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PARK COUNTY COURTHOUSE
FAIRPLAY, COLORADO

NIOSH INVESTIGATOR:
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I. SUMMARY

In September 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the Park County Courthouse, Fairplay, Colorado, to evaluate indoor air quality complaints. Symptoms included headaches, ringing in the ears, worsening eyesight, and sinus problems.

In September, 1987, a NIOSH investigator inspected the facility and collected five air samples for formaldehyde. Sources of emission included pressed wood products used in the furniture and floors of the 7500 sq. ft., 2-year old building where six people are employed in the operation of two courtrooms.

Formaldehyde levels in the offices and courtroom ranged from 0.03 to 0.06 parts per million (ppm), with a mean of 0.05 ppm. NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen and that exposure be reduced to the lowest feasible level. However, the Courthouse formaldehyde levels are within the range of typical residential formaldehyde exposure. The fact that formaldehyde is found in so many home products, appliances, furnishings, and construction materials has prompted several agencies to set standards or guidelines for residential formaldehyde exposure. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has recommended, that for comfort, exposures to formaldehyde be limited to 0.1 ppm. This guideline also has been adopted by NASA, and the Federal Governments of Canada, West Germany, and the United Kingdom.

After the initial visit, it was recommended that non-smoking employees be furnished with "no-smoking" offices and that the fresh-air supply for the furnaces be drawn from the outside instead of the basement.

In late September 1987, the carpets were cleaned and the entire Courthouse was made a "no smoking building". Outside-air vents were connected to the furnaces in early November 1987. The NIOSH investigator conducted a followup visit on February 8, 1988, to assess the amount of fresh air supplied and distributed to the building during varying occupancy conditions. Measurements of carbon dioxide (CO₂), temperature, and relative humidity were collected throughout the building.

CO₂ levels in the building ranged from 250-400 ppm during the NIOSH visit. Indoor CO₂ levels less than 600 ppm indicate that an adequate amount of fresh air is being supplied. However, the air was found to be too dry with relative humidity levels ranging from 14 to 18%. Relative humidity less than 20% is associated with upper respiratory irritation caused by drying of the mucous membranes.

Based on the data collected in this investigation, it was concluded that there was no hazard due to exposure to formaldehyde at the time of the NIOSH visit. Adequate amounts of fresh air were found to be supplied and distributed during the followup visit. Humidification was recommended.

Keywords: SIC 9211 (courts), formaldehyde, indoor air quality, humidification.

II. INTRODUCTION

On September 11, 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at the Park County Courthouse, Fairplay, Colorado. Employees submitted the request after developing symptoms of headaches, ringing in the ears, worsening eyesight, and sinus problems, which they attributed to working in the Courthouse.

On September 21, 1987, a NIOSH investigator conducted an initial visit consisting of a building inspection and formaldehyde air sampling. Formaldehyde was a concern among some of the employees because they had heard rumors that urea-formaldehyde foam insulation was used in the building. The carpet had also been suspected of emitting something and was thoroughly steam-cleaned about a week before the NIOSH visit. At the end of the initial survey, it was recommended that (1) employees be furnished with no-smoking offices, (2) the fresh air supply for the furnaces be drawn directly from the outside instead of the basement, and (3) the building be humidified.

After recommendations (1) and (2) were implemented, a followup study was conducted on February 8, 1988, to evaluate the building's fresh air supply, air distribution and relative humidity levels. At that time personal interviews indicated that most employees thought that the air quality had greatly improved, but opinions were divided on whether it was the carpet-cleaning or the no-smoking policy that was mainly responsible for the improvement. Remaining symptoms included occasional headaches among two of the six employees, also, there was nose irritation among three employees which they attributed to dry air.

III. BACKGROUND

Six people work in the 2-year old building of typical modern residential-type construction. The offices and courtrooms are located on a single level covering approximately 7500 square feet and there is a full basement for the storage of records and building/grounds maintenance materials. The floors and much of the office furniture are made of particle board and the building is insulated with Owens/Coming Pink Fiberglass*. Six Lennox Pulse* gas furnaces are located in the basement. Four of them heat the upstairs and two heat the basement. There is no cooling system due to the temperate summer climate given Fairplay's 10,000 feet elevation above sea level. The windows can be opened for ventilation during warm weather.

IV. METHODS

On September 21, 1987, a NIOSH investigator inspected the facility. No obvious sources of contaminants were noted except the possibility of formaldehyde emissions from pressed wood products. Five air samples were collected in midget impingers containing 1% sodium bisulfite at a flow rate of one liter per minute for about two hours. The samples were analyzed for formaldehyde by visible spectroscopy according to NIOSH Method 3500.

On February 8, 1988, a followup visit was conducted to evaluate the amount of fresh air supplied to the building during varying occupancy while both courtrooms were in session. Fifteen carbon dioxide (CO₂) measurements using short-term colorimetric detector tubes were collected during the day. Temperature and relative humidity measurements were collected with a Bendix* Psychron Model 566.

V. EVALUATION CRITERIA

A. Building-Related Illness Episodes

Building-related illness episodes have been reported more frequently in recent years as buildings have been made more air-tight in order to conserve energy and to reduce air conditioning expenses. Contaminants may be present in make-up air or may be introduced from indoor activities, furnishings, building materials, surface coatings, and air handling systems and treatment components. Symptoms often reported are eye, nose, and throat irritation, headache, fatigue, and sinus congestion. Occasionally, upper respiratory irritation and skin rashes are reported. In some cases, the cause of the symptoms has been ascribed to an airborne contaminant, such as formaldehyde, tobacco smoke, or insulation particles, but most commonly a single cause cannot be pinpointed.

Imbalance or malfunction of the air conditioning system is commonly identified, and in the absence of other theories of causation, illnesses are usually attributed to inadequate ventilation, heating/cooling, or humidification.

Fresh Air Supply²

Carbon dioxide (CO₂) is a normal constituent of exhaled breath and, if monitored, can 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 usually 250-350 ppm. Usually the CO₂ level is higher inside than outside, even in buildings with few complaints. If indoor CO₂ concentrations are more than 1000 ppm (3 to 4 times the outside level), this frequently indicates a problem of inadequate ventilation resulting in complaints such as headaches, fatigue and eye and throat irritation. The CO₂ concentration itself is not responsible for the complaints. However, a high concentration of CO₂ indicates that other contaminants in the building also may be increased which result in occupant complaints. If CO₂ concentrations are maintained below 600 ppm, with comfortable temperature and humidity levels, complaints referable to air quality should be minimal. If CO₂ levels are greater than 1000 ppm, widespread complaints may occur and thus 1000 ppm should be used as an upper limit guideline. This does not mean that if this level is exceeded the building is hazardous or should be evacuated, but rather this level should be a guideline that helps maximize comfort for all occupants. Levels between 600 ppm and 1000 ppm are less clearly interpreted.

Humidity

Excessively dry air is a common problem inherent to many indoor environments during the heating season. Relative humidity levels below 20 percent are associated with increased drying of the mucous membranes resulting in sore, bleeding noses.²

B. Toxicological

Formaldehyde

Formaldehyde and other aldehydes may be released from foam plastics, carbonless paper, particle board, plywood, and textile fabrics. Formaldehyde is an irritant to the eyes, nose, mouth, and throat. These symptoms can occur at concentrations as low as 0.1 ppm. Formaldehyde vapor has been found to cause a rare form of nasal cancer in rats. These results have prompted NIOSH to recommend that formaldehyde be handled as a potential occupational carcinogen. NIOSH recommends that workplace exposures be reduced to the lowest feasible limit.³

The fact that formaldehyde is found in so many home products, appliances, furnishings, and construction materials has prompted several agencies to set standards or guidelines for residential formaldehyde exposure. (ASHRAE) has recommended, based on personal comfort, that exposure to formaldehyde be limited to 0.1 ppm. This guideline has also been adopted by NASA, and the Federal governments of Canada, West Germany, and the United Kingdom.

Table 1 summarizes data from many studies of formaldehyde levels in homes in different parts of the United States, Canada, and the United Kingdom. Mobile homes, due to the large amount of pressed wood products in their construction, have the highest formaldehyde concentrations. A mean of 0.4 ppm has been found in most of the studies conducted in mobile homes. Most other types of homes have average formaldehyde levels less than 0.1 ppm. The older (>15 years) conventional homes have a mean formaldehyde level of 0.03 ppm and they represent the class of dwellings with the lowest levels of formaldehyde.⁴

VI. RESULTS AND DISCUSSION

Formaldehyde

On September 21, 1987, formaldehyde levels in the offices and courtroom ranged from 0.03 to 0.06 ppm with a mean of 0.05 ppm (Table II). The basement had 0.02 ppm formaldehyde in the air.

The Courthouse formaldehyde levels are comparable to those found in conventional homes (Table I) and were within the ASHRAE standard on the day of the NIOSH visit. However, most studies on the effect of seasonal variations on residential formaldehyde exposure indicate that a majority of conventional homes will have a formaldehyde concentration exceeding 0.1 ppm on one or more days of the year. The highest levels usually occur during the hottest, most humid days of summer.⁴

Fresh Air Supply

On the day of the followup survey in February 1988, CO₂ levels were about 250 ppm throughout the building while seven occupants were present in the morning before courthouse patrons began arriving. CO₂ levels reached a maximum of 400 ppm at 9:30 am when there were 29 occupants, then declined to 300 ppm while there were 20 or less occupants before peaking again at 400 ppm at 1:30 pm when there were 36 occupants. The outdoor CO₂ concentration was 200 ppm. Indoor CO₂ levels less than 600 ppm indicate that an adequate amount of fresh air is being supplied.

Increasing the amount of fresh air was not the only reason for connecting the furnace air intakes to the outside. Actually, the more moderately tempered and "reasonably fresh" air from the basement may have been able to provide adequate ventilation to the upstairs, if it were not for those occasions when employees could detect odorous maintenance or cleaning activities or the starting and parking of snow plows in the basement. Therefore, the outdoor-air intakes were connected in early November 1987.

During the followup survey, it was unclear how much of the Courthouse's fresh air was actually supplied by the furnaces. Some outside air was also introduced during the frequent opening and closing of the front doors. Also, a considerable amount of wind could be felt coming through the loosely fitted rear doors. Regardless of the sources, plenty of fresh air was found to be supplied to the offices during the NIOSH visit.

Air Distribution

Most of the work areas in the Courthouse are located in fairly large open areas with plenty of heating registers and no partitions to impede air distribution. Uniform CO₂ levels among the work areas also indicated that the air was well distributed.

Office temperatures varied widely (68° - 78°F) during the NIOSH visit but were not considered to be related to air distribution. Variations were attributed to the solar heating of southward offices and the different settings on each of the four upstairs thermostats which employees are free to adjust to their comfort.

Good air distribution, in fact, is the reason that the entire Courthouse had to be made a "no-smoking building" instead of designating individual no-smoking work areas. Some employees claimed that they could "instantly detect" the odor of a lighted cigarette anywhere in the building.

Humidity

The relative humidity ranged from 14 to 18% during the NIOSH visit. A Northern Humidifier one-gallon cold water "mist vaporizer" was being used in the larger office area where three employees are located. However, this unit was designed to humidify much smaller areas (e.g. bedrooms) and was not having much effect on the excessively dry air in the Courthouse. Relative humidity levels below 20% cause discomfort associated with drying of the mucous membranes.

VII. RECOMMENDATION

Increasing the relative humidity to about 40% would help alleviate upper respiratory irritation caused by dry air during the heating season.²

However, humidifiers should not be used unless care is taken to ensure that they are kept clean. Otherwise, the growth of various molds, fungi, and bacteria can cause hay fever like symptoms in sensitized ("allergic") individuals. Rarely, a more serious recurring respiratory condition called hypersensitivity pneumonitis or "humidifier lung" can develop.

VIII. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods. 3rd ed. Cincinnati, Ohio; National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) publication no. 84-100).
2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. ASHRAE standard 62-1981, ventilation for acceptable indoor air quality. Atlanta, Georgia: ASHRAE, 1981.
3. National Institute for Occupational Safety and Health. Current intelligence bulletin 34 - Formaldehyde: Evidence of carcinogenicity. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication No. 81-111).
4. Gammage RB, Hawthorne AR. "Current Status of Measurement Techniques and concentrations of Formaldehyde in Residences." Turoski V. Formaldehyde: analytical chemistry and toxicology. "Developed from a symposium sponsored by the Division of Environmental Chemistry at the 87th Meeting of the American Chemical Society, St. Louis, Missouri, April 8-13, 1984."

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1. Park County Courthouse
2. U.S. Dept. of Labor/OSHA - Region VIII
3. NIOSH - Denver Region
4. Colorado State Health Dept.
5. Park County Health Department

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

Table I*
 Reported Levels of Formaldehyde in the Indoor Air Classes of
 Private Residences

Type of Residence	No. of Residences	Formaldehyde (ppm)	
		Range	Mean
U.S. homes without urea-formaldehyde foam insulation (UFFI)	41	0.01-0.1	0.03
U.S. homes with UFFI (complaint and noncomplaint)	636	0.01-3.4	0.12
U.S. Mobile homes	431	0.01-3.5	0.38
Canadian houses without UFFI	383	(3% >0.1ppm)	0.036
Canadian houses with UFFI	1850	(10% >0.1ppm)	0.054
U.S. houses without UFFI and without particle board	17	-	0.025
U.S. houses without UFFI and without particle board subfloors	600	-	0.050
U.S. mobile homes	several hundred		0.12
U.K. buildings without UFFI	50	<0.03->0.3 (3% >0.1ppm)	0.047
U.K. buildings with UFFI	128	0.01->1 (7% >0.1ppm)	0.093
U.S. houses without UFFI	42	0.03-0.17	0.06
U.S. houses without UFFI	31	-	0.07
U.S. houses with UFFI	-	-	0.06
Mobile homes (Minnesota complaints)	100	0-3.0	0.4
Mobile homes (Wisconsin complaints)	-	0.02-4.2	0.9
Mobile homes (Wisconsin)	65	<0.10-3.68	0.47

Table I*

(continued)

Reported Levels of Formaldehyde in the Indoor Air Classes of
Private Residences

Type of Residence	No. of Residences	Formaldehyde (ppm)	
		Range	Mean
Mobile homes (Washington)	-	0-1.77	0.1-0.44 (complaint)
U.S. Mobile homes			
Never occupied	260	-	0.86
Older occupied			0.25
East Tennessee homes	40	<0.02-0.4	0.06
Age 0-5 years	18	-	0.08
Age 5-15 years	11	-	0.04
Age >15 years	11	-	0.03
Conventional California, Colorado, and S. Dakota homes	64	0.02-0.11	0.05
Specialized housing	52	0.03-0.3	0.1

*Gammage R.B., Hawthorne A.R. "Current Status of Measurement Techniques and concentration of Formaldehyde in Residences." Turoski V. Formaldehyde: analytical chemistry and toxicology. Page 125. "Developed from a symposium sponsored by the Division of Environmental Chemistry at the 187th Meeting of the American Chemical Society, St. Louis, Missouri, April 8-13, 1984."

Table II

Formaldehyde Air Levels
Park County Courthouse
Fairplay, Colorado
HETA 87-407
September 21, 1987

Location	Sampling Time	Concentration (ppm)
DA's office	8:30a - 10:07a	0.04
Station 2	8:31a - 10:07a	0.03
Court Reporter's Office	8:33a - 10:08a	0.05
Courtroom	8:34a - 10:09a	0.06
Basement	8:35a - 10:10a	0.02