NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2005-0126 and #2005-0138-3004
International Marine Terminal
Scotia Prince Cruises and Department of Homeland Security, U.S. Customs and Border Protection
Portland, Maine

May 2006

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

PREFACE

The Hazard Evaluation 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 employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Gregory Thomas and Nancy Clark Burton of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Ken Wallingford, Donnie Boher, Deborah Sammons, and Barbara MacKenzie. Analytical support was provided by Ray Biagini (DART), Steve Vesper (U.S. Environmental Protection Agency) and P&K Laboratories, Cherry Hill, New Jersey. Desktop publishing was performed by Robin Smith. Editorial assistance was provided by Ellen Galloway.

Copies of this report have been sent to employee and management representatives at IMT and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. The report may be viewed and printed from the following internet address: http://www.cdc.gov/niosh/hhe. Copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161.

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

The National Institute for Occupational Safety and Health (NIOSH) received management requests for health hazard evaluations (HHEs) at Scotia Prince Cruises (SPC) and the United States Customs and Border Patrol (CBP) offices at the International Marine Terminal (IMT) in Portland, Maine. This request concerned possible health problems related to exposure to mold in the IMT offices, which were leased from the city of Portland. The IMT was undergoing mold abatement during the investigations in March 2005.

What NIOSH Did

- We reviewed industrial hygiene reports and conducted walk-through surveys of the IMT building.
- We collected air, bulk, and surface samples for mold in the IMT building.
- We measured temperature, relative humidity, and carbon dioxide levels.
- We conducted a similar survey at the U.S. Customs House, a building without a history of mold contamination also located in Portland, Maine, to serve as a comparison.
- We analyzed blood samples from CBP, SPC and Customs House employees for the presence of Stachylysin™, a possible marker of exposure to *Stachybotrys chartarum*.
- We administered questionnaires to employees at all three sites to obtain information about their work and medical history and possible building-related symptoms.

What NIOSH Found

- The IMT building had visible signs of water incursion, bird roosting, and fungal growth in SPC and CBP areas.
- Environmental evaluations of SPC areas of the IMT by contractors showed microbial contamination throughout that section of the building.
- Our sampling showed fungal contamination in the second floor SPC offices but not in other SPC areas that we tested.
- Low levels of airborne fungi were found in the CBP section of the IMT after abatement.
- Numerous fungi including *Pencillium* and *Stachybotrys chartarum* were found in bulk and dust samples, especially air filters, in the CBP section of the IMT.
- SPC and CBP IMT employees had higher rates of respiratory complaints than Customs House employees (whose building was not moldy).
- The Stachylysin™ test did not distinguish between employees who worked in areas where *Stachybotrys* was found and those who worked in areas where *Stachybotrys* was not found.

What Scotia Prince Cruises and The U.S. Customs and Border Patrol Management with the City of Portland Can Do

- Install vapor barriers between interior and exterior walls.
- Seal holes in the building envelope.
- Consult an engineering firm to evaluate grade and settling issues and ways to stop water from entering into the IMT building.
- Improve ventilation in the CBP area.
- Follow a routine maintenance schedule for all ventilation systems.
- Seal roof openings to prevent bird roosting and water incursion.
- Completely seal off the second floor of the IMT from the remainder of the building if it remains un-remediated. This includes the ventilation system.
- Implement an IEQ management plan for the IMT facility.

What Employees Who Have Worked in the IMT Building Can Do

- Report work-related health concerns to the proper management officials.
- Seek evaluation and care from an experienced occupational medicine physician if you have Our sampling showed fungal contamination in the second floor SPC offices but not in other SPC areas that we tested.

a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2005-0126; 2005-0138-3004

CDC Workplace Safety and Health

NIOSH

Health Hazard Evaluation Report 2005-0126 and 2005-0138-3004
International Marine Terminal
Portland, Maine
May 2006

Gregory Thomas, M.D.
Nancy Clark Burton, M.P.H., M.S., C.I.H.

SUMMARY

On February 14, 2005, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) at the offices of Scotia Prince Cruises (SPC) in the International Marine Terminal (IMT) in Portland, Maine. Employees of Scotia Prince Cruises were concerned their respiratory and neurologic symptoms might be related to mold exposure in the IMT building. An indoor environmental quality (IEQ) evaluation by a SPC consultant during the summer of 2004 revealed extensive fungal contamination of the SPC portion of the IMT, and employees were relocated in August 2004 to temporary offices.

On February 16, 2005, the U.S. Customs and Border Protection (CBP) agency, which is also housed in the IMT building, submitted a separate HHE request based on their concern about exposure to mold and water intrusion. On March 9–11, 2005, NIOSH investigators made an initial site visit of the IMT. This visit included the collection of air, dust, and bulk samples for fungal analyses, and environmental measurements of humidity, temperature, and carbon dioxide. Information concerning the ventilation systems was collected. Confidential interviews were conducted with the SPC and CBP employees.

On March 29–30, 2005, NIOSH returned to the IMT to conduct further environmental testing and to complete the confidential interviews of the CBP employees. Blood was collected from the CBP employees for measurement of Stachylysin™, a possible marker of exposure to *Stachybotrys chartarum*. In addition, NIOSH performed an environmental assessment of the U.S. Customs House, another CBP site in Portland with no known history of fungal (mold) contamination in order to compare findings between employees exposed to mold and those not exposed to mold. Confidential interviews and blood collection for Stachylysin™ were performed with the employees of the U.S. Customs House. Blood from some SPC employees that had been previously collected and stored by physicians in Maine and Maryland between September and November 2004, was obtained by NIOSH for Stachylysin™ analysis because it was closer in time to when the employees occupied the building in August 2004.

The SPC section of the IMT had signs of ongoing water intrusion, pigeon roosting, and visible mold growth in wall cavities. Active fungal growth was noted in areas of the second floor by surface (tape) sampling. The CBP section of the IMT had similar signs of water intrusion and pigeon roosting. Overall, in both portions of the IMT building, low levels of airborne fungi were noted. Most airborne fungi were of the *Basidiospore* genus, common in water-damaged buildings. Settled dust samples revealed many types of fungi, including *Penicillium chrysogenum*. Microscopic analysis of tape samples and culturable air samples showed that *Stachybotrys chartarum* spores and numerous other fungi were present. The walk-through survey of the U.S. Customs House revealed no evidence of water intrusion. Fungal ranking

at the U.S. Customs House was found to be similar between indoor and outdoor samples and fungal levels overall were lower indoors than out doors, providing further evidence that there was no fungal contamination problem in the building.

Among the SPC employees, the most commonly reported work-related sy mptoms were memory problems, irritability, and cough. The CBP-IMT wo rkers reported work-related sy mptoms of sinus problems, fatigue, concentration problem s, and irritability most frequently. SPC employ ees had statistically significantly greater rates of work-related cough, wheeze, irritated eyes, headaches, concentration and memory problems, irritability, chest tightness, shortness of breath, fever/sweats, body aches, sinus problems, fatigue, sore or dry throat, sneezing, dizziness, confusion, depression, and changes in sleep than Customs House employees. The CBP I MT group had higher rates of work-rel ated cough, shortness of breath, body aches, sinus problem s, fatigue, irritated/watery eyes, headaches, nosebleeds, sore or dry throat, sneezing, concentration proble ms, confusion, memory problems, irritability, and depression than Customs House employees but these differences were not statistically significant.

Serum Stachylysin™ concentrations exhibited poor reproducibility, with same sample mean coefficient of variation of 35.8%. Only one blood sample (from an SPC em ployee) was considered positive (greater than or equal to 41.4 nanogram per milliliter [ng/ml]) for Stachy lysin™. Overall, neither the presence of Stachylysin™ nor its concentrations correlated with our assessment of fungal exposure.

NIOSH investigators documented ongoing wa ter incursion and subseque nt fungal contamination in the IMT building. Employees in the IMT had symptoms consistent with fungal exposure. Therefore, a health hazard did exist at the IM T building. The serum Stachylysin™ test showed poor reproducibility when used in the field. Recommendations concerning remediation and the establishmen t of an IEQ management program are included in this report.

Keywords: NAICS 483114 (Ferries), 9211 30 (Public Finance, Taxation, and Monet ary Policy), biological monitoring, Stachylysin™, Chrysolysin™, mold, mold spores, moisture incursion, ventilation, IEQ, indoor environmental quality

Table of Contents

INTRODUCTION

On February 14, 2005, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) at the offices of Scotia Prince Cruises (SPC) in the International Marine Terminal (IMT) in Portland, Maine. The request stated that staff had concerns about exposure to mold in their IMT offices. Employees reported a variety of health effects, including fatigue; sweats; body aches; weakness; sinus problems; photosensitivity; blurred vision and watery, irritated eyes; cough; shortness of breath; headache; vertigo; memory and concentration difficulty; numbness; tingling; and mood swings. On February 16, 2005, the U.S. Customs and Border Protection (CBP) agency, which is also housed in the IMT building, submitted a separate HHE request.

After review of the requests and telephone consultations with the requesters and representatives of the City of Portland, a site visit was made on March 9, 2005. An opening conference was held at the Portland City hall with the management and employee representatives of SPC, representatives of the CBP (including their local union representatives), representatives of the City of Portland (including their general counsel), and representatives of three environmental consultant groups (two hired by SPC and one hired by the City of Portland). Following the opening conference, a walk-through tour of the IMT was conducted. On March 10, 2005, confidential interviews were conducted with SPC and CBP employees. In addition, environmental sampling was performed in the IMT. Following the site visit, a closing conference was held in the Portland City Hall so that preliminary findings and recommendations could be communicated to all interested parties.

On March 29, 2005, NIOSH investigators returned to Portland for a follow-up evaluation. The purpose of this visit was to conduct confidential interviews with CBP employees absent on the initial visit, collect additional environmental samples, and draw blood for fungal hemolysin testing to field test a laboratory method developed to look for biomarkers of fungal exposure. In addition, an environmental survey, confidential interviews, and blood sampling were performed at the U.S. Customs House, another CBP site in Portland with no known history of fungal contamination.

BACKGROUND

Facility Descriptions

IMT

The IMT building was constructed in 1909 as a warehouse. It sits on the edge of the Portland Harbor on wooden supports. Both the CBP and SPC lease space in the IMT from the City of Portland and employed 10 and 15 workers, respectively. SPC operates a passenger and auto ferry between Portland, Maine and Yarmouth, Nova Scotia. The CBP officers are responsible for inspecting incoming international passengers and goods and have corresponding administrative duties.

Originally, the IMT consisted of two separate buildings sharing a common roof canopy. The "west" or "south" building housed the SPC operational offices, ticket office, and storage warehouse. The "east" or "north" building contained two passenger boarding areas, SPC administrative offices, a tourism counter, the mailroom, and the CBP offices and inspection areas. The city started abatement of water-damaged, moldy parts of the IMT building (the "east" or "north" building) in October 2004. In January 2005, the City of Portland demolished the "west" or "south" IMT building because of structural deficiencies related to water incursion.

The current IMT building is divided into two areas (the SPC area and the CBP area). The SPC area consists of two large open passenger areas with a two-story office and administrative space between the open areas. The south passenger area has a drop ceiling and the north passenger area is open to the roof deck. There is also a banking area in one corner that consists of a secure metal room with a single window air

conditioning unit that provides ventilation to the area. With the exception of the office and bank areas, planned mold abatement of this SPC space was approximately two thirds complete at the time of the first NIOSH site visit and was not occupied by the SPC staff.

The SPC space is ventilated by three heating, ventilating, and air-conditioning (HVAC) units located on the second floor. These HVAC units are part of a constant air volume (CAV) system that provides at least 10% outside air. The outside air intakes for these units are located on the outside of the building over the canopy roof facing the parking lot. The units had undergone routine maintenance work in the winter of 2005, including cleaning and fiberglass filter replacement. Gas-fired heating units are suspended from the ceiling of the SPC area to provide additional heating. In 2000, a portion of the exterior walls was replaced by a sealed concrete surface over a corrugated metal surface with fiberglass insulation between the exterior walls and sheet rock.

The CBP area has perimeter offices and a large open public area in the center with two entryways on either side of the building. Fungal growth in the exterior walls of the CBP side was abated in the winter of 2005 prior to the first NIOSH site visit. The main office area is served by four fan coil units (FCUs) located along the perimeter walls. The units have permanent plastic matrix filters designed to be cleaned and reused. The air intakes for these units are located on the outside harbor side of the building approximately one foot from large flower planters. Gas-fired heating units are suspended from the ceiling of the CBP area to provide additional heating. The CBP offices are carpeted, and the public area has vinyl tile flooring. Two CBP offices in the front of the building are not mechanically ventilated.

U.S. Customs House

The U.S. Customs House is located a few blocks from the IMT. It has no significant history of water incursion or mold problems, and was chosen by NIOSH investigators as a comparison to the IMT based on location and similarity of workforce duties for the CBP. It was built in 1871 and is being fully restored and updated to comply with current building codes. The ventilation system for this building consists of a geothermal hot water system for heating, and traditional air-conditioning for cooling.

Some staff of the U.S. Customs House use a separate parking garage storage area across the street for paper record storage and spend up to 3 hours per day at this location. There is no mechanical ventilation system in this storage area.

U.S. Customs Vehicle Inspection Building

The U.S. Customs staff uses a small two-story office building in the parking lot of the IMT while performing vehicle inspections in the summer. At the time of the NIOSH site visit, the building was not staffed. The building has a history of pipes freezing and breaking during the winter. The building has an electric air-conditioning and heating system.

Review of Previous Indoor Environmental Quality and Health Complaint Evaluations of the IMT Building

Employee health complaints attributed to the deteriorated condition of the IMT building prompted SPC to hire Environmental Management, Inc. (EMI) to perform an indoor environmental quality (IEQ) evaluation of both IMT buildings during July/August 2004. This consultant identified extensive fungal contamination within the buildings, including *Penicillium* and *Stachybotrys chartarum*. Elevated levels of these fungi compelled SPC to evacuate the building on August 23, 2004. The City of Portland contracted its own IEQ consultant, Turner Building Science, LLC, who released a report concerning the IMT in August 2004. The Turner Building Science report detailed evidence of moisture incursion and mold growth in both sections of the IMT building, with the heaviest growth along the walls that faced the harbor. They found evidence

of bird roosting, moisture damage around the edges of the doorways, and mold growth in the interior wall cavities.

In early fall 2004, abatement efforts were begun on the "east" or "north" IMT building. During this process, SPC continued to function at a reduced capacity out of trailers in the IMT parking lot. In September and October 2004, SPC employees were evaluated by a local physician, and blood was drawn to assess exposure to mold and other compounds that might be found in the IMT environment. In November 2004, all SPC employees went to a physician in Maryland for evaluation of possible mold-related illnesses. This physician collected blood from the SPC employees, part of which was used for testing and the remainder frozen for possible future testing. The CBP staff remained in the IMT building during the abatement process and none sought medical care.

METHODS

Medical

Private interviews were conducted using a questionnaire either in person or by telephone with SPC, CBP, and U.S. Customs House employees. The interviews focused on job history, overall health, respiratory and allergy history, and any symptoms perceived to be building related. Questionnaire data were analyzed using SAS software Version 8.2. Between group differences in symptom prevalence were analyzed using the Fisher's Exact Test. Findings with a p-value less than or equal to 0.05 were considered statistically significant.

After obtaining informed consent from CBP employees at the IMT and U.S. Customs House, we drew blood samples. With their consent, we obtained the stored blood samples from SPC employees collected between September and November 2004. These blood samples were tested for Stachylysin™, a potential biomarker of exposure to *Stachybotrys chartarum*, a fungus found in the IMT. Additional testing was planned for Chrysolysin™, a potential biomarker for *Penicillium chrysogenum,* another fungus found in the IMT, but this test was not completed due to ongoing analytical issues. The NIOSH Human Subject Review Board reviewed and approved all aspects of the medical evaluation.

Environmental Evaluation

Prior environmental sampling reports concerning the IMT building were reviewed. Environmental samples were collected in the IMT, U.S. Customs House, U.S. Customs House storage, and the vehicle inspections building. During the first site visit on March 10, 2005, eight sticky tape samples for microscopic fungal analysis were collected in the SPC area from ventilation grilles and wall surfaces, and two sticky tape samples were collected from the two FCU filters in the CBP area. Three bulk dust samples were collected from the FCUs in the CBP area and were cultured for fungi using corn meal agar (CMA) and malt extract agars (MEA). A smoke tube was used to visualize airflow patterns within the building and to assess pressurization with respect to the outside. A TRAMEX Moisture Encounter meter was used to qualitatively assess the interior wall moisture levels.

During the second site visit, a more detailed environmental evaluation was conducted. Air sampling using Andersen N-6 samplers with MEA agar plates at 28.3 liters per minute (Lpm) was performed at three indoor locations in the CBP area and near the outside air intakes. Similar sampling was performed at the U.S. Customs House at two indoor and one outdoor location. Spore trap samples were collected using Air-o-Cell® samplers at 15 Lpm at the same sampling locations. Three additional air samples were collected at the CBP location using an SKC Inhalable Button™ Sampler with a 2.0-micrometer pore size polycarbonate filter at 3.5 Lpm. These samples were analyzed using quantitative polymerase chain reaction (PCR). The PCR analysis panel includes 35 species of fungi commonly associated with water-damaged indoor environments as patented by the U.S. Environmental Protection Agency (EPA)

(http://www.epa.gov/nerlcwww/moldtech.htm). Five dust samples were collected using a filter "sock" with a high efficiency particulate air (HEPA) vacuum. Three samples were from areas where water incursion was known to have occurred in the CBP-IMT section, and two were from occupied areas in the U.S. Customs House. These samples were analyzed using the same standardized quantitative PCR technique. The PCR analyses were conducted by the U.S. EPA in Cincinnati, Ohio. Two sticky tape samples were collected of filter dust from the U.S. Customs House. Measurements of carbon dioxide (CO_2), temperature, and relative humidity were made throughout the workday using TSI Q-Trak™ Indoor Air Quality monitors.

Stachylysin™ Assay

Stachylysin™ enzyme-linked immunosorbent assays (ELISAs) were performed (with some modification) by the ELISA II method (1-day, 4°C incubation of sample with antibody) of Van Emon, et al.[1] Microtiter plates (NUNC Maxisorb microplates [Nalgene, Naperville, IL]) were coated with 100 microliters (µl) of 250 ng/ml stachylysin-bovine serum conjugate in coating buffer (0.1 M carbonate-bicarbonate buffer, pH 9.6 Sigma Chemical, St. Louis, MO) and incubated overnight at 4°C.[2,3] After incubation, the coated plates were washed three times with phosphate-buffered saline-0.05% Tween 20 (PBST, Sigma). Standards of 11 different concentrations of stachylysin-BSA (0 to 62.5 ng/ml) diluted in 1:20 diluted (PBST) commercially available human sera or diluted (1:20 in PBST) subject sera (in triplicate) were mixed with affinity-purified rabbit anti-stachylysin IgG (Bethyl Larboratories, Montgomery, TX) diluted 1:20,000 in PBST) in test tubes and incubated at 4 °C for 24 hours. Two-hundred µl of the incubated standards or sera mixtures were added to the wells of a previously coated microtiter plate and incubated for 2 hours at 23°C with shaking. The plates were washed three times with PBST and 100 µl (diluted 1:1200 in PBST) of goat anti-rabbit IgG alkaline phosphatase conjugate (Sigma) added. The plates were again incubated for 2 hours at 23°C with shaking and washed three times with PBST. One-hundred µl of alkaline phosphatase substrate (SIGMAFAST™ p-nitrophenyl phosphate reconstituted in distilled water) was added to the wells and incubated (with shaking) for 21 minutes at room temperature. The optical density (OD) of the yellow p-nitrophenol was read at 405 nm (Molecular Devices SpectraMax 190 plate reader). Samples were run in two batches three times independently. Stachylysin™ concentration was inversely proportional to OD.

Standard curves were constructed. A one way analysis of variance (ANOVA) (SigmaStat, Systat) was used to investigate whether there were any significant differences in standard curve versus sample responses or in interpolated values between triplicates. Serum samples having a Stachylysin™ concentration greater than the mean value of the comparison group plus two standard deviations were considered positive based on the analytical limit of quantification. A type 1 error level of $p < 0.05$ was considered statistically significant.

EVALUATION CRITERIA

Microbial Contamination

Exposure to microbes is not unique to the indoor environment. No environment, indoors or out, is completely free from microbes, not even a surgical operating room. Nevertheless, media reports and some scientific studies have suggested an association between building occupant symptoms and indoor fungi (mold), bacteria, or endotoxin concentrations. Remediation of microbial contamination may improve IEQ conditions even though a specific cause-effect relationship is not determined. NIOSH investigators routinely recommend the remediation of observed microbial contamination and the correction of situations that are favorable for microbial growth and bioaerosol dissemination.

Mold

The types and severity of symptoms related to exposure to mold in the indoor environment depend in part on the extent of the mold present,

the extent of the individual's exposure, and the susceptibility of individuals (for example, whether they have pre-existing allergies or asthma). In general, excessive exposure to fungi may produce health problems by several primary mechanisms, including: (1) allergy or hypersensitivity, (2) infection, and (3) toxic effects. Additionally, molds produce a variety of volatile organic compounds, the most common of which is ethanol.

Allergic responses are the most common type of health problem associated with exposure to molds. These health problems may include sneezing; itching of the nose, eyes, mouth, or throat; nasal stuffiness and runny nose; and red, itchy eyes. Repeated or single exposure to mold or mold spores may cause previously non-sensitized individuals to become sensitized. Molds can trigger asthma symptoms (shortness of breath, wheezing, cough) in persons who are allergic to mold. A recent review of the scientific literature concluded that exposure to molds in the indoor environment may make pre-existing asthma worse, but also concluded that there was not enough evidence to determine whether exposure to mold in the indoor environment could cause asthma.[4] Hypersensitivity pneumonitis (HP) is another allergic response that has developed in people following extensive short-term (acute) or long-term (chronic) exposure to molds. It is a very rare illness, which may resemble bacterial pneumonia, and typically involves respiratory symptoms (such as cough, wheezing, or shortness of breath) as well as other symptoms (such as extreme fatigue and low-grade fever).

People with weakened immune systems (immune-compromised or immune-suppressed individuals) may be more vulnerable to infections by molds. For example, *Aspergillus fumigatus*, a mold that has been found on almost every substrate, has been known to infect the lungs of immune-compromised individuals after inhalation of the airborne spores.[5] Healthy individuals are usually not vulnerable to infections from airborne mold exposure.

Recently, there has been increased concern related to exposure to specific molds that produce toxic substances called mycotoxins. Illness associated with exposures (from inhalation and/or skin contact) to mycotoxins in agricultural or industrial environments has been reported. However, there is currently no conclusive evidence of a link between mycotoxin exposure in the indoor environment and human illness.[6, 7, 8] It is important to note that many molds can potentially produce toxins given the right conditions.

No exposure guidelines for mold in air exist, so it is not possible to distinguish between "safe" and "unsafe" levels of exposure. Nevertheless, the potential for health problems is an important reason to prevent indoor mold growth and to remediate any indoor mold contamination. Moisture intrusion along with nutrient sources such as building materials or furnishings allows mold to grow indoors, so it is important to keep the building interior and furnishings dry. NIOSH concurs with the EPA's recommendations to remedy mold contamination in indoor environments (www.epa.gov/iaq/molds/mold_remediation.html).

Heating, Ventilating, and Air Conditioning

One of the most common deficiencies in the indoor environment is the improper operation and maintenance of ventilation systems and other building components.[9] NIOSH investigators have found correcting HVAC problems often reduces reported symptoms. The majority of studies of ventilation rates and building occupant symptoms have shown that rates below 10 liters per second per person (Ls^{-1}/person) (which equates to 20 cubic feet per minute per person [cfm/person]), are associated with one or more health symptoms.[10] Moreover, higher ventilation rates, from 10 Ls^{-1}/person up to 20 Ls^{-1}/person, have been associated with further significant decreases in the prevalence of symptoms.[10] Thus, improved HVAC operation and maintenance, higher ventilation rates, and comfortable temperature and RH can all potentially serve to improve symptoms without ever identifying any specific cause-effect relationships. When conducting an IEQ survey, NIOSH investigators often measure ventilation

and comfort indicators, such as CO_2, temperature, and RH to provide information relative to the functioning and control of HVAC systems.

Carbon Dioxide

CO_2 is a normal constituent of exhaled breath and is not considered a building air pollutant. It is an indicator of whether sufficient quantities of outdoor air are being introduced into an occupied space. However, CO_2 is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual level at the time the CO_2 is measured. ASHRAE recommends an indoor CO_2 concentration within 700 ppm of the outdoor concentration for comfort (odor) reasons.[11] Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. If CO_2 concentrations are elevated, the amount of outdoor air introduced into the ventilated space needs to be increased. ASHRAE's most recently published ventilation standard, *ANSI/ASHRAE 62.1-2004: Ventilation for Acceptable Indoor Air Quality*, recommends outdoor air supply rates of 17 cfm/person for office spaces and libraries, 13 to 15 cfm/person for classrooms (depending on the students' age), 7 cfm/person for reception areas, and 5 cfm/person for auditoriums.[11]

Temperature and Relative Humidity

Temperature and RH measurements are often collected as part of an IEQ investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[12] Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The *ANSI/ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy*, specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[13] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68.5°F to 76°F in the winter, and from 75°F to 80.5°F in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends maintaining RH at or below 65%.[11] Increased humidity can promote the excessive growth of microorganisms and dust mites.

RESULTS

Medical Evaluation

One hundred percent (15/15) of the SPC employees were interviewed; four by telephone and the rest in person. Stored blood samples were available for eleven of these fifteen. One hundred percent (10/10) of the CBP employees working in the IMT were interviewed in person. Blood samples were collected from all ten. Seventy-five percent (15/20) of CBP employees at the U.S. Customs House were interviewed in person and gave blood samples.

The demographic characteristics of the three employee groups are listed in Table 1. The average age for SPC, CBP IMT, and CBP U.S. Customs House employees was 39, 46, and 54 years, respectively. Average job duration at the IMT for SPC and CBP was 47 months, while at the U.S. Customs House it was 134 months. There were more smokers among SPC employees than CBP.

Atopy is the genetic predisposition to develop the classical allergic diseases, which are allergic rhinitis, asthma, and atopic dermatitis or eczema. Forty-seven percent (7/15) of interviewed SPC employees reported a history of allergic rhinitis, eczema, and/or asthma, and thus would be considered atopic. The CBP IMT and the U.S. Customs House groups had a prevalence of atopy of 30% and 43%, respectively. There was no statistically significant difference in atopy prevalence between the three groups.

Symptoms that were reported to be better when off work or since evacuating the IMT building were characterized as work-related. Of note,

most SPC employees reported no change in symptoms after evacuating the IMT, but did acknowledge an improvement in symptoms following treatment by the physician in Maryland. These symptoms are also reported as work-related.

Table 2 compares work-related symptom prevalence between the three groups. Among the SPC employees, the most common work-related symptoms reported were memory problems (71%); irritability (71%); cough (71%), wheeze (64%), eye irritation (64%), sinus complaints (64%); difficulty concentrating (64%); fatigue (64%), and sneeze (62%). SPC employees had statistically significantly higher rates of work-related cough, wheeze, chest tightness, shortness of breath, fever or sweats, body aches, sinus problems, fatigue, itchy or watery eyes, headaches, sore or dry throat, sneezing, dizziness, concentration and memory problems, confusion, irritability, depression, and change in sleep patterns than those in the U.S. Customs House.

SPC employees also had statistically significant higher rates of work-related cough, wheeze, fever/sweats, chest tightness, itchy or watery eyes, dizziness, memory problems, and sleep disturbances than the CBP IMT employees did. Rates of irritability, depression, and change in appetite were also higher but the differences were not statistically significant.

CBP IMT employees reported more work-related cough, sinus problems, headache, itchy or watery eyes, sore or dry throat, confusion, and concentration problems than U.S. Customs House employees but these differences were not statistically significant.

Twenty-seven percent (4/15) of SPC employees had a history of asthma but three were childhood onset and not affected by exposure to the IMT building. The fourth individual had adult-onset asthma and did experience a worsening of symptoms when in the IMT. There were no individuals with a history of asthma in the CBP IMT group. The U.S. Customs House group had two asthmatics, both adult onset, and neither were affected by exposure to the workplace.

Environmental Evaluation

SPC

During the walk-through inspection of the IMT, the following concerns were noted:

- visible ice formation around two windows on the harbor side of the building in the open ceiling area
- an active leak from the roof onto the carpeting next to the stairwell on the second floor of the SPC over the abated portion of the first floor
- dirty supply air grilles in the central SPC area
- water stains on the wood underneath the HVAC systems, and signs of leakage into the occupied space below
- rainwater entering the building under the entry doors
- pigeons actively roosting in the stairwell area
- visible mold growth in the wall cavities
- water leakage around the first floor windows facing the harbor. High moisture readings were observed for the interior walls in this area
- low moisture readings were noted for walls on the second floor. This included the office facing the harbor, wall near HVAC units, stairwell, and middle office
- visible corrosion of metal studs along the exposed outside walls in the SPC area
- no visual evidence of a moisture barrier in the walls

Tape sample results for all locations are shown in Table 3. Fungal contamination was identified in the wall cavity in the second-floor lunch room (*Penicillium and Chaetomium*) and middle office ceiling tile samples (*Alterneria*) for the second floor of the SPC section. No fungi were found on the other six tape samples in the SPC area. Prior sampling data collected for this portion of the building showed extensive microbial contamination both within the interior air space and inside wall cavities.

CBP- IMT

The walk-through inspection of the CBP-IMT area revealed the following concerns:

- electrical safety problems from water incursion under the exterior harbor-side wall and both exterior doors
- evidence of pigeon roosting
- leaks from holes in the roof
- the FCU nearest the harbor exterior door had operating instructions lying in the condensate drain pan. The paper instructions had heavy microbial contamination, which was likely disseminated into the occupied area when the unit was operating
- leakage around the overhead heating unit in the open public processing area from the flue opening in the roof
- air flow patterns showed little if any air moving in the front offices that were used for interviews
- the men's restroom exhaust fan was not working
- wet carpeting in the previously-abated office area that faced the harbor

Table 4 presents the PCR air sample results for the CBP section of the IMT building. Low levels of fungi were detected, with the exception of one sample taken at the side wall filing cabinet near where the water was found entering the building. Higher levels of fungi, specifically *Penicillium crustosum* were detected here.

Table 5 shows the results of the five PCR vacuum dust samples taken at all locations. *Penicillium chrysogenum, Aspergillus versicolor,* and *Eurotium Amstelodami* were found in the three PCR vacuum samples of carpeting, along with low levels of several other fungi. Sticky tape samples documented high levels of *Stachybotrys chartarum* contamination on the CBP FCU that contained the instructions (Table 3).

Fungal growth was identified on all three bulk samples (Table 6) from the FCU filters. MEA media is a general growth media for fungi associated with damp environments, and CMA media is used to enhance the growth of organisms such as *Stachybotrys* that prefer a cellulose-based material. *Alterneria*, *Basidiomycetes*, *Chaetomium*, *Cladosporium*, *Penicillium*, *Stachybotrys,* and *Paecilomyces* were among the species identified.

The spore trap air sample results (Table 7) show that *Basidiospores, Aspergillus/Penicillium, Ascospores,* and *Cladosporium* were found in all samples. The concentrations were lower indoors than outdoors, but the *Basidiospores* ranking was higher indoors.

Table 8 presents the results of air sampling using an Andersen N-6 sampler. The colony counts were slightly lower in doors than outdoors. *Basidiospores* were the predominant genera identified on all samples. *Rhodotorula glutinis, Aspergillus versicolor,* and a few other fungi were found indoors but not outdoors.

Figure 1 shows the range of CO_2 concentrations in the CBP area. CO_2 ranged from 490 to 1030 ppm in the morning and from 545 to 860 ppm in the afternoon on March 10, 2005. CO_2 levels in the front office area were near the ANSI/ASHRAE-recommended maximum concentration of 700 ppm plus outdoor concentration (350 ppm) in the morning. The remaining CO_2 concentrations were within acceptable ranges according to the ANSI/ASHRAE guidelines. Figure 2 presents the temperature ranges (70°F to 75°F) obtained during the same time frame. These temperatures are considered in the acceptable range in conjunction with a RH of 50%. Figure 3 gives the relative humidity ranges (13%-18%) for the sampling period. These values are fairly low but not uncommon during the heating season.

CBP Vehicle Inspection Building

In the CBP vehicle inspection building, there was visible evidence of water incursion on the ceiling tiles on both levels and around exterior windows. Three tape samples were collected in the small vehicle inspection building where visible water incursion had occurred (Table 3). No fungal structures were identified on these samples.

U. S. Customs House

The U.S. Customs House had no visible evidence of water incursion. To make the fiberglass filters fit into the ventilation units, the filters were bent, which damaged the filter and allowed unfiltered air to flow around the filter into the room air. Two tape samples collected on the filters in two U.S. Custom House ventilation units showed no evidence of fungal growth. The two vacuum dust samples (Table 5) revealed predominantly *Eurotium amstelodami* and *Penicillium chrysogenum.*

The spore trap air sample results (Table 7) show that *Basidiospores, Ascospores, Aspergillus/Penicillium,* and *Cladosporium* were found in all spore trap samples, with concentrations indoors slightly lower than outdoors. Fungal ranking was similar between the indoor and outdoor samples.

Table 8 presents the results of air sampling using an Andersen N-6 sampler. The colony counts were much lower indoors than outdoors. *Basidiospores* were present indoors and outdoors, as was *Cladosporium*. *Penicillium* was identified indoors but not outdoors.

The garage storage area had water leaking along the ceiling edges of the room, and there were visible water stains on some of the storage boxes. Two tape samples (Table 3) were collected in the underground parking storage area for microscopic analysis for fungal growth. One tape showed no evidence of growth. The other tape collected on the top wooden shelf under a visible ceiling leak showed some evidence of *Aspergillus* growth.

Serum Stachylysin™ Results

The Stachylysin™ assay exhibited excellent linearity. A plot of the observed concentration of Stachylysin™ versus the concentration of Stachylysin™ added to the system showed an R^2 value of 0.989 and a slope of 0.999. Reproducibility of the standards was excellent with a triplicate intra-assay coefficient of variation (CV) of 5.1 and an inter-assay CV of 6.4 for the six standard curves.

The limit of detection (LOD) of the assay was 0.15 ng/ml, which, when adjusted for the 1:20 sera dilution used in measuring samples, was 3.0 ng/ml Stachylysin™. Stachylysin™ sera concentrations, measured in all employees, ranged from non-detectable (ND) to 46.8 ng/ml (Table 9). However, the mean CV for sera of exposed individuals was 35.8, much greater than that of the standards triplicates. Because of this high CV, our subsequent cut-off for labeling a test as positive was 41.4 ng/ml. Based on this cut-off, only one sample was positive. The source for this one positive Stachylysin™ test was an SPC employee. The mean Stachylysin™ concentration for CBP-IMT and U.S. Customs House employees were 14.2 ng/ml (range: ND-29.5 ng/ml) and 20.5 ng/ml (range: 9.1-38.9 ng/ml), respectively. The mean Stachylysin™ concentration for SPC employees 3-8 weeks after leaving the IMT was 6.6 ng/ml (range: ND-22.2 ng/ml), and 10-12 weeks after leaving the IMT was 9.6 ng/ml (range: ND-46.8 ng/ml). The Chrysolysin™ assay is still under development. If the laboratory assay work provides a functional test, the stored sera samples will be analyzed, and this report will be amended.

DISCUSSION/ CONCLUSIONS

There is evidence that widespread and ongoing water incursion has occurred in many areas of the IMT resulting in substantial microbial growth. The current abatement work does not address the underlying problem of no moisture barriers in the exterior walls. The presence of *Basidiospores* (commonly associated with wood rot) was not unexpected because the building is sitting on wooden piers in the water. These microorganisms were also the predominant species in sampling conducted by past consultants. The results of the environmental sampling performed by NIOSH in the IMT building showed residual fungal contamination. *Stachybotrys chartarum* spores were detected in one CBP FCU. The abatement work that has been completed removed much of the visible mold but did not address the underlying water

incursion problems. The walk-through survey identified areas in the IMT roof that still allowed water incursion and access for birds. Signs of water damage were identified throughout the IMT, vehicle inspection, and parking buildings.

SPC and CBP IMT employees reported work-related symptoms consistent with those known to occur in damp and/or moldy buildings. In the 2004 report, "Damp Indoor Spaces and Health," the Institute of Medicine (IOM) found sufficient evidence of an association between mold or dampness indoors and nasal and throat symptoms, asthma symptoms in sensitized asthmatics, wheeze, cough, and HP in susceptible persons.[4] The IOM found limited or suggestive evidence of an association between lower respiratory illness in healthy children and damp indoor spaces. There was inadequate or insufficient evidence to determine whether an association exists between dyspnea, airflow obstruction in healthy persons, mucous membrane irritation, skin symptoms, COPD, asthma development, inhalation fevers in non-occupational settings, fatigue, cancer, reproductive effects, neuropsychiatric effects, lower respiratory illness in healthy adults, GI problems, rheumatologic or immune problems, or acute idiopathic pulmonary hemorrhage in infants. No health conditions met the level of evidence for causation. Recently, a small number of published reports implicated molds and mycotoxins in indoor environments as a cause of chronic toxic encephalopathy (CTE). However, these studies have been reviewed by the IOM, which concluded there is insufficient evidence that mold or other agents in damp indoor environments cause neuropsychiatric disease. We also reviewed this literature and concur with the IOM. However, interest in this topic is high and research is ongoing.

SPC and CBP IMT employees had higher rates of respiratory symptoms than the CBP U.S. Customs House employees did, which is consistent with exposure to a building with extensive water damage and microbial contamination. One employee experienced asthma exacerbations. We found that SPC employees had significantly higher rates of most symptoms than either of the CBP employees groups did, despite the CBP-IMT employees being co-located with SPC employees. One potential explanation is that the SPC and CBP IMT employees could have different levels or types of exposure. The SPC and CBP portions of the IMT were supplied by different HVAC systems. SPC employees worked in the now demolished west (south) building, which according to earlier consultant reports may have had more severe water damage than the remaining IMT building.

The use of the current Stachylysin™ assay as a biomarker of internal exposure to Stachybotrys chartarum is limited by its lack of reproducibility. In addition, the assay does not appear to correlate well with environmental sampling measurements of exposure. Until these issues are resolved, the assay does not seem useful in investigations of Stachybotrys chartarum exposure. The Stachylysin™ assay results exhibited high same sample variability. Van Emon et al. reported that rats exposed via nasal instillation to the same dose of *Stachybotrys chartarum* conidia exhibited significant variations in serum Stachylysin™ concentrations. The highest Stachylysin™ group mean occurred in the comparison group (U.S. Customs House) expected to have the lowest rate of mold exposure. However, the lower levels of Stachylysin™ found in the SPC group may have resulted in part from the 3-12 week delay between last exposure and blood collection. The CBP IMT employees were still working in the building at the time their blood was drawn.

RECOMMENDATIONS

The following recommendations are based on the observations of NIOSH investigators during the course of the HHE. Most of these recommendations were discussed at the closing conference. Additional work has been done at the remaining north (east) building of the IMT since the NIOSH site visit. However, the underlying structural defects of the building have not been addressed, resulting in a high likelihood of continued microbial growth. The

following structural, mechanical, and administrative recommendations should be considered if the IMT facility is to continue operating:

1. Vapor barriers should be installed between the interior and exterior walls to prevent water vapor from entering the interior wall cavities.[14]

2. Porous materials that have been wet for more than 48 hours, including carpeting, should be removed because they cannot be effectively cleaned and will support microbial growth.

3. Water drainage into the building should be addressed. The City of Portland should contact an engineering firm to determine whether the water can be diverted from entrances. It appears that the floor of the building is below grade due to settling, which will need to be addressed by a qualified engineering consultant. To prevent electrocution and equipment damage in the event the floor becomes flooded, all electrical devices and computer systems should be located off the floor. A ground fault circuit interrupter (GFCI) could be used as an additional safety device. Water incursion into the U.S. Customs House parking storage area and the CBP vehicle inspection building also needs to be addressed for the preservation of records and to address employee concerns.

4. Ventilation should be provided to any CBP area offices that serve as interview areas. ASHRAE recommends supplying 17 cfm/person of combined air (5 cfm/person of outdoor air) to these areas.[11] The bathroom exhaust systems need to be repaired and operational to meet local building codes.

5. A routine maintenance schedule for all the ventilation systems should be established and followed. The filters in the U.S. Customs House need to be of the appropriate size so that they fit properly and provide the necessary filtration.

6. If the second floor of the SPC area is not renovated, the entire second floor will need to be completely sealed from the other occupied areas of the building. There also is the potential for mold growth to spread from the second floor to the first floor via openings in the wall cavities, as well as to be disseminated through the ventilation system.

7. Openings in the roof should be sealed to prevent birds from roosting in the building ceiling space.

8. To improve communication between building tenants (SPC and CBP) and the City of Portland, building occupants should be told what steps have been taken to address indoor IEQ at the IMT, and why these decisions were made.

An IEQ Management Plan for the IMT facility should be implemented to address the IEQ issues that have evolved over the past several years. An IEQ manager or administrator with clearly defined responsibilities, authority, and resources should be selected. This individual should have a good understanding of the building's structure and function, and should be able to effectively communicate with occupants. Although comprehensive regulatory standards specific to IEQ have not been established, guidelines have been developed by organizations such as ASHRAE, NIOSH, and EPA. An IMT worker representative who can speak for the Scotia Prince and U.S. Customs employees and assist with communication should be included in the program. The NIOSH/EPA Document, Building Air Quality: A Guide for Building Owners and Facility Managers may be helpful for developing and implementing the IEQ management plan.[15] A companion NIOSH/EPA guide: Building Air Quality Action Plan was provided and can serve as

a checklist for developing and assessing an IEQ management program.[16] These are available at http://www.cdc.gov/niosh/pdfs/iaq.pdf and http://www.epa.gov/iaq/largebldgs/graphics/baqactionplan.pdf, respectively. The EPA has also established an IEQ information clearingho use that can provide information on a number of IEQ-related topics and has a website specifically for IEQ issues (http://www.epa.gov/iaq/index.html). Information on consultants is available from the American Industrial Hygiene Association's Guidelines for Selecting an Indoor Air Quality Consultant.[17].

9. Because neither SPCn or CBPIMT employees are working in the IMT now, symptoms attributable to fungal exposure there should resolve. However, any employee with continued health concerns should seek evaluation and care from a physician who is residency trained and board certified in occupational medicine, and is familiar with the types of exposures employees may have had and their health effects. You can locate these occupatio nal medicine physicians through a variety of sources, including the Association of Occupational and Environmental Clinics at www.aoec.org, and the American College of Occupational and Environmental Medicine (ACOEM) at www.acoem.org. It may be useful to provide the physician with a copy of this report.

REFERENCES

1. Van Emon JM, Reed AW, Yike I, Vesper SJ. [2003]. ELISA measurement of stachylysin in serum to quantify human exposures to the indoor mold Stachybotrys chartarum. J Occup Environ Med. 45:582-591.

2. Vesper SJ, Vesper MJ. [2002]. Stachylysin may be a cause of hemorrhaging in humans exposed to Stachybotrys chartarum. Infect Immun. 70:2065-2069.

3. Vesper SJ, Magnuson ML, Dearborn DG, Yike I, Haugland RA. [2001]. Initial characterization of the hemolysin stachylysin from Stachybotrys chartarum. Infect Immun. 69:912-916.

4. IOM [2004]. Human health effects associated with damp indoor environments. In: Damp indoor spaces and health. National Academy Press, Washington, DC. 183-269.

5. Wald P, Stave G [1994]. Fungi (Chapter 24). In: Physical and Biological Hazards of the Workplace. New York, NY: Van Nostrand Reinhold, pp. 394.

6. Page E, Trout D [2001]. Role of *Stachybotrys* mycotoxins in building-related illness. AIHA J 62:644-648.

7. Robbins C, Swenson L, Neally M, Gots R, and Kelman B [2000]. Health effects of mycotoxins in indoor air: a critical review. Appl Occup Environ Hyg 15(10):773-784.

8. Abba TI [2001]. Stachybotrys: relevance to human disease. Ann Allergy Asthma Immunol 87:57-63.

9. Rosenstock L [1996]. NIOSH Testimony to the U.S. Department of Labor on indoor air quality. Appl Occup Environ Hyg 11(12):1365-1370.

10. Seppanen OA, Fisk WJ, Mendell MJ [1999]. Association of ventilation rates and CO_2 concentrations with health and other responses in commercial and institutional buildings. Indoor Air 9:226-252.

11. ANSI/ASHRAE [2004]. Ventilation for acceptable indoor air quality, standard 62.1-2004. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

12. NIOSH [1986]. Criteria for a recommended standard: occupational exposure to hot environments, revised criteria. Cincinnati, OH: U.S. Department of Health and Human

Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-13.

13. ANSI/ASHRAE [2004]. Thermal environmental conditions for human occupancy. American National Standards Institute/ASHRAE standard 55-2004. Atlanta, GA: American Society for Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

14. EPA [2001]. Mold remediation in schools and commercial buildings. Washington, DC: United States. Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division. EPA Publication No. 402-K-01-001. http://www.epa.gov/mold/images/moldremediation.pdf

15. NIOSH/EPA [1991].Building Air Quality: A Guide for Building Owners and Facility Managers Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 91-114; EPA Publication No. 400/1-91/003. http://www.cdc.gov/niosh/pdfs/iaq.pdf

16. NIOSH/EPA [1998]. Building Air Quality Action Plan. Washington. D.C. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 98-123; EPA Publication No. 402-K-98-001. http://www.epa.gov/iaq/largebldgs/graphics/baqactionplan.pdf

17. AIHA [2006].Consultants List. Fairfax, VA: American Industrial Hygiene Association. http://www.aiha.org/Content/AccessInfo/consult/consultlisting.htm

Table 1
Demographic Comparison of Employee Groups
U.S. Customs and Border Protection, Scotia Prince Cruises, U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10 and 29, 2005

Cohort Characteristics	SPC (N=15)	CBP IMT (N=10)	CBP U.S. Customs House (N=15)
Mean Age (years)	39.4	46.5	54.0
Male/Female Ratio	79/21	90/10	64/36
% Current Smokers	36	10	14
Mean Job Duration (months)	47.6	47.8	134
% With History of Atopy	47	30	43

Table 2
Prevalence of Self-reported Work-related Symptoms by Employee Group
U.S. Customs and Border Protection (CBP-IMT), Scotia Prince Cruises (SPC), U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004

Symptom	**SPC versus CBP IMT (%)**	**CBP-IMT versus U.S. Customs House (%)**	**SPC versus U.S. Customs House (%)**
Cough	71 vs 20 (p=**.04**)	20 vs 0 (p=.16)	71 vs 0 (p<**.01**)
Wheeze	64 vs 20 (p<**.01**)	0 vs 0	64 vs 0 (p<**.01**)
Chest tightness	36 vs 0 (p=**.05**)	0 vs 0	36 vs 0 (p=**.04**)
Shortness of breath	43 vs 20 (p=.39)	20 vs 0 (p=.16)	43 vs 0 (p=**.02**)
Fever/Sweats	36 vs 0 (p=**.05**)	0 vs 0	36 vs 0 (p=**.04**)
Body aches	36 vs 10 (p=.34)	10 vs 0 (p=.42)	36 vs 0 (p=**.04**)
Sinus problems	64 vs 40 (p=.41)	40 vs 14 (p=.19)	64 vs 14 (p=**.02**)
Fatigue	64 vs 30 (p=.21)	30 vs 14 (p=.61)	64 vs 14 (p=**.02**)
Rash	7 vs 0 (p=1.00)	0 vs 0	7 vs 0 (p=1.00)
Irritated/Watery eyes	64 vs 20 (p=**.05**)	20 vs 0 (p=.16)	64 vs 0 (p<**.01**)
Headaches	54 vs 20 (p=.20)	20 vs 0 (p=.16)	54 vs 0 (p<**.01**)
Nosebleeds	0 vs 20 (p=.16)	20 vs 0 (p=.16)	0 vs 0
Sore or dry throat	43 vs 20 (p=.39)	20 vs 0 (p=.16)	43 vs 0 (p=**.02**)
Sneezing	62 vs 30 (p=.21)	30 vs 14 (p=.61)	62 vs 14 (p=**.02**)
Dizziness	43 vs 0 (p=**.02**)	0 vs 0	43vs 0 (p=**.02**)
Concentration problems	64 vs 30 (p=.21)	30 vs 0 (p=.06)	64 vs 0 (p<**.01**)
Confusion	36 vs 20 (p=.65)	20 vs 0 (p=.16)	36 vs 0 (p=**.04**)
Memory problems	71 vs 10 (p<**.01**)	10 vs 0 (p=.42)	71 vs 0 (p<**.01**)
Irritability	71 vs 30 (p=.10)	30 vs 7 (p=.27)	71 vs 7 (p<**.01**)
Depression	50 vs 10 (p=.08)	10 vs 7 (p=1.00)	50 vs 7 (p=**.03**)
Change in sleep	46 vs 0 (p=**.02**)	0 vs 7 (p=1.00)	50 vs 7 (p=**.03**)
Change in appetite	31 vs 0 (p=.10)	0 vs 7 (p=1.00)	31 vs 7 (p=.16)

Significant p-values **in bold**.

Table 3
Microscopic Sticky Tape Sample Results
U.S. Customs and Border Protection (CBP), Scotia Prince Cruises (SPC), U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10 and 30, 2005

Sample Location	Genera	Amount of Growth
IMT		
SPC Ventilation Grille – Manager's Office	None	None
SPC 2nd Floor Middle Office	*Alterneria* *Cladosporium* *Epicocuum*	Massive Many Many
SPC Jessie's Office Upper Grille (2nd floor)	None	None
SPC Interior Wall under AC Grille off Kitchen Stairwell (many insect fecal pellets present)	*Aspergillus* *Chaetomium* *Pencillium*	A few Many Massive
SPC Supply Grille Central Corridor 2nd Floor	None	None
SPC Supply Grille Mailroom 1st Floor	None	None
SPC Supply Grille Video Room	None	None
SPC Supply Grille Video Room	None	None
CBP Center Univent filter on back wall	None	None
CBP Univent filter with instructions in drain pan	*Stachybotrys chartarum* *Cladosporium* *Ulocladium*	Massive Many A few
Vehicle Inspection Building		
CBP Wall	None	None
CBP Ventilation Unit	None	None
CBP Bathroom	None	None
U.S. Customs House		
U.S. Customs House Parking Garage – Stained Box	None	None
U.S. Customs House Parking Garage – Wooden Shelf	*Aspergillus*	Some
U.S. Customs House Ventilation Filter	None	None
U.S. Customs House Ventilation Filter	None	None

Table 4
Fungal Spore Equivalents in Air Identified by Quantitative Polymerase Chain Reaction (PCR)
U.S. Customs and Border Protection, IMT
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 30, 2005

Location	**Bookcase on Back Wall**	**Side Wall Filing Cabinet**	**Bookcase on Side Wall**
Sampling Time	**8:25 a.m. – 4:47 p.m.**	**8:25 a.m. – 2:21 p.m.**	**8:25 a.m. – 4:48 p.m.**
Concentration	**SE/m^3***	**SE /m^3**	**SE /m^3**
Aspergillus penicillioides	0	4	1
Eurotium (Asp.) amstelodami	16	4	2
Aureobasidium pullulans	1	1	1
Cladosporium cladosporioides-1	11	8	3
Cladosporium cladosporioides-2	0	2	0
Cladosporium herbarum	6	4	3
Cladosporium sphaerospermum	4	0	6
Epicoccum nigrum	31	11	0
Mucor amphibiorum.group	1	4	0
Penicillium crustosum (group 2)	0	436	0
Stachybotrys chartarum	3	16	6
Trichoderma viride/koningii	0	0	0
Wallemia sebi	3	1	1

* SE/m^3 – Spore Equivalent per cubic meter of air

Table 5
Fungal Spores Identified in Dust Samples Identified by PCR
U.S. Customs and Border Protection IMT, U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 30, 2005

Fungal ID	IMT - Carpet under corner bookcase where leaks occur (SE/mg)*	IMT - Carpet under window along side office area (SE/mg)	IMT - Carpet along inside wall where prior leaks had occurred (SE/mg)	Customs House - Marble floor in main room (SE/mg)	Customs House - Carpet behind counter on right side (SE/mg)
Alternaria alternata	ND	ND	31	ND	ND
Aspergillus fumigatus	ND	ND	ND	6	ND
Aspergillus niger	ND	ND	ND	ND	2
Aspergillus penicillioides	ND	29	ND	7	7
Aspergillus unguis	12	ND	ND	ND	8
Aspergillus ustus	ND	ND	ND	62	5
Aspergillus versicolor	778	ND	ND	ND	ND
Eurotium (Asp.) amstelodami	101	401	572	114	636
Aureobasidium pullulans	ND	ND	ND	2	1
Chaetomium globosum	21	38	48	37	86
Cladosporium cladosporioides-1	6	7	12	5	3
Cladosporium cladosporioides-2	19	13	20	4	12
Cladosporium herbarum	14	41	4	2	4
Cladosporium sphaerospermum	3	15	4	6	19
Epicoccum nigrum	ND	16	7	15	27
Mucor amphibiorum/.group	ND	2	9	1	4
Penicillium brevicompactum	70	ND	ND	ND	ND
Penicillium chrysogenum	6834	1137	233	118	268
Penicillium variabile	ND	ND	1	2	2
Rhizopus stolonifer	ND	5	ND	ND	ND
Scopulariopsis brevicaulis/fusca	ND	ND	ND	1	<1
Scopulariopsis chartarum	ND	ND	ND	ND	2
Stachybotrys chartarum	31	18	17	ND	ND
Trichoderma viride/koningii	71	79	20	ND	5
Wallemia sebi	ND	ND	6	ND	2

* SE/mg – Spore Equilivant per milligram of dust

Table 6
Bulk Sample Results for Culturable Fungi
U.S. Customs and Border Protection IMT
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10, 2005

Sampling Location	Sample Media	Total Concentration (CFU/g*)	Fungal Identification Ranking
CBP Center FCU filter on back wall	CMA#	5.9×10^4	*Paecilomyces* (39%) *Penicillium* (22%) *Alternaria* (13%0 *Stachybotrys chartarum* (13%) *Trichoderma* (9%) *Ulocardium botrytis* (4%)
	MEA^	5.9×10^4	*Paecilomyces lilacinus* (35%) *Cladosporium cladosporioides* (22%) *Paecilomyces variotii* (17%) *Pencillium chrysogenum* (17%) *Trichoderma harzianum* (9%)
CBP Center FCU on Side Wall	CMA	2.21×10^6	*Cladosporium* (57%) *Penicillium* (29%) *Paecilomyces* (14%)
	MEA	3.47×10^6	*Basidiomycetes* (55%) *Cladosporium cladosporioides* (22%) *Pencillium variabile* (17%)
CBP Center FCU filter near housekeeping supplies	CMA	8.67×10^5	*Cladosporium* (91%) *Penicillium* (5%) *Paecilomyces* (4%)
	MEA	9.75×10^5	*Cladosporium cladosporioides* (86%) *Cladosporium sphaerospermum* (7%) *Basidiomycetes* (3%) *Paecilomyces variotii* (2%) *Pencillium chrysogenum* (2%) *Pencillium variabile* (<1%)

* CFU/g – colony forming units per gram of dust
# CMA – corn meal agar
^ MEA – malt extract agar

Table 7
Fungal Spores in Air
U.S. Customs and Border Protection IMT, U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 30, 2005

Sampling Location	Sample Volume (L)	Total Fungal Structure (count/m^3*)	Fungal Identification Ranking
IMT – U.S. Customs and Border Patrol			
Bookcase near windows behind desks	75	213	*Basidiospores* (38%) *Aspergillus/Pencillium* like (19%) *Ascospores* (19%) *Cladosporium* (13%) Hyphal Fragments (13%)
Desk along back corner	75	320	*Basidiospores* (29%) *Aspergillus/Pencillium* like (25%) *Ascospores* (17%) *Cladosporium* (17%) Hyphal Fragments (13%)
Desk along side of wall near repair shop	75	187	*Basidiospores* (50%) *Aspergillus/Pencillium* like (14%) *Ascospores* (14%) *Cladosporium* (14%) Hyphal Fragments (7%)
Outdoor	75	400	*Aspergillus/Pencillium* like (40%) *Basidiospores* (33%) *Ascospores* (13%) Hyphal Fragments (7%) *Cladosporium* (3%) *Curvularia* (3%)
U.S. Customs House			
Center Counter – Left Side	75	240	*Aspergillus/Pencillium* like (39%) *Basidiospores* (28%) *Ascospores* (17%) *Cladosporium* (11%) Hyphal Fragments (6%)
Center Counter – Right Side	75	267	*Basidiospores* (40%) *Ascospores* (20%) *Aspergillus/Pencillium* like (20%) *Cladosporium* (10%) Hyphal Fragments (10%)
Outdoor	75	347	*Basidiospores* (46%) *Ascospores* (23%) *Aspergillus/Pencillium* like (12%) *Cladosporium* (12%) Hyphal Fragments (8%)

m^3 – cubic meter of air

Table 8
Culturable Air Sample Results
U.S. Customs and Border Protection IMT, U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 30, 2005

Sample Location	Air Volume per Replicate (liters)	Average Colony Count (CFU/m^3)*	Fungal Identification Ranking
IMT – U.S. Customs and Border Patrol			
Bookcase near windows behind desks	84.9	114	*Basidiomycetes* *Rhodotorula glutinis* *Aspergillus versicolor*
Desk on corner	84.9	118	*Basidiomycetes* *Cladosporium cladosporioides* *Pencillium variabile* *Rhodotorula glutinis*
Desk along side of wall near repair shop	84.9	134	*Basidiomycetes* *Acrodontium crateriforme* *Cladosporium cladosporioides* *Pencillium viridicatum* *Rhodotorula glutinis*
Outside – along side building near outside air intakes (4)	84.9	192	*Basidiomycetes* *Cladosporium cladosporioides* *Sporobolomyces salmonicolor* Yeast
U.S. Customs House			
Center Counter Left	84.9	121	*Pencillium roqueforti* *Basidiomycetes* *Pencillium chrysogenum*
Marble Counter on Right	84.9	90	*Basidiomycetes* *Pencillium roqueforti* *Aspergillus ustus* *Cladosporium cladosporioides* *Pencillium corylophilum*
Outside	84.9	412	*Basidiomycetes* *Cladosporium cladosporioides* *Rhodotorula glutinis*

*CFU/m^3 – colony forming units per cubic meter (average of three replicates)

Table 9
Serum Stachylysin™ Concentrations
Scotia Prince Cruises, U.S. Customs and Border Protection IMT, U.S. Customs House
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 30, 2005

Serum Sample	**Mean Serum Stachylysin™ (ng/ml**	**Stachylysin™ Range (ng/ml)**
SPC samples collected Nov 2004	9.6	ND-46.8
SPC samples collected Sept-Oct 2004	6.6	ND-22.2
CBP IMT collected March 2005	14.2	ND-29.5
CBP U.S. Customs House collected March 2005	20.5	9.1-38.9

ND=None Detected
Limit of Detection (LOD)=3.0 ng/ml

Figure 1
Indoor Environmental Quality Measurements – Carbon Dioxide
U.S. Customs and Border Protection, IMT
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10, 2005

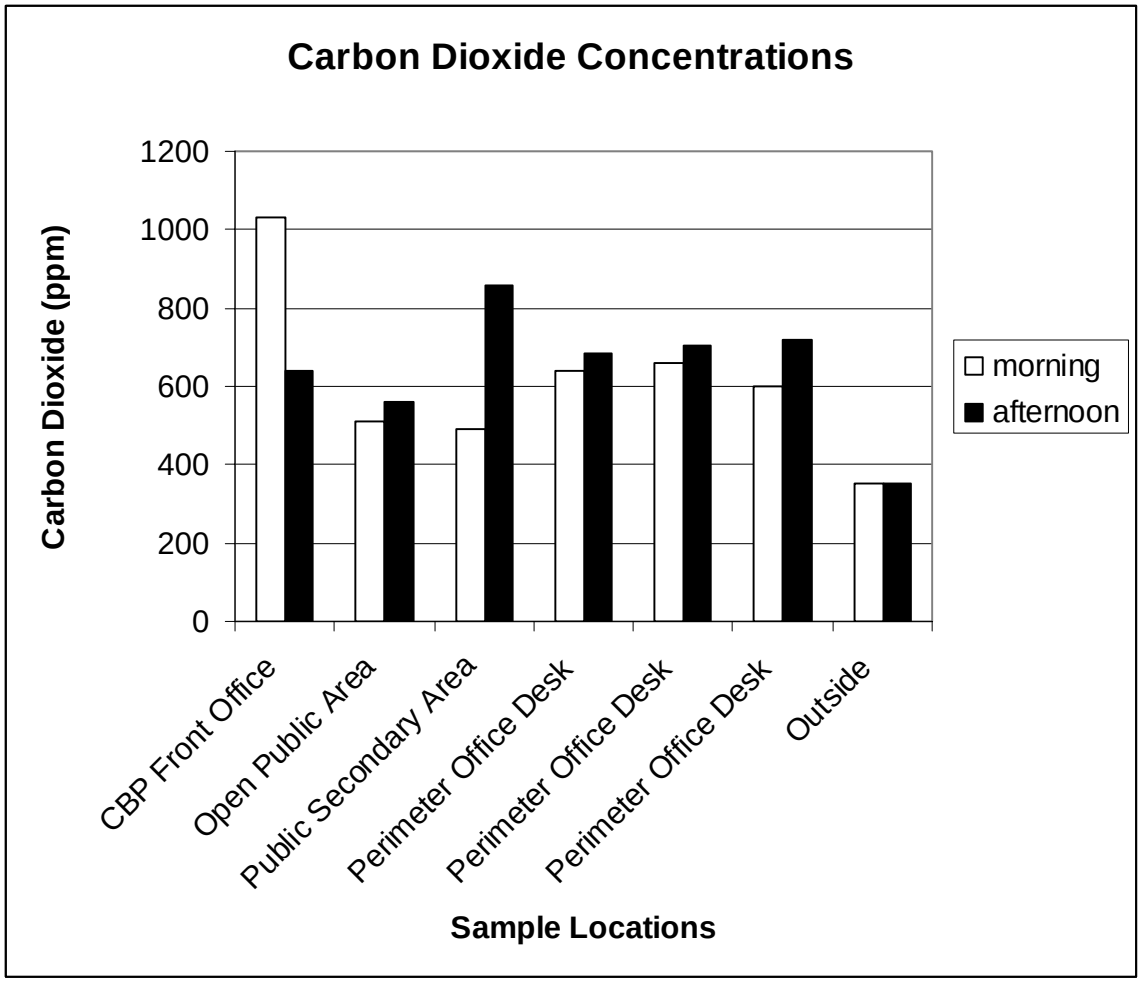


Figure 2
Indoor Environmental Parameter Measurements – Temperature
U.S. Customs and Border Protection, IMT
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10, 2005

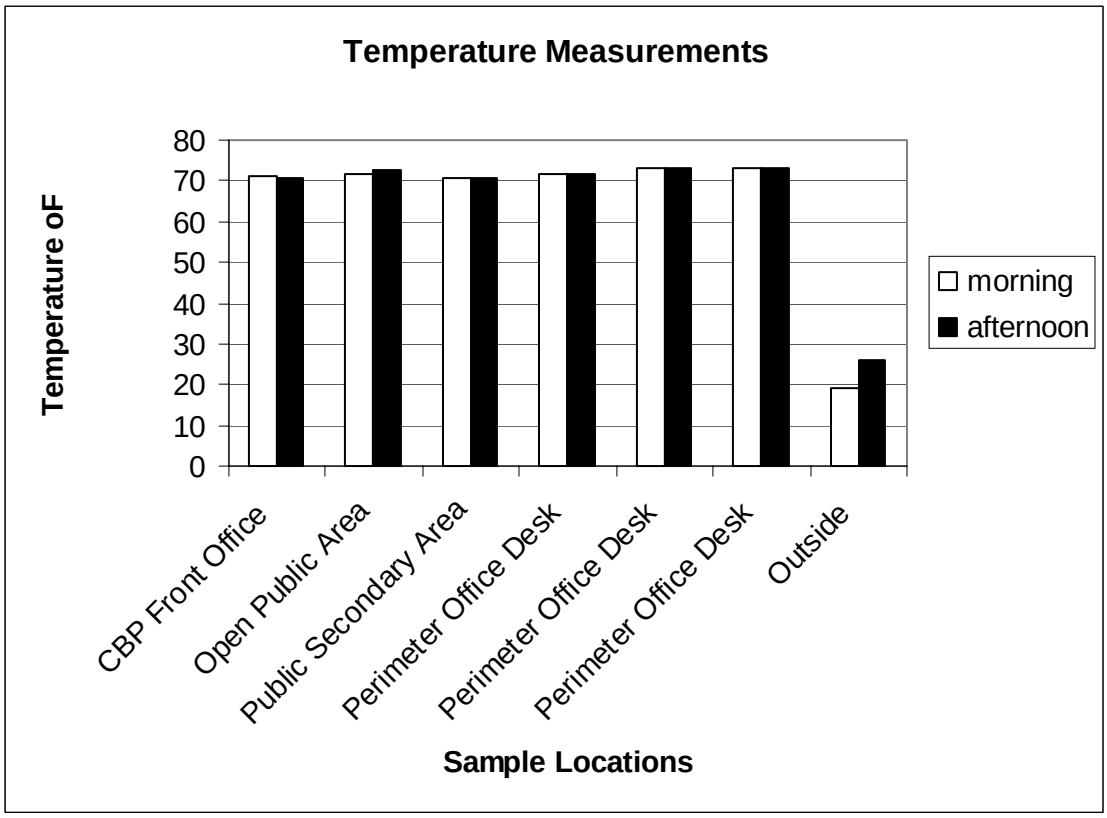
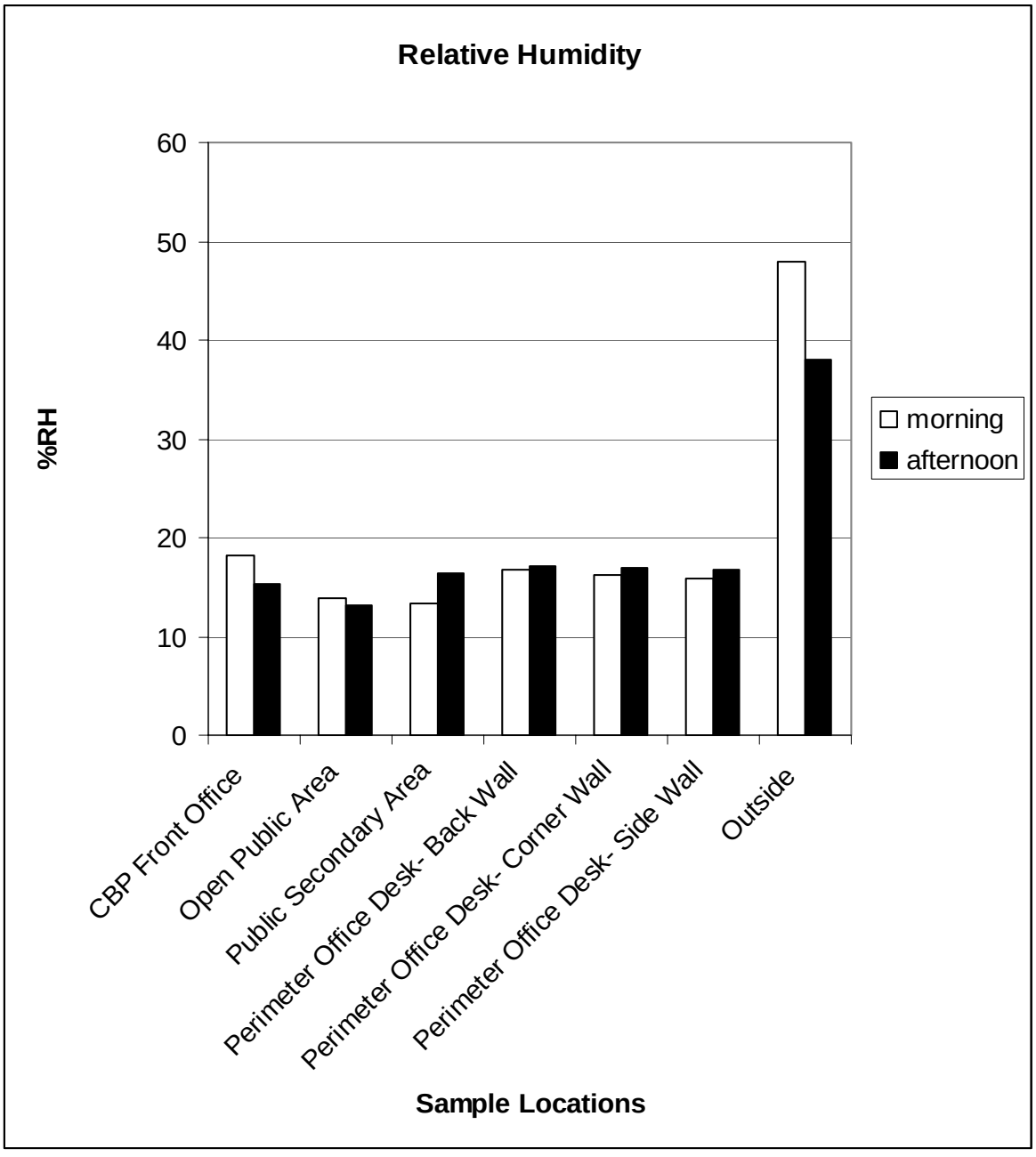
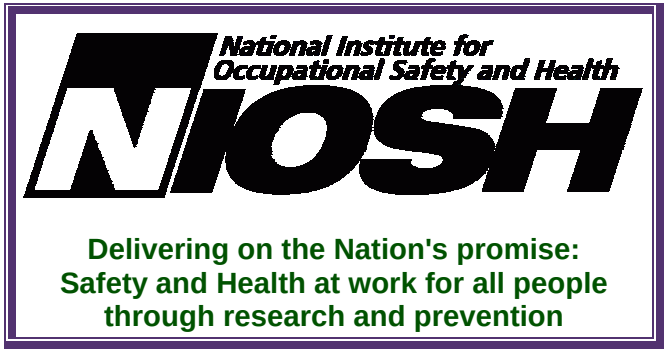


Figure 3
Indoor Environmental Parameter Measurements – Relative Humidity
U.S. Customs and Border Protection, IMT
Portland, Maine
HETA 2005-0126, 2005-0138-3004
March 10, 2005



DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

OFFICIAL BUSINESS
Penalty for private use $300



To receive NIOSH documents or information about occupational safety and health topics contact NIOSH at:

1-800-35-NIOSH (356-4674)
Fax: 1-513-533-8573
E-mail: pubstaft@cdc.gov
or visit the NIOSH web site at:
http://www.cdc.gov/niosh

S A F E R • H E A L T H I E R • P E O P L E™