration at the present time). Investigators should be aware that formaldehyde levels can currently be measured below 0.016 ppm. It may be appropriate to refrain from using numerical limits and instead state that concentrations should be the lowest feasible (in some situations, this may be limited by the ambient background concentration.)

INFORMATION CONCERNING PAPER

A meeting with representatives from several paper manufacturing companies, the Institute of Paper Science & Technology, the American Forest & Paper Association, and NIOSH was held to share information concerning paper and how the irradiation process might affect paper. The representatives stated that paper is mostly composed of cellulose, but chemicals and compounds are added during the manufacturing process to impart desirable qualities to the final paper product. Further, when considering mail, aside from the numerous types and composition of paper that may be contained within any given stack of envelopes, there are other components that might be affected by the irradiation process. These components include plastics from wrappers (polyethylene), envelope windows (polystyrene); synthetic fibers used in some envelopes (Tyvek®); adhesives which are found on labels (natural and synthetic gums); synthetic polymers on tacky strips; metals from paperclips, staples, or aluminum coatings; and inks, dyes and pigments used to write on the various paper surfaces. Taking into consideration all the various components that are contained in the mail, this group could not pinpoint a particular compound or group of compounds potentially generated from the irradiation process that might be responsible for the reported health effects.

Some studies within the paper industry have been conducted on irradiation of paper and paper pulp. These studies have revealed that irradiation results in changes in the structure, chemical, and physical properties of the paper.[40] Irradiated paper becomes more acidic.[41] During the irradiation process cellulose fibers making up the paper are degraded into smaller pieces and the bonds holding these fibers together are broken down by the heat and irradiation. Damaged cellulose fibers do not stick together well and are more easily liberated from irradiated paper during handling (referred to as dusting).[42] Dusting enables cellulose fibers and the other chemical components contained in the paper

to be easily transferred onto the skin surface when the skin directly contacts irradiated paper during handling. Dusting can result in a greater immediate exposure to paper components that are not normally released by undamaged paper (or are released at a much slower rate over time). The researchers we met with did state that cellulose in and of itself is not known to be a skin irritant or to cause dermatitis.

One paper manufacturer stated that the cellulose fiber damage noted in irradiated paper seemed similar to the damage produced during the paper recycling process. Typically, recycled paper is a mixture of true recycled paper pulp and new paper pulp. His company had noted that when attempting to produce paper products using 100% recycled paper fibers, a small proportion of the population that used this paper product complained of developing skin irritation during handling. Because decreasing the amount of recycled paper used in the finished product resolved the irritation, the paper company suspected that the damaged cellulose fibers (from the recycling process) might be the cause of the irritation. The company conducted a study to determine the cause of the skin irritation but was unable to pinpoint the reason why the 100% recycled paper product caused skin irritation.

INDUSTRIAL HYGIENE RESULTS, DISCUSSION, AND CONCLUSIONS FOR EACH BUILDING

Evaluation criteria for compounds sampled are presented in Table 1 and abbreviations used in the tables are listed in Table 2. Mail was sorted and opened in the majority of the Congressional offices (both House and Senate) while air sampling was conducted during our evaluation.

February 13, 2002

Russell Building

Actions Taken

On February 13, 2002, air sampling was conducted in four areas of the Russell Building; [redacted] (area where mail was handled and opened), [redacted] (area where mail was handled and opened), an indoor background area ([redacted] - where there was no mail), and outside of the building [redacted].

Results

Table 3 lists the results for PAHs; all were non-detectable, except for a trace amount of naphthalene in [redacted]. The trace concentration was detected between the minimum detectable concentration (MDC), which is based on the analytical limit of detection (LOD), and the minimum quantifiable concentration (MQC) based on the analytical limit of quantitation (LOQ).

Table 4 presents the semi-quantitative results for VOCs obtained from thermal tubes. Many compounds were detected, but at very low concentrations (levels much lower than relevant evaluation criteria). Charcoal tube air sample results (Table 5) were all low and well below any relevant evaluation criteria. The only sample collected above the LOD [redacted] was for toluene (0.006 ppm). One charcoal tube air sample was analyzed for acetonitrile. This sample was collected in [redacted] and had a very low concentration of 0.012 ppm. All air samples collected for TDI were below the LOD (Table 6).

Table 7 presents total dust air sample results. All samples were below the LOD except for one sample collected in [redacted] (0.04 milligrams per cubic meter [mg/m^3]).

Air samples for formaldehyde are presented in Table 8. Sample concentrations ranged from trace amounts to 0.01 ppm. The highest formaldehyde concentration (0.01 ppm) was collected in [redacted].

CO detectors (Toxilogs) located in [redacted] in the Russell Building did not detect any CO. All CO_2 results were lower than the 800 ppm (guideline based on NIOSH experience) used to indicate inadequate indoor environmental quality, except for one reading in the control area (CO_2 concentration of 911 ppm). [redacted]. Ozone was not detected.

Discussion and Conclusions

All air sampling results are very low, and not suggestive of any particular causative factor for employee health issues. RH levels in a number of areas however, did not fit into the recommended parameters.

Cannon Building

Actions Taken

On February 13, 2002, sampling was conducted at four locations at the Canon Building: outside [redacted], indoor background [redacted] (conference room), [redacted] (area where mail was handled and opened), and [redacted] (area where mail was handled and opened).

Results

The results of the thermal desorption tubes indicated very low concentrations of VOCs, in the parts per billion (ppb) range. Some of the compounds identified on the thermal desorption tubes included ethanol, acetonitrile, methyl tert-butyl ether (MTBE), toluene, hexane, benzene, trichloroethylene, methyl isobutyl ketone (MIBK), toluene, perchloroethylene, xylene, butyl cellosolve, limonene, undecane, octamethylcyclotetrasiloxane, and decamethylcyclopentasiloxane. Results of the charcoal tube analysis are listed in the Table 9. The majority of all these results were non-detected with the exception of formaldehyde which ranged from 2.0 ppb (outside) to 9.5 ppb (inside control area where no mail was handled or opened).

[redacted] particulate size distribution was measured (see Appendix A for particle size results). Ranges for the direct reading results are presented in Table 10. [redacted]. CO, TVOC, and ozone were not detected, and CO_2 levels ranged from 584-815 ppm inside the building.

Discussion and Conclusions

Table 9 indicates that formaldehyde was the only substance found at concentrations above the MDC using quantitative methods (2.0 to 9.5 ppb). Mail handling areas had lower concentrations than the comparison area where no mail was processed.

With respect to qualitative methods (thermal desorption tubes), all of the contaminants studied were found in very low concentrations, in the ppb range. The compounds with the highest relative abundance were butyl cellosolve, decamethylcyclopentasiloxane, and limonene. These compounds are typically found in cleaning/deodorizing solutions, including glass cleaners, deodorizers, and dirt/oil removers. Separate thermal desorption tube samples were collected in the morning and afternoon. Results indicate higher concentrations in the morning, probably from over-night cleaning.

While the results from the thermal desorption tubes are not remarkably different among the four sampling locations, the indoor background sample (comparison area) generally indicated the higher concentrations. Based on measures of general air quality in the Cannon building, the indoor areas studied seem to be well ventilated. [redacted].

Longworth Building

Background

On February 13, 2002, sampling was conducted at four locations in the Longworth House Office Building (LB). [redacted]

[redacted] and is opened by one or more staff workers in the same place each day. The mail received this day was postmarked on a range of dates from November 30, 2001, to about December 20, 2001. The staff workers in charge of opening the mail in each office reported less than normal volumes of mail on the day of the NIOSH study.

Actions Taken and Results

Air sampling was conducted in [redacted] (two mail-opening desks), [redacted] a conference room where irradiated mail is not handled [redacted] 'indoor background'), and outdoors near the building ('outdoor background').

Individual VOCs were identified with thermal desorption tubes (one sample was collected at each location in the morning and a second was collected in the afternoon). Some of the compounds identified on the thermal desorption tubes included ethanol, acetonitrile, MTBE, toluene, hexane, benzene, trichloroethylene, MIBK, toluene, perchloroethylene, xylene, butyl cellosolve, undecane, limonene, and cyclic siloxanes. Ten compounds were selected for further scrutiny via charcoal tube analysis. Results are listed in Table 11. The majority of the results were non-detected. Any detected compounds indicated very low concentrations.

Direct reading instrumentation was also used to assess the following parameters throughout the day: CO, CO_2, temperature, RH, TVOCs, and ozone. Measurements were obtained in four areas: three areas inside the building and one outside. Table 12 lists direct reading results. [redacted]. TVOC were not detected in areas where the mail was processed, and ranged from 0-0.7 ppm in the indoor background area. Ozone was not detected in any of the areas sampled. CO concentrations ranged from 0-2 ppm inside the building and 0-3 ppm outside the building.

Discussion and Conclusions

All monitored compounds were found in very low concentrations. While the results from the thermal desorption tubes are not remarkably different among the four sampling locations, the indoor background sample generally indicated the highest concentrations. Because no irradiated mail was handled in Conference Room [redacted] during air sampling, it is concluded that irradiated mail is not the source of these compounds. Based on measures of general air quality in the LB, the indoor areas studied seem to be well ventilated, [redacted]. In general, CO_2 levels and the concentrations of compounds found on the thermal desorption tubes decreased as the day went on.

Senate Post-Office Screening Facility

Background

After anthrax-contaminated mail was sent to Senators in Washington, D.C., additional measures were taken to screen mail for bioterrorism agents prior to delivery to the Senate. On November 23, 2001, Senate mail room employees began screening the mail at an off-site Senate warehouse storage facility. Irradiated mail is delivered in trays on large carts via the loading dock and X-rayed in the main warehouse. The carts are then moved to the Mail Cutting room for sorting and screening. The Mail Cutting room contains four enclosed hoods equipped with local exhaust ventilation to maintain negative-pressure inside the hood. [redacted] and exhausted back into the work area. While working in the hoods, employees separate mail in envelopes from post-cards.

Employees work one shift from 07:00 to 17:30. On the day of the survey, three Senate transportation employees were being trained to sort the mail. All employees wore non-powdered nitrile gloves. Two employees were observed wearing a N-95 filtering face piece respirator.

Actions Taken

On February 13, 2002, we evaluated the Senate Post-Office Screening Facility (SPOSF) [redacted]. Area air sampling was conducted at four locations at the SPOSF: the Mail Cutting room, the Warehouse, the upstairs break room (comparison area), and outside on the loading dock (comparison area); in the latter two areas irradiated mail was not present.

Compounds selected for quantification based on thermal tube results were MTBE, benzene, toluene, trichloroethylene, xylenes/ethyl benzene, perchloroethylene, limonene, butyl cellosolve, and other hydrocarbons (using decane as a standard). One charcoal tube sample collected in the warehouse was analyzed for acetonitrile. In the Mail Cutting room, particulate load was measured (Appendix A). Additionally, instantaneous monitoring was conducted at intervals throughout the day to measure the following parameters: CO, CO_2, temperature, RH, and ozone.

Results

Direct Reading Survey

Direct reading results for the SPOSF are presented in Table 13. The results of the direct reading survey were unremarkable with the exception of CO readings (ranged 2-7 ppm inside the building). The CO source was suspected to be a slight leak from a gas fired heater/flue adjacent the entrance to the Mail Cutting room in the Warehouse. The heater is elevated and was not accessible for close inspection. We discussed this with management and maintenance staff, and recommended a complete inspection to ensure the heater and flue were operating properly.

With one exception, the CO_2 levels measured were within recommended guidelines for indoor environmental quality. The CO_2 levels in the break room ranged between 810-1100 ppm when it was occupied by eight or more people.

[redacted]. No ozone or significant VOC levels were detected.

Air Sampling

The air sampling results are presented in Table 14. Area charcoal tube samples were quantitatively analyzed for selected organic compounds of interest identified on the thermal desorption tubes. Most of the results for these compounds revealed non-detectable levels. All detected compounds had very low concentrations and were well below occupational evaluation criteria. All samples collected for organic compounds in the Mail Cutting Room and Loading Dock were non-detectable. Three samples collected in the Break Room indicated concentrations of toluene, butyl cellosolve, and other hydrocarbons (using decane as a standard) between the LOD and the LOQ for the method. The LOD for toluene was 0.0003 mg/sample and the MDC was 0.0015 ppm. The LOD for butyl cellosolve was 0.001 mg/sample and the MDC was 0.0026 ppm.

Formaldehyde concentrations ranged from 0.0038 ppm to 0.0082 ppm. The highest concentration of formaldehyde (0.0082 ppm) was sampled in the Break Room where no mail is processed. Total dust, PAHs, and TDI were not detected in any of the samples collected.

The one sample analyzed for acetonitrile indicated a concentration of 0.12 ppm, just above the LOQ. This sample was collected in the Warehouse. This concentration is very low and well below occupational exposure criteria (NIOSH REL 20 ppm).

Discussion and Conclusions

All airborne concentrations of the sampled compounds were low and well below established criteria or guidelines. No sampled airborne environmental contaminants were detected that could be attributed to working with irradiated mail. [redacted].

The VOCs identified on the thermal desorption tubes were typical of those found in non-industrial environments, and there were no substantive differences in the compounds identified or relative concentrations between the indoor background (break room) sample and the samples collected in the mail cutting room or warehouse. Very low levels of a variety of volatile compounds can be found in almost all environments. Likely sources for the VOCs identified include emissions from inks, varnishes, cleaning fluids, urban pollution, grease/oils, perfumes, colognes, etc. The irradiated mail is not considered to be the source of the detected VOCs.

February 14, 2002

Hart Office Building

Background

On February 14, 2002, we evaluated the Hart Senate Office Building (HSOB). [redacted] and is opened by one or more workers in the same place each day. Recently, the person in charge of opening mail in [redacted] left the job so remaining staffers open mail as needed; virtually no mail was opened this day. All mail in [redacted] postmarked before December has been discarded. The workers in charge of opening the mail in the other Senator's office [redacted] reported less than normal volumes of mail on the day of the NIOSH study.

Actions Taken and Results

Air sampling was conducted in the following locations at HSOB: [redacted] (area where mail was handled and opened), [redacted] (area where mail was handled and opened), an office undergoing renovation [redacted] but where no irradiated mail was handled, in the Hart-Dirksen [redacted] mail sorting facility [redacted] and in an empty office cubicle where irradiated mail is not handled [redacted] ('indoor background').

Some of the compounds identified on the thermal desorption tubes included ethanol, acetonitrile, MTBE, toluene, hexane, trichloroethylene, methyl isobutyl ketone, toluene, perchloroethylene, xylene, butyl cellosolve, limonene, undecane, and siloxanes. Ten compounds were selected for further scrutiny via charcoal tube analysis. Results are listed in the Table 15. If detected, compounds found in the air samples indicated only trace amounts (very low concentrations) of VOCs.

In [redacted] a continuous direct-reading particulate monitor (Grimm) was used to measure airborne particulate load at the table where much of the mail is opened (see Appendix A for particle size data). Direct-reading measurements were obtained in each of the above mentioned air sampling locations and results are listed in Table 16. CO_2 concentrations ranged from 484-800 ppm inside the building. [redacted]. TVOC monitoring indicated a concentration of 2.2 ppm when the probe was placed directly within a stack of mail and violently agitated; 0 ppm was detected in the ambient environment. Ozone was not detected.

Discussion and Conclusions

If detected, compounds found in air samples indicated only trace amounts (very low concentrations) of VOCs. These concentrations were in the ppb range and were well below any applicable exposure criteria. The results from the thermal desorption tubes were not remarkably different among the sampling locations, with two exceptions. The thermal desorption tube used in the office being remodeled had higher amounts of xylene on it than on those collected in other offices (50 ppb versus approximately 2 ppb), probably due to the adhesives being used on the floorboards and new carpet. The thermal desorption tube taken in the breathing zone of a staff worker in [redacted] detected small amounts of compounds not found in the other air samples. These particular compounds (patchouli alcohol, butyl benzoate, cinniminic aldehydes, coumarin, citronellal, aliphatic esters) are common components of cosmetics and fragrances. Based only on CO_2 measurements in HSOB, the indoor areas

studied seem to be fairly well ventilated, [redacted] (mail room) had the highest density of workers, which may be reflected in the comparatively higher CO_2 levels found there.

Dirksen Office Building

Background

On February 14, 2002, we conducted an evaluation at the Dirksen Building, which is bounded by Constitution Avenue, First Street, Second Street, C Street, N.E., and is adjoining the HSOB. Area air and direct reading sampling was conducted in four areas of the Dirksen building: [redacted] (area where mail was handled and opened), [redacted] (area where mail was handled and opened), an indoor background comparison area [redacted] and outside of the building [redacted]. Continuous, direct-reading CO detectors were used in [redacted]. A continuous, direct-reading instrument for particulates was used in [redacted] (see Appendix A for particle size data). Instantaneous monitoring was also conducted throughout the day for CO_2, CO, temperature, RH, and TVOCs.

Results

All air samples for PAHs (Table 3) revealed non-detectable concentrations. Table 4 presents the semi-quantitative results for VOCs. Many different compounds were detected at very low concentrations (levels much lower than relevant evaluation criteria). Concentrations of compounds found from the charcoal tube air samples (Table 5) were all very low and below relevant evaluation criteria. The only sample with a result other than a non-detectable concentration or a trace amount was for butyl cellosolve in [redacted] (0.023 ppm). This is an extremely low concentration. All air samples collected for TDI were non-detectable (Table 6). Table 7 presents total dust air sample results (non-detectable). Air sample results for formaldehyde are presented in Table 8. Sample concentrations for formaldehyde ranged from 0.003 to 0.008 ppm.

CO detectors (Toxilogs) located in [redacted] in the Dirksen Building indicated average and maximum CO concentrations of 0-1 ppm. All CO_2 results were within recommended guidelines for indoor environmental quality. [redacted].

Discussion and Conclusions

The air sample results indicate that most compounds were not detected and that any detected compounds were low in concentration. These results are not suggestive of any particular causative factor for employee's symptoms. The information collected concerning RH indicated a number of areas did not fit into the parameters outlined in the evaluation criteria section.

Rayburn Building

Actions Taken

On February 14, 2002, we conducted an evaluation at the Rayburn building. Sampling was conducted at four locations: [redacted] (conference room where mail is opened), [redacted] (annex for [redacted] where mail is opened), [redacted] (mail sorting area for building), and indoor background area [redacted] [conference room]).

Results

Individual VOCs were identified with thermal desorption tubes. The results of these tubes indicated various trace amounts (very low concentrations) of VOCs. These concentrations were in the ppb range and were well below any applicable exposure criteria. Some of the compounds identified on the thermal desorption tubes included ethanol, acetonitrile, MTBE, toluene, hexane, benzene, trichloroethylene, MIBK, toluene, perchloroethylene, xylene, butyl cellosolve, limonene, undecane, octamethylcyclotetrasiloxane, and

decamethylcyclopentasiloxane. Some compounds were selected for further scrutiny via charcoal tube analysis. Results are listed in Table 17. Samples were collected between 09:00 and 16:00. The majority of the compounds were non-detected. Concentrations between MDC and MQC are considered trace and are denoted with parentheses () in Table 17.

In [redacted] a continuous direct-reading particulate monitor (Grimm) was used to measure particulate size distribution (see Appendix A for particle size data results). Additionally, instantaneous monitoring was conducted at intervals throughout the day to measure the following parameters: CO, CO_2, temperature, RH, and ozone. Results are listed in the Table 18. [redacted]. CO_2 levels were above 800 ppm in [redacted] which indicate that adequate amounts of outdoor air may not be supplied to these areas.

Discussion and Conclusions

Table 17 indicates low formaldehyde concentrations which ranged from 7.5 to 13.6 ppb. MTBE, toluene, xylene/ethyl benzene, benzene, and other hydrocarbons (using decane as a standard), were found on the charcoal tube sample collected in the Rayburn mail sorting area in [redacted]. The concentrations were low and well below relevant evaluation criteria. It is not unusual to find low concentrations of these compounds in the air when vehicle exhaust is present.

One air sample [redacted] was chosen for quantitative analysis for acetonitrile based on the thermal desorption tube results. The concentration of 0.35 ppm acetonitrile was very low and well below the OSHA PEL of 40 ppm (8-hr TWA) and the NIOSH REL of 20 ppm (10-hr TWA). Although only one sample was quantitatively analyzed for acetonitrile, qualitative methods identified acetonitrile in all four sampling areas, even in the indoor background area. Since irradiated mail was not handled in the control area it is concluded that irradiated mail was not the source of acetonitrile.

A trace amount (concentration between MDC and MQC) of toluene was found in [redacted] the indoor background area. Toluene is normally found in office environments in trace amounts. Since irradiated mail was not handled in the indoor background area it is concluded that irradiated mail was not the source of toluene.

With respect to qualitative methods (thermal desorption tubes), all of the contaminants studied were found in very low concentrations, in the ppb range. The results from the thermal desorption tubes are not remarkably different among the sampling locations, except in [redacted]. Because no irradiated mail was handled in Conference Room [redacted] (the indoor background area) during air sampling, it is concluded that irradiated mail is not the source of these compounds. Results of the thermal desorption tube collected in [redacted] the building mail sorting area, are different than results in other locations. Air samples in [redacted] contained contaminants such as MTBE, xylene/ethyl benzene, and benzene. As described above it is not unusual to find low concentrations of these compounds in the air when vehicle exhaust is present.

Based on measures of general air quality in the Rayburn building, [redacted]. In addition, the CO_2 levels above 800 ppm in [redacted] indicate that adequate amounts of outdoor air may not be supplied to these areas.

House Post-Office Screening Facility

Background

After anthrax-contaminated mail was sent to Senators in Washington, DC, additional measures were taken to screen mail for bioterrorism agents prior to delivery to the House of Representatives. Since January 3, 2002, all mail sent to the House of Representatives is first irradiated, and then screened

[redacted]. Three trailers are housed inside an abandoned building at this shipyard. Two trailers are used for mail processing and one trailer serves as an office and break room. A building was being constructed beside the trailers to allow delivery trucks to unload packages directly into a controlled area for screening.

Approximately six carts of irradiated mail are received each day. Employees separate mail in envelopes from post-cards in the staging area. On-site representatives reported that each trailer receives 500 cfm of outside air. Each trailer is serviced by a double high efficiency particulate air (HEPA)-filtration recirculation unit.

Seven employees work over two shifts (07:00 to 16:00, 24:00 to 07:00). All employees are required to wear a Tyvek suit with a hood, latex boots, non-powdered nitrile gloves, and a N-95 filtering face piece respirator when working in the mail handling areas. Employees must put on the personal protective equipment (PPE) prior to entering Trailer 1 and 2 and it must be removed in the staging room before exiting the trailer.

Actions Taken

On February 14, 2002, we conducted an evaluation at the House Post Office Screening Facility (HPOSF). Sampling was conducted at four locations at the HPOSF: Trailer 1, Trailer 2, the Administrative Trailer (indoor background area), and outside (outdoor background area). The two background samples were collected in areas where irradiated mail is not present. At each of these locations, area air samples were collected for formaldehyde, VOCs, PAHs, TDI, CO, and total particulate. The compounds identified (from the thermal desorption tubes) for quantification on charcoal tubes were MTBE, benzene, toluene, trichloroethylene, xylenes/ethyl benzene, perchloroethylene, limonene, butyl cellosolve, and other hydrocarbons (using decane as a standard). In Trailer 1, a continuous direct-reading particulate monitor (Grimm) was used to measure particulate load (see Appendix A for particle size data). Additionally, instantaneous monitoring was conducted at intervals throughout the day for CO, CO_2, temperature, RH, and ozone.

Results

Direct Reading Survey

The results of the direct reading survey were unremarkable and did not identify any contaminants that would suggest a health hazard. Direct reading results are listed in Table 19. In some areas CO_2 levels were measured at or above 800 ppm. The Administration Trailer indicated the highest CO_2 levels (830-1100 ppm). [redacted]. No ozone or significant VOC levels were detected.

Air Sampling Survey

Air sampling results are listed in Table 20. Most of the VOC compounds were non-detectable; all measurable concentrations were well below occupational evaluation criteria. Toluene was detected at concentrations between the LOD and LOQ in Trailer 1 and 2. The LOD for toluene was 0.0003 mg/sample and the MDC was 0.0015 ppm. Measurable concentrations of limonene (0.0244 ppm) and toluene (0.0163 ppm) were collected in the Administrative Trailer. The concentration of toluene was extremely low and well below occupational exposure limits (REL 100 ppm, PEL 200 ppm). No exposure limits have been established for limonene but the concentration detected was very low. Concentrations of benzene (0.003 ppm) and other hydrocarbons using decane as a standard (0.33 mg/m^3) were detected between the LOD and LOQ in the Administrative Trailer. One sample collected outside indicated a concentration of MTBE between the LOD and the LOQ for the method. The LOD for MTBE was 0.0010 mg/sample and the MDC was 0.0051 ppm.

Formaldehyde concentrations ranged from 4.1 ppb to 13.5 ppb. The highest concentration of formaldehyde (13.5 ppb) was sampled in the Administrative Trailer where no mail is processed.

TDI and PAHs were not detected in any of the samples collected. Concentrations of total dust collected in Trailer 2 and the Administrative Trailer were 0.05 mg/m^3 and 0.04 mg/m^3, respectively.

Discussion and Conclusions

All compounds monitored at the HPOSF were found at very low concentrations, which were well below established criteria or guidelines. No airborne environmental contaminants were detected that could be attributed to working with irradiated mail. [redacted].

The compounds identified on the thermal desorption tubes were typical of those found in non-industrial environments, and there were no substantive differences in the compounds identified or relative concentrations between the indoor background sample and the samples collected in the mail cutting room or warehouse. Very low levels of a variety of volatile compounds are found in almost all environments. The irradiated mail is not considered to be the source of the detected VOCs.

February 15, 2002

Russell Building

Actions Taken

On February 15, 2002, we conducted an evaluation at the Russell Building. Area air samples and direct reading air samples were collected in two areas of the Russell Building: [redacted] (area where mail was handled and opened) and outside of the building [redacted]. Continuous, direct-reading CO detectors were used in [redacted] and outside. Instantaneous monitoring was also conducted throughout the day.

Results

PAHs were non-detectable in all samples (Table 3). Table 4 presents the semi-quantitative results for VOCs. Many different compounds were detected at very low concentrations (much lower than relevant evaluation criteria). All charcoal tube air samples (Table 5) were non-detectable and all air samples collected for TDI were non-detectable (Table 6). Table 7 presents total dust air sample results. The sample collected in [redacted] was non-detectable and the outside sample resulted in a concentration of 0.05 mg/m^3. This is very low and below relevant evaluation criteria. Air samples for formaldehyde are presented in Table 8. Sample concentrations found were 0.009 ppm in [redacted] and a trace amount outside.

CO detectors located in [redacted] did not detect the presence of CO. The outside CO sample at the Russell Building indicated an average concentration of 2 and a maximum concentration of 3 ppm. All CO_2 results were within recommended guidelines. [redacted]

Discussion and Conclusions

The air sample results indicate low concentrations and are not suggestive of any particular causative factor for employees' symptoms. The information collected concerning RH indicated a number of areas did not fit within recommended guidelines for indoor environmental quality.

Dirksen and Hart Buildings

Background

After screening in the SPOSF, mail is delivered to the Senate offices. Employees reported receiving mail again approximately 3 weeks prior to the NIOSH survey. At the time of the NIOSH evaluation, employees were receiving mail post-marked in October and November. Two employees in [redacted] spend approximately one hour daily opening and sorting the mail. At the time of our survey, one of the Senator's had their office temporarily located in [redacted]. Three staffers in this room reported spending on average 1 to 2 hours sorting and opening the mail each day. Two staffers in [redacted]

reported spending an average of 3 hours sorting and opening the mail each day.

Actions Taken

On February 15, 2002, we conducted an evaluation in [redacted] (where mail is handled and opened), [redacted] (where mail is handled and opened), and [redacted] in the Dirksen and Hart Senate office buildings. Sampling was conducted at one location in each mail room. At each of these locations, area air samples were collected for formaldehyde, VOC, PAHs, TDI, CO, and total particulate. The compounds identified (from the thermal desorption tubes) for quantification on charcoal tubes were MTBE, benzene, toluene, trichloroethylene, xylenes/ethyl benzene, perchloroethylene, limonene, butyl cellosolve, and other hydrocarbons (using decane as a standard). Additionally, instantaneous monitoring was conducted at intervals throughout the day to measure the following parameters: CO, CO_2, temperature, RH, and ozone.

Results

Direct Reading Survey

The results of the direct reading survey were unremarkable and did not identify any contaminants that would suggest a health hazard. Direct reading results are presented in Table 21.

The CO_2 levels measured in [redacted] indicated concentrations within recommended guidelines for indoor environmental quality. CO_2 levels measured in [redacted] were above 800 ppm. [redacted]. No ozone or significant VOC levels were detected.

Air Sampling Survey

Most of the organic compounds were non-detectable. The concentration of other hydrocarbons (using decane as a standard) indicated a concentration of 0.36 mg/m^3 which was between the LOD and the LOQ for the method. Integrated air sampling results are presented in Table 22. Formaldehyde concentrations ranged from 7.3 ppb to 8.6 ppb. The highest concentration of formaldehyde (8.6 ppb) was in [redacted].

Only one sample collected for total dust was above the analytical LOD. This sample was collected in [redacted]. TDI was not detected in any of the samples collected. All samples collected for PAHs were below the analytical LOD.

Discussion and Conclusions

All compounds monitored in [redacted] in the Dirksen and Hart Senate buildings indicated airborne concentrations of the sampled compounds to be low and well below established criteria or guidelines. No airborne environmental contaminants were detected that could be attributed to working with irradiated mail. [redacted] could result in workers experiencing dry skin or eye irritation. The compounds identified on the thermal desorption tubes were similar to those found in other non-industrial environments.

Capitol Building

Actions Taken

On February 15, 2002, NIOSH industrial hygienists conducted an evaluation of the Capitol building. Sampling was conducted at the following locations: [redacted]. Samples were collected between 08:00 and 14:00.

In [redacted], a continuous direct-reading particulate monitor (Grimm) was used to measure particulate size distribution (see Appendix A for results). Additionally, instantaneous monitoring was conducted at intervals throughout the day to measure CO, CO_2, TVOCs, temperature, RH, and ozone.

Results

Compounds identified on the thermal desorption tubes that were selected for further analysis included ethanol, acetonitrile, MTBE, toluene, hexane, benzene, trichloroethylene, MIBK, toluene, perchloroethylene, xylene, butyl cellosolve, limonene, undecane, octamethylcyclotetrasiloxane, and decamethylcyclopentasiloxane. Results are listed in the Table 23. The majority of the compounds were non-detected. A very low concentration of butyl cellosolve was detected (0.007 ppm), and toluene and other hydrocarbons (as decane) were detected at trace levels.

Results of the direct reading measurements are listed in the Table 24. Measurements were made two times during the day. [redacted]. CO_2 concentrations were within recommended guidelines for indoor environmental quality. CO and TVOC were not detected.

Table 23 indicates that formaldehyde was found at concentrations in all sampled locations above the MDC using quantitative methods. The concentrations ranged from 7.0 to 10.1 ppb.

Discussion and Conclusions

Trace amounts of toluene and other hydrocarbons (using decane as a standard) were found in [redacted] and trace amounts of other hydrocarbons were also found in [redacted]. The concentrations were low and well below relevant evaluation criteria. It is not unusual to find trace amounts of these compounds in office environments.

All sampled compounds were found in very low concentrations (ppb range) on the thermal desorption tubes. While the results from the thermal desorption tubes are not remarkably different among the three sampling locations, the indoor background sample generally indicated the highest concentration of each toxicant. Because no irradiated mail was handled in Conference [redacted] (indoor background area) during air sampling, it is concluded that irradiated mail is not the source of these compounds. Based on measures of general air quality in the Capitol building, the indoor areas studied seem to be well ventilated, [redacted].

Ford Building

Actions Taken

On February 15, 2002, we conducted an evaluation at the Congressional Budget Office (CBO), in the Ford Office Building (FB). Air sampling was conducted at three locations at FB: CBO mail sorting room [redacted], CBO conference room [redacted] ('indoor background') where no irradiated mail was handled, and [redacted] ('outdoor background'). At each of these locations, integrated area air samples were collected.

Results

Some of the compounds identified on the thermal desorption tubes were selected for further scrutiny via charcoal tube analysis. Results of air sampling are listed in the Table 25. The majority of these compounds were non-detected. One sample collected in the indoor background area indicated a toluene concentration of 0.008 ppm (this is a very low concentration).

Formaldehyde air samples collected in the building indicated a concentration of 15 ppb in the mail sorting room [redacted] and a concentration of 14 ppb in the indoor background area [redacted]. The outdoor background sample indicated an airborne formaldehyde concentration of 4 ppb.

The total dust concentration in the mail sorting [redacted] was 0.041 mg/m^3, and the indoor background sample was non-detected (MDC = 0.04 mg/m^3). The outdoor background sample indicated a total dust concentration of 0.082 mg/m^3. Particle sizing data are listed in Appendix A.

Direct reading instrumentation was utilized at FB to assess CO, CO_2, temperature, RH, TVOCs, and ozone. Measurements were obtained in each of the above mentioned air sampling locations. Results obtained from direct reading instruments are presented in Table 26. [redacted]

[redacted]. All CO_2 levels were within recommended guidelines for IEQ which indicate adequate ventilation. CO, TVOC, and ozone were not detected in the building.

Discussion and Conclusions

If detected, compounds found in air samples indicated only trace amounts (very low concentrations) of VOCs. These concentrations were in the ppb range and were well below any applicable exposure criteria. The air sampling results from the thermal desorption tubes were not remarkably different among the sampling locations. This indicates that the VOC airborne exposure for mail handlers was not markedly different from anyone occupying the conference room or standing immediately outdoors on the east side of the building, both areas where no irradiated mail was handled. Based only on CO_2 measurements in FB, the indoor areas studied seem to be fairly well ventilated, [redacted].

BULK SAMPLE RESULTS

While handling irradiated mail during the evaluation, we observed that the irradiated mail seemed drier and brittle as compared to non-irradiated paper. A few bulk samples of irradiated mail material were obtained and analyzed for anions, metals, and pH.

Anion

Bulk sample anion results are listed in Table 27. These results are considered semi-quantitative. Although, the irradiated mail samples appear to have higher ranges than the non-irradiated samples, some of the individual non-irradiated samples had higher concentrations than some of the individual irradiated mail samples. No definitive conclusions can be made regarding these results based on the limited number of samples, and the fact that the control samples came from our office stock and are not identical to the irradiated mail samples collected in Washington, D.C.

Metals and pH

Random trace metals were found in both the irradiated and non-irradiated bulk mail samples. These trace metals are indicative of pigments found in the colors and inks on the paper. These pigments may vary widely on paper products depending on the colors, paper, or inks used.

Measurements of pH in irradiated and non-irradiated mail did not indicate meaningful differences.

Screening via Electrospray-Mass Spectrometry

Screening tests performed to identify chemical changes in the mail as a result of the irradiation process, did not indicate any meaningful differences between the irradiated mail and non-irradiated samples. Again, no definitive conclusions can be made based on the limited number of samples, and the different sources of the non-irradiated samples and irradiated mail samples.

TOTAL PARTICULATE AND PARTICLE SIZE ANALYSIS RESULTS

The results of the particle size data indicated that the total and respirable particle concentrations were well below any established occupational criteria. These data also indicated that the particulate concentrations were well below the EPA ambient standards for air particulate with diameters of 10 µm or less (150 micrograms per cubic meter [$\mu g/m^3$]) and particulate with 2.5 µm or less (65 $\mu g/m^3$). Results are presented in Appendix A.

SMALL PARTICULATE RESULTS

Small particle counts are presented in Table 28. Increased small particle counts were not related to handling of irradiated mail. Higher particle count concentrations (as compared to office environments) were measured in post offices near a parking garage. Vehicle exhaust can be a source of small particle generation. The results in Table 28 indicate that fine particle count means for office environments (excluding mail areas near parking garages) were typically much lower than the outdoor background mean. The office environment means generally ranged from 0.4% to 23% of the background outdoor mean particle count. The only exception noted during our evaluation were the two mail areas in the HSOB (see Table 28) on February 14, 2002, where small particle counts were at or above the outdoor level.

Although no occupational exposure criteria exist, excessive exposure to small particles may result in respiratory irritation and therefore, exposure should be reduced where feasible.[43,44] In addition to the particle measurements, we used an observational approach to assess factors that could affect IEQ in the mail areas above the background outdoor mean particle count. In the approximately 9 foot by 9 foot small mail handling area (referred to as 2nd Mail Area [redacted] in Table 28), we observed the following:

- The supply ventilation diffusers were located approximately 3 feet from the return air grilles. The proximity of the supply ventilation diffusers to the return grilles can result in "short-circuiting" of air flow and that can result in poor air mixing. The short circuiting of supply air directly to the ceiling return grills may result in less than 50% of the supply air reaching the occupied zone.[45] This may allow small particle concentrations to build up as a result of poor dilution of the air with filtered supplied air from the HVAC system. The high small particulate counts are consistent with this observation.

- The room was relatively crowded and small, and contained office equipment including a copier, fax machine, and printer. These may be potential sources of small particle generation within the room. Consideration should be given to removing this equipment from the current office area, if the ventilation system deficiencies can not be addressed, or if the ventilation adjustments are not adequate to reduce the small particle counts in the room.

The Architect of the Capital (AOC) was informed of these observations and reported working on adjustments to the HVAC system (during the Irradiated Mail Task Force meeting on February 21, 2002) to alleviate the "short-circuiting" in the small mail handling office space. The HVAC system that supplies air to the other mail handling area [redacted] should also be evaluated to assure adequate supply air is reaching the occupied work areas. ASHRAE has published recommended building ventilation guidelines. ASHRAE recommends supplying 20 cfm of outdoor air per person for office space areas.[46]

MEDICAL RESULTS

Medical Interviews with Employees

The NIOSH medical team visited 11 office buildings located around Capitol Hill, including the Russell, Dirksen, Hart, Cannon, Longworth, Rayburn, and Ford Buildings, the Senate Post-Office Screening Facility, the House Mail Processing Facility, the Capitol building, and Postal Square. Within these buildings the team visited 120 different offices and work areas, speaking to a total of 389 congressional staff employees and other Capitol Hill employees who handle irradiated mail. Within this group of employees, 252 (65%) stated that they spent a majority of their workday opening or handling irradiated mail. The remainder of the employees we spoke to stated that they occasionally or infrequently handled irradiated mail. Of the 252 employees who spend a majority of their time handling irradiated mail, 143 (57%) stated that they had experienced or were currently experiencing symptoms they felt were due to handling irradiated mail. The most

frequently reported symptoms among these employees were headache, skin irritation, eye irritation, skin rash, dry hands, nausea, and nose or throat irritation. Less frequently reported symptoms included skin tingling, hands itching, dry nose, nosebleeds, dry eyes, and dry skin. Many of those reporting symptoms while handling the irradiated mail delivered during the first several weeks of resumption of mail delivery on Capitol Hill (handling 'old mail') stated that they no longer experienced symptoms when handling irradiated mail delivered more recently (handling 'new mail'), or that the symptoms they did experience with the 'new mail' were milder than the symptoms experienced when handling the 'old mail.'

Medical Data from the Office of the Attending Physician

The OAP has been evaluating and treating Capitol Hill employees who have developed symptoms they relate to handling irradiated mail since mail delivery resumed in December 2001. The office compiled data concerning these employee visits from 18 January 2002, through 4 February 2002. During that time period, the OAP logged 192 employee visits and 4 email complaints related to health issues thought by employees to be associated with handling mail. The 192 visits were comprised of 154 one-time employee visits and two or more visits by 18 individuals. The most frequently reported symptoms were headache, eye irritation, rash on hands or arms, urticaria (hives), nausea, and sore throat. Less frequently reported symptoms included chest tightness, other non-specific respiratory complaints, irritation from odors, cough, hand numbness, dizziness, and lightheadedness. Of the 172 employees evaluated, approximately 112 (65%) stated that they open or handle the mail as part of their job activity.

When evaluating the number of employee visits to the OAP by office building, we found that 91 (46%) of the visits were made by employees working in the Hart office building. The percentage of OAP visits from employees in the remaining Capitol Hill offices was much lower than that from the Hart building, with the highest percentage of the remaining visits coming from the Rayburn building (14%). When considering the most commonly reported symptoms, 17% of the employees from the Hart Building reported eye irritation and 18% reported headaches, while 10% of employees from all the other sites reported eye irritation and 23% reported headache.

The OAP representative felt that, in general, the number of complaints from employees of all the office buildings on Capitol Hill had slightly decreased during the week of the NIOSH site visits, although there has been no data available to evaluate trends in symptoms over time.

MEDICAL DISCUSSION

There are numerous potential causes of skin and mucous membrane irritation in any given environment. [redacted] has been shown to be a cause of dermatitis [redacted].[47] [redacted] typically presents as a patchy diffuse mild scaling of the skin on exposed parts of the body and can be associated with mild erythema (reddening) of the skin. [redacted] draws moisture off the outer skin surface, causing cracks and fissures to form in the outer skin layer resulting in chapping and irritation. This type of dermatoses is more common during the winter months than at other times of the year. Individuals with a history of atopy (allergies) and those with a preexisting dermatitis are more vulnerable to the drying effect of [redacted] and resultant skin irritation.[48] Irritated chapped skin, even when mild, is more vulnerable to further damage and irritation by other factors such as mechanical trauma, handwashing, and small particulate irritation.[49,50]

[redacted] dermatoses of the skin among individuals working in these buildings. When [redacted] dermatoses symptoms are mild, individuals may not realize that the condition is present until another factor causes worsening of the condition. As discussed earlier, irradiated paper has an increased

amount of dusting (release of small cellulose particles from the paper surface during handling). While cellulose is not known to cause dermatitis in healthy intact skin, it could function as a particulate irritant on skin mildly effected by [redacted] dermatoses. Cellulose and other paper components released by damaged paper could further irritate the skin and increase symptoms to a noticeable level.

As discussed during our meeting with paper manufacturer representatives, besides damaging the cellulose fibers, the irradiation process heats the mail causing water to be driven out of the paper (dehydrating the paper), resulting in paper which is dry to the touch. Irradiated paper will slowly rehydrate to a normal level by pulling water out of the air and off the skin during handling. Following rehumidification, irradiated paper will continue to readily absorb water due to damage to the cellulose fibers and the paper matrix. For example, when a drop of water is placed on undamaged letter grade paper, the droplet will remain on the paper surface and not be readily absorbed into the paper. When performing the same procedure on irradiated paper, the paper readily absorbs the water droplet. The damaged irradiated paper acts like a sponge, and when handled, can potentially draw water off the skin surface, something that does not occur when handling undamaged paper. Thus, handling irradiated paper can further dry skin that may already be dry, if the environmental humidity is low, and accelerate the development of low-humidity dermatoses.

Another potential source of irritation from irradiated mail is through sensory irritation due to odors released by the mail. Odors consist of airborne molecules that have evaporated from a chemical source or been released into the air when heating of a chemical source occurs. The human nose is able to detect extremely low concentrations of these airborne molecules. In some cases the nose can detect concentrations of molecules at or below the level we are currently able to measure. The paper, plastic, and synthetic components making up the mail contain numerous chemicals and compounds that, when heated and irradiated, break down and release minute quantities of molecules into the environment. Many of these molecules were detected at very low concentrations by our environmental sampling (in the ppm and ppb concentration range), but could not be distinguished from background levels. It has been shown that low-level odors, specifically VOCs, can cause irritation of certain sensory receptors at concentrations around their odor threshold (the molecular concentration at which the human nose can detect a chemical). These sensory receptors are part of the trigeminal nerve and are located on the cornea, and in the nose and throat. Irritation of these sensory receptors can result in sneezing, nasal stuffiness, rhinorrhea (runny nose), facial pain, eye irritation, watery eyes, headache, sinus congestion, cough, throat irritation, and wheezing.[51] Exposure to sensory irritants can, in susceptible individuals, trigger airway hyperreactivity resulting in asthma attacks, cough, chest tightness, and shortness of breath.[52,53,54]

The specific symptoms noted by a person when exposed to certain chemical odors will vary from individual to individual. One person may not be bothered by a certain airborne concentration of a chemical while another may experience multiple symptoms. This difference can have more to do with perceived environmental factors associated with the odor than with the chemical or molecular concentration producing the odor, especially when the molecular concentration is well below concentrations known to be harmful. An odor that is given a negative connotation or presented in a negative situation can result in more symptoms than the same odor presented with a positive connotation or in a positive situation. In some instances, the same odor will have no effect when encountered under more positive circumstances. Generally, this suggests that many odors (by themselves) do not fully impart a specific symptom or set of symptoms when encountered, but rather individuals form a perception of the smell and produce symptoms based on cognitive variables taken in from the environment.[55] Individuals encountering irradiated mail might be expected to form a negative association with this mail due to its damaged, irregular appearance (discolored, burned, brittle). This negative association may have played a part in forming and enhancing the symptoms noted by

employees who handle the mail, and may have precipitated some of the additional symptoms not normally associated with sensory irritation.

One factor that may have impacted the employees working on Capitol Hill is the recent terrorist acts. All employees have been either directly or indirectly affected in some fashion by these events. Employees may now feel more vulnerable in their work environment and may experience higher levels of stress and anxiety while performing job activities that in the past would not have produced these feelings. Overall, employees likely have developed a heightened awareness of the environment around them. This heightened awareness could potentially make them notice and evaluate things that they might not have paid attention to in the past, such as minor bodily changes, skin irritation, headache, or fatigue. When symptoms are experienced, they can seem more intense and more urgent than they otherwise would be due to the heightened awareness. Heightened awareness, while not the root cause of the symptoms noted by the employees evaluated, is likely contributing on many levels to the symptoms experienced by individuals.

pH was discussed during the meeting with the paper manufacture representatives as a potential contributing factor to skin irritation. Paper manufactured today typically has an alkaline base which helps preserve the paper. Paper with an acidic base will discolor, become brittle and degrade faster.[56] During the meeting, a published paper was discussed which reported that irradiation processes cause chemical reactions and pH changes in paper (making irradiated paper acidic).[57] However, the human surface skin pH ranges from 4-6 (acidic).[58] It is therefore unlikely that the mild acidity of irradiated paper will cause skin irritation or have any effect on the formation or progression of dermatitis.

CONCLUSIONS

Air samples indicated non-detectable or low concentrations of sampled contaminants. No link could be made between the air sampling results during this evaluation and worker symptoms reported while working with irradiated mail in the buildings. These results are consistent with the results reported by AFRRI (see Appendix B). Some of the VOCs detected are common in indoor air environments, and the results of the thermal desorption tubes in the Federal Office Buildings generally are similar to results seen on thermal desorption tubes collected in other indoor air environments.[1,59,60]

RH levels in most of the buildings were [redacted] during the time of our evaluation. Some studies have suggested [redacted] may be associated with symptoms of eye and skin irritation,[22,23, 24,25,26] similar to some of the symptoms reported among the federal building occupants.

CO_2 was generally within recommended guidelines for IEQ. However, there were a few instances when measured CO_2 concentrations were higher than 800 ppm, suggesting that these areas may be receiving inadequate ventilation.

During our evaluation, small particle counts were generally much lower in office areas (not inclusive of warehouses or mail rooms located near parking garages) compared to the outdoors. [redacted]. The only exceptions noted during our evaluation were the two mail areas in the Hart Senate Office Building (see Table 28), where small particle counts were at or above the outdoor level.

During our evaluation, staff in some of the offices indicated that the mail load was lower on the day we sampled as compared to other days. We do not expect that daily variability of the mail load will have an effect on the results of our environmental evaluation based on the number of buildings and offices evaluated, the number of samples collected, and the low concentrations of any detectable compounds.

Among the 389 congressional staff employees interviewed, the most common symptoms were headache, skin irritation, eye irritation, skin rash, dry hands, nausea, and nose or throat irritation. We believe that it is likely that multiple factors are

responsible for the reported symptoms. The [redacted] along with the added dryness and absorptive nature of irradiated mail can lead to skin dryness and irritation following repeated handling of the mail. The resultant chapping and irritation of the skin can further progress due to particulate irritation from cellulose particles released by the damaged paper. Individuals with a history of atopy (allergies) may be particularly vulnerable to these effects.

Regarding the odors and symptoms of headache, eye irritation, nausea, and nose and throat irritation reported among the employees, there is evidence in the medical literature that these types of symptoms can be produced by exposure to VOCs by activating sensory receptors in the nervous system. The activation and amplification of these sensory receptors can occur from exposure to extremely low molecular concentrations of airborne chemicals, concentrations that are difficult or impossible to measure with currently available testing techniques. These odors have likely played a role in many of the irritant symptoms experienced by the employees handling irradiated mail. Again, individuals with a history of atopy (allergies) may be particularly vulnerable to the effects of odors. Further, the unusual appearance of irradiated mail would cause individuals to form a negative opinion of the mail and potentially interpret the odors produced by the mail as hazardous. This can result in individuals cognitively amplifying the irritant symptoms, such as headache or nasal irritation, produced by the mail odor and produce symptoms, such as nausea or dizziness, typically unrelated to sensory irritation.

The fact that the conditions and exposures discussed above took place in a climate of heightened awareness and unusual anxiety due to recent terrorist acts likely contributed to the reporting of symptoms by Capitol Hill employees responsible for handling the mail.

RECOMMENDATIONS

NIOSH has worked with the Legislative Mail Task Force, the OAP, and the General Services Administration (GSA), to offer the following guidelines for handling irradiated mail in Capitol Hill offices and in offsite mail handling facilities. The recommendations are provided to address the symptoms reported by employees.

- Employees who experience symptoms they feel are associated with presence in the workplace or a specific work activity (such as handling irradiated mail) should report their symptoms to the OAP. Continued surveillance of reported symptoms by the OAP may provide useful information concerning the possible work-relatedness of those symptoms.

- If areas are identified by the OAP where there are consistent concerns, an IEQ investigation should be conducted in these areas to identify any potential sources of contaminants or identify any adjustments that could be made to the HVAC system to improve the air quality.

- Because [redacted] levels are associated with discomfort and irritation, the AOC should be consulted to [redacted] are maintained to provide comfort without resulting in other problems [redacted] and mold).

- No specific PPE (such as gloves) is recommended for House and Senate office employees. Individuals who choose to wear gloves while handling irradiated mail should first consider using a glove made of a breathable material known as a non-occlusive glove. A non-occlusive glove that could be used is a thin cotton glove (other non-occlusive gloves with gripper pads on the palm and finger tip surfaces are also available). While not recommended, if an occlusive glove is used it should be a non-latex, powder-free glove of an appropriate size (latex gloves are not recommended because of the potential for developing an allergy to latex over time). Occlusive gloves (non-latex, powder-free gloves) should only be worn for short periods of time while handling mail and immediately removed when done to prevent excessive hand sweating and irritation by the

gloves. Cotton glove liners used underneath the non-latex, powder-free gloves can decrease occlusive glove irritation of the hands, and absorb perspiration. If used, gloves should be changed when they are grossly dirty or have perforations in them, and should be removed when eating, drinking, or smoking.

- Employees should avoid touching the mouth, eyes or facial skin when handling mail, even when wearing gloves.

- Excessive hand washing can cause drying of the skin and may lead to increased skin irritation. Mild, lotion-based soaps should be available at all employee wash stations in place of harsh soaps. Hand washing is recommended after handling large amounts of mail, when hands are grossly dirty, after removing occlusive gloves, and before eating, drinking or smoking. A water-based lotion or moisturizer should be applied to the hands after each time hands are washed and several times throughout the day for those persons who may have dry skin.

- Individuals who experience eye or nose dryness or irritation may use over-the-counter saline eye drops or saline nose spray as frequently as they feel necessary to alleviate symptoms.

- Individuals should handle mail in areas that are well ventilated. To ventilate the mail as much as possible, mail should be spread out and not enclosed in a box or drawer. Spreading out the mail can help reduce the odor associated with irradiated mail and may decrease the incidence of headache.

- All information about ongoing changes in mail and mail handling procedures should be shared with employees in a timely manner.

REFERENCES

1. NIOSH [1994]. NIOSH manual of analytical methods. 4th ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94–113.

2. Grimm. Dust Monitor Instruction Manual, Series 1.100 v.5.10 E, Grimm Labortechnik GmbH & Co. KG, Ainring, Germany.

3. NIOSH [1992]. Recommendations for occupational safety and health: compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

4. ACGIH [2001]. 2001 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

5. CFR [1997]. 29 CFR 1910.1000. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

6. ASHRAE [1992]. Thermal environmental conditions for human occupancy. American National Standards Institute/ASHRAE standard 55-1992. Atlanta, GA: American Society for Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

7. ASHRAE [2001]. Ventilation for acceptable indoor air quality, standard 62-2001. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

8. Kreiss KK, Hodgson MJ [1984]. Building associated epidemics. In: Walsh PJ, Dudney CS, Copenhaver ED, eds. Indoor air quality. Boca Raton, FL: CRC Press, pp 87-108.

9. Gammage RR, Kaye SV, eds [1985]. Indoor air and human health: Proceedings of the Seventh Life Sciences Symposium. Chelsea, MI: Lewis

Publishers, Inc.

10. Burge S, Hedge A, Wilson S, Bass JH, Robertson A [1987]. Sick building syndrome: a study of 4373 office workers. Ann Occup Hyg 31:493-504.

11. Kreiss K [1989]. The epidemiology of building-related complaints and illness. Occupational Medicine: State of the Art Reviews 4(4):575-592.

12. Norbäck D, Michel I, Widstrom J [1990]. Indoor air quality and personal factors related to the sick building syndrome. Scan J Work Environ Health 16:121-128.

13. Morey PR, Shattuck DE [1989]. Role of ventilation in the causation of building-associated illnesses. Occupational Medicine: State of the Art Reviews 4(4):625-642.

14. Molhave L, Bach B, Pedersen OF [1986]. Human reactions to low concentrations of volatile organic compounds. Environ Int 12:167-176.

15. Burge HA [1989]. Indoor air and infectious disease. Occupational Medicine: State of the Art Reviews 4(4):713-722.

16. Nagda NI, Koontz MD, Albrecht RJ [1991]. Effect of ventilation rate in a health building. In: Geshwiler M, Montgomery L, and Moran M, eds. Healthy buildings. Proceedings of the ASHRAE/ICBRSD conference IAQ'91. Atlanta, GA: The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

17. Jaakkola JJK, Heinonen OP, Seppänen O [1991]. Mechanical ventilation in office buildings and the sick building syndrome. An experimental and epidemiological study. Indoor Air 1(2):111-121.

18. Levin H [1989]. Building materials and indoor air quality. Occupational Medicine: State of the Art Reviews 4(4):667-694.

19. NIOSH [1991]. Hazard evaluation and technical assistance report: Library of Congress, Washington. DC Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 88-364-2104.

20. Boxer PA [1990]. Indoor air quality: a psychosocial perspective. JOM 32(5):425-428.

21. Baker DB [1989]. Social and organizational factors in office building-associated illness. Occupational Medicine: State of the Art Reviews 4(4):607-624.

22. NIOSH [1980]. Hazard evaluation and technical assistance report: Fischer and Porter Company, Warminster, Pennsylvania Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE-80-072-787.

23. NIOSH [1991]. Hazard evaluation and technical assistance report: Philadelphia Newspapers, Inc., Philadelphia, Pennsylvania. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA-90-363-2115.

24. NIOSH [1991]. Hazard evaluation and technical assistance report: Shamokin Elementary, Shamokin, Pennsylvania. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA-90-202-2116.

25. NIOSH [1982]. Hazard evaluation and technical assistance report: National Institute of Mental Health, Rockville, Maryland. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for

Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA-82-023-1136.

26. NIOSH [1984]. Hazard evaluation and technical assistance report: George Washington University Medical Center, Washington, DC Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA-84-004-1568

27. NIOSH [1972]. Criteria for a recommended standard: occupational exposure to carbon monoxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-11000.

28. NIOSH [1977]. Occupational diseases: a guide to their recognition. Revised ed. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.

29. NIOSH [1979]. A guide to work-relatedness of disease. Revised ed. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 79-116.

30. Proctor NH, Hughes JP, Fischman ML [1988]. Chemical hazards of the workplace. Philadelphia, PA: J.B. Lippincott Company.

31. ACGIH [1996]. Documentation of threshold limit values and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

32. NIOSH [1999]. Pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99-115.

33. EPA [1991]. Air quality criteria for carbon monoxide. Washington, DC: US Environmental Protection Agency, Publication No. EPA-600/8-90/045F.

34. Molhave L, Nielsen GD [1992]. Interpretation and limitations of the concept "Total Volatile Organic Compounds" (TVOC) as an indicator of human responses to exposures of volatile organic compounds (VOC) in indoor air. Indoor Air, Vol. 2, pp 65-77.

35. Molhave L, Bach B, Pedersen OF [1986]. Human reactions to low concentrations of volatile organic compounds. Environ Int 12:167-176.

36. ATSDR [1999]. Toxicological profile for formaldehyde. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

37. NIOSH [1977]. Criteria for a recommended standard: occupational exposure to formaldehyde. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-126.

38. Stayner L, Smith AB, Reeve G, Blade L, Keenlyside R, Halperin W [1985]. Proportionate mortality study of workers exposed to formaldehyde. Am J Ind Med 7:229-40.

39. OSHA [1992]. Occupational exposures to formaldehyde: final rule. Washington, DC: Occupational Safety and Health Administration, Federal Register 57(102)22289-22328. U.S. Governmental Printing Office.

40. Kukielka A, Ghmielewski AG, Zimek Z, et al. [2000]. Radiochemical activation of various types of cellulose pulps to be used for manufacture of derivatives. Inst Chem Tech Jadrowej, Warsaw,

Poland Przeg. Papier 56(8): 468-471.

41. Takahashi M, et al. [1995]. Effect of election beam irradiation on characteristics of paper. Japan, TAPPI 49(7): 68.

42. Baum G [2002]. Paper of March 15, 2002, from G.A. Baum, Vice President, Institute Operations, Institute of Paper Science and Technology. Atlanta, GA.

43. Wilson WE and Suh HH [1997]. Fine particles and coarse particles: concentration relationships relevant to epidemiological studies. J of Air Waste and Management Assoc 47:1238-1249.

44. Peters A., Wichmann HE, Tuch T, Heinrich J, Heyder J [1997]. Respiratory effects are associated with the number of ultrafine particles. Am Journal of Resp and Critical Care Medicine 155:1376-1383.

45. ACGIH [1998]. Industrial ventilation: a manual of recommended practice. 23nd ed. American Conference of Governmental Industrial Hygienists.

46. ASHRAE [1999]. Ventilation for acceptable indoor air quality, standard 62-1999. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

47. Rycroft RJ [1985]. Low humidity and microtrauma. Am J Indust Med 8:371-373.

48. Rosenstock L, Cullen MR, eds. [1994]. Textbook of clinical occupational and environmental medicine. Philadelphia: W.B. Saunders Company, p. 523.

49. Rycroft RJ [1985]. Low humidity and microtrauma. Am J Indust Med 8:371-373.

50. Adams RM [1990]. Occupational skin disease. 2nd ed. Phildelphia: W.B. Saunders Company, pp. 53-54.

51. Sullivan JB, Kreiger GR, eds. [2001]. Clinical environmental health and toxic exposures. 2nd ed. Philadelphia: Lippincott Williams & Wilkins, pp. 394-396.

52. Cain W, Cometto-Muniz J [1995]. Irritation and odor as indicators of indoor pollution. Occup Med State of the Art Reviews 10(1):133-145.

53. Damgard G [1991]. Mechanisms of activation of the sensory irritant receptor by airborne chemicals. Toxicology 21(3):183-208.

54. Cometto-Muniz J, Cain W [1990]. Thresholds for odor and nasal pungency. Physical Behav 48:719-725.

55. Dalton P [1999]. Cognitive influences on health symptoms from acute chemical exposure. Health Physiology 18(6):579-590.

56. Baum G [2002]. Paper of March 15, 2002, from G.A. Baum, Vice President, Institute Operations, Institute of Paper Science and Technology. Atlanta, GA.

57. Takahashi M, et al. [1995]. Effect of election beam irradiation on characteristics of paper. Japan, TAPPI 49(7):68.

58. Ohman H, Vahlquist A [1994]. In vivo studies concerning a pH gradient in human stratum corneum and upper epidermis. Acta Derm Venereol 74:375-379.

59. Grote A [2001]. CEMB Analytical Laboratory Report, Qualitative Analysis of Thermal Desorption Tubes. Sequence number 9842-AA, AB,AD. HETA 2002-0136. February 28 , 2002.

60. Etkin DS [1996]. VOC Measurements. In: Volatile organic compounds in indoor environments. Arlington, MA: Cutter Information Corp., pp 165-176.

Table 1
Air Sampling Compounds and Evaluation Criteria (ppm, unless otherwise specified)
HETA 2002–0136,
United States Senate and House Office Buildings
Washington, D.C.

Abbr.	Compound	OSHA Permissible Exposure Limit (PEL)	NIOSH Recommended Exposure Limit (REL)	ACGIH Threshold Limit Value (TLV)
Ac	Acetonitrile	40	20	40, ST 60, A4
An	Anthracene	0.2, $		
Ay	Acenapthylene			
Ane	Acenapthalene			
Ba	Benzo(a)anthracene	0.2, $		
Bb	Benzo(b)fluoranthene			
Bc	Butyl cellosolve	50, S	5, S	20, S
Bk	Benzo(k)fluoranthene	1, ST 5	0.1, ST 1, Ca	0.5, ST 2.5, S, A1, BEI
Bp	Benzo(ghi)perylene			
Bz	Benzene	1	0.1	0.5
Bap	Benzo(a)pyrene			
C	Chrysene	0.2, $		
CO	Carbon monoxide	50	35, C 200	25, BEI
D	Decamethylcyclopentasiloxane	NA	NA	NA
Da	Dibenz(a,h)anthracene			
EBz	Ethylbenzene	100	100, ST 125	100, ST 125, BEI
Et	Ethanol	1000	1000	1000, A4
F	Fluorene			
Fa	Fluoranthene			
Form	Formaldehyde	0.75, ST 2.0	0.016, C 0.1, LFC	C 0.3, SEN, A2
Hex	Hexane	500	50	50, S, BEI
I	Indeno(1,2,3–cd)pyrene			
Lim	Limonene	NA	NA	NA
MIBK	Methylisobutylketone	100	50, ST 75	50, ST 75, BEI

Table 1 (Continued)
Air Sampling Compounds and Evaluation Criteria (ppm, unless otherwise specified)
HETA 2002–0136,
United States Senate and House Office Buildings
Washington, D.C.

Abbr.	Compound	OSHA Permissible Exposure Limit (PEL)	NIOSH Recommended Exposure Limit (REL)	ACGIH Threshold Limit Value (TLV)
MTBE	Methyl t–butyl ether	NA	NA	40, A3
N	Napthalene			
O	Octamethylcyclotetrasiloxane	NA	NA	NA
P	Pyrene	0.2, $		
PAHs	Polyaromatic hydrocarbons	NA	NA	NA
Perc	Perchloroethylene	100, C 200, *	Ca	25, ST 100, A3, BEI
Ph	Phenanthrene	0.2, $		
TCE	Trichloroethylene	100, C 200, **	Ca	50, ST 100, BEI
TD	Total Dust	15 (tot.), 5 (resp.)	***	10 (tot.), 3 (resp.)
TDI	Toluene diisocyanate	C 0.02	Ca	0.005, ST 0.02, A4
Tol	Toluene	200, C 300, ****	100, ST 150	50, S, A4, BEI
U	Undecane	NA	NA	NA
Xy	Xylenes	100	100, ST 150	100, ST 150, A4, BEI

Table 2
Definitions of Abbreviations Listed in Table 1 and Subsequent Air Sample Result Tables
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

A1	=	a substance that ACGIH considers a confirmed human carcinogen
A2	=	a substance that ACGIH considers a suspected human carcinogen
A3	=	a substance that ACGIH considers a confirmed animal carcinogen with unknown relevance to humans
A4	=	a substance that ACGIH considers not classifiable as a human carcinogen
BEI	=	substances for which there are biological exposure indices
C	=	ceiling concentration that must not be exceeded during any part of the workday
Ca	=	a substance that NIOSH considers to be an occupational carcinogen
LFC	=	lowest feasible concentration – see formaldehyde in Evaluation Criteria section
NA	=	not applicable
S	=	"skin" designation which indicates the potential for dermal absorption
SEN	=	sensitizer
ST	=	short-term exposure limit (15 min. exp. limit, not be exceeded at any time during the day)
$	=	in milligrams per cubic meter (benzene-soluble fraction), classified as coal tar pitch volatiles
*	=	300 ppm (5-min. max peak in any 3-hrs)
**	=	300 ppm (5-min. max. peak in any 2-hrs)
***	=	see total dust in Evaluation Criteria section
****	=	500 ppm (10-minute maximum peak)
ppm	=	parts per million
lpm	=	liters per minute
Vol.	=	volume
l	=	liters
ND	=	the substance was "not detected" in the air at a concentration at or above the MDC
T	=	the substance was detected in a "trace" concentration which is between the MDC and MQC
MDC	=	minimum detectable concentration
MQC	=	minimum quantifiable concentration

Table 3
Air Sampling for Polynuclear Aromatic Hydrocarbons (PAHs)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Flow Rate (lpm)	Sample Time (military)	Vol. (l)	Concentration (milligrams per cubic meter)														
				N	Ay	Ane	F	Ph	An	Fa	P	Ba	C	Bb	Bk	Bap	Da	Bp	I
Russell Building (February 13, 2002)																		
[redacted] (Mail handling area)	2	09:38 – 16:09	783	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
[redacted] (Mail handling area)	2	09:59 – 16:26	769	T	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
[redacted] (Control area)	2	10:11 – 16:36	769	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Outside	2	10:25 – 16:40	746	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dirksen Building (February 14, 2002)																		
[redacted] (Control area)	2	09:28 – 16:00	781	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
[redacted] (Mail handling area)	2	09:41 – 15:13	666	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
[redacted] (Mail handling area)	2	09:54 – 15:24	652	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Outside	2	10:19 – 15:47	653	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russell Building (February 15, 2002)																		
[redacted] (Mail handling area)	2	08:17 – 13:10	587	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Outside	2	08:30 – 13:21	585	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Minimum Detectable Concentration (MDC) Minimum Quantifiable Concentration (MQC)				0.0004 0.001	0.0004 0.001	0.0008 0.003	0.00005 0.0003	0.00004 0.0001	0.00004 0.0001	0.00008 0.0004	0.00004 0.0001	0.00004 0.0001	0.00004 0.0001	0.00008 0.0003	0.00004 0.0001	0.00009 0.0003	0.0004 0.0004	0.0001 0.0005	0.0001 0.0004

Table 4
Air Sampling for Volatile Organic Compounds using Thermal Tubes
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Sample #	Flow Rate (lpm)	Sample Time (military)	Vol. (l)	Concentration (ppm)													
					Et	Ac	Hex	Bz	TCE	MIBK	Tol	Perc	Xy	Bc	Lim	U	O	D
Russell Building (February 13, 2002)																		
[redacted] (Mail handling area)	AO5487 AO3393	0.05	09:40 – 13:33 13:33 – 16:09	12 8	0.027 0.025	0.128 T	0.008 0.004	ND ND	0.004 T	ND ND	0.009 0.005	ND ND	T T	0.003 0.002	T 0.002	T ND	ND ND	0.002 0.004
[redacted] (Mail handling area)	AO3725 AO4085	0.05	09:59 – 13:40 13:40 – 16:29	11 8	0.292 T	0.106 0.183	0.003 T	T ND	ND ND	ND ND	0.003 T	0.004 ND	0.006 0.008	0.003 0.002	0.001 0.002	ND ND	T ND	0.006 0.004
[redacted] (Control area)	AO4718 AO4150	0.05	10:11 – 13:50 13:50 – 16:36	11 8	0.042 0.039	0.236 0.182	0.007 0.004	ND ND	0.004 T	ND ND	0.008 0.005	ND ND	T T	0.003 0.002	T 0.001	ND ND	ND ND	0.004 0.002
Outside	AO4075 AO3929	0.05	10:25 – 14:00 14:00 – 16:40	11 8	ND ND	T 0.012	ND ND	ND ND	ND ND	ND ND	T T	ND ND	T T	ND ND	ND ND	ND ND	ND ND	ND ND
Dirksen Building (February 14, 2002)																		
[redacted] (Control area)	AO3428	0.05	09:28 – 16:00	20	T	0.110	0.005	6e–4	ND	ND	0.003	ND	0.001	0.002	T	T	ND	T
[redacted] (Mail handling area)	AO3231	0.05	09:41 – 15:13	17	0.009	0.176	T	T	ND	ND	0.001	ND	T	0.030	7e–4	ND	0.002	0.004
[redacted] (Mail handling area)	A39629	0.05	09:54 – 15:24	16	T	0.065	0.002	T	ND	ND	T	ND	T	T	9e–4	ND	ND	0.003
Outside	A39449	0.05	10:19 – 15:47	16	ND	0.006	ND	T	ND	ND	T	ND	T	ND	ND	ND	ND	ND
Russell Building (February 15, 2002)																		
[redacted] (Mail handling area)	AO4210	0.05	08:17 – 13:10	15	0.013	0.011	T	T	ND	ND	T	ND	T	0.003	7e–4	ND	8e–4	0.003
Outside	A39694	0.05	08:30 – 13:21	12	ND	0.023	ND	ND	ND	ND	ND	ND	T	ND	ND	ND	ND	ND
Minimum Detectable Concentration (MDC) Minimum Quantifiable Concentration (MQC)					0.002 0.007	0.001 0.004	0.0003 0.001	0.0002 0.0005	0.0004 0.001	0.0003 0.0009	0.0003 0.0009	0.0004 0.001	0.0002 0.0008	0.0002 0.0006	0.0002 0.0005	0.0001 0.0004	0.00009 0.0003	0.00009 0.0003

Table 5
Air Sampling for Volatile Organic Compounds using Charcoal Tubes
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Flow Rate (lpm)	Sample Time (military)	Vol. (l)	Concentration (parts per million [ppm])									
				MTBE	Bz	Tol	TCE	Xy	Perc	L	Bc	EBz	TH
Russell Building (February 13, 2002)													
[redacted] (Mail handling area)	0.2	09:41 – 16:09	77	ND	T	0.006	ND	ND	ND	ND	ND	ND	ND
[redacted] (Mail handling area)	0.2	09:59 – 16:26	77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
[redacted] (Control area)	0.2	10:11 – 16:36	77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Outside [redacted]	0.2	10:25 – 16:40	75	ND	ND	ND	T	ND	ND	ND	ND	ND	ND
Dirksen Building (February 14, 2002)													
[redacted] (Control area)	0.2	09:28 – 16:00	78	ND	ND	T	ND	ND	ND	ND	T	ND	ND
[redacted] (Mail handling area)	0.2	09:41 – 15:13	67	ND	ND	ND	ND	ND	ND	ND	0.023	ND	ND
[redacted] (Mail handling area)	0.2	09:54 – 15:24	65	ND	ND	T	ND	ND	ND	ND	ND	ND	ND
Outside [redacted]	0.2	10:19 – 15:47	66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Russell Building (February 15, 2002)													
[redacted] (Mail handling area)	0.2	08:17 – 13:10	60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Outside [redacted]	0.2	08:30 – 13:21	59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Minimum Detectable Concentration (MDC) Minimum Quantifiable Concentration (MQC)				0.004 0.011	0.002 0.004	0.001 0.003	0.002 0.01	0.003 0.009	0.004 0.013	0.002 0.007	0.003 0.011	0.003 0.009	

Table 6
Air Sampling for Toluene Diisocyanate (TDI)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Flow Rate (lpm)	Sample Time (military)	Volume (liters)	Concentration (ppm)
Russell Building (February 13, 2002)				
Room [redacted] (Mail handling area)	1.5	09:36 – 16:09	590	ND
Room [redacted] (Mail handling area)	1.5	09:59 – 16:26	578	ND
Control Area [redacted]	1.5	10:11 – 16:36	577	ND
Outside	1.5	10:25 – 16:40	559	ND
Dirksen Building (February 14, 2002)				
Control Area [redacted]	1.5	09:28 – 16:00	586	ND
Room [redacted] (Mail handling area)	1.5	09:41 – 15:13	501	ND
Room [redacted] (Mail handling area)	1.5	09:54 – 15:24	489	ND
Outside [redacted]	1.5	10:19 – 15:47	490	ND
Russell Building (February 15, 2002)				
Room [redacted] (Mail handling area)	1.5	08:17 – 13:10	443	ND
Outside [redacted]	1.5	08:30 – 13:21	437	ND
Minimum Detectable Concentration (MDC)				18 parts per trillion (400 L volume)

Table 7
Air Sampling for Total Dust HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Flow Rate (lpm)	Sample Time (military)	Volume (liters)	Concentration (milligrams per cubic meter)
Russell Building (February 13, 2002)				
Room [redacted] (Mail handling area)	2	09:39 – 16:09	781	0.04
Room [redacted] (Mail handling area)	2	09:59 – 16:26	771	ND
Control Area [redacted]	2	10:11 – 16:36	770	ND
Outside [redacted]	2	10:25 – 16:40	746	ND
Dirksen Building (February 14, 2002)				
Control Area [redacted]	2	09:28 – 16:00	780	ND
Room [redacted] (Mail handling area)	2	09:41 – 15:13	667	ND
Room [redacted] (Mail handling area)	2	09:54 – 15:24	652	ND
Outside [redacted]	2	10:19 – 15:47	654	ND
Russell Building (February 15, 2002)				
Room [redacted] (Mail handling area)	2	08:17 – 13:10	587	ND
Outside [redacted]	2	08:30 – 13:21	581	0.05
Minimum Detectable Concentration (MDC)				0.03

Table 8
Air Sampling for Formaldehyde
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Flow Rate (lpm)	Sample Time (military)	Volume (liters)	Concentration (ppm)
Russell Building (February 13, 2002)				
Room [redacted] (Mail handling area)	0.2	09:44 – 13:34 13:34 – 16:09	77	0.010
Room [redacted] (Mail handling area)	0.2	09:59 – 13:42 13:42 – 16:26	77	0.010
Control Area [redacted]	0.2	10:11 – 13:50 13:50 – 16:36	77	0.008
Outside [redacted]	0.2	10:25 – 14:01 14:01 – 16:40	74	T
Dirksen Building (February 14, 2002)				
Control Area [redacted]	0.2	09:28 – 16:00	78	0.005
Room [redacted] (Mail handling area)	0.2	09:41 – 15:13	67	0.008
Room [redacted] (Mail handling area)	0.2	09:54 – 15:24	65	0.006
Outside [redacted]	0.2	10:19 – 15:47	66	0.003
Russell Building (February 15, 2002)				
Room [redacted] (Mail handling area)	0.2	08:17 – 13:10	59	0.009
Outside [redacted]	0.2	08:30 – 13:21	59	T
Minimum Detectable Concentration (MDC) Minimum Quantifiable Concentration (MQC)				0.0005 0.0021

Table 9
Air Sampling Summary of Results for Cannon Building (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	MDC / MQC	Location			
		[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (control)	Outside
Formaldehyde (ppb)	0.9 – 3.4	8.5	8.9	9.5	2.0
Perchloroethylene (ppm)	0.003 – 0.012	ND	ND	ND	ND
Xylene/ Ethyl Benzene (ppm)	0.0024 – 0.0079	ND	ND	ND	ND
Toluene (ppm)	0.0009 – 0.0031	ND	ND	ND	ND
Trichloroethylene (ppm)	0.002 – 0.009	ND	ND	ND	ND
MTBE (ppm)	0.003 – 0.010	ND	ND	ND	ND
Butyl cellosolve (ppm)	0.002 – 0.010	ND	ND	ND	ND
Limonene (ppm)	0.0017 – 0.0062	ND	ND	ND	ND
Other hydrocarbons using decane as a standard (ppm)	0.014 – 0.040	ND	ND	ND	ND
†PAHs (ppb)	0.005 – 0.017	ND	(0.010)	ND	ND
TDI (ppm)	0.076	ND	ND	ND	ND
Total Dust (mg/m^3)	0.03	ND	ND	ND	ND

Notes: ND = is not detected.
ppb = parts of analyte per billion part of air.
ppm = parts of analyte per million parts of air.
mg/m^3 = milligrams of analyte per cubic meter of air.
† = phenanthrene was the only PAH compound detected.
( ) = Indicates sampling results were between the analytical Minimum Detection Concentration and Minimum Quantifiable Concentration.

Table 10
Direct reading Results for Cannon Building (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Temp (°F)	RH (%)	CO_2 (ppm)	CO (ppm)	TVOC (ppm)	O_3 (ppm)
[redacted] (mail handling area)	74 – 77	[redacted]	585 – 815	0	0	ND
[redacted] (mail handling area)	71 – 72	[redacted]	584 – 744	0	0	ND
[redacted] (control area)	70 – 71	[redacted]	626 – 704	0	0	ND
Outdoor [redacted]	59 – 66	[redacted]	399 – 427	0	0	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
ND = not detected.
ppm = parts per million.
O_3 = ozone

Table 11
Integrated Air Sampling Results for Longworth Building (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte (MDC in ppm unless otherwise noted)	Location			
	[redacted] (Mail handling area)	[redacted] (Mail handling area)	Indoor background	Outdoor background
Formaldehyde, ppb	10	10	10	2
PAHs	ND	ND	ND	ND
TDI (18 parts per trillion)	ND	ND	ND	ND
Total Dust (0.026 mg/m^3)	0.03	ND	ND	ND
Perchloroethylene (0.004)	ND	ND	ND	ND
Xylene/ Ethyl Benzene (0.003)	ND	ND	ND	ND
Toluene, (0.001)	0.005	ND	0.021	ND
Trichloroethylene (0.003)	ND	ND	ND	ND
Benzene (0.002)	ND	ND	ND	ND
Limonene (0.005)	ND	ND	ND	ND
Total Xylenes (0.003)	ND	ND	ND	ND
MTBE (0.004)	ND	ND	ND	ND
Butyl cellosolve (0.003)	ND	ND	0.002	ND
Other hydrocarbons using decane as a standard (0.018)	ND	ND	0.02	ND

Notes: ND = not detected.
ppb = parts per billion
mg/m^3 = milligrams per cubic meter

Table 12
Direct Reading Results for Longworth Building (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 09:00 and 16:30					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
Conference Room [redacted] (indoor background)	1–2	659–900*	73–75	[redacted]	0-0.7	ND
Outdoor background	0–3	425–439*	69–70	[redacted]	0	ND
[redacted] (Mail handling area)	0–2	690–767*	73–74	[redacted]	0	ND
[redacted] (Mail handling area)	0–2	763–836	73	[redacted]	0	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
*CO_2 concentrations fell as the day progressed.
ppm = parts per million.
O_3 = ozone

Table 13
Direct Reading Results for Senate PO Mail Screening Facility (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 11:00 and 13:00					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
Mail Cutting Room	2–6	535–655	63–68	[redacted]	1	ND
Warehouse	2–7	545–780	63–65	[redacted]	1	ND
Breakroom (control)	2–5	810–1100	68–69	[redacted]	0.7–1	ND
Loading Dock	0–1	360–390	47–57	[redacted]	0–1	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
O_3 = ozone
ppm = parts per million

Table 14
Integrated Sampling Results for Senate PO Screening Facility (2/13/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	Location			
	Mail Cutting Room	Warehouse	Breakroom (control)	Loading Dock (Control)
Formaldehyde (ppm)	0.0071	0.0081	0.0082	0.0038
PAHs	ND	ND	ND	ND
TDI	ND	ND	ND	ND
Total Dust (mg/m^3)	ND	ND	ND	ND
Perchloroethylene	ND	N/A	ND	ND
Benzene	ND	N/A	ND	ND
Total Xylenes	ND	N/A	ND	ND
Limonene	ND	N/A	ND	ND
Ethyl Benzene	ND	N/A	ND	ND
Toluene (ppm)	ND	N/A	(0.02)	ND
Trichloroethylene	ND	N/A	ND	ND
MTBE	ND	N/A	ND	ND
Butyl cellosolve (ppm)	ND	N/A	(0.005)	ND
Other hydrocarbons using decane as a standard (mg/m^3)	ND	N/A	(0.33)	ND
Acetonitrile (ppm)	N/A	0.12	N/A	N/A

( ) = Indicates sampling results were between the analytical Limit of Detection and Limit of Quantification
ppm = parts of gas or vapor per million parts air
mg/m^3 = milligrams of contaminant per cubic meter of air sampled.
ND = not detected.

Table 15
Integrated Air Sampling Results for Hart Building (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte (MDC in ppm unless otherwise noted)	Location			
	[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (Mail handling area)	Indoor background
Formaldehyde, ppb	13	11	5	7
PAHs	ND	ND	ND	ND
TDI (18 ppt)	ND	ND	ND	ND
Total Dust (0.03 mg/m^3)	ND	ND	0.094	ND
Perchloroethylene (0.004)	ND	ND	ND	ND
Xylene/ Ethyl Benzene (0.003)	ND	ND	ND	ND
Toluene, (0.001)	0.003	ND	0.003	0.001
Trichloroethylene (0.003)	ND	ND	ND	ND
MTBE (0.004)	ND	ND	ND	ND
Benzene (0.002)	ND	ND	ND	ND
Limonene (0.005)	0.012	ND	ND	ND
Total Xylenes (0.003)	ND	ND	ND	ND
Butyl cellosolve (0.003)	ND	ND	0.001	ND
Other hydrocarbons using decane as a standard (0.018)	0.064	ND	0.027	0.02

Notes: ND = not detected.
ppb = parts of analyte per billion part of air.
ppm = parts of analyte per million parts of air.
ppt = parts of analyte per trillion parts of air.
mg/m^3 = milligrams of analyte per cubic meter of air.

Table 16
Direct Reading Results for Hart Building (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 09:00 and 16:30					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
[redacted] Mail sorting room	0	484–551*	68–69	[redacted]	0	ND
[redacted] (Mail handling area)	1	800	70	[redacted]	0	ND
[redacted] (Mail handling area)	1	560–580	71–73	[redacted]	2.2**	ND
[redacted] (indoor background)	1	520	74	[redacted]	0	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
*CO_2 concentrations fell as the day progressed.
**2.2 ppm detected when sensor placed within stack of mail and mail was violently agitated, 0 ppm detected in the ambient environment
ppm = parts per million.
O_3 = ozone

Table 17
Integrated Air Sampling Results for Rayburn Building (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	MDC / MQC	Location			
		[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (control)
Formaldehyde (ppb)	0.9 – 3.4	12.2	13.6	8.4	7.5
Perchloroethylene (ppm)	0.003 – 0.012	ND	ND	ND	ND
Benzene (ppm)	0.0014 – 0.0036	ND	ND	0.010	ND
Xylene/Ethyl Benzene (ppm)	0.0024 – 0.0079	ND	ND	0.011	ND
Toluene (ppm)	0.0009 – 0.0031	ND	ND	0.020	(0.001)
Trichloroethylene (ppm)	0.002 – 0.009	ND	ND	ND	ND
MTBE (ppm)	0.003 – 0.010	ND	ND	0.003	ND
Butyl cellosolve (ppm)	0.002 – 0.010	ND	ND	ND	ND
Limonene (ppm)	0.0017 – 0.0062	ND	ND	ND	ND
Acetonitrile (ppm)	0.048 – 0.137	0.35	NA	NA	NA
Other hydrocarbons using decane as a standard (ppm)	0.014 – 0.040	ND	ND	0.161	ND
†PAHs (ppb)	0.072 – 0.238	ND	ND	(0.182)	ND
TDI (ppt)	18	ND	ND	ND	ND
Total Dust (mg/m^3)	0.03	ND	ND	0.03	ND

Notes: ND = not detected.
ppb = parts of analyte per billion part of air.
ppm = parts of analyte per million parts of air.
ppt = parts of analyte per trillion parts of air.
mg/m^3 = milligrams of analyte per cubic meter of air.
NA = not analyzed. Based on thermal desorption data, only one sample was analyzed for acetonitrile
† = naphthalene was the only PAH detected.
( ) = Indicates sampling results were between the analytical Minimum Detection Concentration and Minimum Quantifiable Concentration.

Table 18
Direct Reading Results for Rayburn Building (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Temp (°F)	RH (%)	CO_2 (ppm)	CO (ppm)	TVOC (ppm)	O_3 (ppm)
[redacted] conference room	72 – 73	[redacted]	700 – 934	0 – 2	0	ND
[redacted] (where mail is opened)	74 – 75	[redacted]	813 – 944	0 – 1	0	ND
[redacted] (mail sorting area for building)	74 – 75	[redacted]	513 – 1113	0 – 3	0 – 0.6	ND
[redacted] conference room (control area)	69 – 72	[redacted]	639 – 737	0 – 1	0	ND
Outdoor	64	[redacted]	410	NC	NC	NC

Notes: TVOCs were measured with a PID which is a non-specific detector.
CO_2 measurements in room [redacted] varied more than other locations since the number of personnel changed frequently from 4 to 20 individuals throughout the day.
TVOC concentrations in room [redacted] were highest when a vehicle drove by.
Outdoor measurements were only collected one time since outdoor sampling at the Rayburn building was not part of the protocol.
NC = not collected.
ppm = parts per million.
O_3 = ozone

Table 19
Direct Reading Results for House Mail Processing Facility (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 11:00 and 13:00					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
Trailer 1 (mail proc.)	0 – 1	530 – 820	67 – 71	[redacted]	0 – 0.5	ND
Trailer 2 (mail proc.)	0 – 1	570 – 800	67 – 69	[redacted]	0 – 0.5	ND
Admin. Trailer (control)	0 – 2	830 – 1100	70 – 71	[redacted]	0 – 0.3	ND
Outside control	0	450 – 500	69	[redacted]	0	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
Mail is not processed in the Administration Trailer
Outside control is within large unconditioned facility housing the mail handling trailers.
O_3 = ozone
ppm = parts per million

Table 20
Integrated Air Sampling Results for House Mail Processing Facility (2/14/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	Location			
	Trailer 1	Trailer 2	Administrative Trailer (control)	Outside (Control)
Formaldehyde (ppb)	6.9	10.8	13.5	4.1
PAHs	ND	ND	ND	ND
TDI	ND	ND	ND	ND
Total Dust (mg/m^3)	ND	0.05	0.04	ND
Perchloroethylene	ND	ND	ND	ND
Benzene (ppm)	ND	ND	(0.003)	ND
Total Xylenes	ND	ND	ND	ND
Limonene	ND	ND	0.0244	ND
Ethyl Benzene	ND	ND	ND	ND
Toluene (ppm)	(0.004)	(0.003)	0.0163	ND
Trichloroethylene	ND	ND	ND	ND
MTBE (ppm)	ND	ND	ND	(0.009)
Butyl cellosolve	ND	ND	ND	ND
Other hydrocarbons using decane as a standard (mg/m^3)	ND	ND	(0.33)	ND

Note: ( ) = Indicates sampling results were between the analytical Minimum Detection Concentration and Minimum Quantifiable Concentration.
ND = not detected.
mg/m^3 = milligrams per cubic meter.
ppm = parts per million.

Table 21
Direct Reading Results for [redacted] (2/15/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 11:00 and 13:00					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
[redacted] (Mail handling area)	0	720-800	72-73	[redacted]	0.2-0.5	ND
[redacted] (Mail handling area)	0	630-660	72-73	[redacted]	0-0.5	ND
[redacted] (Mail handling area)	0	820-850	74	[redacted]	0.1-0.33	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
O_3 = Ozone
ppm = parts per million.

Table 22
Integrated Air Sampling Results for [redacted] (2/15/2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	Location		
	[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (Mail handling area)
Formaldehyde (ppb)	7.3	8.6	8.1
PAHs	ND	ND	ND
TDI	ND	ND	ND
Total Dust (mg/m^3)	0.05	ND	ND
Perchloroethylene	ND	ND	ND
Benzene	ND	ND	ND
Total Xylenes	ND	ND	ND
Limonene	ND	ND	ND
Ethyl Benzene	ND	ND	ND
Toluene	ND	ND	ND
Trichloroethylene	ND	ND	ND
MTBE	ND	ND	ND
Butyl cellosolve	ND	ND	ND
Other hydrocarbons using decane as a standard (mg/m^3)	ND	ND	(0.36)

( ) = Indicates sampling results were between the analytical Minimum Detection Concentration and Minimum Quantifiable Concentration.
ppm = parts per million.
ND = not detected.
ppb = parts per billion.
mg/m^3 = milligram per cubic meter

Table 23
Air Sampling Summary Results for Capitol Building (2/15/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte	MDC / MQC	Location		
		[redacted] (Mail handling area)	[redacted] (Mail handling area)	[redacted] (control)
Formaldehyde (ppb)	0.9 – 3.4	8.9	7.0	10.1
Perchloroethylene (ppm)	0.003 – 0.012	ND	ND	ND
Benzene (ppm)	0.0014 – 0.0036	ND	ND	ND
Xylene/Ethyl Benzene (ppm)	0.0024 – 0.0079	ND	ND	ND
Toluene (ppm)	0.0009 – 0.0031	(0.004)	ND	ND
Trichloroethylene (ppm)	0.002 – 0.009	ND	ND	ND
MTBE (ppm)	0.003 – 0.010	ND	ND	ND
Butyl cellosolve (ppm)	0.002 – 0.010	0.007	ND	ND
Limonene (ppm)	0.0017 – 0.0062	ND	ND	ND
Other hydrocarbons using decane as a standard (ppm)	0.014 – 0.040	(0.024)	(0.029)	ND
PAHs (ppb)	0.72 – 0.238	ND	ND	ND
TDI (ppt)	18	ND	ND	ND
Total Dust (mg/m^3)	0.03	ND	ND	ND

Notes: ND = not detected.
ppb = parts of analyte per billion parts of air.
ppm = parts of analyte per million parts of air.
mg/m^3 = milligrams of analyte per cubic meter of air.
ppt = parts of analyte per trillion parts of air
( ) = Indicates sampling results were between the analytical Minimum Detection Concentration and Minimum Quantifiable Concentration.

Table 24
Direct Reading Results for Capitol Building (2/15/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Temp (°F)	RH (%)	CO_2 (ppm)	CO (ppm)	TVOC (ppm)	O_3 (ppm)
[redacted] (Mail handling area)	71 – 75	[redacted]	631 – 737	0	0	NC
[redacted] (Mail handling area)	74 – 75	[redacted]	550 – 740	0	0	NC
[redacted] conference room (control area)	73 – 74	[redacted]	558 – 670	0	0	NC

Notes: TVOCs were measured with a PID which is a non-specific detector.
NC = not collected.
ppm = parts per million.

Table 25
Integrated Air Sampling Results for Ford Building (2/15/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Analyte (MDC in ppm unless otherwise noted)	Location		
	Mail Sorting [redacted]	Indoor background [redacted]	Outdoor background
Formaldehyde, ppb	15	14	4
PAHs	ND	ND	ND
TDI (18 parts per trillion)	ND	ND	ND
Total Dust (0.04 mg/m^3)	0.041	ND	0.082
Perchloroethylene (0.004)	ND	ND	ND
Xylene/ Ethyl Benzene (0.003)	ND	ND	ND
Toluene, (0.001)	ND	0.008	ND
Trichloroethylene (0.003)	ND	ND	ND
MTBE (0.004)	ND	ND	ND
Benzene (0.002)	ND	ND	ND
Limonene (0.005)	ND	ND	ND
Total Xylenes (0.003)	ND	ND	ND
Butyl cellosolve (0.003)	ND	ND	ND
Other hydrocarbons using decane as a standard (0.018)	ND	ND	ND

Note: mg/m^3 = milligrams per cubic meter.
ppb = parts per billion.
MDC = Minimum Detection Concentration

Table 26
Direct Reading Results for Ford Building (2/15/2002)
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Location	Range of measurements obtained between 09:00 and 14:00					
	CO (ppm)	CO_2 (ppm)	Temp °F	%RH	TVOC (ppm)	O_3 (ppm)
CBO conf. room, [redacted] (control)	0	610 – 620	73	[redacted]	0	ND
Mail sorting room, [redacted]	0	625 – 660	73-74	[redacted]	0	ND
Outside, [redacted]	0-1	425 – 460*	52	[redacted]	0	ND

Notes: TVOCs were measured with a PID which is a non-specific detector.
*CO_2 concentrations fell as the day progressed.
ppm = parts per million.
O_3 = ozone.

Table 27
Bulk Sample Anion Results Presented in Ranges of µg/g
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

	Number of Samples	Fluoride	Chloride	Nitrite Ion	Bromide	Nitrate Ion	Phosphate Ion	Sulfate
Irradiated Mail Samples	9	21 – 410	100 – 6100	ND – 3.1	ND – 27	4 – 28	ND – 110	110 – 1100
Control Samples	3	20 – 89	190 – 2200	ND – 2.7	(0.9) – 7.9	6 – 18	ND – 42	61 – 320

Notes: ND = not detected.
( ) = Indicates sampling results were between the analytical LOD and LOQ.

Table 28
Fine Particle Counts (particles/cubic centimeter) in Various Senate and House Buildings 2/13/02 - 2/15/02
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Sample Location	Mean, particles/cc *(n=15)*	Sample Standard Deviation	Mean as a % of Outdoor Background (BG) Mean
Russell Building 2/13/02			
[redacted] (Mail handling area)	1376	56	4
[redacted] (Mail handling area)	2462	396	6
Lobby area near room [redacted]	7905	1116	20
4th floor hallway	3296	348	9
Near freight elevators [redacted]	19370	505	50
Outside BG [redacted]	38591	3248	--
Cannon Building 2/13/02			
[redacted] Indoor background	379	16	0
[redacted] (Mail handling area)	2650	72	3
[redacted] (Mail opening area)	4171	55	5
Outside BG [redacted]	92418	9188	—
Longworth Building 2/13/02			
[redacted] (Mail handling area)	4552	96	7
Indoor BG (Hallway by elevators, near [redacted]	6895	108	11
[redacted] (Indoor BG in conf. Room)	2006	85	3
[redacted] (Mail handling area)	4847	137	8
Outside BG [redacted]	63267	11744	—
Mail Processing Center (Alexandria, VA) 2/13/02			
Warehouse sort area next to IH samples	17168	819	64
Near mail cutting station	3775	796	14

Table 28 (Continued)
Fine Particle Counts (particles/cubic centimeter) in Various Senate and House Buildings 2/13/02 - 2/15/02
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Sample Location	Mean, particles/cc *(n=15)*	Sample Standard Deviation	Mean as a % of Outdoor Background (BG) Mean
Indoor BG (2nd floor breakroom)	6902	298	26
Outdoor BG (loading dock)	26893	4311	—
Dirksen Building 2/14/02			
[redacted] (Mail handling area)	8027	196	23
[redacted] (Mail handling area)	5828	357	17
Indoor BG [redacted]	1992	91	6
Hart/Dirksen Post Office [redacted]	33529	1735	97
Outside [redacted]	34486	798	—
Hart Senate Building 2/14/02			
[redacted] Mail area	35389	502	103
2nd Mail area [redacted]	66495	6675	193
[redacted] (Mail handling area)	4632	291	13
[redacted] (Mail handling area)	7338	203	21
Control [redacted]	4485	59	13
Outside [redacted]	34486	798	—
Rayburn Building 2/14/02			
[redacted] (Mail handling area)	6492	384	14
[redacted] (Mail handling area)	14199	509	30
[redacted] (Mail handling area)	2006	90	4
[redacted] (Mail handling area)	6999	715	15
Indoor BG - [redacted]	2338	86	5
Outdoor BG	47356	5453	—

Table 28 (Continued)
Fine Particle Counts (particles/cubic centimeter) in Various Senate and House Buildings 2/13/02 - 2/15/02
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

Sample Location	Mean, particles/cc *(n=15)*	Sample Standard Deviation	Mean as a % of Outdoor Background (BG) Mean
Postal Square Senate Sergeant At Arms Offices 2/14/02			
CPC [redacted]	7512	90	na
U.S. Capitol Building 2/15/02			
[redacted] (Mail handling area)	1056	62	2
Indoor BG - [redacted]	2325	61	5
[redacted] (Mail handling area)	984	35	2
Outside [redacted]	46481	1262	—
Ford Building 2/15/02			
Indoor BG - [redacted]	5610	123	5
[redacted] - Ford Mail Room	3387	70	3
Outdoor BG - [redacted]	113573	33289	—

APPENDIX A

Total Dust and Particle Size Analysis

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 eight 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. Because the calibration of the aerosol spectrometer varies with aerosol properties, the output of the instrument is viewed as a measure of relative concentration.

The aerosol spectrometer was used to obtain the mass gain, mass fraction (MF), cumulative mass fraction (CMF), CMF less than indicated size, concentration, average respirable fraction, and respirable MF for particle size analysis conducted in the Federal Office Buildings. Tables A-1 through A-9 list the results of the aerosol spectrometer particle size evaluation conducted on 02/13/02 – 02/15/02.

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. In instances where there was a non-detectable concentration on the total dust sample, a minimum detectable concentration was calculated using the limit of detection for the analytical method. The minimum detectable concentration from the total particulate sample was then used with the total integrated aerosol spectrometer concentration to obtain a conversion factor. The conversion factors were then used to adjust the concentration values.

The results of the particle size data indicated that the total and respirable particle concentrations were well below any established occupational criteria. These data also indicated that the particulate concentrations were well below the 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 $\mu g/m^3$).

Table A1

Particle size data collected [redacted] of the Cannon Building on February 13, 2002

HETA 2002–0136

United States Senate and House Office Buildings

Washington, D.C.

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	0.005027	0	0.00503	0.475	1.000	0.525	0.01401	0	0
2	10	10	15	5	0.008501	0.005027	0.00347	0.328	0.525	0.196	0.00968	0.005	0.00164
3	7.5	7.5	10	2.5	0.009372	0.008501	0.00087	0.082	0.196	0.114	0.00243	0.0425	0.00350
4	5	5	7.5	2.5	0.009943	0.009372	0.00057	0.054	0.114	0.060	0.00159	0.1875	0.01013
5	3.5	3.5	5	1.5	0.010415	0.009943	0.00047	0.045	0.060	0.015	0.00132	0.455	0.02031
6	2	2	3.5	1.5	0.01051	0.010415	0.00010	0.009	0.015	0.006	0.00027	0.775	0.00698
7	1	1	2	1	0.010554	0.01051	0.00004	0.004	0.006	0.002	0.00012	0.97	0.00405
8	0.5	0.5	1	0.5	0.010575	0.010554	0.00002	0.002	0.002	0.000	0.00006	1	0.00196
Totals							0.010575				0.03		0.05
Total Aerosol Concentration 0.03 mg/m3													
Respirable Mass Fraction 0.05 or 5%													
Respirable Mass Concentration 0.0014 mg/m3													

Table A2
Particle size data collected [redacted] of the Longworth Building on February 13, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.006811	0	0.00681	0.577	1.000	0.423	0.02118	0.07	0.040421659
2	5	5	6.5	1.5	0.008096	0.006811	0.00129	0.109	0.423	0.314	0.00400	0.22	0.02397
3	3.5	3.5	5	1.5	0.009591	0.008096	0.00149	0.127	0.314	0.187	0.00465	0.455	0.05766
4	2	2	3.5	1.5	0.010396	0.009591	0.00080	0.068	0.187	0.119	0.00250	0.775	0.05288
5	1	1	2	1	0.010747	0.010396	0.00035	0.030	0.119	0.089	0.00109	0.97	0.02887
6	0.75	0.75	1	0.25	0.010913	0.010747	0.00017	0.014	0.089	0.075	0.00052	1	0.01409
7	0.5	0.5	0.75	0.25	0.011208	0.010913	0.00030	0.025	0.075	0.050	0.00092	1	0.02504
8	0.3	0.3	0.5	0.2	0.011795	0.011208	0.00059	0.050	0.050	0.000	0.00182	1	0.04975
Totals							0.011795				0.037		0.29
Total Aerosol Concentration 0.037 mg/m3													
Respirable Mass Fraction 0.29 or 29%													
Respirable Mass Concentration 0.011 mg/m3													

Table A3
Particle size data collected on top of the ventilation hood at the Senate Post-Office Screening Facility on February 13, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.006843	0	0.00684	0.517	1.000	0.483	0.01550	0.07	0.03620847
2	5	5	6.5	1.5	0.009186	0.006843	0.00234	0.177	0.483	0.306	0.00531	0.22	0.03897
3	3.5	3.5	5	1.5	0.011716	0.009186	0.00253	0.191	0.306	0.114	0.00573	0.455	0.08703
4	2	2	3.5	1.5	0.012726	0.011716	0.00101	0.076	0.114	0.038	0.00229	0.775	0.05917
5	1	1	2	1	0.013033	0.012726	0.00031	0.023	0.038	0.015	0.00069	0.97	0.02247
6	0.75	0.75	1	0.25	0.0131	0.013033	0.00007	0.005	0.015	0.010	0.00015	1	0.00507
7	0.5	0.5	0.75	0.25	0.013145	0.0131	0.00005	0.003	0.010	0.006	0.00010	1	0.00342
8	0.3	0.3	0.5	0.2	0.013229	0.013145	0.00008	0.006	0.006	0.000	0.00019	1	0.00634
Totals							0.013229				0.030		0.26
Total Aerosol Concentration 0.03 mg/m3													
Respirable Mass Fraction 0.26 or 26%													
Respirable Mass Concentration 0.008 mg/m3													

Table A4
Particle size data collected [redacted] of the Hart Building on February 14, 2002
HETA 2002–0136
United States Senate and House Office Building
Washington, D.C.

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	0.00667	0	0.00667	0.555	1.000	0.445	0.01828	0.07	0.038818871
2	5	5	6.5	1.5	0.00849	0.00667	0.00182	0.151	0.445	0.294	0.00499	0.22	0.03328
3	3.5	3.5	5	1.5	0.01059	0.00849	0.00210	0.175	0.294	0.120	0.00576	0.455	0.07944
4	2	2	3.5	1.5	0.011545	0.01059	0.00096	0.079	0.120	0.040	0.00262	0.775	0.06155
5	1	1	2	1	0.011838	0.011545	0.00029	0.024	0.040	0.016	0.00080	0.97	0.02366
6	0.75	0.75	1	0.25	0.011911	0.011838	0.00007	0.006	0.016	0.010	0.00020	1	0.00603
7	0.5	0.5	0.75	0.25	0.011959	0.011911	0.00005	0.004	0.010	0.006	0.00013	1	0.00401
8	0.3	0.3	0.5	0.2	0.012028	0.011959	0.00007	0.006	0.006	0.000	0.00019	1	0.00574
Totals							0.012028				0.033		0.25
Total Aerosol Concentration 0.033 mg/m3													
Respirable Mass Fraction 0.25 or 25%													
Respirable Mass Concentration 0.008 mg/m3													

Table A5
Particle size data collected in [redacted] of the Dirksen Building on February 14, 2002
HETA 2002–0136
United States Senate and House Office Building
Washington, D.C.

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	0.005067	0	0.00507	0.405	1.000	0.595	0.01057	0	0
2	10	10	15	5	0.008431	0.005067	0.00336	0.269	0.595	0.326	0.00701	0.005	0.001
3	7.5	7.5	10	2.5	0.009949	0.008431	0.00152	0.121	0.326	0.205	0.00317	0.0425	0.005
4	5	5	7.5	2.5	0.011228	0.009949	0.00128	0.102	0.205	0.103	0.00267	0.1875	0.019
5	3.5	3.5	5	1.5	0.012067	0.011228	0.00084	0.067	0.103	0.036	0.00175	0.455	0.031
6	2	2	3.5	1.5	0.012343	0.012067	0.00028	0.022	0.036	0.014	0.00058	0.775	0.017
7	1	1	2	1	0.012441	0.012343	0.00010	0.008	0.014	0.006	0.00020	0.97	0.008
8	0.5	0.5	1	0.5	0.012513	0.012441	0.00007	0.006	0.006	0.000	0.00015	1	0.006
Totals							0.012513				0.03		0.09
Total Aerosol Concentration 0.03 mg/m3													
Respirable Mass Fraction 0.09 or 9%													
Respirable Mass Concentration 0.0023 mg/m3													

Table A6
Particle size data collected in [redacted] of the Rayburn Building on February 14, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.00473	0	0.00473	0.367	1.000	0.633	0.01098	0	0
2	10	10	15	5	0.008115	0.00473	0.00339	0.263	0.633	0.370	0.00786	0.005	0.001
3	7.5	7.5	10	2.5	0.009615	0.008115	0.00150	0.116	0.370	0.254	0.00348	0.0425	0.005
4	5	5	7.5	2.5	0.011228	0.009615	0.00161	0.125	0.254	0.128	0.00375	0.1875	0.023
5	3.5	3.5	5	1.5	0.012483	0.011228	0.00125	0.097	0.128	0.031	0.00291	0.455	0.044
6	2	2	3.5	1.5	0.012793	0.012483	0.00031	0.024	0.031	0.007	0.00072	0.775	0.019
7	1	1	2	1	0.012862	0.012793	0.00007	0.005	0.007	0.002	0.00016	0.97	0.005
8	0.5	0.5	1	0.5	0.012882	0.012862	0.00002	0.002	0.002	0.000	0.00005	1	0.002
Totals							0.012882				0.03		0.10
Total Aerosol Concentration 0.03 mg/m3													
Respirable Mass Fraction 0.10 or 10%													
Respirable Mass Concentration 0.0030 mg/m3													

Table A7
Particle size data collected in the trailer inside a warehouse at the House Post-Office Screening Facility on February 14, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.005221	0	0.00522	0.446	1.000	0.554	0.01783	0.07	0.031240515
2	5	5	6.5	1.5	0.007124	0.005221	0.00190	0.163	0.554	0.391	0.00650	0.22	0.03578
3	3.5	3.5	5	1.5	0.009534	0.007124	0.00241	0.206	0.391	0.185	0.00823	0.455	0.09373
4	2	2	3.5	1.5	0.010905	0.009534	0.00137	0.117	0.185	0.068	0.00468	0.775	0.09079
5	1	1	2	1	0.011438	0.010905	0.00053	0.046	0.068	0.022	0.00182	0.97	0.04424
6	0.75	0.75	1	0.25	0.01155	0.011438	0.00011	0.010	0.022	0.013	0.00038	1	0.00952
7	0.5	0.5	0.75	0.25	0.011626	0.01155	0.00008	0.007	0.013	0.006	0.00026	1	0.00654
8	0.3	0.3	0.5	0.2	0.011699	0.011626	0.00007	0.006	0.006	0.000	0.00025	1	0.00624
Totals							0.011699				0.040		0.32
Total Aerosol Concentration 0.04 mg/m3													
Respirable Mass Fraction 0.32 or 32%													
Respirable Mass Concentration 0.013 mg/m3													

Table A8
Particle size data collected in [redacted] at the Capitol Building on February 15, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.004534	0	0.00453	0.355	1.000	0.645	0.01426	0	0
2	10	10	15	5	0.007875	0.004534	0.00334	0.262	0.645	0.383	0.01051	0.005	0.001
3	7.5	7.5	10	2.5	0.009578	0.007875	0.00170	0.133	0.383	0.250	0.00536	0.0425	0.006
4	5	5	7.5	2.5	0.011265	0.009578	0.00169	0.132	0.250	0.118	0.00531	0.1875	0.025
5	3.5	3.5	5	1.5	0.012441	0.011265	0.00118	0.092	0.118	0.026	0.00370	0.455	0.042
6	2	2	3.5	1.5	0.012707	0.012441	0.00027	0.021	0.026	0.005	0.00084	0.775	0.016
7	1	1	2	1	0.012755	0.012707	0.00005	0.004	0.005	0.001	0.00015	0.97	0.004
8	0.5	0.5	1	0.5	0.012773	0.012755	0.00002	0.001	0.001	0.000	0.00006	1	0.001
Totals							0.012773				0.04		0.09
Total Aerosol Concentration 0.04 mg/m3													
Respirable Mass Fraction 0.09 or 9%													
Respirable Mass Concentration 0.004 mg/m3													

Table A9
Particle size data collected in [redacted] at the Ford Building on February 15, 2002
HETA 2002–0136
United States Senate and House Office Buildings
Washington, D.C.

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	0.006097	0	0.00610	0.506	1.000	0.494	0.01821	0.07	0.03543183
2	5	5	6.5	1.5	0.007829	0.006097	0.00173	0.144	0.494	0.350	0.00517	0.22	0.03164
3	3.5	3.5	5	1.5	0.009957	0.007829	0.00213	0.177	0.350	0.173	0.00636	0.455	0.08038
4	2	2	3.5	1.5	0.011014	0.009957	0.00106	0.088	0.173	0.086	0.00316	0.775	0.06799
5	1	1	2	1	0.011403	0.011014	0.00039	0.032	0.086	0.053	0.00116	0.97	0.03137
6	0.75	0.75	1	0.25	0.011558	0.011403	0.00015	0.013	0.053	0.040	0.00046	1	0.01286
7	0.5	0.5	0.75	0.25	0.011754	0.011558	0.00020	0.016	0.040	0.024	0.00058	1	0.01622
8	0.3	0.3	0.5	0.2	0.012045	0.011754	0.00029	0.024	0.024	0.000	0.00087	1	0.02420
Totals							0.012045				0.036		0.30
Total Aerosol Concentration 0.036 mg/m3													
Respirable Mass Fraction 0.30 or 30%													
Respirable Mass Concentration 0.011 mg/m3													

APPENDIX B

AFRRI Legislative Mail Analysis

Executive Summary

AFRRI (Armed Forces Radiobiology Research Institute) is a tri-service laboratory that conducts research in the field of radiobiology and related matters essential to the operational and medical support of the U.S. Department of Defense and the military services. The institute collaborates with other governmental facilities, academic institutions, and civilian laboratories in the United States and other countries. Its findings have broad military and civilian applications.

The events of September 11th and the subsequent receipt of anthrax tainted letters by Senator Daschle's office and others prompted AFRRI to apply its diverse resources and teams of experts on matters related to Homeland Security. AFRRI has a very unique pool of experts that had previously focused on the deactivation of *Bacillus anthracis*, as well as many years of research into the effects of ionization radiation. After the first batches of irradiated mail were received, the peculiar smells and other apparent side effects once again prompted the response of the radiation experts at AFRRI, along with others from the Uniformed Services University to determine what effects the radiation was having on the materials contained within the letter mail, and what volatile compounds were being released at the workplace.

Modern gas chromatography/mass spectrometry (GC/MS) methods and equipment, and the sensitivity and structural information these methods provide make GC/MS an excellent choice for field detection and identification of a range of organic chemicals. Numerous sampling techniques allow detection of GC/MS analytes in environmental matrices, although multiple sample handling steps and use of extraction solvents increase the complexity and time needed to complete analyses. Solid phase microextraction (SPME) has been shown to be suitable for sampling environmental contaminants from air, water, and soil for GC/MS analysis. We collected environmental samples in the U.S. Capitol office buildings and analyzed them on site using SPME-GC/MS for qualitative identification of possible workplace air contaminants. Passive SPME sampling concentrated analytes from the air following short sampling periods and was followed immediately by GC/MS analysis in the Dirksen Building using field portable equipment. A number of volatile organic compounds were identified, however the concentrations of these analytes were at barely detectable levels. There were no hazards identified as a result of the analysis.

Technical Synopsis

Introduction

Traditionally, occupational and environmental sampling for volatile and semi-volatile organic compounds have relied upon the proven and reliable methods of capturing analytes that have been used for years. These sampling methods have essentially remained unchanged while detection and identification equipment has become smaller, more reliable, and increasingly sensitive. Gas chromatography (GC) tools have undergone important improvements such as development of open tubular columns with bonded stationary phase material, providing improved chromatography and decreased fragility compared to packed column GC. Mass spectrometry hardware for electron impact (EI) mass spectrometry (MS) has grown smaller and increasingly sensitive.

With the improvements in GC/MS hardware, there is growing demand for rapid field analysis in both the civilian and military communities.[1,2,3,4]. Traditional sampling methods do not easily support rapid sampling and analysis carried out completely, or mostly in the field. Numerous applications for solid phase microextraction (SPME) have been developed for clinical, forensic, and environmental applications.[5]. SPME is a technique that is well suited for field sampling and analysis. It is a passive sampling method that extracts organic analytes, concentrating them onto a thin fiber coated with a stationary phase material. SPME allows rapid extraction and transfer to an analytical instrument[6] of choice where the analyte is usually thermally desorbed, i.e. in the injection port of a GC system. Use of SPME eliminates the need for time-consuming sample preparation steps required by traditional sampling methods.[7] We have applied this method to identify possible volatile compounds emitted from irradiated mail on site at the location of irradiation and the same methods are applicable to the analysis of possible contaminated office air.

Air samples were collected on 13, 14, and 15 February 2002, in various House and Senate office buildings, and at selected Capitol locations for on-site analysis by gas chromatography/mass spectrometry (GC/MS). The sampling and analyses were completed by the AFRRI/USUHS team consisting of Shelly Hodge and Stephen Miller from the Armed Forces Radiobiology Research Institute and Gary Hook, Greg Kimm, Tara Hall, and Philip Smith from the Uniformed Services University of the Health Sciences. The purpose of the sampling and analyses completed was to provide rapid detection of volatile organic compounds that may be of concern as air contaminants. Had unusual or harmful air contaminant concentrations been observed, the field sampling and analysis methods used would have allowed immediate feedback with this information.

Materials and Methods

Materials

All SPME fibers and holders used in this study were commercially available from Supelco (Bellefonte, Pennsylvania). Prior to use, each fiber was conditioned following the manufacturer's recommendations. To ensure there was no carryover of analytes from previous extractions, blank runs were completed at least once daily before use of any fibers for sampling. The standards used to confirm analyte identification were purchased from Aldrich (Milwaukee, Wisconsin).

Sampling

The samples were collected as “mail area” samples by placing the SPME holders in the vicinity of the mail operations and exposing the fibers to the air for 15 min. The samples were collected using 85 µm thickness Carboxen / polydimethylsiloxane (PDMS) fibers based on previous studies at the IBA plant in Bridgeport. Carboxen is a porous synthetic carbon material blended in the liquid PDMS fiber coating. Its unique pores which pass completely through the particle are especially well suited for extraction of volatile organic compounds. The 85 µm thickness was selected over thinner coatings as it allows for a greater mass of analytes to absorb into the fiber coating, providing greater sensitivity. Between collection of field samples and analysis (10-30 min in all cases), the tip of the SPME fiber was retracted into the protective sheath. The sheath was then inserted into a Thermogreen LB-2 septum (Supelco) to minimize further extraction onto or loss of analytes off of the SPME fiber.

For qualitative identification and retention time match, samples of single compound standards were placed in 15 ml glass vials with PTFE/silicone septa (Supelco), and headspace sampling was completed.

Instrumentation

For analyses performed in the field, the SPME fiber samples were desorbed thermally in the injection port of a field portable Viking Spectra Trak 573 GC/MS system. The MS section of this instrument is based on an Agilent Technologies 5973 ion source and monolithic quadrupole mass filter.

The injection port as used for SPME samples was equipped with a deactivated injection port liner designed for thermal desorption of analytes from a SPME fiber (0.75 mm I.D., Supelco). A 30 m x 0.250 mm I.D. DB1-MS column (0.25 µm film thickness, J&W Scientific, Folsom, California) was used with He carrier gas and an initial linear velocity of 35 cm/s. Temperatures were: 250˚C (injection port), 260˚C (transfer line), 90˚C (MS transfer line), and 195˚C (MS ion source). GC oven temperature began at 35˚C, was held there for 3 min and then increased at 15˚C/min to 175 ˚C. These analyses were performed in splitless injection mode. EI (70eV) ionization was used and mass spectra were collected over 10-350 mass-to-charge ratio (*m/z*) range.

Because no solvent is used in SPME introduction of samples into the GC/MS inlet, the typical solvent delay for startup of MS data collection was not required for analysis of field SPME samples. Data analysis was carried out using MS Chemstation chromatogram integration software (Agilent Technologies, Palo Alto, California).

Sampling Issues

The selectivity of an SPME fiber for a given analyte must be considered when evaluating unknown samples and when quantifying analytes. The relative abundance of a given analyte and hence, sensitivity, can change dramatically between various fiber types. Disregard for the fiber phase can result in inappropriate dismissal of an apparently insignificant peak during qualitative screening which, in reality, is only insignificant due to a low affinity between the analyte and the fiber phase used for the screening extraction. For obvious reasons, maximum sensitivity is desirable when quantitation of analytes is the goal. Therefore, use of multiple fibers of varying polarities would be prudent for screening unknown samples. We had already established that Carboxen/PDMS was the most suitable fiber type for these analyses from our previous studies on the irradiated mail at the IBA plant in Bridgeport, New Jersey. We had also established suitable extraction time, extraction conditions, and desorption conditions. Normally industrial hygienists would monitor for exposure to a known array of possible compounds. In the case of irradiated mail, there is no list of compounds to monitor. During our previous studies in Bridgeport, we identified the compounds produced inside irradiated mail bags and used that list as a starting point for compounds to look for using extracted ion chromatograms for ions specific to the mass spectrum of each respective analyte.

Results

A number of organic compounds were detected at very low levels in office spaces, and these are listed in Tables (1) and (2). Only one analyte was present at levels (although still quite low) that allowed unambiguous detection and identification: limonene, a common organic compound found in air fresheners, citrus-type cleaners, and other sources such as soft drinks and orange peels. With the exception of limonene (in only two samples), the other organic compounds detected were present at levels so low that special data interpretation methods were required to confirm their presence (examination of extracted ion chromatograms for ions specific to the mass spectrum of each respective analyte). As completed on 15 February 02, the analyses essentially provided a field screening method using only the National Institute of Standards and Technology (NIST) mass spectral library software[13] for tentative identification. Without access to standards or elution order data, the identified compounds observed are (within a given group of isomers) poorly distinguished based solely on mass spectra. Further study in the laboratory with purchased standards confirmed the peak identities for the compounds listed in Tables (1) and (2).

Semi-quantitative analyses were completed in the laboratory for four of the analytes observed: limonene, toluene, benzene, and acetone. A static dilution (10 parts-per-billion or ppb by volume) of these compounds was prepared, and SPME sampling was completed as per field samples followed by GC/MS analysis. Using extracted ion chromatograms (58 *m/*z for acetone, 78 *m/*z for benzene, 68 *m/*z for limonene, and 91 *m/*z for toluene) the GC/MS detector response was less than that from the 10 ppb quantitative analysis for all of the samples collected in the field, indicating that levels of these analytes were likely well below 10 ppb. By completing a static dilution calibration curve for limonene, the concentration of limonene in [redacted] at the time of our sampling is estimated to have been between 50 and 100 ppb.

Conclusions

SPME was used as a sampling and sample preparation method for on-site field GC/MS. Its simplicity of operation, sensitivity, selectivity, portability, and the solvent-free nature of the method make it a powerful tool for screening airborne organic chemicals. This work identified an array of compounds that could be monitored for quantitatively if indicated. Several compounds (acetone, furan, 2-methyl furan, benzene, limonene, hexane, xylenes, toluene, 2-butanone) were focused on by examination of extracted ion chromatograms for ions specific to the mass spectrum of each respective analyte. With the exception of limonene, those compounds have also been identified in irradiated mail. Some semi-quantitative results were obtained for limonene, toluene, benzene, and acetone. None of these were found to have significant concentrations. The air samples collected do not indicate that hazardous concentrations existed for any of the contaminants detected.

References

1. Müller L [1999]. Field Analysis by SPME, in J. Pawliszyn, editor Applications of Solid Phase Microextraction, Royal Society of Chemistry, Herfordshire, UK, p. 269.

2. Overton HB, Dharmasena HP, Ehrmann U, Carney KR [1996]. Field Analytical Chemistry and Technology 1(2):87.

3. Gorecki T, Pawliszyn J [1997]. Field Analytical Chemistry and Technology 1(5):277.

4. Department of Defense, United States of America, DOD Instruction 6490.3, Implementation and application of joint medical surveillance for deployments, 7 August 1997.

5. J. Pawliszyn, editor. Applications of Solid Phase Microextraction, Royal Society of Chemistry, Hertfordshire, UK, 1999. p1-655.

6. LordH, Pawliszyn J [2000]. Chromatogr A 885:153.

7. Koziel J, Jia M, Pawliszyn J [2000]. Anal Chem 72:5178.

8. NIST [1995]. NIST/EPA/NIH mass spectral database, standard reference database 1A and the NIST mass spectral search program version 1a. Gaithersburg, MD: National Institute of Standards and Technology.

Table (1)

Senate	Room	Acetone	Furans	Benzene	Limonene	Hexane	Xylenes	Toluene	2-Butanone
Hart:									
	[redacted]	Yes	No	No	Yes	No	No	Yes	No
	[redacted]	No	No	No	Yes	No	Yes	Yes	Yes
	[redacted]	No	Yes	No	Yes	No	Yes	Yes	No
	[redacted]	Yes	No	No	No	No	No	Yes	No
Russell:									
	[redacted]	Yes	No	No	Yes	Yes	Yes	No	No
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	No	No
	[redacted]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dirksen:									
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	Yes	No
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	Yes	No
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Capitol:									
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Senate Mail	Hart	No	No	No	Yes	Yes	Yes	Yes	Yes

Table (2)

House	Room	Acetone	Furan	Benzene	Limonene	Hexane	Xylenes	Toluene	2-Butanone
Rayburn:									
	[redacted]	Yes	No	Yes	Yes	No	Yes	Yes	No
	[redacted]	Yes	No	Yes	Yes	No	Yes	Yes	No
Longworth:									
	[redacted]	Yes	No	Yes	Yes	No	Yes	Yes	Yes
	[redacted]	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Cannon:									
	[redacted]	Yes	No	Yes	Yes	No	Yes	Yes	No
	[redacted]	Yes	No	Yes	Yes	No	Yes	No	Yes
House Mail	[redacted] Rayburn	Yes Yes	Yes Yes	Yes Yes	Yes Yes	No No	Yes Yes	Yes Yes	Yes Yes

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