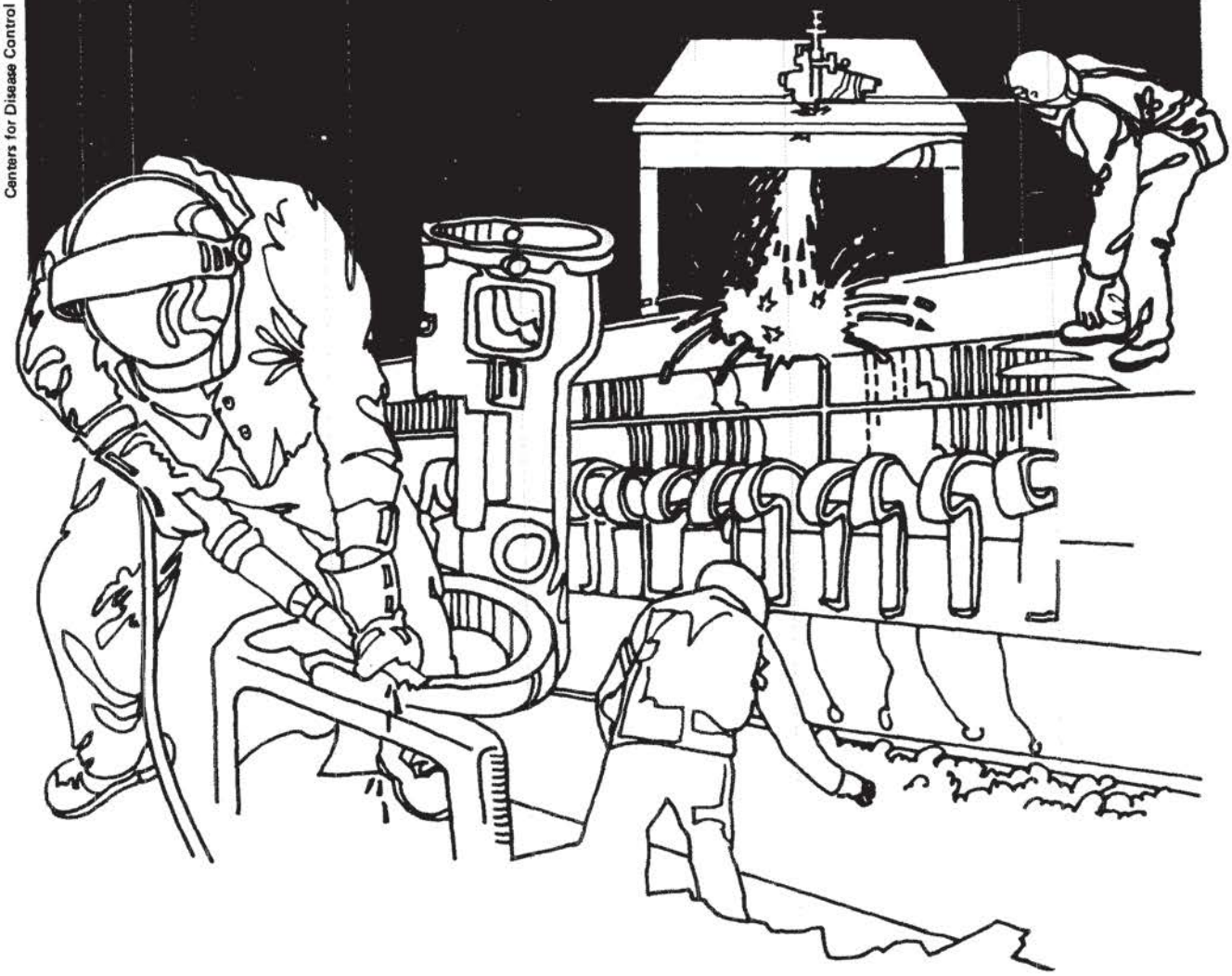
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 83-042-1283
DIOCESE OF PUEBLO
PUEBLO, COLORADO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of 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 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 employer 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.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) 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.

HETA 83-042-1283
MARCH 1983
DIOCESE OF PUEBLO
PUEBLO, COLORADO

NIOSH INVESTIGATOR:
Theodore W. Thoburn, M.D.

I. SUMMARY

On November 9, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate carbon monoxide (CO) exposures and worker complaints (headaches, eye and nose irritation) in the offices in the Chancery Building, Diocese of Pueblo, Pueblo, Colorado. Symptoms were reported to have started when the building's furnace was turned up because of cold weather. The local city-county sanitarian had measured concentrations of 8 parts per million (ppm) of carbon monoxide (CO) in a second floor office. Although he suspected the furnace as the source of CO, he was unable to find elevated readings in the furnace room.

On November 17 and 18, 1982, the NIOSH investigator visited this 90-year old stone building to obtain information on the heating system, inspect the premises, interview the workers, and to obtain detector tube readings for carbon dioxide (CO_2) and carbon monoxide (CO) levels, and to take temperature and humidity readings.

Heat is supplied by hot water baseboard radiators. The natural gas furnace is located in the basement in a separate room along with the gas water heater. There is no central air circulating system, although the heating pipes run through holes knocked out of the walls and cut into the ceilings. By and large these were not sealed in basically unfinished rooms. Ventilation is obtained by opening windows.

Nine of the ten workers interviewed had had headaches during the problem period, and four had eye irritation. Air sampling by NIOSH failed to identify a CO buildup, even after running the furnace at daytime levels all night. However it did appear that at least some thermostats were not functioning properly as the building had temperature readings of 76.5° and 80° F. on first entering in the morning. Humidity was low (less than 25%) as would be expected in a dry climate with no added humidification. CO_2 levels were uniformly low, only slightly above outside levels.

The most likely explanation for the problem at the beginning of the heating season is that some blockage in the chimney had occurred over the summer and is now burned away. CO could have reached the 2nd floor office through the holes in the furnace room ceiling and the abandoned dark room wall. Dusty baseboard radiators could have contributed to the eye irritation.

On the basis of environmental and medical data, NIOSH concluded that a health hazard did not exist in the Chancery Building of the Diocese of Pueblo, Pueblo, Colorado, at the time of the NIOSH visit. It is suggested that a CO problem probably did exist at the beginning of the heating season due to a chimney obstruction. Recommendations for preventing future problems are included in this report.

KEYWORDS: SIC 8661 (Religious Organization), carbon monoxide, indoor air quality, carbon dioxide, temperature, relative humidity.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request on November 9, 1982, from the Building Manager/Director of Bishop's Development Fund (BDF) to conduct a health hazard evaluation of carbon monoxide (CO) exposures and worker complaints in the offices of the Diocese of Pueblo in the Chancery Building, Pueblo, Colorado. Workers then complained of headaches and burning eyes and noses.

The problem was first called to NIOSH's attention October 26, 1982, when the local city-county sanitarian called the NIOSH Region VIII office in Denver, Colorado. He had been called in to investigate the problem which had been going on for the previous three weeks. The problems started when the furnace was turned up because of cold weather. He obtained readings of 8 parts per million (ppm) of carbon monoxide (CO) in a second floor office using an MSA direct reading CO meter. Although he suspected the furnace as the source of CO, he was not able to find elevated readings in the furnace room.

He suggested to the Building Manager that NIOSH be invited in to see if we could solve the problem.

The NIOSH investigator visited the building on November 17 and 18, 1982, to obtain information on the heating system, inspect the premises, interview the workers, and to obtain detector tube readings for carbon dioxide (CO_2) and carbon monoxide (CO), and temperature and humidity readings.

III. BACKGROUND

The Chancery Building is about 90 years old, of stone construction, and has three floors and a basement. It is sited on a corner lot in rolling terrain. The front of the building is set well back from a street with light traffic most of the day. The side is somewhat closer to a quiet side street. The basement contains a number of storage rooms. The furnace room is located at the far end of the hall from where the stairs come down to the basement. There is a door at the top of the basement stairs which is usually closed. The first and second floors contain offices. The Bishop's office on the first floor has just been remodeled, but this was done since the problem being studied was at its worst. The third floor is an apartment for the Chancellor. There is a door at the top of the stairs which is usually kept closed.

Heat is supplied by hot water baseboard radiators. The natural gas furnace is located in the basement in a separate room along with the gas water heater. Chimney pipes lead into a stone chimney which runs to roof peak level, although at third floor level the roof slopes away from the chimney. There is no central air circulating system, although the heating pipes run through holes knocked out of the walls and cut into the ceilings. By and large these were not sealed in basically unfinished rooms. The rooms on the different floors are grouped into a number of zones, each with its own thermostat. Ventilation is obtained by opening windows. There are window air conditioners for some of the first floor offices and the third floor apartment. There is a swamp cooler at the end of the second floor hall for the second floor.

IV. METHODS

A. General

Initially information was obtained about the building in general, heating, cooling and ventilation, and housekeeping. Individual workers were interviewed for job histories, health problems, and smoking habits. Because the weather was somewhat warmer than was the case when the problem started, by afternoon many windows were being opened. Therefore arrangements were made to have the heat left at the usual daytime settings overnight the night before samples were to be taken. Unfortunately the second floor thermostats were set back, but the first floor thermostats were left at their day time settings. Air quality assessment involved obtaining temperature and humidity readings and detector tube samples for carbon dioxide (CO_2) and, in some cases, carbon monoxide (CO) at a variety of locations. CO measurements were done at most locations in the morning, but in only a few locations in the afternoon.

B. Sampling Locations

Outside air by front door.
Furnace room - basement.
1st floor hall at foot of stairs to 2nd floor.
2nd floor hall near top of stairwell.
3rd floor hall near back window.
A number of 1st and 2nd floor offices (see Table I).

C. Instrumentation

Temperature and Humidity were obtained using a Bendix model 566-2 Psychron® which measures both dry bulb and wet bulb temperatures. Relative humidity is read from a chart using the difference between the two temperature readings.

Carbon Dioxide (CO_2) was measured using a Drager Tube - Carbon Dioxide 0.01%/a. With ten pump strokes this tube measures concentrations between 0.01 and 0.3% by volume.

Carbon monoxide (CO) was measured using a Drager Tube - Carbon Monoxide 5/c. With ten pump strokes this tube measures concentrations between 5 and 150 parts per million (ppm). These tubes, when used with the Dragor Pump, have been certified by NIOSH to an accuracy of $\pm$35% at 25 ppm CO and of $\pm$25% at 50 to 250 ppm (less pump strokes for higher readings). Twenty (20) strokes were used to get readings approximately half of this range.

V. EVALUATION CRITERIA

A. Ventilation adequacy was estimated from the potential for CO_2 buildup within an occupied area.[1] Air normally contains about 0.03% carbon dioxide. As most living creatures, including man, produce CO_2 as an end product of metabolism, if an enclosed area is occupied and not adequately ventilated the concentration of CO_2 will gradually build up. The ventilation can further be evaluated by observing how long it takes after occupancy has been reduced for the CO_2 levels to return to

normal. CO_2 is also produced by combustion, such as smoking. CO_2 levels anticipated in this study would have no health effects. Experience in Finland in a building of concrete block construction and carpeted floors found regulating fresh air by CO_2 level worked acceptably with maximum CO_2 level set at 0.08%.[2] At higher levels complaints were received concerning air quality. About 35% of workers were smokers.

B. Carbon Monoxide[3] (CO) is produced when carbon containing compounds are burned in a limited air supply. The likely sources in this study would be a malfunctioning furnace and/or cigarette and pipe smoke. Under other circumstances automobile exhaust or a malfunctioning cook stove might be considered. Small quantities of CO result from the metabolic breakdown of hemoglobin in man, but the amounts would be too small to measure by the methods used in this study. CO binds to the hemoglobin in the red blood cells 220 to 290 times more strongly than does oxygen. This impairs the blood's ability to carry oxygen to the tissues of the body. The immediate health effects are related to the proportion of hemoglobin which is bound with CO. This proportion in turn is determined by how concentrated the CO is in the air, how long the contaminated air is breathed, and how much air is breathed during the exposure time. (Hard physical work increases depth and rate of breathing.)

Non-smokers usually have 0.3 to 0.7% of their hemoglobin tied up with CO. In smokers this may rise to 5 to 10%. Although there are some circulatory changes at lower levels which could affect individuals with severe cardiorespiratory problems, at carboxyhemoglobin levels of less than about 15% saturation about the only noticeable effect would be a loss of visual sensitivity to light, most noticeable as a decrease in night vision. Above that symptoms include headaches of progressive severity, nausea, decreased manual dexterity and judgment, and at higher levels (50+%) coma, convulsions, and death. Non-smokers not regularly exposed to CO might notice symptoms at somewhat lower levels. Unless severe poisoning has deprived the brain of oxygen long enough to cause damage, recovery is usually complete if the individual is rapidly moved to uncontaminated air. Recovery is hastened if oxygen is administered.

To prevent excessive CO absorption three sources of criteria commonly accepted to assess workroom concentrations of contaminants are:

1. NIOSH criteria for recommended standards..... 35 ppm
2. Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), January 1978..... 50 ppm
3. American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs) for Chemical Substances in the Workroom Environment..... 50 ppm

These levels should prevent significant health problems even with exposures of 8 to 10 hours per day, 40 hours per week for a working lifetime. Higher concentrations can be tolerated for short periods.

C. Temperature as experienced in an office building is more a matter of comfort than health risk. Because it is more sociably acceptable to put on extra clothing for warmth than to take off clothing for coolness, workers are more likely to be comfortable in a cooler room if they are

prepared for it. Federal energy conservation dictated offices only be cooled to 78° F. This was generally regarded by the occupants as a little warm for sustained mental activity. Heating above the low 70's not only can make the occupants uncomfortable, but wastes energy.

D. Relative Humdity measures how much water vapor is present in the air in relation to how much water air at that temperature could hold if it were completely saturated. Relative humidities in mid range, about 30% to 80%, are the more comfortable. Except at extreme ranges there are no health consequences. Dry air tends to dry the mucous membranes of eyes, nose and throat, but reduce the preception of discomfort due to temperature. Moist air increases the preception of uncomfortable temperatures and reduces the efficiency of sweating as a way of getting rid of excess body heat. Relative humidity will change with temperature changes. When air is heated during the winter the relative humidity drops considerably because warm air can hold much more water vapor than can cold air. If this becomes too much of a problem, for example considerable problems with static electricity, the air can be humidified by adding water vapor through a number of mechanisms. Because moist, warm surfaces encourage growth of molds and slimes, it is necessary that the humidifying devices be kept clean. Spores from molds and slimes can cause respiratory problems in some sensitive people.

VI. RESULTS AND DISCUSSION (See Table I)

A. Carbon Monoxide (CO)

No hazardous levels of CO were found. The highest levels found in the furnace room (2-3 ppm) were the same as those found outside the front door the first thing in the morning. What levels as were found may have related to the operation of the furnace (in the furnace room) or to the smokers on the staff. (At such low levels the detector tube readings are not very accurate.) Assuming that the levels found by the city-county sanitarian were accurate, the most likely source of CO would be a malfunction in the furnace provided there was a reasonably direct way for the CO to get from the furnace room to the second floor office (the BDF Secretaries' Office) where it had been measured. The Director of BDF, a smoker, was not in the office that day so he could not have contributed to the CO level.

Although the furnace appeared to be operating properly at the time of the NIOSH study, it is quite possible that some blockage, such as a bird's nest, could have developed in the chimney over the summer and has since burned away. It could have caused trouble during the first few weeks of furnace operation. The CO could have reached the second floor office by following the pipes through the holes in the ceiling of the furnace room and out through the hole in the wall in the abandoned dark room just off the office in question. As the weather was cold, the building would have been shut up as tightly as possible which would hold in CO as well as warmth.

B. Carbon Dioxide (CO_2)

The highest CO_2 levels were found in the Chancellor's Office right after a closed door meeting with the windows shut (.07-.08%). After a window was open, levels dropped to those of the outside air. CO_2

levels also tended to be slightly higher in the offices of smokers (.04-.05%). The other two elevations were in the 2nd floor hall when the bathroom door was closed (.06%), and in the furnace room (.04% rising to .06%). The elevation in the 2nd floor hall probably relates to the occupancy of the second floor offices with the usual source of ventilation (the bathroom window) cut off. The elevation in the furnace room might relate to the operation of the furnace and/or water heater, or could relate to the relative stillness of the air. Carbon dioxide, being nearly twice as heavy as air, tends to settle in depressions and enclosures if there are few or no disturbances to keep the air mixed. This latter explanation may well be the correct one as the CO level dropped in the afternoon whereas the CO_2 level continued to rise.

C. Temperature and Humidity

Outside temperatures were low enough overnight to keep the furnace running, desired for this study to allow CO buildup if it were to occur. What was not expected was that temperatures in the building would be 76.5° F. in the 1st floor hall and 80° F. in the second floor hall. This suggests that some of the thermostats are not functioning properly. As expected, relative humidities were on the low side (11.5 to 18%) first thing in the morning rising somewhat during the day as the building cooled down, was occupied, and windows were opened. Outside humidity dropped to 24.5% by afternoon. As expected, the inside humidities were slightly lower as the air was heated without adding water vapor.

D. Employee Interviews and Other Interview Data

Ten persons who worked in the building were individually interviewed for job history, health problems, and anything else they could tell about the problem being studied. All but one had experienced headaches which characteristically developed during the day, were helped by analgesics and got better with fresh air or leaving the office. The situation has gotten better in the recent past. Two workers also identified headache problems of longer duration.

Four of the workers also complained of eye irritation. It was determined that the radiators had not been thoroughly cleaned before the heating season began. Heating the summer's dust along with the drop in humidity caused by heating already dry air could account for the eye irritation. This problem had subsided some by the time of the NIOSH study.

E. Other Observations

On the second floor of the hallway was a small room with window which contains a postal machine, a Scritomatic® Duplicator for addresses, a small spirit duplicator, and the coffee machine. No one is officed in the room so no air samples were taken during this study. Past studies by NIOSH have shown that extensive use of a spirit duplicator in an inadequately ventilated area can lead to excessive methanol exposures. When the duplicator is to be used it would be wise to open the window. Also if use is to be extensive, consideration should be given to rotating the job between several of the secretaries.

VII. CONCLUSIONS

1. Currently there is no carbon monoxide (CO) problem, although by history it appears likely that there was a problem at the beginning of the heating season. The holes in ceilings and walls would have allowed CO and other fumes from the furnace room to reach the 2nd floor office where the city-county sanitarian measured 8 ppm CO. Somewhat elevated CO levels could have contributed to the headaches noted by most workers.

2. Eye irritation probably related to decreases in humidity when the inside air began being heated, and possibly to dust accumulated on the baseboard radiators over the summer.

3. Judging by the temperatures in the building first thing in the morning when thermostats were left at the daytime settings, it appears that some of the thermostats are not functioning properly. Excessive room temperatures could also have contributed to the headaches noted by most workers. Additionally, it appears that the zonal control of heat is not ideal in some areas where there has been subsequent partitioning.

VIII. RECOMMENDATIONS

1. The thermostats should be checked for proper functioning.

2. Consideration should be given to some humidification during the heating season. As warm, moist surfaces encourage growth of molds and slimes which produce spores which can cause allergic respiratory reactions in some people, it is important that humidifying devices be kept clean.

3. At the start of the heating season the furnace and chimney should be checked for proper functioning and the baseboard radiators thoroughly cleaned.

4. If it is decided to considerably tighten up the building, provisions should be made for adequate fresh air intake.

IX. REFERENCES

1. I. Turiel and J.V. Rudy, "Occupant-Generated CO_2 as an Indicator of Ventilation Rate". To be published in ASHRAE Transactions 1982, vol. 88.

2. Ripatti, Harri, "Air Quality Control of Ventilation in an Office Building". Presented at Indoor Air Conference sponsored by University of Washington, Department of Environmental Health, and Washington State Department of Ecology, December 1982, held in Seattle, Washington.

3. G.D. Clayton & F.E. Clayton, eds., Patty's Industrial Hygiene and Toxicology, 3rd revised ed. John Wiley & Sons: New York, 1982. pp. 4114-4124.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By: Theodore W. Thoburn, M.D.
Medical Officer
NIOSH - Region VIII
Denver, Colorado

Originating Office:	Hazard Evaluation and Technical Assistance Branch (HETAB) Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS) NIOSH, Cincinnati, Ohio
Report Edited By:	Marilyn K. Schulenberg Occupational Health Technician NIOSH - Region VIII Denver, Colorado

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Diocese of Pueblo.
2. Pueblo City-County Health Department.
3. U.S. Department of Labor/OSHA - Region VIII.
4. NIOSH - Region VIII.
5. Colorado Department of Health.
6. State Designated Agency.

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 I

Environmental Measurements

Chancery Building, Diocese of Pueblo
Pueblo, Colorado

November 18, 1982

Location	Time	Temperature Dry Bulb °F.	Temperature Wet Bulb °F.	Relative Humidity %	CO_2 %	CO parts per million	Notes
Outside Front Door	6:50	35.5	32	76.5	.02	2-3	1,2,3
	8:25	----	----	----	.01-.02	1-2	4,5
	11:20	57	43	26	.02	trace	5,6
	15:45	64.5	48	24.5	.02	trace	1,7
Furnace Room, basement	7:25	82	62	30	.04	2-3	
	11:08	79.5	50	3.5	.05	2-3	
	14:00	81	56.5	18.5	.06	trace	
Hall, 1st floor	7:07	76.5	51.5	11.5	.03	1-2	
	14:45	76	55	22	.03-.04	---	
Hall, 2nd floor	7:40	80	56	18	.02-.03	1-2	
	12:05	77	54	17	.06	---	8
	15:10	76	53.5	15	.03	---	
Hall, 3rd floor	8:40	74	53	20	.04	1-2	9
	15:25	75	54	21	.04	---	
Bishop's Secretary's Office 1st floor	10:10	76	53	16	.03-.04	2	
Chancellor's Office, 1st floor	11:30	76	55	22	.07-.08	2-3	10
	14:35	73.5	53.5	22.5	.02	---	11
Chancery Office, 1st floor	9:55	78.5	54	14.5	.03-.04	2-3	
	14:40	75	53.5	17	.03	---	12
Director BDF Office, 2nd floor	8:10	77	55	20	.04	2-3	13,14
BDF Secretaries' Office, 2nd floor	9:15	76.5	55	21.5	.04	1-2	15
	14:55	76.5	54.5	19.5	.04	trace	15
Business Manager's Office, 2nd floor	7:55	80	56	18	.04-.05	1-2	13
	14:15	77.5	56.5	23.5	.04	2	13,16
Business Secretaries' Office, 2nd floor	9:40	73	53	22	.04	2-3	
Bookkeeper's Office, 2nd floor	9:25	74.5	54	22	.04-.05	2-3	13,14
	11:50	73.5	53	20.5	.05	3	13,14

TABLE I (continued)

Environmental Measurements (Notes)

Chancery Building, Diocese of Pueblo
Pueblo, Colorado

November 18, 1982

1. No breeze.
2. No traffic.
3. Relative humidity may not be accurate as wet bulb temperature dropped to freezing.
4. Slight breeze.
5. Light traffic.
6. Light breeze.
7. Moderate traffic.
8. Door to bathroom off hall closed. Bathroom window often left open a crack.
9. Some windows to rooms opening into the hall open.
10. Just after a closed door meeting with 5 people--one a cigarette smoker, one a pipe smoker.
11. One window open wide.
12. One window open a crack.
13. Smoker's office.
14. Two cigarettes smoked in room in last 1-2 hours.
15. Office where 8 parts per million (ppm) of CO had been measured by the city-county sanitarian.
16. Pipe smoking in progress.