NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2003-0368-2961
Nye County Justice Court Building
Pahrump, Nevada

March 2005

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 Captain Yvonne Boudreau, MD, MSPH and Commander Eric Esswein, MSPH, CIH, CIAQP, of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Lisa Maestas. Editorial assistance provided by Ellen Galloway.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Indoor Environmental Quality Remediation Efforts in the Nye County Justice Court Building

NIOSH responded to a confidential request from employees for a health hazard evaluation (HHE) at the Nye County Justice Court Building (NCJCB) in Pahrump, Nevada. On September 12, 2003, the employees asked NIOSH to evaluate health concerns they believed were related to the indoor environmental quality (IEQ) in the building.

What NIOSH Did

- We conducted telephone interviews with requestors, building and safety personnel, Occupational Safety and Health Administration (OSHA) inspectors, NCJCB legal counsel, and consultants who performed sampling and remediation at the NCJCB.
- We reviewed OSHA reports, data from air and surface samples, and reports of past building remediation activities.

What NIOSH Found

- The presence of hydrogen sulfide, solvents, and other volatile chemicals from sewer lines were the most probable cause for the reported odors and employee health symptoms.
- The Nye County Board of Directors hired subcontractors who remediated the moisture intrusion problems.
- We found no convincing evidence that significant mold contamination or fungal exposures would adequately explain the reported health symptoms, considering the other events and circumstances at the Courthouse.

What Managers Can Do

- Monitor for sewer gases if employees continue to report sewer odors and/or related symptoms.
- Discontinue ozone generator use.
- Develop a health and safety committee/program.
- Protect employees with definite or possible occupational health problems from exposures presumed to cause or worsen their condition.

What Employees Can Do

- Report sewer odors and related symptoms to managers as they occur.
- Participate in the health and safety committee/program.
- For medical concerns, obtain a full evaluation by a physician familiar with occupational conditions.

What To Do For More Information:
We encourage you to read the full report. If you would like 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 #2003-0368-2961.

Health Hazard Evaluation Report 2003-0368-2961
Nye County Justice Court Building
Pahrump, Nevada
March 2005

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SUMMARY

On September 12, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees to evaluate health concerns thought to be related to the indoor environmental quality (IEQ) of the Nye County Justice Court Building (NCJCB) in Pahrump, Nevada. In response to this request, NIOSH investigators conducted telephone interviews with requesters, building health and safety personnel, Occupational Safety and Health Administration (OSHA) inspectors, NCJCB legal counsel, and consultants who performed sampling and remediation at the NCJCB. We also reviewed OSHA reports, data from air and surface samples, and reports of past building remediation activities.

We found that the employees' health concerns and building odors could be explained by the presence of hydrogen sulfide from sewer gases in the NCJCB. It also appears that the NCJCB had a moisture problem caused by failures of several building-related components. Repair of the sewer lines and recent remediation of the moisture problems should alleviate or reduce the cause for employee concerns.

NIOSH investigators determined that employee symptoms and odor reports were most likely due to hydrogen sulfide and other sewer gases from the sewer main. Moisture intrusion problems have been remediated. Based on evaluation of available information, there was no convincing evidence of significant building mold contamination or mold exposure among employees.

Keywords: 9211 indoor air quality, IAQ, indoor environmental quality, IEQ, hydrogen sulfide, H_2S, mold, odor, headache, itchy eyes, burning eyes, sinus infections, asthma, heart palpitations, memory loss

Table of Contents

INTRODUCTION

On September 12, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from Nye County Justice Court Building (NCJCB) employees for a health hazard evaluation (HHE) of the building's indoor environmental quality (IEQ). Since occupying the building in 1999, employees reported headaches, itchy and burning eyes, chronic sinus infections, asthma, heart palpitations, and memory loss. They were concerned that these symptoms might be caused by mold contamination in their building.

BACKGROUND

The NCJCB is a one-story building that was constructed in 1999 and opened in July of that year. It consists of county government offices including the Sheriff's Department, District Court, Justice Court, juvenile probation and District Attorney's office. Approximately 120 employees including clerks, secretaries, maintenance workers, judges, court officials, police, and probation officers work in the building. In August 1999, some employees began reporting a variety of symptoms thought to be related to the building IEQ. Symptom reports continued despite numerous and extensive efforts by Nye County officials to respond to the concerns and remediate the potential problems (Table 1).

Beginning in August 1999, workers in the NCJCB Sheriff's office intermittently reported smelling "sewer" odors and experiencing eye, nose, throat, and respiratory irritation. On November 3, 1999, investigators from Nye County Emergency Services (NCES) responded to a report of sewer odors and found levels of hydrogen sulfide (H_2S) at 35 parts per million (ppm), methane (CH_4) at 10 ppm and toluene at 30 ppm directly above a floor drain in the mechanical room. Monitoring did not detect the presence of sewer gases elsewhere in the building, but the investigators noted the odor of sewer gas throughout the building. The source of the odors was traced to the sewer main. Levels of H_2S ranging from 2,400 to 140,000 ppm were detected in the sewer vault outside of the NCJCB. It was later determined that 57 manholes for the Central Nevada Utilities Commission (CNUC) sewer system had been sealed with plastic caps to prevent the entry of rain run-off into the sanitary sewer system. This reportedly prevented natural dilution ventilation of the sewer and resulted in the accumulation of significant concentrations of H_2S in the sewer system, which apparently back-flowed into connections of the NCJCB sewer system. When the manhole cover in the building's parking lot was opened, sewer gas odors in the building reportedly diminished.

Further investigation on November 5, 1999, revealed that H_2S was also being generated by a recently abandoned septic system at the former Nye County Animal Control Building, located north of the NCJCB. The septic system serving this facility had been abandoned when the CNUC sewer system was extended to the Nye County Complex, which includes the NCJCB. The Animal Control septic system was left intact, in violation of Nevada law, which requires pumping out an abandoned septic system and either removing the septic tank or filling it with dirt or sand. Consequently, the sewage left in the abandoned septic tank continued to decay and generate large amounts of H_2S gas. The H_2S was reportedly neutralized by pouring chlorine bleach into the NCJCB sewer lines. Afterward, gas monitor readings taken by a Hazardous Materials team reported nominal levels of CH_4, carbon monoxide (CO), and H_2S.

On November 15, 1999, NCES again responded to reports of sewer odors in the NCJCB. Monitoring revealed 3 ppm CO and 1 ppm H_2S in the hallways and in the dispatch center of the building. The sewer lines were excavated, a p-trap was attached to the main sewer line in an effort to prevent gases from backing up or being entrained into the building and three sewer "clean-outs" were opened to relieve any trapped gases. The lines were flushed with water to remove debris and ensure that the p-trap was operating effectively. Shortly after these

interventions, odors in the building reportedly dissipated.

Despite these interventions, employee reports of sewer odors continued, and a consulting firm was hired by the county to evaluate the NCJCB. On November 16, 1999, the consultant reportedly sampled in areas implicated by the previous investigations. Sample results showed adequate oxygen levels and zero levels for all toxic gas readings inside the building. However, the manhole for the CNUC sewer in the Sheriff's office parking lot showed an oxygen deficient atmosphere (oxygen readings between 16.9% and 17.2%). The consultant reported that the engineering interventions carried out by Nye County personnel were appropriate. A memorandum was issued by the Nye County Manager stating that, based on the tests conducted by the consultant, the odor problems and other concerns had been rectified and the building was safe to occupy. The memo also encouraged employees to see their doctor if they had ongoing symptoms and to file necessary workers' compensation forms.

The State of Nevada, Department of Business and Industry, Division of Industrial Relations, Occupational Safety and Health Enforcement Section (Nevada OSHA) conducted an evaluation of the NCJCB on November 18, 1999.[1] Employees had requested the inspection due to symptoms of headaches and eye, nose, throat, and respiratory irritation from sewer gas odors. Nevada OSHA inspectors conducted monitoring for carbon dioxide (CO_2), CO, and H_2S and found no concentrations exceeded 50% of any published OSHA limit[2] and that the indoor environment was within the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) limits for air contaminants.[3] Nevada OSHA also inspected the ventilation and sewer systems; reviewed chemicals used in the building; and inspected the ceilings, floors, walls, and carpets. OSHA reported that indoor mold was not observed, less than 1 square foot of minor water stains were seen on acoustical ceiling tiles, pollens and other dusts were not observed in any significant amounts on air grills or surfaces, cleaning agents and bleaches were used regularly, and smoking was not permitted inside the building. On December 6, 1999, OSHA reported that no unusual circumstances were encountered. No citations were issued and no additional monitoring was recommended.

In early March 2000, NCES responded to several reports of a noxious odor at the Sheriff's Office. On March 15, 2000, a memo from the Nye County Health Officer to the Nye County Manager stated that an odor investigation revealed the rooftop vent stack to the sewer line p-trap was found capped. A Hazardous Materials team removed the cap and ventilated the area. Why or by whom the sanitary stack was capped was not determined.

On March 22, 2000, an employee reported feeling ill. The District Attorney's office was inspected and revealed H_2S at 3 ppm and CO at 30 ppm. Screening conducted by the County Health Officer reportedly showed indoor CO concentrations ranging from undetected to 25 ppm. The CO was attributed to the use of a propane powered floor buffer that day and the building's ventilation system shutting off all air dampers due to cool weather. When the outdoor air intakes were opened, the CO dissipated.

On December 20, 2000, a memo from the Workplace Safety and Training Officer to the Nye County Manager stated that a majority of employees had exhibited various health problems while in the building, but no source contaminant had been identified. This memo mentioned mold as a possible cause for the employee health symptom reports and indicated that mold sampling kits had been ordered, even though it was acknowledged that the building's history contained no discussion of significant water intrusion events or the presence of mold. Mold sampling was conducted using the sampling kits and results reportedly showed low counts of typical mold species, including trace amounts of *Cladosporium*, *Aspergillus* and *Penicillium*. The highest cumulative contaminant reading found in the survey was 100 colony forming units (CFU) per cubic meter (m^3). The sampling analysis report suggested that further investigation would only be

warranted when the results showed 2000 CFU/m^3. A December 27, 2000 memo from the Nye County General Services Director to the Nye County Manager stated that the lab analysis indicated the air quality within the Pahrump Justice Facility is a mirror image of the air quality outside the facility. The memo concluded that there was no cause for alarm and suggested no further action was required at that time.

In January 2001, the Nye County Health Officer noted in a memo that their office was responding to employee symptom reports on nearly a daily basis and those employees reported that they thought their health concerns were not being taken seriously. The memo recommended contacting a particular consultant who subsequently conducted a preliminary evaluation of the Justice Court facility on January 10, 2001, including collection of bulk samples. His report was issued on January 12, 2001,[4] and attributed the employee symptoms to "non-infectious fungal bioaerosol exposure." Recommendations included surface, bulk, and air sampling for microorganisms.

Based upon the recommendation for further sampling, on January 26, 2001, an environmental sampling consultant retained by the County collected indoor vacuum, swab, tape strip surface and bulk samples. No outdoor air samples were collected. The tape strip surface samples were analyzed by microscopy. The remaining samples collected during the previous bioaerosol evaluation and the bulk samples collected on January 10, 2001 were cultured for analysis. [5]

On April 23, 2001, outdoor samples (which had not been collected in the previous evaluations) as well as additional indoor samples were collected by the consultant.[6] Employee reports of symptoms continued and it was decided that further testing should be conducted, including destructive testing to allow visual inspection and sampling of the ceiling plenum and interiors of walls for biological contamination. On May 4, 2001, a sub-contractor performed this testing, which consisted of cutting holes in drywall just above the ceiling line. The insulation was pushed away and the area was visually inspected for any signs of mold growth. A boroscope and remote video were used to examine behind wall cavities. Base molding was removed and a small hole opened at the bottom of the walls. Video tapes were made of the interior of the walls and samples were collected from each location for further analysis. No evidence of mold or other problems was identified.[7] It was therefore concluded by the investigators that the single source of mold contamination was water intrusion from leaking water-regulating valves in plenum-mounted variable air volume (VAV) enclosures. They also noted that the ventilation system air grilles did not exactly fit the supply air ducting for the system, resulting in an approximately 2-inch gap between the ventilation ducts and the supply grilles. They reported that this opening allowed ventilation air to pressurize the return air plenum, giving rise to the possibility that mold, formed on the ceiling tiles and duct insulation due to VAV water leaks, could have been spread throughout the building via a positively pressurized ceiling plenum (rather than the design criterion of a negatively pressurized plenum). A consulting firm for design and diagnostic testing of buildings subsequently performed an investigation of the mechanical air distribution system and operation of computer monitored controls and related units, and interviewed Nye County Administration facilities management personnel and other employees.[8] Their recommendations included further investigation of the HVAC with specific attention to system balance, correct installation, air intake and distribution, and the boiler water feed system.

Due to continued employee symptom reports and concerns, the Nye County Board of Directors decided to close the facility, effective June 22, 2001, and perform a "remediation" of the building. All departments of the building moved to temporary lodging in portable buildings. A subcontractor decontaminated all office materials before they were removed from the building, with the exception of the Sheriff's evidence vault.

In July 2001, an epidemiologic study to "identify the nature, extent, and distribution of

occupant illness" in the NCJCB was conducted; however, litigation prevented discussion of the study's results.

The remediation of the building was completed by the end of August 2001. Employees moved back into the building on September 4, 2001. Additional sampling was conducted "to determine the surface-associated mycotoxin levels in samples collected in selected locations following remediation and re-occupation of the building." All samples were surface samples, three from carpet and three from air handler filters. Results were that "the reported mycotoxin levels were below the detection limit for all samples."[9]

A tour of the building by the Nye County Workplace Safety and Training Officer, 1 week after re-occupancy, revealed some employee symptom concerns. A second tour conducted 1 week later revealed more employee concerns. In response, all employees were placed back into their previous temporary lodgings.

On September 12, 2001, sampling was conducted "to determine the surface-associated mycotoxin levels in a sample collected in a selected location following remediation." One surface sample of an air handler filter was taken and the reported mycotoxin levels were below the detection limit.[10] On the same day, sampling was conducted "to determine the airborne and surface-associated fungi in locations re-occupied following remediation."[11] The report summarized the results as follows:

- Airborne culturable and total fungal spores indoors were lower in concentration and consistent in population to that observed in the outdoor control samples. Culturable fungi isolated from the carpet vacuum samples were consistent with that observed in samples from carpeted indoor environments. The isolation of *Stachybotrys* in one sample was at the lower limit of detection for the method used and it may reflect tracking from the outdoors.

On September 21, 2001, sampling was conducted "to determine the surface-associated fungi on new ceiling tile to assist in comparison of field data from ceiling tiles from the administration complex." A vacuum surface sample was collected from a new, never-used ceiling tile. Results stated in the report were, "Some 2670 colonies of non-sporulating fungi were isolated per gram of material collected from a new ceiling tile indicating that the surface was relatively free of fungal structures."[12]

On September 27, 2001, sampling was again conducted "to determine the airborne and surface-associated fungi in selected locations following remediation and re-occupation of the building."[13] Summary results given in the report were as follows:

- Few airborne culturable fungi were isolated from the indoor and outdoor locations. Indoor fungal spore concentrations were lower than the outdoor control and populations were similar indoors and outdoors. The vacuum samples from the printer at the assessor's office and the cash register at the treasurer's office show the absence of fungi in the post-cleaning samples. The vacuum samples from the HVAC filters 1, 2, and 3 show the presence of numerous fungi including *Stachybotrys* in high concentrations, but few fungi were present on the supply side of these units. Few fungi were isolated from the desk/credenza top at investigator #2 west. No fungi were isolated from the swab samples pre- and post-cleaning of the printer in the assessor's office and the cash register at the treasurer's office. Few fungi were isolated from the other swab samples. These data demonstrate *Stachybotrys* was present in the air entrained on the HVAC filters. It is unclear if these spores had been circulating within the building, the ducting, or from outdoor air.

On October 2, 2001, additional microbiological sampling was conducted "to determine the airborne and surface-associated fungi in selected locations following remediation and re-occupation of the building"[14] and "to determine the surface-associated mycotoxin levels in

samples collected in selected locations following remediation and re-occupation of the building."[15] Summary results given in the reports were as follows:

- Fungi consistent with that isolated from settled dust in carpeted indoor environments were isolated from 9 of 13 carpet sites sampled. However, *Stachybotrys* was isolated in high concentrations from an upholstered bench and from 3 carpeted locations. The source of this fungal presence is unknown.

- The reported mycotoxin levels were below the detection limit for all samples.

Nevada OSHA conducted another inspection of the building between June and November 2001.[16] The OSHA investigation was requested by employees who were concerned about becoming ill from mold in the building. The inspection revealed that the building had water leaks from 26 of the 53 VAV boxes located in the plenum and that these water leaks had resulted in a mold "infestation" which included *Stachybotrys chartarum*. The OSHA report noted that:

- The allegation that the Nye County Court building has a mold problem that is making employees sick has never been medically proven, though it remains a possibility.

- The allegation that Nye County management has not taken adequate actions to remediate the problem is belied by the actions taken. Nye County management has spent a vast amount of time and money in attempting to resolve this problem and continues to try to determine the nature of the problems associated with the still-unoccupied Nye County Justice Court Building.

- Employee interviews were conducted via distribution of a health questionnaire, to which 31 employees responded. Employee concerns were varied, including every symptom listed on the questionnaires. No relevant conclusions could be drawn from the widely distributed data. The only common thread to the employee concerns is that all employees feel better when they are not in the building.

The OSHA inspection was closed on November 5, 2001.

On December 4, 2001, sampling of new, in-the-box air filters was conducted prior to their installation at the complex. No culturable fungi were isolated from the filters.[17]

On December 28, 2001, additional sampling was conducted "to determine the surface-associated fungi on air-handling filters at the complex and in carpet dust sampled within the building."[18] Results were summarized as follows:

- Mixed populations of fungi similar to that associated with dust were isolated from the samples collected from the fresh air intakes on the roof of the complex. *Stachybotrys* was isolated from two of the three intake filters, but the concentrations were at or near the lower limit of detection for the method, indicating low concentrations. Mixed populations of fungi similar to that associated with dust were isolated from the samples collected in the mechanical room from air-handling unit filters. Mixed populations of fungi associated with settled dust in indoor environments were isolated from the samples collected from carpeting in selected locations. *Stachybotrys* was isolated from two locations.

On February 6, 2002, sampling was conducted "to determine the surface-associated fungi in selected locations prior to re-occupancy of the building."[19] Results were summarized as follows:

- Although the concentrations of culturable fungi in samples of settled dust cultured on malt extract agar amended with chloramphenicol (MEAC) medium were consistent with that routinely found in settled dust in indoor environments, the percentage of *Penicillium* isolated from the HVAC #1 return duct district attorney clerical support (50%) and HVAC #3 return

duct sheriff's office/men's locker room (38%), and the isolation of *Stachybotrys* (300 CFU/g) in the sample from HVAC #3 return duct sheriff's front lobby cultured on cellulose agar amended with chloramphenicol (CAC) demonstrate populations of fungi consistent with problem buildings and occupant symptom reports.

- The data presented in this report indicate the continued presence of contaminant fungi and suggest the need for additional testing of the HVAC duct system.

On March 1, 2002, sampling of the Nye County Administration Building and "control" buildings was conducted in order "to determine the surface-associated fungi in the Administration Complex, the Building and Grounds (B&G) building, and the Repository building. Additionally, air samples for total airborne fungal spores were collected at the four sides of the Administration Complex to provide supplemental data on background airborne fungi."[20]

On March 28, 2002, another IEQ survey was conducted. Measurements were made for oxygen, CO, CO_2, humidity, temperature, and total volatile organic compounds (VOCs). A surface assessment was conducted for settled dusts. Measurements were taken at 20 locations in the building, reportedly representative of the three ventilation zones served by the HVAC system. Results indicated that all of the IEQ measurements were found to be within the range of acceptable IEQ conditions except percent relative humidity (RH). RH readings were low; approximately 22% RH was reported among the 20 sampling locations.

On June 6, 2002, sampling was conducted "to determine the airborne and surface-associated fungi in selected locations following remediation."[21] The report summarized the results as follows:

- Airborne fungal spores indoors were either not detectable or were consistent with that observed in the outdoor control. While the concentration of fungi isolated from a cloth poster board was low, contaminant fungi were isolated. It is recommended that this poster board be removed from the building and replaced. The other vacuum samples were consistent with fungal populations present in indoor occupied environments. No fungal structures were observed in the tape sample of the vinyl chair.

On June 13, 2002, sampling was conducted "to determine the airborne and surface-associated fungi in selected locations."[22] The report's summary results were as follows:

- The airborne fungal spore populations in the front office and the Patrol Sergeant's office – Jasperson/Balding - are elevated. These areas should be re-cleaned. The other locations are consistent with the outdoors and/or populations in other occupied buildings.

- Although the concentration of surface-associated culturable fungi is low, *Aspergillus niger* was the only fungus isolated from the vacuum sample collected in the front office. It is recommended that this area be re-cleaned. The other locations sampled using vacuum sampling demonstrated populations of fungi consistent with that found in non-problem indoor environments. No fungal structures were observed on tape samples.

On July 1 and 2, 2002, additional sampling was conducted "to determine the airborne fungi in selected locations following remediation."[23,24] The report's summary results were as follows:

- Although the concentrations of fungi were consistent with that observed in the outdoor sample, the populations of *Aspergillus/Penicillium* in the District Attorney's office and the Deputy District Attorney #2's office on July 1 were 75% and 80%, respectively. This is higher than that found in the outdoor sample and may be an indicator of continued fungal contamination in these locations. Other locations were consistent with the outdoor sample.

On August 12, 2002, further sampling was conducted "to determine the surface-associated fungi in selected locations."[25] The report's summary results were as follows:

- The data show the presence of *Stachybotrys* on upholstered chairs stored following cleaning by a professional remediation company. While *Stachybotrys* was isolated from only a few chairs, these data re-emphasize the difficulty encountered in remediating upholstered materials that have been located in a fungal-contaminated indoor environment. The general consensus is to remove and discard upholstered furniture instead of trying to clean it. Consideration should be given to discard these chairs rather than attempt to re-clean them or re-install them in the building.

On August 15, 2002, additional sampling was conducted "to determine the airborne fungi in selected locations following additional remediation."[26] Three air samples were taken and the summary results were as follows:

- *Aspergillus/Penicillium* was observed at the lower limit of detection in the District Attorney's office, likely representing a low ambient background of these spores. No fungal spores were observed in the District Attorney #2 office. Fungal spores consistent with previous outdoor airborne spore populations were observed in the outdoor sample. These data demonstrate the absence of unusual airborne fungal spores in the indoor locations and indicate that these indoor locations are representative of indoor locations in non-problem buildings.

Nevada OSHA conducted another inspection of the Nye County Justice Court building on October 28, 2003.[27] Employees who requested this inspection were concerned about the building's IEQ contributing to chronic respiratory problems, sinus infections, diarrhea, and blotchy red skin. The OSHA complaint made no reference to any specific contaminants, but employees were concerned about water intrusion and mold growth. The OSHA report listed the following observations and findings:

- Significant amounts of money have been spent by the County of Nye to clean the building of contaminants.
- At one point, the building was essentially reduced to a shell and power washed.
- All soft goods (e.g., carpets, chairs, ceiling tiles, etc.) were replaced and paper items (e.g., files) were cleaned by a contractor.
- Vacuum samples from paper files were evaluated and yielded no fungal growth or presence of spores.
- Thousands of pages of sampling information, correspondence and other relevant information were compiled onto a compact disc (CD) and made available for all employees to view.
- At the time of the OSHA inspection, fewer than 10 employees had requested a copy of the CD.
- A review of the OSHA 300 Log of Injuries and Illnesses revealed no claims of biological exposure, chemical exposure, or other environmental exposures by any employees working in the building.
- Three employees filed claims but they were not treated by a physician, so the cases were not logged as recordable illness on the OSHA 300 Log.
- A lawsuit was instigated by employees alleging injury as a result of mold exposure.
- A memo was sent to NCJCB employees by the safety and training officer, inviting employees to contact the OSHA inspector by phone or email, but no employees responded.

The OSHA inspection found no unusual circumstances or violations, and no citations were issued.

METHODS

NIOSH investigators conducted telephone interviews with requesters, building health and safety personnel, OSHA inspectors, NCJCB legal counsel, and consultants who had been

hired by the County to perform sampling and remediation of the NCJCB. We also reviewed OSHA reports, memos from local public health officials, reports of past building remediation activities, and data from air and surface samples taken from the building.

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 this 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),[28] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[29] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[30] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

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.

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

Hydrogen sulfide

Hydrogen sulfide (H_2S) is a colorless, flammable gas with a strong odor of rotten eggs. Acute exposure to H_2S at airborne concentrations above 10 ppm has been associated with the development of eye disorders including conjunctivitis and keratitis.[31] One-hour exposure to H_2S concentrations between 50 and 100 ppm can produce mild eye and respiratory irritation, which becomes markedly worse when the concentrations rise to the 200 to 300 ppm range. At H_2S concentrations between 500 and 700 ppm, exposures for 0.5 to 1 hour can result in unconsciousness and death; between 1000 to 2000 ppm or more, unconsciousness and death can occur within minutes. Conclusive evidence of adverse health effects from chronic exposure to H_2S at concentrations below 20 ppm is lacking.[32,33,34,35,36,37] However, there is some evidence that H_2S alone at low concentrations, or in combination with other chemical substances (e.g., petroleum products or carbon

disulfide), is associated with the development of eye irritation and disorders of the nervous, cardiovascular, and gastrointestinal systems. Repeated exposure to H_2S results in increased susceptibility, so that eye irritation, cough, and systemic effects may result from concentrations previously tolerated without effect.

H_2S has an odor threshold between 0.0002 and 0.3 ppm for humans. The smell is faint, but easily perceptible at 0.77 ppm and offensive at 3 to 5 ppm. Up to about 30 ppm, H_2S smells of rotten eggs, but at about 30 ppm the smell is described as sweet or sickening sweet. At 150 ppm, H_2S causes olfactory nerve paralysis and the smell is no longer perceptible. The smell of H_2S therefore is not a reliable warning of its presence, especially at high concentrations.

The NIOSH REL for H_2S is a 10-minute ceiling concentration of 10 ppm.[35] When there is a potential for exposure to H_2S at a concentration of 50 ppm or higher, NIOSH recommends continuous monitoring. The OSHA standard for H_2S is a 10-minute ceiling concentration of 20 ppm or a maximum allowable one-time peak of 50 ppm for 10 minutes, if no other measurable exposures occur.[36] The ACGIH® recommends a TLV® of 10 ppm as an 8-hour TWA and a short-term exposure limit STEL of 15 ppm.[37] The TLV and STEL for H_2S are both currently being reviewed by ACGIH for possible reduction, based on consideration of upper respiratory and central nervous system health effects. The NIOSH concentration of H_2S considered immediately dangerous to life and health (IDLH) is 100 ppm.

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 the individual (for example, whether pre-existing allergies or asthma exist). 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 VOCs, the most common of which is ethanol, that have been postulated to cause upper airway irritation.[38] However, potential irritant effects of VOCs from exposure to mold in the indoor environment are not well understood.

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. Single or repeated exposure to mold or mold spores may cause previously non-sensitized individuals to become sensitized. Molds can trigger asthma symptoms (e.g., 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.[39] Hypersensitivity pneumonitis 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 almost everywhere on every conceivable type of substrate, has been known to infect the lungs of immune-compromised individuals after inhalation of the airborne spores.[40] 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.[41,42,43] 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 (http://www.epa.gov/iaq/molds/mold_remediation.html).[44,45] Additional information regarding the evaluation and remediation of indoor mold contamination is available from the EPA at http://www.epa.gov/iaq.

DISCUSSION

During the first 8 months of the occupation of the NCJCB, employees reported symptoms and "sewer odors," and monitoring repeatedly revealed the presence of sewer gases in the building. Several memos document that an IEQ problem existed when the NCJCB was first occupied and that this problem existed in an adjacent building (a juvenile detention facility) before occupation of the NCJCB. The cause of the reported sewer odors was traced to two sources: a main sewer line and an abandoned septic system. It was documented that, at least 2 years prior to occupancy of the NCJCB, 57 manhole covers had been sealed with plastic to prevent rainwater intrusion into the sewer systems; required provisions for venting the manhole covers had not occurred. The sealing created anaerobic conditions and a lack of ventilation, which allowed sewer gases to proliferate. Monitoring at the NCJCB detected 35 ppm H_2S, 3% toluene and 1% methane in the NCJCB mechanical room. (Note: 3% toluene is equivalent to 30,000 ppm toluene as a vapor and 1% methane is equivalent to 10,000 ppm methane as a gas.) At a manhole cover 400 feet from the Sheriff's office, H_2S was measured in excess of 3%, the upper detection limit of a direct reading monitor. High concentrations of flammable gases (likely toluene) were also reported. The abandoned septic tank, connected to the main sewer lines, was confirmed to also be generating H_2S (50 and 80 ppm measured at two separate tanks). At least one definitive pathway for these gases to enter the NCJCB, the floor drains, was established.

The symptoms reported by occupants in the building (headache, upper respiratory irritation, eye irritation, fatigue, neurological symptoms, shortness of breath, chest tightness and vomiting) are hallmark symptoms of exposure to H_2S.[46] Although this was not investigated, it is reasonable to assume that, in addition to H_2S, other irritating and toxic chemicals were present from the degradation of organic material and that these could have contributed to occupant symptoms and health concerns. The literature reports that a variety of organic sulfur compounds (including dimethyl sulfide, dimethyl disulfide, alkyl benzenes and a variety of alcohols) are constituents in sewer gases, sewer sludge, and sewage, and are highly irritating and have acute and chronic toxicity profiles.[47,48,49,50,51,52] In addition, exposure to solvents (including toluene, detected in high concentrations) could cause central nervous system and irritant health effects.

The circumstances and documentation of IEQ problems at the NCJCB imply that employees may have been exposed to a variety of VOCs from the time the building was first occupied and for some time thereafter. Documentation suggests that chemicals entered the building from a pressurized sewer line due to lack of a p-trap (a water-filled "U" tube designed to prevent sewer gas backflow into a building). Once volatilized, these gases could have become widely distributed throughout the building by the air handling systems, since initial entry into

the building was in the main mechanical room (a negatively pressurized space). It was also documented in several reports that additional routes of entry were present, including reentrainment of sewer gases into the building air handling unit make-up air intakes from rooftop exhaust sewer exhaust stacks.

It is unclear why the chemical exposures were not accepted as the cause for IEQ concerns when the building was initially occupied and for months thereafter. As early as November 1999, a pollutant source was identified, along with a pollutant pathway: the building's ventilation system. Three persuasive explanations exist for an IEQ problem created from chemical exposures: 1) a history of reported odors and a toxicological association for occupant health concerns consistent not only with H_2S exposure, but with a variety of other organic sulfur compounds and solvents likely to be present; 2) the presence of these chemicals detected in the floor drain of the main mechanical room for the building's air handling systems, confirming a potential pathway for the distribution of chemicals from the sewer system into the building; and 3) an explanation for dissemination throughout the building via the building's air handling system.

There are several possible explanations for why the occupant symptoms and odor reports continued after the sewer problems were apparently "fixed." The most likely explanation is that the problem was not fixed. After the first identification of H_2S as a problem, neutralization of the H_2S was attempted by pouring chlorine bleach into the NCJCB sewer lines. It is unlikely that pouring household bleach (sodium hypochlorite) into the sewers was sufficient to kill all sulfur-producing bacteria and eliminate this source of organic sulfur compounds present in the sewer system. Free chlorine is essential for disinfection, but household bleach contains only 5.25% free chlorine. Free chlorine is highly reactive, but becomes "bound" after contacting highly organic materials. Maintaining free residual chlorine is essential for killing sulfur-producing bacteria that create organic sulfur compounds. Strong sewage is highly organic and the relatively small amount (gallons) of free chlorine that was poured into the sewer and septic systems would have quickly become bound and unavailable in the considerable surface area present in a municipal sewer system, comprising an area of at least 57 manhole covers. Bound chlorine (and the resultant chloramines) would have been relatively ineffective as disinfectants and, although gas measurements immediately following the addition of the chlorine might have been temporarily lowered, the bacteria would have persisted and continued to produce sulfur compounds.

Another possible explanation for ongoing occupant symptoms is the presence of additional chemicals in the building. Ozone generators were used in the building for a period of time, presumably in an attempt to resolve the IEQ problem. It is possible that exposures to indoor ozone helped to sustain IEQ problems and even create additional ones. Ozone generators are not appropriate to control IEQ problems; there is no scientific evidence demonstrating ozone to be an effective IEQ solution. Creating ozone indoors can itself create indoor air pollution because ozone is a regulated air pollutant in both the occupational and the ambient environments. Generating ozone indoors can also create secondary chemicals and particles that can be highly irritating.[53,54,55,56] Using ozone and ozone generators has not been found to be useful or effective in reducing concentrations of indoor bacteria or fungi at concentrations that would not be acutely toxic to building occupants.[57]

Finally, a third possible explanation is that when a series of building investigations fails to identify a "smoking gun," or even when a definitive cause for an IEQ problem is found, if results are not adequately communicated to employees, employees may react with suspicion, believing that management is not sufficiently responding to their concerns. Employee perception of an insufficient response appears to have been the case in this situation. Employee dissatisfaction with management's response seems to have occurred as early as 2 weeks after the sewer gas problem was identified. This is supported by an employee request to Nevada

OSHA dated November 15, 1999. Complaint number 202780144 states, "Sewer gas has been occurring on the weekend and on Monday. The smell is causing employees to become ill with irritation to the eyes, nose, throat and upper respiratory system. Some are also experiencing headaches. Management is not doing anything to resolve the problem." It seems apparent that Nye County management responded quickly and with the best of intents to identify and resolve the IEQ problem. Unfortunately, the true causality was not sufficiently identified and resolved, and it appears that some employees did not perceive management's efforts to be adequate. Possibly, the efforts that had been made to resolve the problem were not completely understood, accepted, communicated to, or heard by all employees, causing them to file a request with Nevada OSHA.

In the documents available for review, no sampling, toxicological, or building related data show clear evidence that indoor exposures to mold were the cause of IEQ problem at the NCJCB. While there are reports of water damage, there are also reports that "no visible mold growth was observed on ceiling tiles and walls." The reports list observations, not a systematic inspection of the building's HVAC systems, the building envelope, or results of a more comprehensive IEQ investigation including supporting measurements, such as indoor/outdoor pressure differentials, temperatures, relative humidity, etc.

The data from sampling reports were not sufficient to conclude that "significant fungal contamination of the building was related to chronic water intrusion." Although the presence of water damage in the building appears to be adequately supported by field observations (and in some cases, by the genera of fungi that were reported), the data do not appear to support that significant fungal contamination existed and presented a health hazard to building occupants. Additional sampling reports indicated the presence of certain fungi known to be related to wet structures and dampness; however, many other reports showed that concentrations of indoor vs. outdoor fungi were similar, or that outdoor concentrations of fungi exceeded those indoors, which can be a sign that IEQ problems of microbial origin may not be an issue. Sampling reports also stated that "the presence of *Stachybotrys chartarum* in several carpet dust samples, as well as the HVAC filter, is unequivocally abnormal and signifies a primary surface source." *Stachybotrys chartarum* is not an uncommon fungus and its presence in carpet samples and an HVAC filter is not surprising.

Despite what appeared to be a very aggressive sampling approach to identify the presence of mycotoxins, the laboratory reports indicate that mycotoxins were never detected (either in surface dust or in carpets) at concentrations above the limits of detection.

CONCLUSIONS

Based on reviews of numerous documents submitted to NIOSH, and from telephone interviews with NCJCB representatives and primary investigators, NIOSH investigators conclude that occupant concerns of poor IEQ at the Nye County Justice Facility were not initially caused by exposure to molds, bioaerosols, fungi, spores or mycotoxins. Rather, the initial occupant reports of poor IEQ were related to and caused by exposure to a constellation of chemical constituents in "sewer gas" that was present in the building from the time of first occupancy.

Based on this review, it does appear that the NCJCB had a moisture problem caused by failures of several building-related components, including leakage around skylights, some degree of failure of external facing materials and, to a larger degree, by water intrusion from leaking valves in VAV control boxes.

Microbial contamination in the building may have been a factor at a later point due to delayed remediation, which may have resulted in microbial amplification due to continued moisture intrusion in the building. Remediation of these problems seems to have occurred and should alleviate the moisture intrusion issues.

Clear communication between management and employees about the occurrence and results of investigative efforts seems to have been lacking. This might have contributed to employee perceptions of an insufficient response to their ongoing concerns.

RECOMMENDATIONS

Conduct monitoring for sewer gases if employees continue to report sewer odors and related symptoms.

Discontinue ozone generator use.

Develop a health and safety committee/program at NCJCB. We recommend making top management commitment and employee participation a significant part of the program. This joint employee-management IEQ Committee, with representation from all affected departments, should be supported with resources and convened on a regular basis. The responsibility of the committee should include involvement in decisions regarding appropriate interventions.

Encourage each person concerned about possible work-related health problems to be fully evaluated by a physician. A physician familiar with occupational conditions is preferable, so that the work-relatedness of certain health concerns can be assessed. A complete evaluation would include a full review of symptoms and occupational history, a medical exam, a review of exposures, targeted diagnostic tests, and follow-up examination(s) to note the progress of the affected worker. Individuals with definite or possible occupational health problems should be protected from exposures that are presumed to cause or worsen the disease. In some cases, workers may have to be reassigned to areas where exposure is minimized or nonexistent.

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Table 1: Summary of Events at the Nye County Justice Court Building, 1999-2004
July 1999: Newly constructed building opens
August–November, 1999: Employee reports of sewer odors; monitoring reveals presence of H_2S
November 1999: H_2S detected in building, traced to sewer main and remediated; Nevada OSHA conducts inspection and finds no unusual circumstances and less than 1 square foot of minor stainage on acoustical ceiling tiles; no violations and no citations issued
March 2000: Employee reports of noxious odors; discovery of capped sanitary vent stack; obstruction removed; CO elevated due to indoor use of floor buffer and outdoor air dampers closed off; all situations addressed
December 2000: Memo from Workplace Safety and Training Officer to Nye County Manager reporting continued employee concerns; mentions mold as possible cause without supporting evidence; mold sampling conducted via mold-sampling kits; no elevated levels reported
January 2001: Continued employee concerns reported to Nye County Health Officer who recommends contacting specific consultant who collects bulk samples indoors (no outdoor samples collected) and reports that employee health concerns are consistent with building-related illness due to fungal bioaerosol exposure; recommends conducting a comprehensive inspection for water damage and fungal contamination; biological sampling (indoor only) performed by a specific environmental sampling consultant
February 2001: Consultant interprets results of environmental sampling as support for fungi being associated specifically with the employee health concerns and recommends additional sampling, including "destructive" sampling
April 2001: Additional sampling (including outdoor) conducted
May 2001: Destructive sampling done and results show no remarkable infestations and a single source of mold contamination from leaky VAV boxes
June 2001: HVAC system evaluated and recommendations include full evaluation of HVAC functionality; building closed by Nye County Board of Directors (NCBD)
July 2001: Consultant performs unsuccessful duct leakage test
June–August, 2001: Extensive remediation of building
June–November 2001: Nevada OSHA conducts inspection and finds no indication of active mold growth; also notes no OSHA regulations would mandate occupant removal, given the symptoms experienced by employees
September 2001: Building reoccupied; employee symptom reports ensue; building closed again by NCBD
March 2002: IAQ survey conducted; O_2, CO_2, RH, temp, VOCs measured; only abnormal finding was 22% RH
September 2001–May, 2003: Building completely gutted and cleaned; 18 separate sampling investigations of building environment and contents
May 2003: Building reoccupied and employee concerns are again noted
September 2003: NIOSH receives employee request for an HHE
October 2003: Nevada OSHA conducts another inspection; offers to meet with any employee who has any health concerns and no one participates; OSHA finds no unusual circumstances or violations; no citations issued
January–October 2004: Law firm handling employee legal suits reports no IEQ health concerns from employees

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