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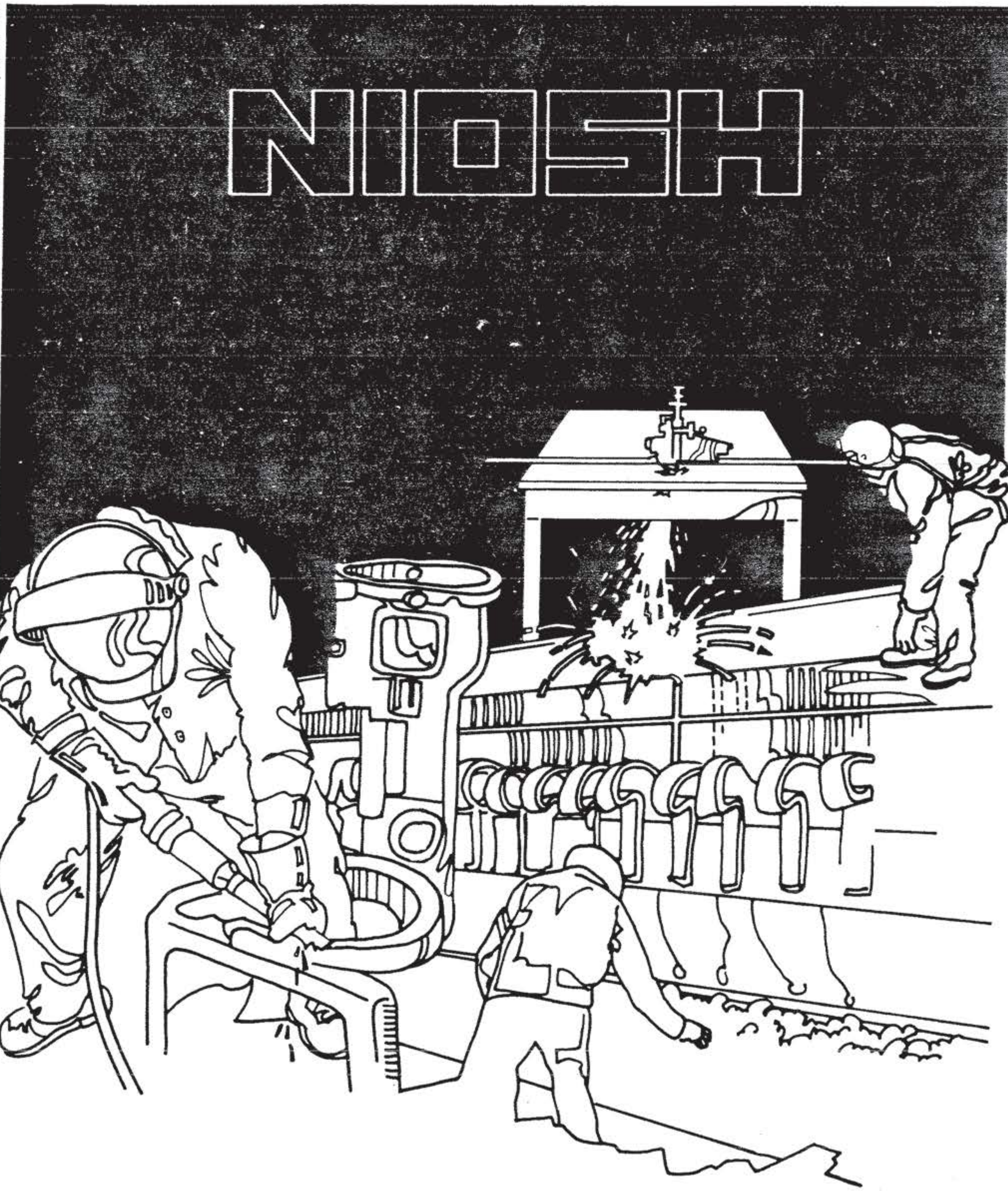


# Health Hazard Evaluation Report

HETA 83-129-1296
AMERICAN ENTERPRISE INSTITUTE
WASHINGTON, D.C.

# 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.

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## I. SUMMARY


In February 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at American Enterprise Institute, Washington, D.C. The request concerned possible carbon monoxide contamination associated with the indoor parking garage located near the offices.

The 12 story office building was built in 1969. Air is supplied and exhausted by air handlers located on the roof about 40 feet apart. The proportion of fresh air being supplied ranges from 25% to 100%, depending on the weather. The indoor parking garage has three levels with two supply and two exhaust fans per level. The exhausts are at street level.

NIOSH conducted employee interviews and environmental sampling on February 24, 1983. Eight (38%) of the 21 employees (20 present and one former) who were interviewed believed they had health problems which could have been related to their office environment. Complaints included eye irritation among 19% of the workers, headaches (14%), fatigue (14%), sinus congestion (14%), and increased frequency of colds (14%). Seven people (33%) reported that their symptoms were worse in the late afternoon, and two of these also reported more problems later in the week. No odors were associated with the occurrence of symptoms. Most of the symptomatic workers were located in offices at the front (east) of the building.

Carbon monoxide (CO) levels were determined by both long-term and short-term detector tubes, and by continuous direct-reading measurements using an Ecolyzer Model 6000. All three methods gave fairly consistent results. CO levels in the offices were below five parts per million (ppm) from 9 a.m. till 1 p.m., then slowly rose to a maximum of 10 ppm by about 2 p.m. After 2:30 p.m., office CO concentrations dropped to less than 5 ppm for the rest of the day. CO levels at the corner of 17th and M Streets, and inside the parking garage, were 5 ppm and 10 ppm, respectively, in the early afternoon; these levels rose to 15 ppm and 30 ppm, respectively, by the late afternoon rush hour.

Five long-term detector tube samples for CO taken throughout the offices all showed 8-hour time-weighted average concentrations of less than 5 ppm. The NIOSH recommended standard for CO is 35 ppm for up to a 10-hour work day, 40-hour work week. The OSHA standard is 50 ppm.

Short-term colorimetric detector tubes were also used to measure formaldehyde (HCHO), ozone ($O_3$), sulfur dioxide ($SO_2$), and oxides of nitrogen ($NO + NO_2$). All levels were below the limits of detection (HCHO <0.5 ppm; $O_3$ <0.05 ppm; $SO_2$ <1 ppm; and $NO + NO_2$ <2 ppm).

Although increases in CO levels during heavy traffic were observed outdoors and in the parking garage, the CO concentrations in the offices remained lower than what would be likely to cause any health problems. The presence of general urban air pollution, particularly during stagnant weather conditions, causes frequent concern for persons with respiratory disorders, and could be the cause of some of the symptoms reported in this study. Other contributing factors include the presence of seasonal allergens and tobacco smoke which could be causing problems in sensitive individuals.

No health hazards due to the presence of hazardous substances were found by NIOSH at the time of this investigation. However, to ensure adequate employee comfort, NIOSH recommends that the building management check to make sure that adequate quantities of air are being supplied and circulated among second floor offices in accordance with standards developed by the American Society of Heating, Refrigerating and Air Conditioning Engineers. Those ventilation criteria are presented in this report.



KEYWORDS: SIC 7392 (Opinion Research), office building, office air quality, building ventilation, carbon monoxide, indoor parking garage.

## II. INTRODUCTION

In February 1983, NIOSH received a request for a health hazard evaluation at American Enterprise Institute, Washington, D.C. The request was submitted by employees of the institute who were concerned about potential carbon monoxide contamination of their offices, possibly related to the enclosed parking garage located directly beneath and to the side of them.

## III. BACKGROUND

Twenty employees work in offices on the second floor of the twelve story office building located on the corner of 17th and M Streets. The building was built in 1969. Air is supplied and exhausted by air handlers located on the roof with about 40 feet of separation between them. The proportion of fresh air that is supplied to the offices varies from 25% to 100%, depending mostly on the outdoor temperature.

Only half of the second floor is occupied by offices. The other half is the top level of the three floor parking garage. Each of the three levels has two supply and two exhaust systems, with all of the exhausts being located at street level.

## IV. METHODS

NIOSH conducted environmental monitoring and employee interviews on February 24, 1983. Carbon monoxide (CO) concentrations in the offices were determined by both long-term and short-term colorimetric detector tubes, and by continuous direct-reading measurements using an Ecolyzer Model 6000. The five long-term samples were drawn by battery-powered sampling pumps operating at 20 cubic centimeters per minute. Proper calibration of the Ecolyzer was checked every hour using a span gas containing 20 parts per million (ppm) of CO.

CO levels in the parking garage and outdoors near the street corner were measured with short-term detector tubes. Detector tubes were also used in the offices to measure formaldehyde (HCHO), ozone ($O_3$), sulfur dioxide ($SO_2$), and oxides of nitrogen ($NO + NO_2$).

All 20 of the present employees and one former employee were interviewed to determine if they had any health problems which they believed could have been related to their office environment.

## V. EVALUATION CRITERIA

### 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. Modern high-rise office buildings are constructed primarily of steel, glass, and concrete, with large windows that cannot be opened, thus making the building totally dependent on mechanical systems for air conditioning.

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.

In 1981, the National Research Council (National Academy of Sciences) issued a report urging a major national effort be mounted to study the subject of indoor air pollution. Some of the major types of contaminants found in indoor air are:

1. <u>Products of Combustion</u>

   Carbon monoxide and nitrogen dioxide are often considered the most important toxic products of the combustion of fossil fuels and other organic materials. Gas stoves may be a significant source of these pollutants. Carbon monoxide is an asphyxiant, and nitrogen dioxide a pulmonary irritant.

2. <u>Formaldehyde</u>

   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. It is also a possible human carcinogen, based on its ability to produce nasal cancer in rats.

3. <u>Sprayed-On Insulation Materials</u>

   Asbestos, fibrous glass, and mineral wool fibers have been used in some buildings in sprayed-on fireproofing insulation for walls, ceilings, and structural steel beams. Fibers and dust particles may be dislodged from the insulation and become airborne. Asbestos fibers can cause pulmonary disease and cancer. Mineral wool and fibrous glass particles are irritants.

4. Tobacco Smoke

Tobacco smoke contains several hundred toxic substances, the more important of which are: carbon monoxide, nitrogen dioxide, hydrogen cyanide, formaldehyde, hydrocarbons, ammonia, benzene, hydrogen sulfide, benzo(a)pyrene, tars, and nicotine. Tobacco smoke can irritate the respiratory system and, in allergic or asthmatic persons, often results in eye and nasal irritation, coughing, wheezing, sneezing, headache, and other related sinus problems. People who wear contact lenses often complain of burning, itching, and tearing eyes when exposed to cigarette smoke. While cigarette smoking is the leading cause of lung cancer in the United States, currently available evidence is not sufficient to conclude that passive or involuntary smoking causes lung cancer in non-smokers.[1]

5. Microorganisms and Allergens

Microorganisms have been spread through ventilation systems in buildings where air filters became wet and moldy, where pools of stagnant water accumulated under air conditioning cooling coils, and where decaying organic matter was found near air conditioning intakes. Health effects may be infections, irritation, or allergic symptoms.

6. Hydrocarbon Vapors

Hydrocarbon vapors are released from dispersants and toners used in photocopying machines and telecopiers, from printing processes, and from certain cleaning compounds. Hydrocarbons can be irritants and, at high concentrations, are central nervous system depressants.

A. Air Contamination Evaluation Criteria

The primary sources of air contamination criteria generally consulted include: (1) NIOSH Criteria Documents and recommendations for occupational exposures, (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's), (3) the U.S. Department of Labor (OSHA) federal occupational health standards, and (4) the indoor air quality 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 a day, 40 hours per week for a working lifetime without adverse health effects. The ASHRAE standards are general air quality standards for indoor environments, and are applicable for the general population exposed for up to a 24-hour day of continuous exposure without known toxic effects.

Indoor air should not contain concentrations of contaminants known to impair health, or to cause discomfort to a substantial majority of the occupants. Ambient air quality standards/guidelines available from federal, state, or local authorities should be consulted. If the air is thought to contain any other contaminants, reference to OSHA, ACGIH, and NIOSH recommendations should be made; for application to the general population, the concentration of these contaminants should not exceed 1/10 of the limits which are used in industry.

Several examples of common contaminants found in both industrial and non-industrial (indoor air) environments are shown below with their relevant environmental exposure criteria:

| Contaminant | Concentration/Exposure Period 8-Hour TWA | Continuous | Source |
|---|---|---|---|
| Carbon monoxide (ppm) | 50 | --- | OSHA/ACGIH |
| | 35 (200$^{C}$) | --- | NIOSH |
| | --- | 9 | ASHRAE |
| Formaldehyde (ppm) | 3 | --- | OSHA |
| | CA | --- | NIOSH |
| | --- | 0.1 | ASHRAE |
| Total particulates ($mg/m^3$) | 15 | --- | OSHA |
| | 10 | --- | ACGIH |
| | --- | 0.26 (24-hr$^{C}$)or 0.075 (1-yr mean) | ASHRAE |
| Asbestos (fibers/cc) | 2 | --- | OSHA |
| | 0.5--2 | --- | ACGIH |
| | 0.1, CA | --- | NIOSH |
| | --- | CA | ASHRAE |

NOTE: ppm = parts of contaminant (gas or vapor) per million parts of air, by volume
$mg/m^3$ = milligrams of contaminant per cubic meter of air
CA = lowest feasible level (suspect or confirmed carcinogen), use best control technology
C = short-term (15-30 min) or ceiling limit

Other contaminants may be identified or suspect, dependent upon the particular situation and processes existing, and thus warrant further consideration.

### B. Ventilation Evaluation Criteria

Neither NIOSH nor OSHA has 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, air-tight office buildings became common. These older buildings permitted more air infiltration through leaks in cracks and interstices, 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 assure adequate outdoor air supply in modern, air-tight buildings.

Subsequently, ASHRAE has revised its standard and has published the new standard, ASHRAE 62-1981, "Ventilation for Acceptable Indoor Air Quality." The new standard is based on an occupant density of 7 persons per 1000 $ft^2$ of floor area, and recommends higher ventilation rates for areas where smoking is permitted. The new ASHRAE standard states that indoor air quality for "General Offices" shall be considered acceptable if the supply of outdoor air is sufficient to reduce carbon dioxide to less than 2500 ppm and to control contaminants, such as various gases, vapors, microorganisms, smoke, and other particulate matter, so that concentrations known to impair health or cause discomfort to occupants are not exceeded. However, the threshold levels for health effects from these exposures are poorly documented. For "General Offices" where smoking is not permitted, the rate recommended under the new standard is 5 cfm of outdoor air per person. Higher ventilation rates are recommended for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control at the source. When smoking is allowed, the amount of outdoor air provided should be 20 cfm per person. Areas that are nonsmoking areas may be supplied at the lower rate (5 cfm/person), provided that the air is not recirculated from, or otherwise enters from, the smoking areas.[2]

The ASHRAE Standard 62-1981 also provides ventilation requirement guidelines for a wide variety of commercial, institutional, residential, and industrial facilities and should be consulted for application to the specific situation under evaluation.

## VI. RESULTS

All three methods for measuring CO concentrations gave fairly consistent results. CO levels in the offices were below five parts per million (ppm) from 9 a.m. till 1 p.m., then slowly rose to a maximum of 10 ppm by about 2 p.m. After 2:30 p.m., office CO concentrations dropped to less than 5 ppm for the rest of the day. CO levels at the corner of 17th and M Streets, and inside the parking garage, were 5 ppm and 10 ppm, respectively, in the early afternoon; these levels rose to 15 ppm and 30 ppm, respectively, by the late afternoon rush hour.

Five long-term detector tube samples for CO taken throughout the offices all showed 8-hour time-weighted average concentrations of less than 5 ppm (Table 1).

The concentrations of the other contaminants that were sampled were all below the limits of detection (HCHO < 0.5 ppm; $O_3$ < 0.05 ppm; $SO_2$ < 1 ppm; and NO + $NO_2$ < 2 ppm).

Eight (38%) of the 21 employees who were interviewed believed they had health problems which could have been related to their office environment. Complaints included eye irritation, headaches, fatigue, sinus congestion, and increased frequency of colds (Table 2). Seven people (33%) reported that their symptoms were worse in the late afternoon, and two of these also reported more problems later in the week.

No odors were associated with the occurrence of symptoms. Most of the symptomatic workers were located in offices at the front (east) of the building. Four of the eight (50%) employees who reported possible work-related health problems were smokers.

## VII. CONCLUSIONS

CO levels in the parking garage and outdoors near the street increased significantly shorty following the onset of the afternoon rush hour. However, only a very small increase in the CO concentration was observed for a short time in the offices. It appears likely that the air being supplied to the building from twelve stories high contains less CO than the air at street level.

The causes of the symptoms reported in this study remain unclear. During stagnant weather conditions the presence of general urban air pollution frequency causes concern for persons with respiratory disorders, and this could be the cause of some of the symptoms reported in this study. Other contributing factors include the presence of seasonal allergens and tabacco smoke which could be causing eye irritation, sinus congestion, and headaches in sensitized persons.

## VIII. RECOMMENDATIONS

The building managers should check to make sure that adequate quantities of air are being supplied and circulated among second floor offices in accordance with the ASHRAE standards presented in this report. It should be noted that four times more outside air must be supplied in areas where smoking is permitted. In addition, workers should be provide with no smoking offices upon request.

## IX. REFERENCES

1. U.S. Department of Health and Human Services. The health consequences of smoking: cancer 1982, a report of the Surgeon General. Washington, D.C.: U.S. Department of Health and Human Services, 1982.

2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE standard 62-1981, ventilation for acceptable indoor air quality. Atlanta, Georgia: ASHRAC, 1981.

## X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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| Originating Office: | Hazard Evaluations and Technical Assistance Branch<br>Division of Surveillance, Hazard Evaluations, and Field Studies |
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## XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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. American Enterprise Institute
2. Building Management
3. U.S. Department of Labor, Region III
4. NIOSH, Region III

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.

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Table 1

Air Sampling Results for Carbon Monoxide

American Enterprises Institite
Washington, D.C.
HETA 83-129

February 24, 1983

| Location | Sample Time | Concentration |
| --- | --- | --- |
| Southeast corner | 9:30-16:45 | N.D.* |
| Corridor | 9:32-16:45 | N.D. |
| Southwest corner | 9:35-16:45 | N.D. |
| Reception area | 9:40-16:45 | N.D. |
| East side | 9:42-16:45 | N.D. |

*N.D. = below detectable limits (< 5 ppm)

Table 2

Prevalence of Reported Symptoms Among 21 Employees

American Enterprises Institite
Washington, D.C.
HETA 83-129

February 24, 1983

| Symptom | Number | Percent |
|---|---|---|
| Eye irritation | 4 | 19 |
| Headache | 3 | 14 |
| Fatique | 3 | 14 |
| Sinus congestion | 3 | 14 |
| Increased frequency of colds | 3 | 14 |

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