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DECEMBER 1991
GARFIELD COUNTY COURTHOUSE
GLENWOOD SPRINGS, COLORADO

NIOSH INVESTIGATOR:
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I. SUMMARY

On April 8, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Administrator of Garfield County, Colorado to conduct a health hazard evaluation (HHE) at the Garfield County Courthouse in Glenwood Springs, Colorado. The requestor was seeking assistance with indoor air quality concerns in the building.

On May 9, an initial evaluation of the 4-story Courthouse building was conducted. On the first visit, a meeting was held with county administrators, an environmental consulting firm, affected employees, and supervisors of affected employees. Completed questionnaires from employees in the building were collected and reviewed between the first and second visits. Responses were received from 47% of the building occupants. Workers in the building started reporting problems in 1984 after a major building expansion was completed. The major complaints, other than comfort-related, were about itchy eyes and stuffy/runny nose. A thorough visual inspection of the heating, ventilating, and air-conditioning (HVAC) units serving the building was conducted. Also, carbon dioxide (CO₂), temperature, relative humidity, and smoke tube tests were conducted to evaluate efficiency of the HVAC systems. Selected employees from throughout the building were interviewed. A second visit was conducted on June 6, 1991, where additional CO₂, temperature, and humidity measurements were made along with air sampling for airborne dusts and aldehydes.

The ventilation in the building consisted of a central variable air volume (VAV) HVAC system with hot water reheat on the exterior terminal units. Cooling was provided by an indirect chilled water coil and a direct evaporative cooling section. The central HVAC system was in good condition, had a good maintenance program, and had an intake located on the rooftop well away from any contaminant sources. The ducts in the renovated part of the building were made from rigid fiberglass with an aluminum foil lining.

Temperature and humidity measurements were consistent throughout the building, ranging from 71° to 76°F and 36% to 42% RH. These values generally fall within the guidelines of 73° to 77°F temperature range (the temperature in a few areas was slightly below the recommended range early in the morning) and the 20 to 60 percent relative humidity range recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Carbon monoxide (CO) levels

were measured throughout the building and were found to be less than 2 parts per million (ppm). Air samples for aldehydes were all below the limit of quantitation (1.5 micrograms per sample); air samples for airborne dusts resulted in only low levels of common, low-toxicity materials.

Based on the building inspection and the environmental monitoring results, the investigator was unable to identify an airborne contaminant which would constitute a health hazard. Recommendations are made in Section VII to help alleviate the employee complaints.

KEYWORDS: SIC 9222 (Legal Counsel and Prosecution), indoor air quality, indoor air pollution, IAQ.

II. INTRODUCTION

On April 8, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Administrator of Garfield County, Colorado to conduct a health hazard evaluation (HHE) at the Garfield County Courthouse in Glenwood Springs, Colorado. The requestor was seeking assistance with indoor air quality concerns in the building. Employees in the building had been complaining of itchy watery eyes, stuffy and/or runny nose, headaches, sore throats, and other problems since the building had been expanded in 1984.

On May 9, an initial evaluation of the 4-story Courthouse building was conducted. On the first visit, a meeting was held with county administrators, an environmental consulting firm, affected employees, and supervisors of affected employees. Completed questionnaires from employees in the building were collected and reviewed between the first and second visits. Responses were received from 47% of the building occupants. The major complaints, other than comfort-related, were about itchy eyes and stuffy/runny nose. A thorough visual inspection of the heating, ventilating, and air-conditioning (HVAC) units serving the building was conducted. Also, carbon dioxide (CO₂), temperature, relative humidity, and smoke tube tests were conducted to evaluate efficiency of the HVAC systems. Selected employees from throughout the building were interviewed. A second visit was conducted on June 6, 1991 during which additional CO₂, temperature, and humidity measurements were made along with air sampling for airborne dusts and aldehydes.

III. BACKGROUND

The Garfield County Courthouse was built in 1928, consists of 4 stories plus a basement, and is located in Glenwood Springs, Colorado. In 1984 the building was expanded to the north. Shortly after this building addition was completed, workers began complaining about various upper respiratory problems. The complaints have continued on a periodic basis.

The ventilation in the building consisted of a central variable air volume (VAV) HVAC system with hot water reheat on the exterior terminal units. Cooling was provided by an indirect chilled water coil and a direct evaporative cooling unit. The HVAC system is equipped with an economizer section which contains outside, return and exhaust air dampers. There are 90 VAV boxes throughout the building. The ducts immediately downstream of the fan and cooling coils are lined inside with an insulated material, i.e. fiberglass. The ducts in the newer portions of the building are made of rigid fiberglass and covered with an aluminum foil.

The county has hired a number of environmental and HVAC consultants in response to the workers' complaints. A number of changes were made as a result of the consultants' recommendations including the elimination of the underground parking garage (since carbon monoxide was found in occupied spaces), and the moving of a battery storage area from the first floor into the basement due to concerns about high hydrogen levels. A large number of ventilation-related changes were implemented in 1988 including the replacement of all VAV operating controls, a complete balancing of the HVAC system, the extension of the waste vent above the HVAC unit, the modification of the return air ducts to the main handler to smooth out the transition, the addition of some hot water baseboard units, the modification of elevator relief vents, the addition of CO monitoring controls to the exhaust fan in the basement, and the recalibration of the rooftop HVAC units to cycle for occupied/unoccupied control. The complaints in certain areas of the building continued after these changes were made.

IV. MATERIALS AND METHODS

The NIOSH evaluation consisted of: (1) an assessment of questionnaire results from building employees, (2) an examination of the building's heating, ventilation and air conditioning (HVAC) system, (3) an examination of the building for identifiable contaminant sources, (4) interviews with representatives from the building management and building employees; (5) and an environmental survey designed to assess key parameters related to the building's air quality. The specific measurements and types of samples collected in the environmental survey are detailed below.

- A. Instantaneous measurements of carbon dioxide (CO₂) concentrations were made at several different times and locations throughout the building and outdoors. These measurements were made using a GasTech (Model RI 411) portable direct-reading CO₂ analyzer capable of measuring CO₂ concentrations from 50 to 5000 parts per million (ppm). The instrument was calibrated before use and checked against outdoor levels at various intervals throughout the workday.
- B. Measurements of dry bulb temperatures and relative humidity were made at several different times and locations throughout the building and outdoors using an Extech Instruments Digital Humidity and Temperature Meter.
- C. Concentrations of carbon monoxide (CO) were measured using a Draeger Model 190 Datalogger. This is a direct-reading electrochemical instrument which is specific for CO.
- D. Air samples for suspended dust were collected on 34-millimeter (mm) glass fiber filters using battery operated sampling pumps (Gilian model HFS 513A) at 2 liters per minute.

- E. Air samples for aldehydes were collected on ORBO-23 collection tubes at 30-50 cubic centimeters per minute (cc/m) using Gilian low flow personal sampling pumps. These samples were analyzed by gas chromatography according to NIOSH analytical method #2539.¹

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for 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 if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting 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 evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, such contact may increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of air contamination criteria generally consulted include: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), (2) the American Conference of Governmental Industrial Hygienist's (ACGIH) Threshold Limit Values (TLVs), (3) the U.S. Department of Labor (OSHA) federal occupational health standards, and (4) the ventilation standards developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The first three sources provide environmental limits based on airborne concentrations of substances to which workers may be occupationally exposed in the workplace environment for 8 to 10 hours per day, 40 hours per week for a working lifetime without adverse health effects. These evaluation criteria apply to industrial settings and may not be adequate for indoor air quality problems in office buildings. The ASHRAE guidelines specify recommended outside air ventilation rates needed to maintain acceptable indoor air quality for the majority (at least 80%) of a building's occupants.

The industrial criteria for the substances evaluated in this survey are presented in Table 1. 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 short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high, short-term exposures. A discussion of the substances evaluated in this survey and the ASHRAE comfort and ventilation guidelines is presented below.

A. Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath, and, if monitored in the indoor air, can often be used as a screening technique to evaluate whether adequate quantities of fresh outdoor air are being introduced into a building or work area. The outdoor, ambient concentration of CO₂ is about 350 ppm. Typically the CO₂ level is higher inside than outside (even in buildings with few complaints about indoor air quality). However, if indoor CO₂ concentrations are more than 1000 ppm (3 to 4 times the outside level), the building may be receiving inadequate outside air, or the air may be poorly distributed by the HVAC system. Under these conditions, complaints such as headache, fatigue and eye and throat irritation may frequently be reported. Although the CO₂ is not responsible for these complaints, a high level of CO₂ does indicate that other contaminants in the building may also be increased and could be responsible for symptoms among building occupants.²

B. Carbon Monoxide

Carbon monoxide can occur as a waste product of the incomplete combustion of carbonaceous fuels. Sources of carbon monoxide in indoor environments include tobacco smoke, malfunctioning or improperly vented heating systems, and the introduction of contaminated air from outside sources such as loading docks. Carbon monoxide exposure in sufficient concentrations can result in headache, dizziness, drowsiness, nausea, vomiting, collapse, coma, and death.³

C. Temperature and Relative Humidity

The majority of references addressing temperature and humidity levels as they pertain to human health frequently appear in the context of assessing conditions in hot environments. Development of a "comfort" chart by ASHRAE presents a comfort zone considered to be both comfortable and healthful. This zone lies between 73° and 77°F (23° and 25°C) and 20 to 60 percent relative humidity.⁴

D. Ventilation

Neither NIOSH nor OSHA have developed ventilation criteria for general offices. Criteria often used by design engineers are the guidelines published by ASHRAE. Until recently, the ASHRAE

Ventilation Standard 62-73 (1973) was utilized, but recommendations were based on studies performed before the more modern, airtight office building became common. These older buildings permitted more air infiltration through leaks and cracks around windows and doors, and through floors and walls. Modern office buildings are usually much more airtight and permit less air infiltration. Due to the reduced infiltration, ASHRAE questioned whether the 1973 minimum ventilation values assured adequate outdoor air supply in modern, airtight buildings.

The minimum rate of outside air permitted under the new ASHRAE Standard 62-1989 is 20 cfm/person for general office areas.⁵ For smoking lounges, ASHRAE Standard 62-1989 recommends an outside or adjacent area air supply rate of at least 60 cfm/p. The basis of the outside air supply rates recommended by ASHRAE is for maintaining an indoor air quality that is considered acceptable by at least 80% of the building's occupants. However, unless referenced or specified by local building codes, building owners are not legally required to comply with these ASHRAE Standards. Most building codes refer to an earlier version of this standard (ASHRAE Standard 62-73) which was intended to conserve energy more so than promoting adequate indoor air quality.

E. Environmental Tobacco Smoke (ETS)

Environmental tobacco smoke is a well-recognized health hazard, associated with effects ranging from eye irritation to lung cancer⁶⁻¹¹. NIOSH has recently published a Current Intelligence Bulletin (CIB #54) on Environmental Tobacco Smoke in the Workplace, Lung Cancer and Other Health Effects¹². This document summarizes the literature on ETS and concludes that ETS meets the OSHA criteria as a potential occupational carcinogen and, therefore, exposures to ETS should be reduced to the lowest feasible concentration. The document further recommends that "Employers should minimize occupational exposure to ETS by using all available preventative measures."

The Federal Occupational Safety and Health Administration (OSHA) currently has no specific regulation regarding exposure to environmental tobacco smoke.

VI. RESULTS AND DISCUSSION

A. HVAC System Inspection

The central HVAC system is a variable volume system which was in good condition, had a good maintenance program, and had an intake located on the roof well away from any contaminant sources. The intake filters were fiberglass with a particulate efficiency rating

of 40%. The filters were replaced every 6 months. The central HVAC system was on an economizer cycle which would adjust the outside air dampers according to the outside temperature. The HVAC system is run continuously with no shut down in the evenings or on the weekends.

Cooling for the system is provided by an evaporative cooling system which received routine maintenance and appeared to be free from any standing water. No signs of mold growth could be found. The ducts just downstream from the evaporative cooler were lined inside with fiberglass insulation but this area was not able to be inspected due to the lack of any access panels. Workers in the building had complained in years past of a fishy odor in the building. The older rigid cardboard media used in the evaporative cooler system was found to contain a fish oil binder which was thought to cause the odors. This media was subsequently replaced and the fishy odors have not been noticed since.

B. Environmental Survey Results

The carbon dioxide (CO₂) levels ranged from 350 up to 475 ppm throughout the building during the first visit (May 9) and on the second visit (June 6). Outside levels stayed fairly constant at 300 to 325 ppm of CO₂. No CO₂ levels were measured above 1000 ppm anywhere in the building.

Likewise, temperature and humidity measurements were consistent throughout the building, ranging from 71° to 76°F and 34% to 42% RH. Most of these values fall within the guidelines of 73° to 77°F temperature range and the 20 to 60 percent relative humidity range recommended by ASHRAE.⁴ A few lower temperatures were found early in the day.

Carbon monoxide (CO) levels were measured throughout the building and were found to be less than 2 ppm. The areas of primary concern based on earlier monitoring were in the basement (formerly used as a parking garage) and in the boiler room. No elevated levels of CO were found.

The air samples for aldehydes were all found to contain no appreciable levels of aldehydes (limit of detection was 0.5 to 3 ug [depending on the aldehyde compound] per tube, limit of quantitation was 1.5 to 8 ug per tube). The analysis scanned for formaldehyde, acetaldehyde, crotonaldehyde, valeraldehyde, hexanal, heptanal, butyraldehyde, and benzaldehyde. The airborne dust samples were found to have light loading containing mostly aluminum-silicate, gypsum, and cellulose fibers. None of these materials are considered toxic, particularly in the amounts found.

C. Results of Interviews, Questionnaires, and Investigation of Areas

Prior to NIOSH's arrival, questionnaires had been circulated by the requestor. The questionnaires were collected at the time of the first site visit. The questionnaire used was that contained in the NIOSH Guidance for Indoor Air Quality Investigations.² The results of these questionnaires are summarized in Table 2. Typically, of the people responding to the questionnaire (47%), 80-90% of them had complaints about the building. The majority concerned comfort; it was too hot, too cold, or there was a lack of air circulation (stuffy feeling), or there was a noticeable odor. The major health complaints were stuffy/runny nose, itchy/watery eyes, and headache. Most occupants thought the problem occurred all day and on a daily basis.

VII. CONCLUSIONS

In general, measurements of ventilation system parameters (i.e., CO₂, temperature, and relative humidity) did not reveal any particular problems with the system on the days examined. The temperatures in the morning were slightly below what is recommended by ASHRAE (71°F versus 73°F). The ventilation system appeared to be providing adequate amounts of outside air throughout the building. One area on the 3rd floor in the Social Services Child Support offices had very little air movement. The CO₂ levels were fairly low but this was probably due to the fact that there were few people in this area on the day measurements were taken. The lack of air movement appears to be the result of renovations which partitioned the area into many small offices and the ventilation system had not been redesigned to fit the spaces.

Many of the complaints in the building were comfort related, particularly concerning odors. Upon further questioning, many of these complaints centered around the fishy odor that had been associated with the old evaporative cooler media. Most occupants agreed that the odor problem was better now.

The symptoms that occupants most often reported were itchy, watery eyes and stuffy, runny noses. These problems appeared to be fairly consistent throughout the building. Workers on the first floor were the most vocal about these problems and had the most documentation regarding the timing and duration of the symptoms. Several employees related chronic sinus problems that they claimed were related to working in the building. No obvious source of a contaminant could be found for these symptoms.

The majority of the building does not allow smoking, yet there are several areas where environmental tobacco smoke (ETS) can get into

non-smoking areas. ETS is a known carcinogen and is a strong irritant and allergen. Exposure to ETS should be reduced to the lowest amount feasible.

VIII. RECOMMENDATIONS

- 1) The maintenance schedule for the HVAC system should be continued. There is concern in the Colorado area regarding evaporative coolers and their potential for growing certain bioaerosols. The evaporative cooler system, particularly the media, should be cleaned with a mild biocide on a periodic basis to kill any biological growth. The media manufacturer should be contacted relative to the frequency and the type of biocide recommended. The unit should be treated and flushed when there are no occupants in the building.
- 2) Check the balancing on the HVAC system in the third floor Social Services offices to insure proper air distribution to all occupied spaces. A qualified ventilation consultant should be hired for this purpose.
- 3) Constant recording temperature and relative humidity units should be installed to track these environmental factors. Most of the complaints in the building centered around thermal comfort issues. These recording devices would provide a hard copy record of times when the temperature and humidity were outside the ASHRAE guidelines.
- 4) In accordance with Department of Health and Human Services recommendations, no smoking should be allowed in the building. This should help reduce irritant and odor complaints associated with environmental tobacco smoke.

IX. REFERENCES

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1. County Administrator, Garfield County, Glenwood Springs, Colorado.
2. Judicial District Administrator, Glenwood Springs, Colorado.
3. Safety and Loss Control Representative, Division of Risk Management, State of Colorado
4. U.S. Department of Labor/OSHA - Region VIII.
5. NIOSH, Region VIII
6. Colorado State Health Department, Denver, Colorado

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

Table 1
 ENVIRONMENTAL CRITERIA FOR SELECTED SUBSTANCES
 GARFIELD COUNTY COURTHOUSE
 GLENWOOD SPRINGS, COLORADO
 NOVEMBER 1991

SUBSTANCE	OSHA PEL	NIOSH REL	ACGIH TLV
Carbon Dioxide	10,000 ppm 8-hr TWA 30,000 ppm STEL	10,000 ppm* 8-hr TWA 30,000 ceiling (10 min)	5,000 ppm 8-hr TWA 30,000 ppm STEL
Carbon Monoxide	35 ppm 8-hr TWA 200 ppm ceiling (no minimum time)	35 ppm 8-hr TWA 200 ppm ceiling (no minimum time)	50 ppm 8-hr TWA 400 ppm STEL

Abbreviations and Key

TWA - Time-weighted average concentration

ppm - Parts of contaminant per million parts of air

STEL - Short-term exposure limit; 15-minute TWA exposure

*1000 ppm is used as a guideline for availability of fresh air in office environments.

TABLE 2
 RESULTS OF SELF-ADMINISTERED QUESTIONNAIRE FOR INDOOR AIR
 GARFIELD COUNTY COURTHOUSE
 GLENWOOD SPRINGS, COLORADO
 NOVEMBER 1991

	ROOM NUMBER		104	100-2,5,9	300	306	400,1,3,7
	200	201-6					
% OF OCCUPANTS RESPONDING*	42	42	85	85	36	36	50
COMPLAINTS							
I have a complaint	100	91	100	50	67	91	90
Temperature too hot	56	36	33	25	33	45	10
Temperature too cold	33	9	33	25	33	64	10
Lack of air circulation	100	73	100	25	56	82	90
Noticeable odors	44	64	67	25	22	18	60
Dust in the air	67	0	33	13	0	9	20
Disturbing noises	22	0	11	0	11	0	30
Other	22	27	33	0	11	18	0
HEALTH PROBLEMS OR SYMPTOMS							
Sneezing	22	18	22	0	0	9	0
Itchy, watery eyes	67	36	44	25	56	18	40
Stuffy, runny nose	44	45	78	25	33	64	20
Headache	44	0	33	13	22	36	60
Sore throat	44	9	33	0	0	0	10
Cough	22	0	11	0	0	2	10
Chest congestion	22	0	0	0	0	0	10
Other	0	0	56	0	0	3	60
OCCURRENCE							
Morning	11	0	22	0	11	0	0
Afternoon	33	0	0	0	22	0	0
All day	56	45	22	0	56	82	50
Daily	56	55	22	13	11	45	20
No trend	0	9	56	13	22	0	40

* Numbers reflect averages per floor.

TABLE 2 (Continued)
 RESULTS OF SELF ADMINISTERED QUESTIONNAIRE FOR INDOOR AIR
 GARFIELD COUNTY COURTHOUSE
 GLENWOOD SPRINGS, COLORADO
 NOVEMBER 1991

	<u>ROOM NUMBER</u>		104	100-2,5,9	300	306	400,1,3,7
	200	201-6					
<hr/>							
OTHER FACTORS							
Smokers	11	0	0	12	0	27	0
Allergies	33	45	22	25	22	36	30
Contact wearers	11	18	11	0	11	0	20
VDT users	100	55	33	0	44	27	20

COMMENTS

Questionnaires were sent to all of the 144 current workers. Forty-seven percent (47%) of those receiving questionnaires returned them. Numbers above reflect the percentage of room occupants responding positively to the question.