

## 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 83-418-1449  
April 1984  
Randolph County Register of Deeds Office  
Asheboro, North Carolina

NIOSH Investigators:  
J. L. S. Hickey, Ph.D., P.E., C.I.H.  
T. M. Williams, M.S.P.H.  
University of North Carolina

## I. SUMMARY

On August 22, 1983 the National Institute for Occupational Safety and Health received a request from employees of Randolph County Courthouse for a health hazard evaluation of the Register of Deeds office spaces in Asheboro, NC. The request stated that regular employees of this office complain of increased sinus headaches, colds that "hang on," and burning eyes, and that some persons, who work in the office occasionally, complain of headaches or sinus problems every time they come in. Symptoms are most pronounced in winter and when the air conditioner is on. One employee experiencing flu-like and allergenic symptoms reported disappearance of symptoms upon leaving the building.

Surveys were made of the facility September 16, and December 13, 1983. The Deeds offices are on the ground floor of a recently-built brick courthouse annex, first occupied in August 1981, and consist of a main office, records room, and copy/storage room. Activities consist of recording, storing, and occasionally copying deeds and other documents. Binding of deed books is done elsewhere. Three walls of the offices are formaldehyde foam-insulated exterior walls. The offices are carpeted. Records and movable furnishings were moved from the facility's previous location where no problems were experienced.

Ventilation to these offices is provided by a general building recirculating air system with fresh makeup air added. Recirculated air is drawn from the offices, using the suspended ceiling as the duct, filtered, cooled if necessary and resupplied to building offices. Heat, when needed, is supplied by baseboard heating units in the offices.

Five general air samples collected in the Deeds offices on September 13 showed formaldehyde concentrations from 0.19 to 0.69 parts per million. Air samples taken on December 13 showed 0.34 ppm formaldehyde inside built-in wooden office cabinets and 0.05 ppm in general office air. Temperature was 75-77°F and relative humidity was 40-50% in the offices. Three air samples analyzed for 23 common organic vapors showed only trace amounts of all except benzene, for which concentrations ranged from 0.38 to 0.54 ppm. Bulk samples of sprayed-on beam-insulating material in the return air plenum were analyzed for asbestos content and found to contain none.

Water seals of floor drains in three restrooms, one in the Deeds office and two in adjacent spaces, were found to be empty. This condition permits sewer gas to enter the building.

No definite cause of the employees' symptoms was found. Concentrations of formaldehyde and benzene found in air were below 1.0 ppm. However, exposure to 0.1 ppm or more of formaldehyde in air is known to elicit eye and respiratory irritation in sensitive persons. Sampling indicates that the most likely potential formaldehyde sources are the wooden cabinets. Carpeting and foam wall insulation are not significant contributors of formaldehyde. Other factors that may contribute are dust and insufficient fresh and recirculated air in the office ventilation system. The source of the benzene in office air was not found.

Because of the carcinogenic potential of formaldehyde and benzene, and since safe levels for exposure to carcinogens have not been determined, NIOSH recommends that occupational exposures to these substances be minimized. Additional recommendations are contained in Section VIII of the report.

KEY WORDS: SIC 9199; 9390; formaldehyde; benzene; ventilation; respiratory symptoms; office building.

## II. INTRODUCTION

On August 22, 1983 the National Institute for Occupational Safety and Health received a request from employees of Randolph County Courthouse for a health hazard evaluation of the Register of Deeds offices in Asheboro, NC. The request stated that regular employees of this office complain of increased sinus headaches, colds that "hang on," and burning eyes, and that some persons, who work in the office occasionally, complain of headaches or sinus problems whenever they work for some time in the Deeds office. Symptoms are most pronounced in winter and when the air conditioner is on. One employee experiencing flu-like and allergenic symptoms reported disappearance of symptoms upon leaving the building.

On-site surveys of the facility were conducted September 16 and December 13, 1983 by an industrial hygienist and an engineer. The goals of the survey were to evaluate the working environment for possible excess respiratory exposure to air contaminants, and to develop appropriate recommendations to county officials to reduce or alleviate any problems found.

## III. BACKGROUND

The following information was obtained in initial correspondence and discussions with office personnel, and during the surveys. The Deeds offices are on the ground floor of a recently-built brick courthouse annex, first occupied in August 1981, and consist of a main office, records room, and copy/storage room. Activities of the five regular employees consist of recording, storing, and copying deeds and other documents. Binding of deed books is done elsewhere. Three sides of the offices are exterior brick cavity walls containing urea-formaldehyde foam insulation, according to the building architect's office. The offices are carpeted. Records and furnishings, except for some table tops and a built-in counter with drawers and cabinets, were moved from the facility's previous location, where no respiratory problems were experienced during the previous several years. A sketch of the floor plan is shown in Figure 1.

The regular employees have desks located in the main office area behind the service counter, but their duties take them to the records and copy rooms frequently. Smoking is not permitted in the Deeds offices.

Since moving into this newly constructed facility in August, 1981, some employees have reported experiencing one or more of the following symptoms:

- increased sinus headaches
- burning eyes
- colds that "hang on"
- flu-like symptoms

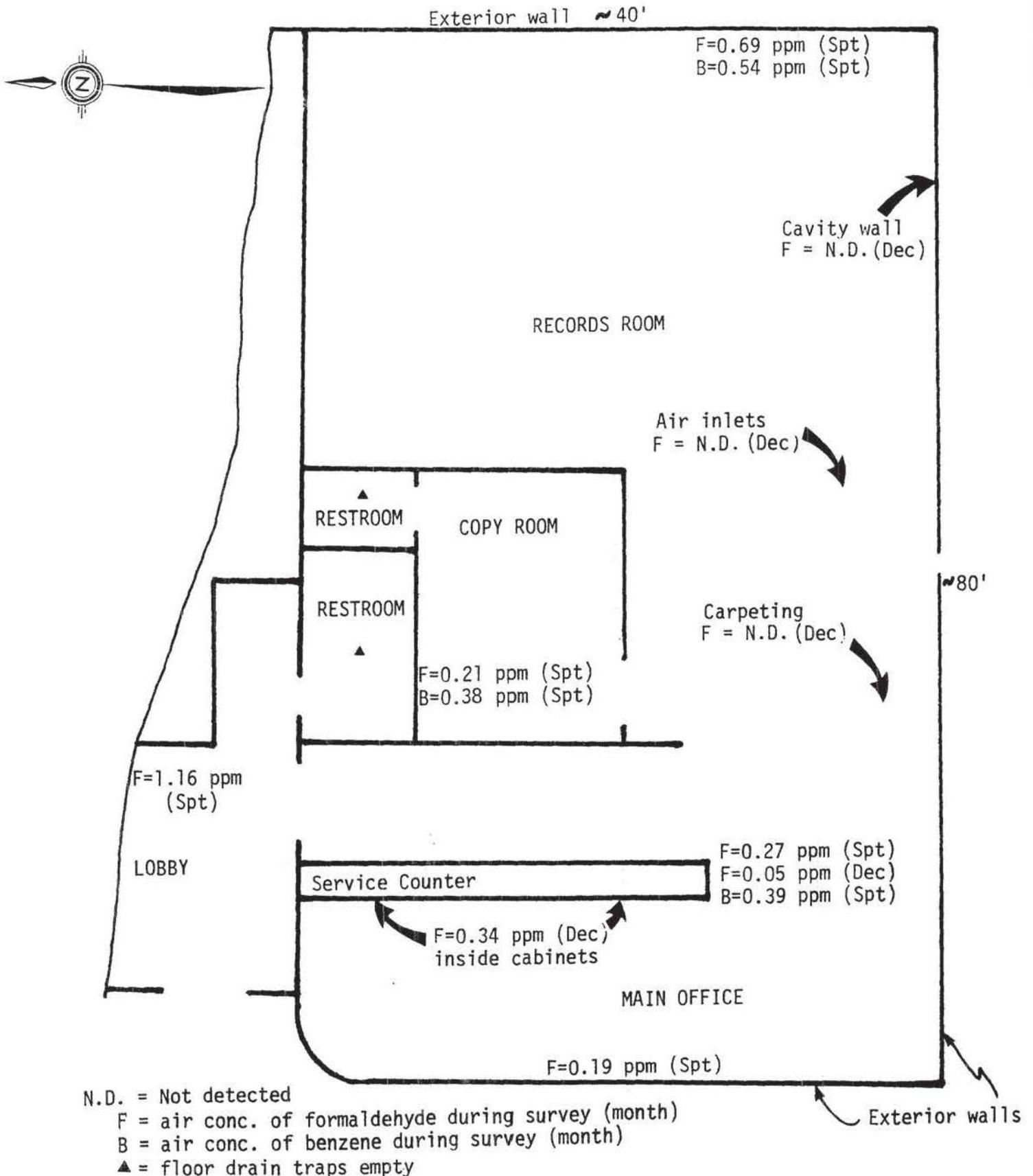


FIGURE 1 - DEEDS OFFICES, RANDOLPH COUNTY (NC) COURTHOUSE ANNEX

The employee most affected has reported allergic reactions to dust and molds. Ventilation to these offices is provided by a general building recirculating air system with provision for adding fresh makeup air. Recirculated air is drawn from the offices using the suspended ceiling as the return-air duct, filtered, cooled if necessary and resupplied to building offices. Heat, when needed, is supplied by convection baseboard heating units in the offices. The amount of fresh makeup air added may be adjusted by a damper accessible to the building engineer. On September 16, the fresh air damper was positioned to add some fresh air. No air flow quantity measurements were made.

#### IV. METHODS AND MATERIALS

Environmental evaluation consisted of interviews with affected employees about environmental conditions, a walk-through industrial hygiene survey, examination of the ventilation system for the offices, review of properties of chemicals used, and collection of air samples for formaldehyde and other organic vapor analyses. Questionnaires were not used; employees were requested to provide such information as they were able in the interviews.

Three area 4-hour air samples were collected on September 16, 1983 using charcoal tubes and analyzed for a variety of organic vapors by means of gas chromatography following elution by carbon disulfide. Area air samples were also collected with duPont Pro-Tek<sup>R</sup> passive monitors and analyzed for formaldehyde. Five 4-hour samples were collected on September 16, and four 24-hour samples on December 13. In addition, several short-term formaldehyde analyses were made with detector tubes during the December 13 survey.

A bulk sample of sprayed-on insulating material above the ceiling (in the return air plenum) was collected for analysis for asbestos content.

#### V. EVALUATION CRITERIA

##### A. Environmental 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 pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the 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 potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations; 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's are usually based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard. Limits appearing below reflect the lowest prescribed or recommended limits found among the above sources.

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 or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

<u>Substance</u>	<u>Ceiling Limit or STEL<sup>a</sup> (ppm)</u>	<u>8-hour Time Weighted Average Limit (ppm)</u>	<u>Source</u>	<u>OSHA Limit (ppm)(6)</u>
Isopentane	610	120	NIOSH (1)	1,000
n-Pentane	610	120	NIOSH (1)	1,000
2,2-Dimethylbutane	510	100	NIOSH (1)	none
3-Methylpentane	510	100	NIOSH (1)	none
2-Methylpentane	510	100	NIOSH (1)	none
n-Hexane	125	50	ACGIH (2)	500
Cyclopentane	900	600	ACGIH (2)	none
Methylcyclopentane	1,000	500	ACGIH (2)	none
n-Heptane	440	85	NIOSH (1)	500
Cyclohexane	375	300	ACGIH (2)	300
Methycyclohexane	500	400	ACGIH (2)	500
n-Octane	385	75	NIOSH (1)	500
1,1,1-Trichloroethane	350	350	NIOSH (4)	350
Methyl ethyl ketone	300	200	ACGIH (2)	200
Isopropanol	500	400	ACGIH (2)	400
Benzene	LFL <sup>b</sup>	LFL <sup>b</sup>	NIOSH (5)	10
Trichloroethylene	150	25	NIOSH (3)	100
Toluene	150	100	ACGIH (2)	200
Ethylene dichloride	15	5	NIOSH (4)	50
Xylenes; o,p,m	150	100	ACGIH (2)	100
Formaldehyde	LFL <sup>b</sup>	LFL <sup>b</sup>	NIOSH (7)	3

<sup>a</sup>Short-term Exposure Limit

<sup>b</sup>Lowest Feasible Limit

The ventilation criteria used are the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommendations for general and dilution ventilation (8,9), applicable to general office buildings where no unusual contaminant load is expected.

These are 0.25 to 0.4 cubic feet per minute (cfm) of fresh air and 0.75 to 2.0 cfm of total recirculated air per square foot of floor area served. Criteria for contamination control by dilution ventilation are based on the amount and type of contaminant generated and the generation rate. ASHRAE recommends a relative humidity of 40 percent (but not more than 60 percent in summer or less than 20 percent in winter) for optimum comfort conditions.

## VI. RESULTS AND DISCUSSION

### A. Results

Figure 1 presents a sketch of the Deeds offices indicating the locations where vapor samples were taken. Formaldehyde was detected in air at the locations and concentrations shown in Figure 1 and in Table 1, with date of collection indicated. Office temperatures (75-77°) and relative humidities (40-50%) were normal. No formaldehyde odors were observed by the survey team, and no formaldehyde was detected in wall cavities or under carpeting.

Other organic vapor concentrations (except benzene), were all <0.1 ppm and so not indicative of any problem. Benzene concentrations of 0.38, 0.39, and 0.54 ppm were detected at locations shown in Figure 1. No benzene source was found.

Heavy dust accumulations were observed on window blinds. Such dust may become airborne due to blind adjustment or air movement. Potential sources of this dust are the fiberglass lining of the air supply ducts and construction debris reportedly left in these ducts.

The insulation sample taken in the return air plenum was found to contain no asbestos.

Floor drain traps in three restrooms were found to be empty, permitting backflow of sewer gas into the building.

### B. Discussion

Formaldehyde concentrations in the air of the Deeds office varied from 0.05 to 0.69 ppm. Exposure to formaldehyde at the concentrations found has been associated with some of the symptoms reported by employees. First symptoms noticed on exposure to formaldehyde at concentrations as low as 0.1 parts per million (ppm) are burning of eyes, tearing (lacrimation), and general irritation to the upper respiratory tract (7). Higher exposures produce more severe symptoms. The current regulatory or recommended occupational exposure limits for formaldehyde are: 3 ppm (OSHA 8-hr. time-weighted average limit) (6); and 2 ppm (ACGIH ceiling limit) (2). These values were based on acute toxic effects of irritation, before the carcinogenic potential of formaldehyde was reported in 1979. The National Institute for Occupational Safety and Health (NIOSH), in recognition of its carcinogenic potential, now recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen, and that as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit (7). ACGIH has proposed lowering its recommended threshold limit value to a concentration of 1.0 ppm, based on formaldehyde's suspected carcinogenicity in man (2).

Table 1 - Formaldehyde Concentrations in Air,  
Randolph County Courthouse

Location	Sample Code Nos.	Formaldehyde Concentration (ppm)	
		Sept. 16, 1983	Dec. 13, 1983
<u>LONG-TERM SAMPLES<sup>a</sup></u>			
Deeds office, west wall	RCC-7005	0.19	-
Deeds office, top of service counter	RCC-7002/7009	0.27	0.05
Duplicating room	RCC-7000	0.21	-
Records room, east wall	RCC-7001	0.69	-
Lobby	RCC-7003	1.16	-
Deeds office, inside counter cabinets	RCC-7006/7007	-	0.34, 0.34
Courtroom D, judge's desk	RCC-7008	-	0.05
<u>DETECTOR TUBES</u>			
Deed's office, inside counter cabinets		-	0.5, 1.0
Inside exterior walls, Deed's office		-	N.D.
Under carpet, Deed's office		-	N.D.
Air supply ducts, Deed's office		-	N.D.
Under table tops, records room		-	N.D.
Courtroom D, inside furniture drawers		-	0.5
Courtroom D, general area		-	N.D.

<sup>a</sup> Long-term sampling was 4 hrs on Sept. 16, 1983 and 24 hrs on Dec. 13, 1983.

N.D. - none detected; limit of detection: 0.2 ppm

Formaldehyde is widely used as a bonding agent in the manufacture of myriad products. Formaldehyde as an indoor office air pollutant has been studied at length (10). Generally, "energy-efficient" office buildings allow much less air infiltration because of tighter construction, and provide less fresh air and lower circulated air rates than buildings built more than 10 years ago, resulting in higher concentrations of indoor air contaminants, such as formaldehyde, that were not a problem in older less energy-efficient buildings. Possible sources of formaldehyde in the air of office buildings are urea-formaldehyde foam insulation, cigarette smoke, carpeting, laminated and particle-board furniture, wall fabrics (10), and carbonless forms (11) if present in abundance. Experience has shown that the formaldehyde contamination, if caused by emissions from materials other than foam insulation, often disappears in a year or more. The ventilation system of a building may also enhance buildup of contaminants by designs which provide poor air mixing (11).

Sampling was performed during September to determine if formaldehyde was present in office air. After results indicated substantial formaldehyde concentrations, further sampling was carried out in December in an attempt to discover the source. In December there was little formaldehyde detected in the office air, and the only indicated emission source was the built-in cabinetry, principally in the Deeds office service counter. Although some wooden cabinets are known to contain and emit formaldehyde, there is some question whether the counter installation alone could deliver the concentrations found in September. The lower general air formaldehyde concentrations may be indicative of higher winter ventilation rates.

Often low ventilation rates will permit accumulation of air contaminants in offices to a point that they become irritating, and increased fresh air will often alleviate the problem even if the specific offending substance is not identified. No ventilation measurements were made, but at least 10 percent fresh makeup air should be maintained in the air supply. A minimum of 800 cfm fresh air and 2500 cfm total recirculated air should be supplied to the Deeds offices.

Recent studies at the University of North Carolina and the National Institute for Environmental Health Sciences (12) have shown that, when the source of formaldehyde is office furnishings, increased dilution ventilation has been effective in reducing peak formaldehyde concentrations in the air of offices from 0.8 ppm to less than 0.1 ppm. Experience has shown that few subjective complaints of respiratory and eye irritation are received when formaldehyde levels are consistently held below 0.1 ppm.

Samples indicated that there may be other formaldehyde sources in other parts of the new annex. The courtrooms contain much built-in staging and furniture. Courtroom D showed little formaldehyde in air, but 0.5-1.0 ppm in a desk drawer.

Benzene concentrations ranged from 0.38 to 0.54 ppm in the Deeds office. In view of benzene's potential for causing cancer, any concentration should be eliminated if possible. No chemicals could be found in the Deeds office which might account for this benzene.

## VII. CONCLUSIONS

1. No definite health hazard was found. Formaldehyde in the air in the Deeds offices, possibly from built-in cabinets, may contribute to the reported symptoms and discomfort of the employees. Other factors that may contribute are dust and insufficient fresh or recirculated air in the office ventilation system.

2. Apparently some benzene is entering the air in the Deeds offices. The source could not be found. Benzene is sometimes found in book binding glues and cleaning solvents.
3. Empty P-traps in floor drains allow air from the sewer line serving the restrooms to be drawn into some rooms.

#### VIII. RECOMMENDATIONS

1. At least 800 cubic feet per minute of fresh makeup air and 2500 cfm total recirculated air should be provided to the Deeds offices on a continuing basis. This may lower air contaminant levels and help abate respiratory symptoms in affected employees.
2. Should respiratory problems persist after recommended ventilation is provided, consideration should be given to replacement of the built-in cabinets in the Deeds office, the only specific formaldehyde emission source found.
3. Affected persons should consult their personal physicians regarding the findings of this survey.
4. Solvents, duplicating materials and binding agents should be investigated to find the benzene source. If found, it should be eliminated by use of other materials.
5. Floor drain traps should be kept filled with water to avoid backflow of sewer gas into restrooms.

#### IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

The cooperation of Mrs. Annie Shaw and Mrs. Ann Shaw in the environmental evaluation is hereby acknowledged.

Evaluation conducted and report prepared by:

Chemical Analyses:	Carolyn C. Bishop, M.S.P.H.
Report and Industrial Hygiene Evaluation:	J.L.S. Hickey, Ph.D.,C.I.H.,P.E.
Industrial Hygiene Evaluation:	Ted M. Williams, M.S.P.H.
Report Typed By:	Pamela Hooker

Originating Office:

Occupational Health Studies Group  
School of Public Health  
University of North Carolina  
Chapel Hill, NC 27514

Representing the National  
Institute for Occupational Safety  
and Health under Cooperative  
Agreement 1 U01 OH 01164-01

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Copies of this report have been sent to:

- (a) Register of Deeds, Randolph County, Asheboro, NC 27203
- (b) U.S. Department of Labor, OSHA, Region IV
- (c) NIOSH Region IV
- (d) North Carolina Department of Human Resources
- (e) North Carolina Department of Labor