U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health
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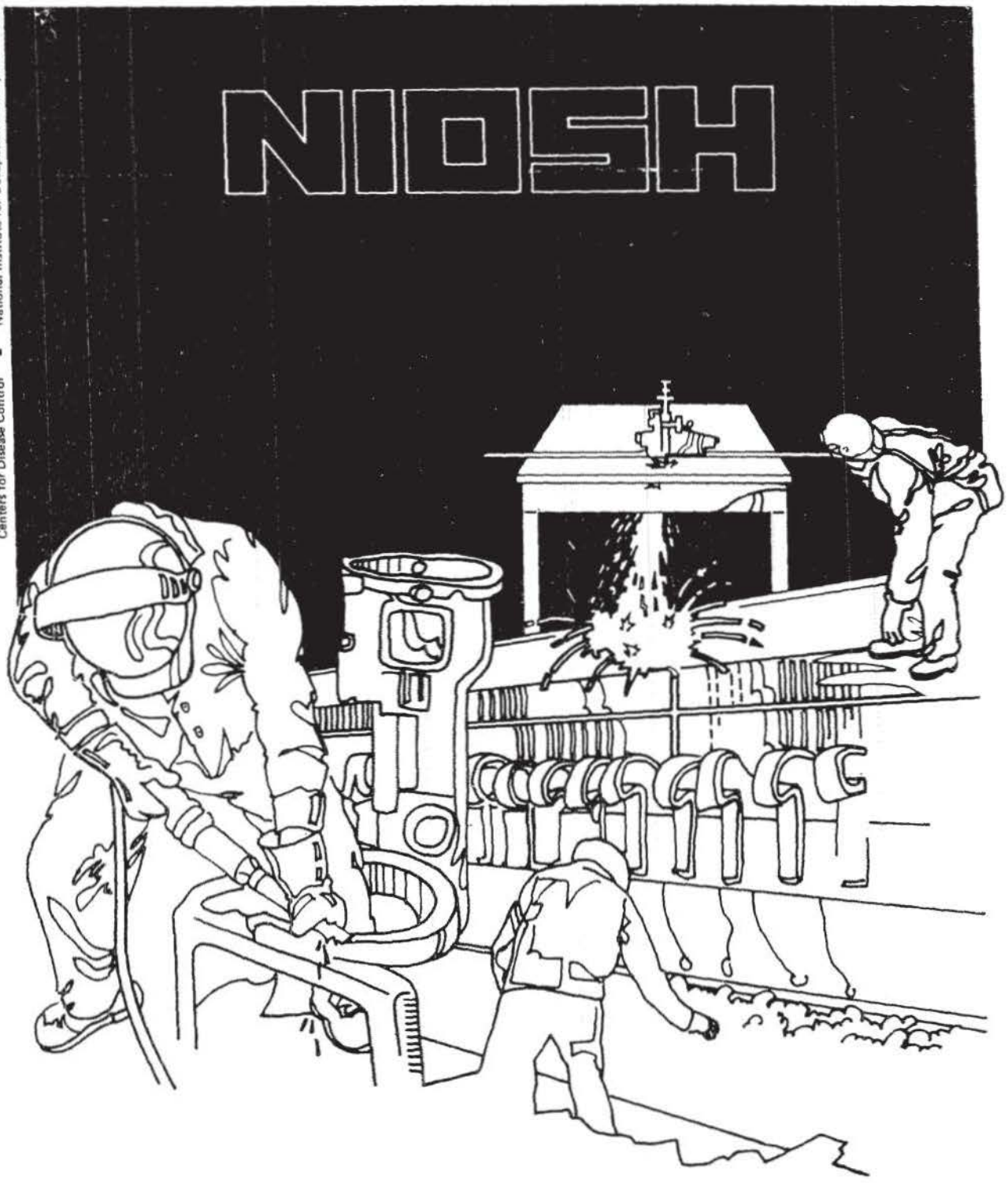
NIOSH



Health Hazard Evaluation Report

HETA 82-014-1057
COMPUTER SERVICES OF ROANOKE, INC.
ROANOKE, VIRGINIA

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 82-014-1057
March, 1982
Computer Services of Roanoke, Inc.
Roanoke, Virginia

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I. SUMMARY

On September 29, 1981, the National Institute for Occupational Safety and Health received a letter request for a health hazard evaluation from Computer Services of Roanoke, Inc., Roanoke, Virginia. Of concern were employee complaints of eye, nose and throat irritation, coating of the skin, and occasional offensive odors. Current complaints are from employees working in the computer operations area, which occupies about 5,200 square feet on the ground floor and basement in a two-story air conditioned building.

On November 10-11, 1981, an on-site survey of the facility was conducted. Interviews with employees indicated presence of the same problems originally reported, plus occasional skin rash and headaches. Thirteen air samples taken in and around the areas occupied by affected employees were analyzed for formaldehyde and/or 22 other vapors with negative results. Two air samples analyzed for total particulates indicated 1.5 and 2.7 milligrams/cubic meter of dust in the air of the storage/work room during decollating operations. No medical examinations were performed.

The area is served by five separate air conditioning systems, which circulated air but which supplied virtually no fresh air to the area served. Recirculated air quantities were generally marginal or less than recommended ranges. The entire area was under negative pressure with respect to the outside, permitting incursion of outside air without filtration or conditioning. Since "sewer-gas" odors were reported, the known sanitary drain lines were examined and appeared to be properly installed (except for one unvented sink trap not considered to be associated with the problem).

No specific cause or source of the reported symptoms was discovered. The virtual absence of fresh air supply and the negative pressure in the area, possibly permitting incursion of sewer gases and unconditioned and unfiltered outside air, were considered to be contributors to the problems.

It was recommended that adequate quantities of fresh and circulated air, based on ASHRAE guidelines, be provided and that the facility be kept under positive pressure relative to the outside. Other recommendations addressed placement of air intakes, filtration of fresh and recirculated air, and checking of the sanitary sewer system for proper venting. Recommendations are in Section VIII.

KEYWORDS: SIC 7374, respiratory symptoms, office building, computer facility, sewer odor.

II. INTRODUCTION

On September 24, 1981, Computer Services of Roanoke, Inc. requested a health hazard evaluation of the Company's computer facility in its office building in Roanoke, Virginia. The request stated that there are employee complaints of eye, nose and throat irritation, film type coating on skin, and occasional offensive odors.

An on-site survey of the facility was conducted November 10-11, 1981 by an industrial hygienist and an engineer. The goals of the survey were to evaluate the environmental conditions (particularly the ventilation system) for possible sources of work-associated respiratory and skin problems, to determine the specific source of the reported problems if possible, and to develop, based on findings, appropriate recommendations to management to alleviate the problems.

III. BACKGROUND

The following information was obtained in initial discussions with Company management personnel. The building was built about 1960 and two extensions have since been added. The building was renovated in 1972/1973, shortly after it was occupied by the Company. The building has two stories and a basement and is air-conditioned by six units, five of which serve different portions of the area surveyed. Mercaptan odors appeared in 1975; these were traced to a new carpet in the computer room, and its replacement eliminated these odors.

Current complaints are from employees who work on the ground floor in the area of the computer room, storage/work room, punch room and programmer offices. Complaints began in December 1979 and were especially pronounced in April 1980. Twelve or thirteen persons work in this area, and about half are affected at times. Previous surveys by Virginia Polytechnic Institute and the Virginia State Department of Health have not identified the source(s) of the problems.

IV. METHODS AND MATERIALS

Environmental evaluation consisted of interviews with Company officials and affected personnel about environmental conditions, a walk-through industrial hygiene survey, examination of the ventilation system in the area of concern, and collection of air samples for particulate and organic vapor analyses. Questionnaires were not used; the number of employees is small, and they were permitted to provide such information as they were able in the interviews.

The quantities of fresh and recirculated air supplied to the affected areas were calculated from air velocities measured using a rotating vane anemometer and a thermoanemometer. Air drift within the area was determined with smoke tubes.

Eight air samples were collected using charcoal tubes and analyzed for a variety of organic vapors by means of gas chromatography following elution by carbon disulfide. Two particulate samples were analyzed for total dust concentration in air. Five air samples were collected with passive monitors and analyzed for formaldehyde.

V. EVALUATION CRITERIA

The criteria for evaluating the 23 organic vapors assayed are the current American Conference of Governmental Industrial Hygienists Threshold Limit Values (ACGIH-TLV), the U.S. Department of Labor Occupational Health Standards (OSHA), NIOSH Criteria Documents and other publications, and the NIOSH Registry of Toxic Effects of Chemical Substances. Limits appearing below reflect the lowest prescribed or recommended limits found among these sources.

Substance	Ceiling Limit or STEL (ppm)	8-hour Time Weighted Average (ppm)	Source	OSHA Limit (6)
Isopentane	610	120	NIOSH (1)	1,000
n-Pentane	610	120	NIOSH (1)	1,000
2,3-Dimethylbutane	510	100	NIOSH (1)	none
2-Methylpentane	510	100	NIOSH (1)	none
3-Methylpentane	510	100	NIOSH (1)	none
n-Hexane	125	100**	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
Methylcyclohexane	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	1***	-	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****	LFL****	NIOSH (7)	2

* Proposed TLV
** TLV of 50 ppm proposed by ACGIH
*** 2-hr. TWA Limit
**** Lowest Feasible Limit

The criterion for evaluating nuisance particulate (total dust) concentrations in air is the ACGIH recommended limit of 10 milligrams/cubic meter (mg/m^3)(2). The OSHA limit is 15 mg/m^3(6).

The ventilation criteria used are the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASRHAE) recommendations for ventilation and for maintaining comfortable temperature and humidity (8,9). These are 0.25-0.4 cubic feet per minute (cfm) fresh air per square foot of floor area served, and 0.75-2.0 cfm total recirculated air per square foot of floor area.

VI. RESULTS AND DISCUSSION

1. Results

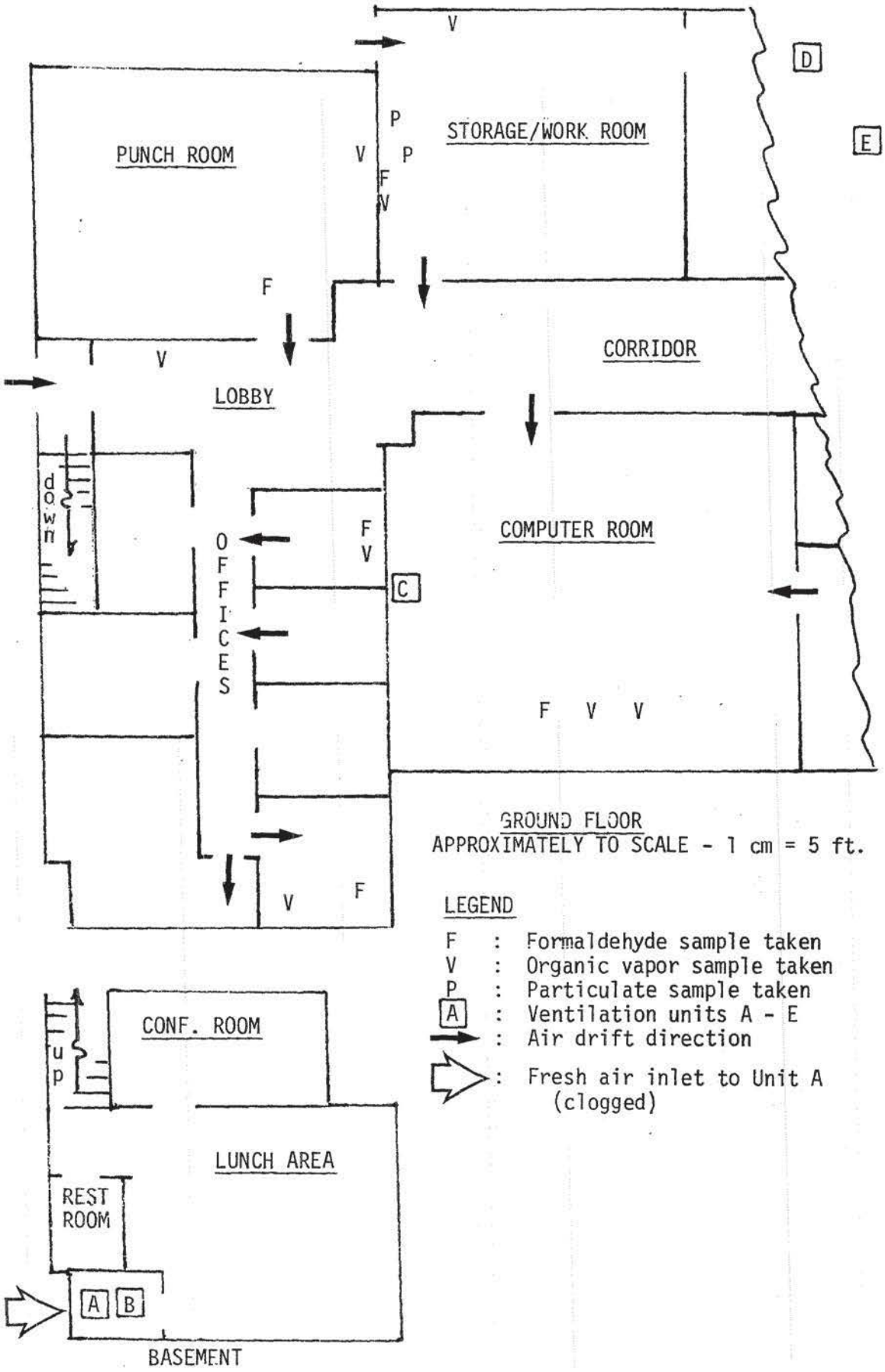
The area of the building where effects were reported is shown in Figure 1. The employees generally move about through the several rooms, so it was not possible to correlate effects with a specific location. Employees were interviewed and reported the same symptoms (eye, nose and throat irritation, film on skin, and occasional odor) plus two additional occasional symptoms, headache and skin rash.

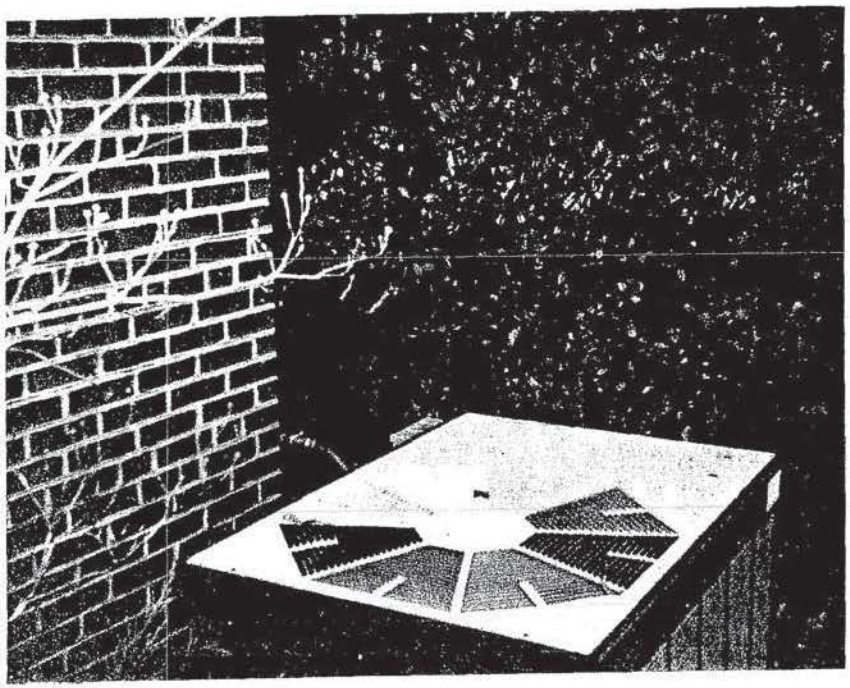
Air samples were taken at the locations indicated in Figure 1. All of the 23 organic vapors assayed indicated virtually zero (< 0.06 ppm) concentrations. The nuisance particulate samples indicated dust concentrations of 2.7 and 1.5 mg/m^3 in air for personal and area samples respectively, during operation of the mechanical check signing, paper perforation and carbon paper removal (decollater) operations. Particulate sampling is shown in Figure 2A.

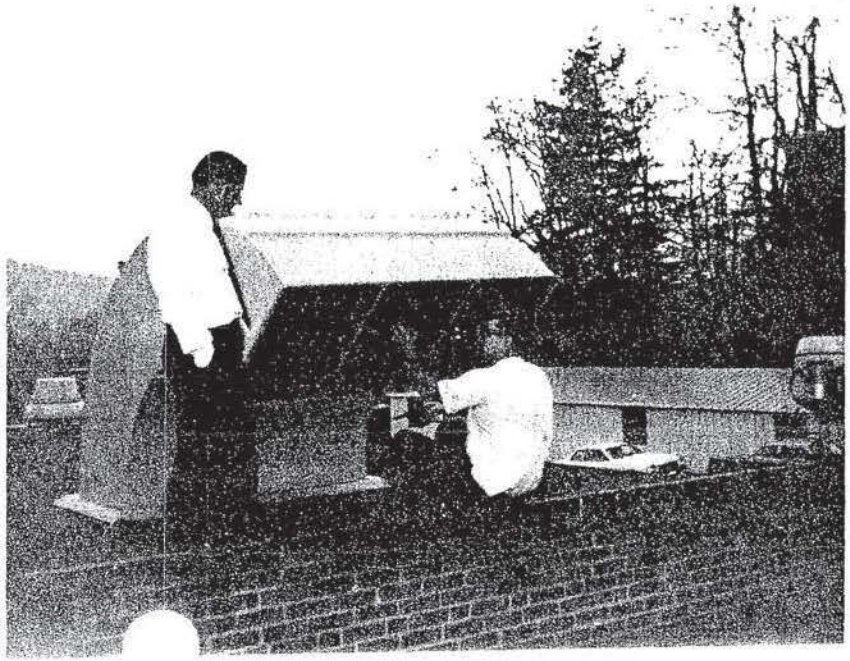
Attention was focused on the five air conditioning/ventilation systems serving the area shown in Figure 1. These are described below using arbitrary designations A-E.

Unit A is a heat pump which cools or heats air as needed but adds no humidity. Unit A is located in the basement utility closet and serves the ground floor of the last building addition which contains seven offices, several of which are occupied by affected employees. The ventilation unit is designed to circulate approximately 1,320 cubic feet per minute (cfm) of air to the 1,176 sq. ft. area, and to provide 180 cfm of fresh air. At the time of the evaluation, measured air circulation was 896 cfm, and fresh air supplied was zero, due to a clogged inlet screen. Cleaning of the screen increased the fresh air supply to approximately 90 cfm.

FIGURE 1 - FLOOR PLAN OF COMPUTER OPERATIONS AREA







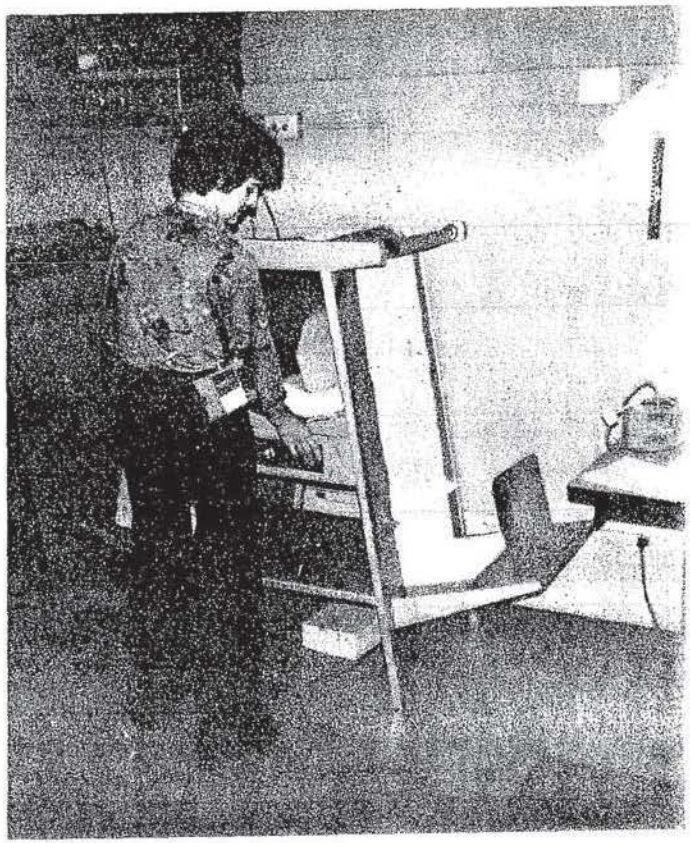


FIGURE 2A (above) - Personal and area particulate samples being taken during decollating and paper perforation.

FIGURE 2B (upper left) - Fresh air intake to ventilation unit A serving ground floor offices.

FIGURE 2C (left) - Fresh air inlet velocity being measured at main ventilation unit air intake on roof.

The outside fresh air intake grill for Unit A, a heat pump, is located about 2 feet above ground level behind a Japanese holly bush (See Figure 2B). The particulate filter which cleaned fresh and recirculated air in Unit A had been replaced with a charcoal filter in April, 1980 in an attempt to alleviate the odors previously mentioned.

Unit B, also a heat pump, serves the 600 square foot basement which consists of a lunchroom, conference room, restroom, and a utility closet in which units A and B are located. Unit B has no fresh air supply but recirculates basement air, using the utility room door as the return air intake. The particulate filter had been replaced by a charcoal filter. Unit B was not operating during the survey so the recirculated air flow could not be measured.

Unit C is the main building unit which serves the bulk of the second floor, and also the punch room and lobby of the ground floor. These latter two areas have a combined floor space of approximately 1,170 square feet. Measured recirculated air flow in the two areas was 1,130 cfm. The estimated total floor area served by unit C was estimated to be 8,000 square feet. The quantity of fresh air supplied to unit C was calculated from intake air velocity measurements to be 600 cfm. However, cross-breezes at the air intake, its large size, and low inlet air velocity made accurate measurements difficult (See Figure 2C).

Unit D serves the 672 square-foot storage and work room. This area receives a calculated 243 cfm of air which is drawn from other parts of the ground floor. No fresh air is supplied to this room.

Unit E serves the main computer room and a storage room immediately behind it. The unit supplies no fresh air. Recirculated air is heated or cooled and humidified as needed. Total floor area served is 1,620 square feet. The quantity of air recirculated could not be readily measured.

The only air exhaust found in the area surveyed (Figure 1) was 130 cfm exhausted from a basement restroom. The entire area surveyed was under negative pressure with respect to the outside. Air drift, as measured by smoke tubes, was from the storage/work room toward the main computer room and office area, and from the punch room toward the lobby and office areas, as shown in Figure 1.

Table I summarizes the estimated fresh and recirculated ventilation rates at the time of the survey and compares them to recommended ranges.

Table I - Estimated Ventilation Rates
as Compared to ASHRAE Recommendations

Unit and Location	Area Served (ft^2)	Estimate or Measured Air Flow (cfm)		Ventilation Rate (cfm/ft^2)	
		Fresh	Recirculated	Fresh	Recirculated
A (offices)	1176	0	896	0	0.76
B (basement)	600	0	UNK	0	UNK
C (punch room)	720	60	585	0.08	0.8
(lobby)	450	35	544	0.08	1.2
*(2nd floor)	6800	515	UNK	0.08	UNK
D (work room)	672	0	243	0	0.36
E (comp. rooms)	1620	0	UNK	0	UNK
ASHRAE Recommended Ranges (8,9)		-	-	0.25-0.4	0.75-2.0

UNK = Unknown
Units A,B,C,D,E identified in Figure 1
* No problems reported on second floor

The occasional offensive odors were identified by one employee as similar to sewer odors. The sanitary system was visually checked for breaks and untrapped openings. Two drain lines were found in the area shown in Figure 1. They appeared to be properly installed, except that a sink on the second floor served by one drain line had an unvented trap. Condensate drains (if any) serving the computer area were enclosed and could not be easily examined.

2. Discussion

No specific material or condition was identified as being the direct cause of the problems reported. However, several conditions exist which may be contributing causes. These are discussed below.

a. It can be seen in Table I that there is virtually no fresh air being supplied to most of the area surveyed. It is possible that air contaminants generated during usual office work, and which normally do not cause problems, may accumulate in the air due to the lack of adequate ventilation, to the point that sensitive persons do experience respiratory distress.

b. The location of the air intake to Unit A is such that it is subject to stoppage from ground, road, and vegetation debris. Either the clogging of this vent, which reduced the fresh air supply, or the drawing into the system of extraneous material could contribute to the existing problems. Consultation with personnel in the Botany Department of North Carolina State University indicated that proximity of the holly bush to the Unit A air intake posed no particular toxicity problems.

c. Particulate filters had been replaced with charcoal "filters" in some ventilation units. The adsorption capacities of charcoal filters become exhausted quickly and such filters have low efficiency for removal of particulates from air. The particulate filters, with adequate ventilation, should provide air of better quality than do charcoal filters.

d. Sewer gas-like odors were reported to occur from time to time in the building, raising the possibility that a defect in the plumbing may allow entrance of sewer gas into the building under some wind or ventilation conditions. Prime suspect areas are the drain line serving the basement fixtures and the drain line (if any) serving the air treatment system in the computer room (the odors were noticed in the office adjacent to the computer room air treatment unit). An unvented sink drain above the punch room was not considered to contribute to the problems.

e. Air drift was from the storage/work room toward the other areas occupied by affected workers. Moderate to low dust levels were observed in this room, probably paper dust from normal room operations. It is not likely that this dust contributes to the problems reported. However, altering the air flow pattern to place this room under negative pressure with respect to the other areas would minimize incursion of dust into the office and computer areas.

f. The entire area was under negative pressure with respect to the outside. This condition is indicative of a poorly balanced ventilation system and permits direct incursion of outside air into occupied areas without filtration or conditioning. Unexplained odors classically accompany this condition.

VII. CONCLUSIONS

No specific cause or source of the reported problems was found. However, the several conditions found and discussed in Section VI are conducive to the types of problems reported, and could contribute to or aggravate them. It is concluded that carrying out the following recommendations should do much to alleviate these problems.

VIII. RECOMMENDATIONS AND FOLLOWUP

It is recommended that:

1. Ventilation units serving the areas occupied by employees reporting problems should be altered to provide adequate fresh and recirculated air, based on ASHRAE recommended guidelines. Using these guides, for example, Unit A should provide approximately 300 cfm fresh air to the office area. Sufficient fresh air should be provided to maintain a positive air pressure (outward air flow) in the area with respect to the outside.

2. The air inlet opening to Unit A should be raised to about twelve feet above ground level and properly screened and positioned.

3. Particulate filters should be used in ventilation system units in preference to charcoal filters. If there is enough space for them in the filter housing, charcoal filters may be used also; they should be changed frequently to be effective in odor removal.

4. Because sewer-like odors were reported in the area surveyed, oil of wintergreen or other odorant should be introduced into the roof vents serving the area to determine if the odor penetrates into the occupied spaces of the building. If it does, the plumbing should be altered as needed to eliminate the possibility of sewer gas entering the building. In particular, the condensate drain lines for the computer room units should be checked for proper traps and vents. The second floor sink above the punch room should also be checked for proper trapping and venting (although it is not likely to be associated with current problems).

5. Consideration should be given to providing a negative pressure condition in the work/storage area to prevent incursion of paper dust into the office and computer areas.

The company reported by telephone January 20, 1982 that all oral recommendations made at the time of the survey had been carried out and that the problems had virtually disappeared, except for complaints by one employee. Specifically:

a) The fresh air supply to Unit A had been increased to 180 cfm and the inlet raised 12 feet. Particulate filters had been placed back into all units, and charcoal adsorbers left in where space permitted;

b) Oil of wintergreen was introduced into the sanitary drain systems and odor did not penetrate to the computer operations area;

c) The unvented trap on the second floor sink had been corrected.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Copies of this report have been sent to:

(a) Computer Services of Roanoke, Inc., Roanoke, Virginia
(b) U.S. Department of Labor, OSHA, Region III
(c) NIOSH Region III
(d) Virginia State Department of Health
(e) Virginia Department of Labor and Industry