



NIOSH HEALTH HAZARD EVALUATION REPORT

**HETA #2004-0246- 2979
Cherokee County Fire Station
Ball Ground, Georgia**

August 2005

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PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) 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), or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorize 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.

RDHETAP 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 Terri A. Pearce, Ph.D., Margaret Kitt, MD, MPH and Michelle R. Vingle, MS of RDHETAP, Division of Respiratory Disease Studies (DRDS). Desktop publishing was performed by Terry Rooney.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Indoor Air Quality

NIOSH received a confidential health hazard evaluation request to conduct an indoor air quality evaluation of Cherokee County Fire Station 21 in Ball Ground, Georgia.

What NIOSH Did

- Interviewed workers and management
- Reviewed reports prepared by outside consultants
- Conducted walk-throughs in five identically constructed fire stations
- Monitored the workplace for indoor air quality parameters (temperature, relative humidity, and carbon dioxide)
- Combined visual inspection for mold, moisture, and dampness with the use of a moisture meter for determining water content in building materials
- Conducted one-on-one interviews with employees to discuss health symptoms and the possibility of building-relatedness

What NIOSH Found

- Roof leaks and water incursion in the garage bays
- Condensation in heating and cooling ducts
- Evidence of sewer back-ups
- Evidence of water damage and visible mold in internal wall cavities
- Condensation and visible mold growth on bathroom air supply vents and ceilings
- High rates of self-reported health symptoms in firefighters working in Station 21

What Cherokee County Can Do

- Repair current water leaks and provide for thorough discovery to identify and correct water damage or mold

- Hire a licensed, qualified contractor to evaluate the heating, ventilation, and air conditioning system and ensure it is meeting design specifications and providing adequate fresh air to the occupied spaces
- Provide for adequate ventilation in equipment rooms and other specialized storage areas
- Follow the Environmental Protection Agency guidance for cleaning or removing building materials, furnishings, or other items that have been previously wetted
- Hire a licensed, qualified plumber to evaluate sanitary and run-off sewer systems and ensure proper operation
- Implement a reporting system for conditions or concerns that may adversely effect indoor air quality

What Firefighters Can Do

- Report indoor air quality concerns and health symptoms to management
- Promptly report leaks or other factors that might impact air quality
- Comply with policies that are designed to protect indoor air quality
- Employees with asthma and allergic conditions should bring this report to their physicians for counsel regarding investigation of possible work-related patterns of peak flow, airways hyper-reactivity, and/or medication use



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 #2004-0246-2979



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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a confidential request from firefighters of Cherokee County Fire Station 21 in Ball Ground, Georgia. In the request, firefighters expressed concerns about the air quality in the building and the possibility that the indoor environment might be causing health effects experienced by some of the firefighters. Primary health concerns were: asthma, bronchitis, respiratory infections, sinusitis, growths in the sinus cavity, bloody mucous, nose bleeds, shortness of breath, coughs, fevers, eye/skin irritation, mold allergies, and diarrhea. Listed exposures included air fresheners, dirty air ducts and vents, inadequate fresh air, water leaks in restrooms, and other airborne irritants.

The NIOSH response consisted of calls to requesters and county officials, reviews of Indoor Air Quality (IAQ) reports prepared by independent consultants and sent to NIOSH by the requesters, and a walkthrough of the community center that houses Fire Station 21. NIOSH also visited 4 other community centers and fire stations of the same design and built in the same time-frame by county contractors. During the walkthrough, the NIOSH industrial hygienist conducted: visual inspection of the building for indicators of mold, moisture, and dampness; real-time monitoring of temperature, relative humidity, carbon dioxide, and carbon monoxide concentration in and outside of the buildings; and use of a moisture-meter for differential determination of water content in building materials. The NIOSH medical officer conducted interviews with employees to assess what health symptoms were present and whether they may be building-related.

Visual observations of conditions that were deemed to have potential for impacting IAQ were made. Visible mold, rust, and water condensation on air supply vents was found in the restrooms. Inspection of the wall cavities located between the restrooms and the kitchen area in all five of the fire stations found evidence of water damage and mold at the base of the interior wall surfaces. Visible mold was present on clothing and other items stored in the Station 21 turn-out gear room. Condensation was evident on the interior surfaces of ductwork observed through an inspection panel at the air conditioning unit. A sewer drain back-up occurred during the site visit in the Station 21 laundry room floor drain. Measured indoor relative humidity levels were above the recommended guidelines, and levels of carbon dioxide were within the recommended range.

Firefighters reported various health problems including headaches, allergies/congestion, sinusitis, fatigue, and asthma. In most cases, these symptoms were perceived as temporally related to work. Firefighters who had relocated from Station 21 to other stations, reported a decrease in symptoms after leaving Station 21. Thirty-three percent of firefighters at Station 21 reported a confirmed diagnosis of asthma, a prevalence much higher than in the general population which is about 10%. Two additional firefighters were being treated with asthma medications, but had not yet been tested for asthma. If these two additional individuals are also diagnosed, this elevates the number of personnel with asthma to 44%. Of the individuals with confirmed or likely asthma, 75% never had asthma prior to working in Station 21. The other 25% reported having childhood asthma that had resolved, but recurred after working at Station 21.

NIOSH conducted one walkthrough at Cherokee County Fire Station 21 in Ball Ground, GA, to address employee concerns about the indoor environment and health effects they were experiencing. We measured excessive relative humidity in the firefighter living quarters and found visible mold in plumbing chases. High rates of self-reported symptoms in Station 21 raise concern that a portion may be building-associated health effects. In particular, the prevalence of reported physician diagnosed asthma is much higher (33%) than the asthma prevalence in the general population, which is about 10%. We recommend further evaluation of the building envelope including the roof for areas of water damage or mold. Water damaged materials should be removed and replaced using appropriate precautions for protecting occupants and for persons conducting the remediation. Additionally, employees with asthma and allergic conditions should bring this report to their physicians for counsel regarding the investigation of possible work-related patterns of peak flow, airways hyper-reactivity, and/or medication use.

Keywords: NAICS code: 922160 (Firefighting (except forest) Government and Volunteer (except private), indoor air quality, IAQ, mold, dampness, humidity

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request from firefighters of Cherokee County Fire Station 21 in Ball Ground, GA. The request listed concerns about the air quality in the building and the possibility that the indoor environment might be causing health effects experienced by some employees.

The confidential request listed primary health concerns which included asthma, bronchitis, respiratory infections, sinusitis, growths in the sinus cavity, bloody mucous, nose bleeds, shortness of breath, coughs, fevers, eye/skin irritation, mold allergies and diarrhea. Listed possible exposures included water intrusion, problems with the heating, ventilating, and air-conditioning (HVAC) system, and high levels of mold.

BACKGROUND

In 2001, the administration of Cherokee County, Georgia began construction on a set of 5 community centers to house their fire stations and sheriffs' offices. The buildings are of nearly identical design with the floor plans consisting of a central two- or three-bay garage connecting the firefighter quarters on one side of the building with the sheriff's offices and community rooms on the opposite side. Each building is approximately 6000 square feet and of steel frame construction with steel, concrete block, and brick exterior finishes. The roof is metal with the individual portions of the roof over each of the garage bays pitched side-to-side on center. The portion of the roof over the rest of the building is pitched front to back off-center with the front sloping more steeply than the back. Foundations are on-grade concrete slabs with a concrete driveway in the front of the building leading to the garage bays and a combination driveway/concrete parking lot in the back. The garage interior finishes consist of painted concrete block walls, a concrete slab floor, and a finished wood ceiling.

Although unconfirmed, we were told that a dispute between the building contractor and the roofing sub-contractor caused 3 out of 5 of the community centers to be built with the interior finishes completed prior to completion of the roofs. Rainy weather during the construction caused wetting of the interior materials and led to mold growth within the buildings. The county hired an outside contractor to conduct environmental testing in each building both pre- and post-occupancy and to make recommendations for removal of previously wetted materials. We were told that those recommendations were not properly followed. Building occupants reportedly experienced respiratory and other health problems since occupying the building.

We spoke to requesters by telephone to discuss the nature of the health complaints and environmental conditions in the workplace. The requesters stated that they felt better when away from the building and that their physicians had indicated that their symptoms appeared to be connected to their workplace.

We also spoke by telephone with the Cherokee County health and safety representative who stated that county management was aware of the indoor air quality concerns and that an environmental company had been hired to conduct indoor air quality evaluations in the buildings.

Review of Previous Consultant Reports

NIOSH was supplied with copies of several indoor air quality reports prepared for Cherokee County by outside consultants. The reports were prepared in the fall of 2001 and documented water damage and mold growth in Fire Stations 4, 12, and 21.^{1,2,3} The reported water damage and mold were a result of water incursion that had taken place during construction of the buildings. The reports were prepared prior to building occupancy and contained recommendations for remedial actions of mold and water damage. The remediation was to occur before occupancy of the buildings.

Reports of additional investigations conducted after occupancy included visual inspection and air sampling for mold. In December 2001, a consultant reported visible mold. Air sampling conducted at Stations 4, 12, and 21 found airborne fungi levels to be similar to outdoor concentrations.⁴

A consultant hired by the firefighters and the consultant for Cherokee County conducted simultaneous investigations of Stations 12 and 21 in January 2004.^{5,6} The investigations included a) swab samples for mold collected from surfaces such as air supply vents, ceilings, and HVAC units, and b) tape-lift sampling for surface mold. The Cherokee County consultant also conducted sampling for airborne mold.

Results from the surface samples collected by both consultants showed similar types of molds or yeasts. Air samples for mold spores at Station 21 found indoor concentrations to be greater than outdoors. Recommendations made for Station 21 by the Cherokee County consultant included cleaning the interior of the HVAC systems and other interior surfaces in the occupied spaces.⁶

METHODS

Walk-through Observations

A NIOSH medical officer and an industrial hygienist conducted building walkthroughs during November 3-5, 2004, in all five of the similarly constructed buildings, Cherokee County Fire Stations 4, 12, 16, 21, and 23. On each walk-through, the sleeping quarters and common rooms for firefighters and the garage bays housing the fire trucks and other equipment were visually assessed. In addition, the sheriffs' offices and community spaces on the other side of the garage bays were visited. Other areas examined were the return air space between the roof decking and the drop ceilings, the mechanical room and HVAC units, and the plumbing wall cavity located between the kitchen and bathrooms in each station. The building was equipped with smoke alarms and

carbon monoxide detectors were present in the sleeping quarters.

Real-time Measurements

During each walkthrough, we measured indoor air quality parameters: temperature in Fahrenheit (°F), relative humidity in percent (%), and carbon dioxide and carbon monoxide in parts per million (ppm). In addition, we used a moisture meter to measure conductivity of building materials such as gypsum board and the concrete slab.

Employee Interviews

The NIOSH medical officer met with firefighters from Station 21 on November 4th and 5th, 2004. The medical officer individually interviewed 18 of 19 firefighters currently stationed at Station 21 and spoke with several workers who had left Station 21 to work at other fire stations.

Video Tape Review

During the walkthrough, the NIOSH industrial hygienist viewed video tapes supplied by the requesters and reportedly filmed by an electrical contractor in February and March of 2001 during construction of the buildings. Also viewed was a video tape reportedly filmed by the Building and Grounds Department Manager. The videos showed significant water infiltration into the fire station buildings as the roofs were not yet complete although interior finishes such as flooring and drywall were in place.

RESULTS

Visual Observations

The NIOSH industrial hygienist visited all five buildings on Day 1 of the walkthrough (November 3rd, 2004). A consultant hired by Cherokee County and a firefighter representative accompanied the NIOSH industrial hygienist. The buildings were very clean and in good overall repair.

Station 21 houses 19 firefighters across 3 shifts and has the largest staff load, and the hazardous materials response team is stationed there. The other stations also have 3 shifts with 3 to 4 firefighters assigned per shift. Firefighter quarters include a kitchen/common room, sleeping room, men's bathroom with showers, women's bathroom, offices, storage room, laundry room, and turnout gear room all connected by a central hallway leading to the garage bay. Interior wall finishes are painted gypsum board with metal grid/acoustic tile ceilings. Bathroom walls are ceramic tile to mid-wall and gypsum board to the ceiling. Bathroom ceilings are also gypsum board. Flooring is mainly vinyl tile with carpet in offices and sleeping rooms. Each side of the building is served by a separate HVAC system housed in an enclosed mechanical room entered from the garage bays.

Prior to the NIOSH walkthrough, mold was discovered in the plumbing chase/wall cavity between the bathrooms and kitchen in Station 21. We found evidence of water damage and some visible mold at floor level to a height of approximately 6 inches on the interior of the bathroom wall in Fire Station 21 (Figure 1). Inspection of the plumbing chase in Fire Station 23 found similar evidence of water damage and mold.

Additional areas in Fire Station 21 found to have evidence of water infiltration or mold included interior drywall around an office window (Figure 2). We found evidence of excessive condensation in the air conditioning supply duct covers in several stations, some with signs of rust or visible mold on the metal grill surface and on drywall ceiling around the duct (Figure 3). Some firefighting equipment stored in the turn-out gear room had surface evidence of mold (Figure 4). Cherokee County personnel placed a stand-alone dehumidifier in this room during our site visit.

Day 2 was the weekly cleaning day for all fire stations and firefighters were cleaning, doing laundry, mopping floors, and wiping down surfaces including air supply vents with a water

and bleach solution. During these activities, the door connecting the living quarters to the garage bay was often open with the garage doors also open. The laundry equipment was being used at Fire Station 21. Soapsuds were observed at the wastewater drain for the washing machine (Figure 5) and also appeared at the laundry room floor drain (Figure 6) raising questions about whether sewer drainage was adequate. The exhaust from the industrial-sized dryer is not direct to outdoors and routes into a metal box that surrounds an opening to the outside fitted with a filter (Figure 7). It was unclear whether this configuration allows adequate exhaust of moisture from the dryer.

Other observations that indicated moisture issues in the buildings included characteristics that were specific to the construction. The concrete slab is the sub-floor for the occupied areas. Some moisture measurements of the concrete slab under the carpeting in the sleeping quarters were higher than measurements in other parts of the slab. Small amounts of sand were observed in the stress control joints under the carpet and appeared to be coming from below the building (Figure 8). No other building materials had above normal moisture content as determined by the moisture meter. Another indicator of high moisture conditions was firefighter reports that millipede-type insects were present in large numbers inside the building during certain times of the year. These insects are known to favor damp conditions.

Examination of the building structure above the acoustic tile ceiling found evidence of non-continuous insulation in the exterior wall cavity (Figure 9) and no clear evidence of a vapor barrier in the exterior walls. Rust was observed on the roof rafters of Fire Station 21 (Figure 10) but not on rafters in other stations. The roof itself appeared to be a multi-layer construction with a continuous metal sub-roof and the exterior finished metal roof overlaid upon it. It was not possible to determine what was between the two layers although the videotapes filmed during construction indicated that there was at least a tarpaper overlay on the sub-roof.

Fire station 21 also exhibited signs of moisture build-up due to insufficient drainage. What appeared to be drywall intended for interior use was applied as the exterior ceiling for the porch area (Figure 11). Staining was observed at some roof downspouts (Figure 12). It was reported that downspouts connect to a sub-surface drain system that transported the water to a storm water-runoff holding pond for each location. Each station was equipped with a lawn sprinkler system with the sprinkler head locations appearing to be appropriate and to point away from the buildings.

While roof integrity appeared to be good overall at fire stations 4, 12, 16, and 23, water leaks were observed in the garage bays at Fire Station 21. The leaks appeared to be occurring at the junction of the roof and the exterior brick cladding.

Indoor Air Quality Measurements

A Q-trak™ indoor air quality monitor was used for real-time measurement of temperature, relative humidity, carbon dioxide and carbon monoxide concentration during visits to each location. Stations were evaluated as they were during the time of the visit. This included having some doors open to the outside or to the garage bays that then had doors open to outside.

Table 1 presents values for parameters measured at specific locations in all five fire stations on Day 1. Table 2 provides the values for the four stations visited on Day 2 and Table 3 presents the values measured at Station 21 on Day 3. Carbon monoxide was found to be very low to non-detectable, i.e., 0-1 parts per million (ppm) at all stations. Temperature measurements were within the acceptable range of 73-79° Fahrenheit as specified in the American National Standards Institute/American Society for Heating, Refrigeration, and Air Conditioning Engineers (ANSI/ASHRAE) Standard 55-2004.⁷ Carbon dioxide concentrations were within the ANSI/ASHRAE Standard 62.1-2004 recommendations of no more than 700 parts per million greater than outdoors in all stations.⁸ Station 21 was observed to have a higher level of carbon dioxide in the kitchen/common room

space immediately after breakfast when approximately eight employees were present. While the carbon dioxide level was within the ANSI/ASHRAE recommendations, this observation indicated that concentration in the building might become elevated with increased occupancy. Most of the relative humidity measurements obtained on Day 1 were above the recommended levels at all fire stations (Table 1). The weather outdoors was also humid and appeared to influence the indoor humidity although all measurements were made with the doors and windows closed and the air conditioning operating. Readings for Days 2 and 3 were within the guidelines. Outdoor levels were also lower as rain had occurred overnight and during the morning of Day 2.

The HVAC system for Fire Station 21 had been modified to insert inspection panels on the supply ducts leading away from the HVAC units. The ducts were clean with no signs of rust or dirt evident. However, visible moisture condensation was evident on the interior duct surfaces.

Employee Symptoms

The following historical symptoms were reported during the time the 18 firefighters worked at Station 21:

- 33% experienced conjunctivitis or eye irritation
- 39% had headaches (varying in type and location)
- 78% experienced allergies or congestion
- 44% reported nosebleeds or bloody nasal discharge (usually upon awakening)
- 50% experienced bouts of sinusitis
- 28% had sleeping difficulties
- 55% experienced extreme fatigue
- 39% developed a rash
- 33% had “flu-like illnesses”
- 33% reported a confirmed diagnosis of asthma

Two additional firefighters were being treated with asthma medications, but had not yet been

tested for asthma. If these two additional individuals are also diagnosed, this will elevate the number of personnel with asthma to 44%, a prevalence much higher than in the general population which is about 10%. Of the individuals with confirmed or likely asthma, 75% never had asthma prior to working in Station 21. The other 25% reported having childhood asthma that had resolved, but recurred after working at Station 21. All symptoms were self-reported and had a temporal relationship to the time spent at Station 21. Workers who had previously worked at Station 21 with similar symptoms reported that their symptoms had improved following relocation to other stations.

DISCUSSION AND CONCLUSIONS

Several observations in Fire Station 21 provide evidence for excessive moisture in this building. The videotapes filmed during construction support historical water damage. Visual observations made during the walkthrough also provide evidence of previous and current water incursion. Observation of water leaks, condensation on interior and exterior surfaces, and sewer backups in Fire Station 21 demonstrate that this building has current issues with building dampness and bring into question the integrity of the roof and the building envelope. The finding of visible mold growth in the plumbing chase indicates that actions to repair sites of previous water damage have not been adequate. The videotapes documented extensive roof leaks and wetting of building materials including flooring during construction. The requesters reported that the extent of the repairs and replacement of wetted materials conducted prior to occupancy differed among the fire stations with some areas of wetted carpeting or drywall being removed and replaced and other areas allowed to dry in place. At the time of the site visit, no materials other than observed in the plumbing chase appeared obviously deteriorated or damaged due to previous wetting. The construction of the roof and the building envelope did not allow for in-depth inspection of these building elements.

However, rust on metal roof rafters indicated exposure to the elements at some point in their history. Window leaks that had caused growth of visible mold around some windows were observed. Condensation and visible mold on bathroom air supply vents and Q-trak™ readings of elevated relative humidity in the interior of the building with doors and windows closed demonstrated that the HVAC system was not adequate for moisture control under normal building operation. The periodic presence of millipedes inside is indicative of a damp building.

The Cherokee County attorney provided NIOSH with a copy of the report prepared by the environmental consultant hired by the county and who accompanied NIOSH during Day 1 of the walkthrough.⁶ The consultant confirmed the presence of visible mold in wall cavities and on bathroom ceilings and the high humidity levels in the occupied areas. The Cherokee County consultant made the following specific recommendations:

1. Remediation of the plumbing chases in Stations 21 and 23
2. More detailed investigation of plumbing chases in Stations 4, 12, and 22
3. Consideration of more in-depth evaluation of the building envelope for signs of moisture or mold
4. Removing fungal growth from HVAC ducts following cleaning procedures as outlined by the National Air Duct Cleaners Association standards
5. Replacing or modifying the HVAC systems to adequately dehumidify stations and installing a dedicated outside air unit

These recommendations are in keeping with those made verbally by NIOSH during the walkthrough and are appropriate for discovery and remediation of mold within the building.

An additional recommendation made by the Cherokee County consultant was the installation of ultraviolet (UV) lights in the HVAC ducts. While reports in the scientific literature have demonstrated that UV can decrease the amounts

of mold in HVAC ductwork,^{9,10} this technology is not an established method for remediating existing mold. Proper clean-up of existing mold should be conducted along with modification of the HVAC system to prevent excessive humidity prior to installation of UV in the ductwork.

In conversations with the requesters since the site visit, Cherokee County has implemented some of the changes suggested by their consultant including plans for remediating mold in the plumbing chases of Stations 21 and 23 and the installation of UV lights in the HVAC ductwork.

Much of the research on the health effects of damp indoor spaces includes self-reported symptoms or clinical outcomes and their association with the presence of dampness, either measured or reported. The Institute of Medicine in its 2004 report, *Damp Indoor Spaces and Health*, evaluated the strength of the available scientific evidence concerning possible associations between damp environments and health outcomes.¹¹ The committee concluded there was sufficient evidence of an association between exposure to damp indoor environments and nasal and throat symptoms, cough, wheeze, and asthma in sensitized asthmatic persons. The committee felt there was limited or suggestive evidence of an association with asthma development. Lastly, there was insufficient evidence to determine whether an association exists with mucous membrane irritation syndrome, inhalation fevers, skin symptoms, gastrointestinal tract problems, or fatigue. However, the report acknowledged that indoor environments are complex and the committee recommended greater research attention to the role of damp indoor environments to address current gaps in scientific knowledge.

The health impacts for persons working in damp indoor environments are a continuing and evolving focus for NIOSH and others within the scientific community. The body of scientific evidence thus far shows limited associations as outlined above. The high rates of self-reported symptoms in Station 21 raises concern that a portion may be building-associated health effects. In particular, the prevalence of asthma

is much higher than the asthma prevalence in the general population, which is about 10%.

RECOMMENDATIONS

- Repair current water leaks and provide for thorough methods of discovery (including examining interior or exterior wall cavities and materials between the roof layers) to identify and correct water damage or mold
- Hire a licensed, qualified contractor to evaluate the HVAC system and ensure it is meeting design specifications and providing adequate fresh air to the occupied spaces
- Ventilate turnout gear rooms to allow for proper exhaust and to prevent excessive humidity
- Follow the Environmental Protection Agency guidance¹² for cleaning or removing building materials, furnishings, or other items that have been previously wetted
- Hire a licensed, qualified plumber to evaluate sanitary and run-off sewer systems and ensure proper operation
- Implement a reporting system for conditions or concerns that may adversely affect indoor air quality
- Employees with asthma and allergic conditions should bring this report to their physicians for counsel regarding investigation of possible work-related patterns of peak flow, airways hyper-reactivity, and/or medication use

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TABLES

Table 1. Indoor Air Quality Values by Location - Measured November 3, 2004.

Location	CO ₂ concentration (ppm)	Relative humidity* (%)	Temperature (°F)	Time of day
Station 21 - Common Room	818	63	74	8:30 a.m.
Station 21 - Turn-out Gear Room	688	71	73	9:00 a.m.
Station 12 - Central Hallway	532	73	72	11:45 a.m.
Station 22 – Sleeping Quarters	694	70	72	1:30 p.m.
Station 22 – Common Room	840	75	72	2:00 p.m.
Station 22 – Outdoors	380	73	80	2:15 p.m.
Station 23 – Common Room	610	57	73	3:12 p.m.
Station 23 – Sleeping Quarters	546	61	69	3:30 p.m.
Station 4 – Common Room	526	72	71	5:20 p.m.
Station 4 – Sleeping Quarters	590	72	71	5:30 p.m.

*ASHRAE recommends an indoor relative humidity range of 30-60%

Table 2. Indoor Air Quality Values by Location - Measured November 4, 2004.

Location	CO ₂ concentration (ppm)	Relative humidity* (%)	Temperature (°F)	Time of day
Station 4 – Outdoors	592	52	72	2:20 p.m.
Station 4 – Sleeping Quarters	575	52	73	2:40 p.m.
Station 4 – Common Room	443	43	74	2:50 p.m.
Station 12 – Common Room	581	48	70	3:42 p.m.
Station 12 – Turn-out Gear Room	600	54	68	3:45 p.m.
Station 12 – Sleeping Quarters	539	55	69	3:50 p.m.
Station 23 – Common Room	466	53	71	4:45 p.m.
Station 23 – Sleeping Quarters	508	53	69	5:00 p.m.
Station 21 – Turn-out Gear Room	564	50	74	6:00 p.m.
Station 21 – Common Room	568	50	72	6:05 p.m.

*ASHRAE recommends an indoor relative humidity range of 30-60%

Table 3. Indoor Air Quality Values at Station 21 - Measured November 5, 2004.

Location	CO ₂ concentration (ppm)	Relative humidity* (%)	Temperature (°F)	Time of day
Station 21 – Common Room	904	58	70	8:30 a.m.
Station 21 – Turn-out Gear Room	681	51	68	8:45 a.m.
Station 21 – Outdoors	395	37	56	9:05 a.m.
Station 21 – Sleeping Quarters	574	48	68	9:20 a.m.

*ASHRAE recommends an indoor relative humidity range of 30-60%

Figures



Figure 1. Visible mold and water damage in wall cavity (plumbing chase)



Figure 2. Visible mold on interior drywall at window header in Station 21 office.



Figure 3. Rust and visible mold on bathroom air supply vent



Figure 4. Visible mold on firefighting clothing in turnout gear room.



Figure 5. Washing machine sewer drain open to the laundry room. Soap bubbles and water leaking from joints and running onto floor.



Figure 6. Soap bubbles exiting floor drain during washing machine operation.



Figure 7. Dryer exhaust configuration. Dryer exhausts into metal box, exits at filter (arrow).



Figure 8. Concrete slab sub-floor with carpet tiles removed. Sand accumulation in the stress control joint.



Figure 9. Exterior wall at roof viewed from inside the building above the drop ceiling. Insulation is not continuous to roof.



Figure 10. Station 21 - Underside of roof. Roof support with visible rust.



Figure 11. Drywall applied as outdoor porch ceiling



Figure 12. Roof downspout with evidence of puddling and moisture accumulation.

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