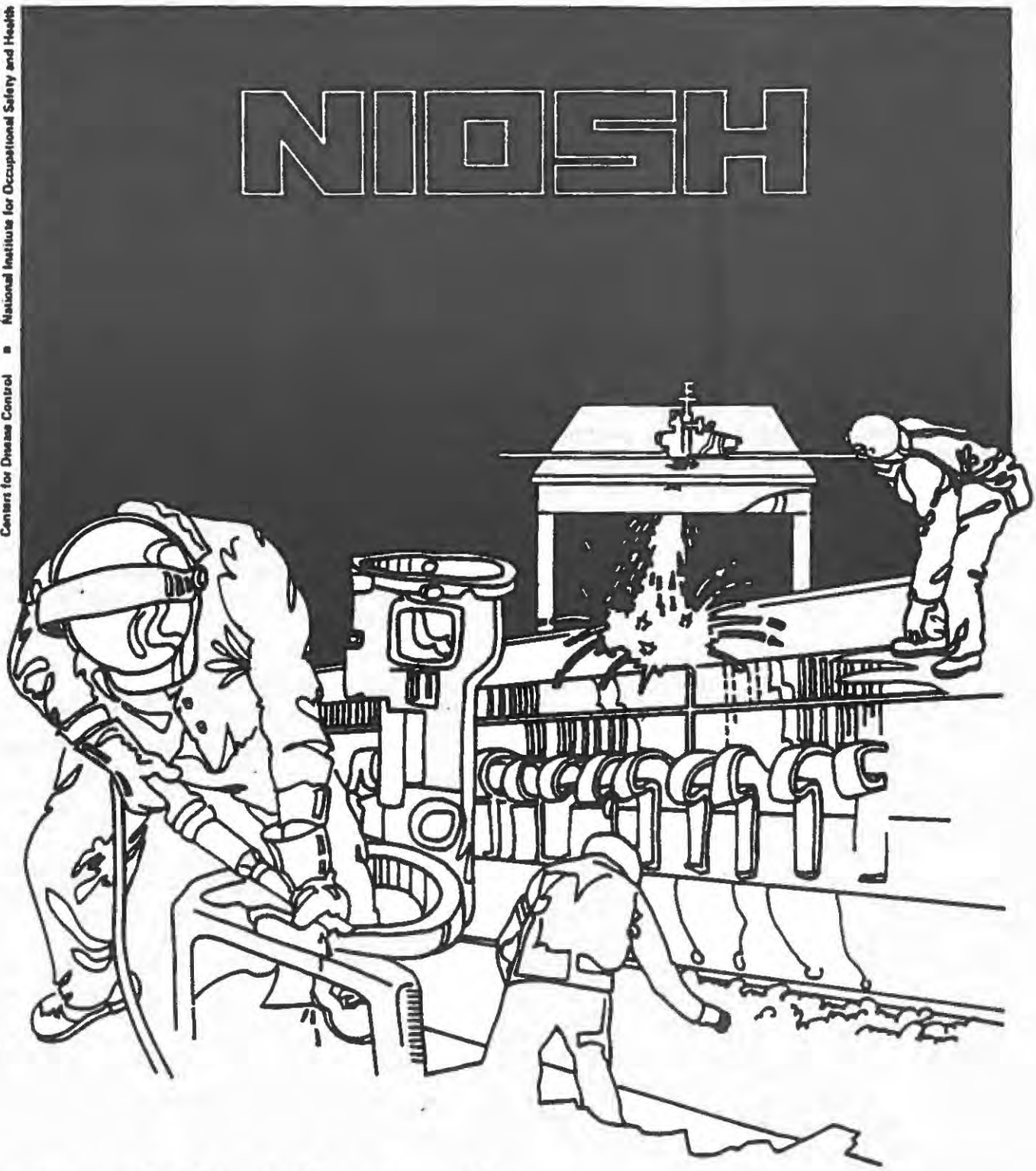
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 84-392-1597
SYNTEX DENTAL PRODUCTS, INC.
AUDUBON, PENNSYLVANIA

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 84-392-1597
June 1985
SYNTEX DENTAL PRODUCTS, INCORPORATED
AUDUBON, PENNSYLVANIA

NIOSH Investigator:
Walter J. Chrostek

I. Summary

On June 4, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at the Syntex Dental Products, Incorporated, offices in Audubon, Pennsylvania. Since mid-January the office employees were experiencing itching and burning of the eyes, coughing, sneezing and tightness in the chest.

On July 12, 1984, NIOSH industrial hygienists met with management and conducted a walk through survey. Percent relative humidity (%RH) and carbon dioxide air concentrations were measured. A bulk sample of carbonless paper was collected for formaldehyde content. Informal interviews with some of the employees verified the above health complaints. A subsequent visit was made on August 14 to make additional ventilation, relative humidity and carbon dioxide measurements. Bulk samples of new and used air filters and carpeting were also collected to determine if bioaerosols were present. On January 18, 1985 environmental air samples were collected for formaldehyde and mercury.

Carbon dioxide levels ranged from 510-600 parts per million (ppm) parts of air on July 12, and from less than 500-800 ppm on August 14. The Occupational Safety and Health Administration (OSHA) standard is 5000 ppm. Intake and exhaust air ventilation determination were made on 8 air handling units. The amount of outside air supplied ranged from 8-63 percent. Indoor relative humidity ranged from 78-90% and from 63-73%, on July 12, and on August 14.

The dirty air filter contained as high as $1.1X10^4$ of bacteria per gram and $6.3X10^2$ fungi per gram and the dirty carpet as high as $1.9X10^3$ bacteria per gram and $9.6X10^2$ fungi per gram. There are no standards for bioaerosol.

Formaldehyde air concentrations in the accounting and executive offices were less than the lower limit of detection (2 micrograms per sample). The OSHA standard is 4.5 milligrams per cubic meter of air sampled (mg/M^3). NIOSH recommends that formaldehyde be handled as a potential occupational carcinogen and worker's exposure be reduced to a minimum.

Personal and general air samples were collected for mercury. The samples collected in the machine shop and mercury room were less than the lower limit of detection 0.005 milligram per cubic meter of air mg/M^3. The personal air sample collected at the amalgam cap assembly was 0.015 mg/M^3. The NIOSH recommended standard for mercury is $0.05mg/M^3$.

On the basis of these results, it was determined that the OSHA standards were not exceeded. There is a potential for certain susceptible individuals to be affected by the high relative humidity, lack of outside air and bioaerosol. Recommendations to alleviate this condition are made in Section VIII of this report.

KEYWORDS: SIC 5086 (Profession equipment suppliers) itching and burning of the eyes, coughing, sneezing, tightness in chest, %RH, ventilation, bioaerosol.

II. Introduction

On June 4, 1984, NIOSH received a confidential request for a health hazard evaluation at the Syntex Dental Products, Incorporated, Audubon, Pennsylvania. The employees complained that since mid-January they were experiencing itching and burning of eyes, coughing, sneezing, tightness in the chest and early afternoon drowsiness.

At the request of management, the loss control division of the company's insurer visited the offices on March 6, 1984 performed environmental air evaluations for formaldehyde, total dust and toluene. No appreciable amounts of these contaminants were found.

NIOSH Industrial Hygienist visited the offices on July 12, 1984, August 14, 1984 and January 18, 1985 to perform environmental air evaluations.

Interim reports were sent to management and the requestor on August 7, 1984 and November 29, 1984.

III. Background

Syntex Dental Products Incorported is located in a one-story building. Approximately one-half of the building is occupied by offices and research while the other half is occupied by packaging and light manufacturing of dental equipment and supplies.

The total office is approximately 103,000 cubic feet (ft^3). The area of concern is approximately 36,000 ft^3 and the HVAC system capacity in this area is 10 ton.

Two of the walls, approximately 360 feet long, have windows which cover approximately two-thirds of the wall. The windows are not covered with a sun shade and the areas near the windows becomes very warm.

Partial partitions are utilized to separate some of the desks.

IV. Environmental Design

A. Relative Humidity - Measurements were made at various times during all visits with a Bendix Psychron psychrometer.

B. Carbon Dioxide - Determinations were made with long term, length of stain detector tubes with a pump operating at 20 cc/m. These results were utilized to determine if the amount of supplied outside air was adequate.

C. Formaldehyde - A sample of the carbonless paper was collected to determine if formaldehyde was present. This sample was analyzed according to the Burlington Industries standard test for latent formaldehyde. The paper contained approximately 120 micrograms of latent formaldehyde per gram of bulk sample.

As a result, it was determined to perform environmental air sampling for this contaminent. Sampling was done with ORBO 22 tubes and personal sampling pumps operating at 50 cc/m. These samples were analyzed by NIOSH method P&CAM 354[1].

D. Ventilation - Both intake and exhaust air distribution measurements were made with a Shortridge flowhood meter in the office where the request originated. These measurements were compared with the findings of a consultant who had done the evaluation in July 1984. Some adjustments were made to the ventilation system.

E. Viable Organisms - Samples of the new and used air filters and carpet were collected. The submitted samples were analyzed for fungal and bacterial levels by standard serial dilution techniques using rose bengal streptomycin agar (100 ug streptomycin per ml) and tryptic soy agar (100 ug cyclohexinide per ml), respectively.

F. Mercury - Three air samples were collected at the amalgam cap assembly machine, in the machine shop area and mercury room. The samples were collected on 3M diffusional monitors and analyzed by the 3M analytical laboratory.

V. Environmental Criteria

As a guide to the evaluation of the hazard 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, pre-existing medical conditions, 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 exposures.

Evaluation criteria may change over the years as new information on the toxic effects of an agent becomes 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 Standards. Often, the NIOSH recommendations and ACGIH TLV°s are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV°s usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of contolling 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 recomendations 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.

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 exposures.

	Criteria*		
Substance	NIOSH	OSHA[3]	ACGIH[4]
Carbon Dioxide	10,000	5,000	5000
Formaldehyde	LFL**	3	1
Mercury***	0.05	0.1	0.1

*Denotes - parts per million parts of air sampled.
** Denotes - lowest feasible level.
*** Denotes - milligram per cubic meter of air sampled.

Neither NIOSH nor the Occupational Safety and Health Administration (OSHA) has developed ventilation criteria for general offices. Criteria often used by design engineers are the guidelines published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). ASHRAE Standard 62-1981[5] provides ventilation requirement guidelines for a wide variety of commercial, institutional, and industrial facilities, including office buildings. This standard is based on an occupant density of seven persons per 1000 $ft^{(2)}$ of floor area, and recommends higher ventilation rates for areas where smoking is permitted. The standard states that indoor air quality for general offices shall be considered acceptable if the supply of outdoor air is sufficient to reduce CO_2 to less than 2500 ppm and 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 standard is five cubic feet per minute (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 at a minimum, be 20 CFM per person. Non-smoking areas may be supplied at the lower rate (5 CFM/person), provided the air is not recirculated from, or otherwise enters from, the smoking areas.

Several studies have suggested that in occupied spaces a level of CO_2 in excess of 1000 ppm is an indicator of inadequate outdoor air supply in the HVAC system. Occupant discomfort results from build-up of numerous contaminants, including cigarette smoke, hydrocarbons from copiers, etc.,in the recirculated air within a building. The following evaluation criteria with regard to CO_2 in offices has been suggested by a Canadian investigator:

CO_2 Level (ppm)	Comments
<600	Adequate outside air.
600-800	Occupational complaints, particularly if the air temperature rises.
800-1000	Complaints are more prevalent.
>1000	Inadequate outdoor air in HVAC system; complaints are general.

Relative humidity [8] has been shown to have a significant effect on the control of airborne infrecion. At 50%RH, the mortality rate of certain organisms is the highest and the influenza virus loses much of its virulence. The mortality rate decreases both above the below this value.

Microorganisms - There is no environmental criteria for deciding if a measured airborne level of fungi or bacteria is a risk factor with regard to hypersensitivity pneumonitis, asthma, or similar illnesses[7]. Any quantitative criteria must take into account the qualitative nature of the viable and non-viable etiologic agents thought to be responsible for these illnesses. Is air containing a total of 500 fungi/M^3 of which 20% are Penicillium spp inherently safer than that with 1000 fungi/M^3 but with only 10% Penicillium spp? Establishment of a quantitative standard is further complicated because non-viable spores [10] and microbial products[11] may cause illness and large doses of organic dust may be needed to produce sensitization, whereas a subsequent response may be evoked by a small quantity of material[12].

Nevertheless, several suggestions have been made concerning acceptable levels of airborne viable particulate. In 1948, a level of approximately 1775 bacteria-containing particles/M^3 was described as the threshold for clerical offices in need of improvement[13]. Levels of about 700 bacteria/M^3 were considered reasonable. In 1969, it was stated that total levels of microorganism exceeding 1700M^3 were seldom exceeded in rooms[14]. During an outbreak of humidifier fever, levels of Flavobacterium spp approximating 3000/M^3 were associated with the operation of a contaminated humidifier; this bacterium was absent from the air when the unit was turned off[11]. The threshold levels of Cladosporium spp and Alternaria spp spores for evoking allergenic symptoms have been reported to 3000 and 100 CFU/M^3, respectively [15]. Levels of fungi approximating 5000 to 10,000 CFU/M^3 were associated with an outbreak of hypersensitivity pneumonitis in a small office[16]. These literature citations collectively suggest that a level of viable microorganisms or viable particles in excess of about 100 per M^3 indicates that the indoor environment may be in need of investigation and improvement [9]. However this is not to say that the air containing this or higher counts of microorganisms is unsafe or hazardous or that air containing lower counts is safe. Illness in the workplace cannot be determined by environmental studies alone.

VI. Results

A. Relative Humidity - On July 12, 1984, the %RH ranged from 78 to 90. Following the adjustment of the HVAC system, the %RH on August 14, 1984, ranged from 63 to 73. On January 18, 1985, the %RH was 66. (Table I)

B. Carbon Dioxide - On July 12, 1984, the carbon dioxide air concentrations ranged from 510 to 600 parts per million parts of air sampled (ppm). On August 14, 1984, the air concentrations ranged from less than 330 to 800 ppm. The highest concentration was found in the R&D draft area. On January 18, 1985, the carbon dioxide air concentrations ranged from 520 to 700 ppm (Table II). The determinations were utilized to evaluate that adequate outside air was being introduced.

C. Formaldehyde - Three air samples were collected for formaldehyde (2 in accounting, 1 in executive office). These samples were analyzed by NIOSH method P&CAM 354[1]. All samples were less than the lower limit of detection. (2 micrograms per sample)

D. Ventilation - Both intake and exhaust air distribution measurements were made on August 14, 1984 with a Shortridge flowhood meter in the office where the request originated. These measurements were compared with the findings of a consultant, who had done his evaluation in July 1984. Some adjustments were made to the ventilation system. Table III contains the measurements of NIOSH and the consultant.

E. Viable Organisms - Samples of new and used air filters and carpet were collected. The submitted samples were analyzed for fungal and bacterial levels by standard serial dilution techniques using rose bengal streptomycin agar (100 ug streptomycin per ml) and tryptic soy agar (100 ug cyclohexinide per ml), respectively.

Fungi and bacteria were not detected in new samples (Table IV). One of the two used carpet samples and both filter samples contained some microorganisms. Samples No. 2 and 6 contained the highest numbers of viable microorganisms. (Table 4)

F. Mercury - Three personal and general air samples were collected for mercury. The samples collected in the machine shop and mercury room were less than the lower limit of detection 0.005 milligram per cubic meter of air mg/M^3. The personal air sample collected at the amalgam cap assembly was 0.015 mg/M^3. The NIOSH recommended standard for mercury[2] is 0.05 mg/M^3.

VII. Discussion

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 by reducing air conditioning expenses. Modern 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. 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. In many of these buildings, occupants offer complaints about "stuffy" or stale air. Some investigators refer to the above spectrum of complaints by the term "tight building syndrome".

Imbalance or malfunction of the HVAC system is commonly identified, and in the absence of other causes, building-related illnesses are usually attributed to inadequate ventilation, heating/cooling, or humidification.

Relative humidity has been shown to have a significant effect on the control of airborne infection. As 50% RH, the mortality rate of certain organisms is the highest and the influenza virus loses much of its virulence. The mortality rate decreases both above and below this value.

There is no comparable data from "Normal" and "Sick" buildings. However, it is safe to state that given a relative humidity of 63 to 90 percent, fungal spores entrained in carpet, filter and fibrous glass ceiling tiles will germinate and proliferate, and thus potentially contaminate occupied space.

The amount of outside air being brought into the work area ranged from 8 to 63 percent. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends that general offices where smoking is not permitted, the rate recommended under the standard is 5 cubic feet per minute (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, at a minimum, be 20 cfm/person. Non-smoking areas may be supplied at the lower rate (5 cfm/person), provided the air is not recirculated, or otherwise enters from the smoking areas.

Since this building is located in a country setting with plenty of morning dew, bringing in as high as 63% outdoor air will greatly decrease air contaminants, such as tobacco smoke, but greatly increase the relative humidity.

Also note that there is a wide disparity in the amount of air coming in from the many diffusers from one air handling unit. For example, air handler No. 4 has nine diffuser and the amount of air ranges from 115 to 470 cfm.

Exposure to formaldehyde and mercury were well within the acceptable ranges.

At the present time, the fibrous glass filters are being replaced with others that do not contain this material.

VIII. Recommendations

The recommendations made in Interim Reports 1 and 2 are reiterated:

1) During the initial visit, I was informed that only 5-10 percent outside air was being introduced. It is recommended that sufficient outdoor air be supplied viz that recommended in ASHRAE 62-1981[3] for smoking.

2) The percent relative humidity should be maintained at approximately 50%.

3) Areas where air filters or carpet analysis showed a presence of viable organisms should be replaced or treated with a proprietary biocide. Vacuuming with an instrument incorporating a HEPA filter, perhaps at bi-weekly intervals, may be sufficient to remove the spores and other microbial products that may have been generated when the carpet was wet.

IX. Authorship and Acknowledgments

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X. 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).

XI. References

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Table I

Syntex Dental Products, Incorporated
Audubon, Pennsylvania

HHE 84-392

July 12, 1984

Percent Relative Humidity

Location	Time	Percent
Executive Office	11:25	82
	15:45	78
R&D Draft	12:05	82
	16:00	78
Accounting	12:15	78
	16:10	90
Outdoors (shade)	13:00	75
	16:45	83

August 14, 1984

Executive Offices	09:00	67
	11:35	66
	14:20	73
R&D Draft	09:05	68
	11.33	66
	14:15	63
Accounting	08:55	69
	11:40	66
	14:25	65
Outdoors (shade)	09:10	91
	11:30	75
	14:05	63
Private Office	14:35	68

January 18, 1985

R & D Draft	11:30	66
Executive	11:35	66
Outdoors	11:45	75

Table II

Syntex Dental Products Incorporated
Audubon, Pennsylvania

HHE 84 392

July 12, 1984

Carbon Dioxide Concentrations (ppm)*

Location	Time	Concentration
Executive Office	11:07-15:17	600
R&D Draft	11:10-15:47	510
	August 14, 1984	
Accounting	08:23-13:55	500**
Executive	08:27-13:43	500
R&D Draft	08:30-13:43	800
	January 18, 1985	
Accounting	09:10-13:19	520
Executive	09:15-13:17	700

* Denotes parts per million parts of air sampled.
** Denotes less than.

Table III

Health Hazard Evaluation Report
HHE 84 392

Syntex Dental Products Incorporated
Audubon, Pennsylvania

August 14, 1984

Ventilation Determinations (cubic feet per minute)

Air Handling Unit 1.

Diffuser No.	Consultant	NIOSH
1	450	450
2	270	270
3	385	375
4	270	260
5	175	170
6	170	170
7	120	140
Total Air Supplied	1840	1835
Design	2000	
Return Air		
E 1	1100	1040
E 2	-----	110
E 3	-----	175
Total	1100	1325

Outside Air = Total Air - Return Air. 1840 - 1325 = 735 (40%)

Air Handler 2.

Diffuser No.	Consultant	NIOSH
1	345	340
2	335	330
3	375	375
4	400	405
5	400	420
6	365	365
7	220	230
8	170	170
9	325	340
10	335	340
Total Supplied Air	3270	3315
Design	4000	
Return Air		
E 1	1480	1340
E 2	1560	1340
Total	3040	2680

Outside Air - 635 (19%)

Table III (Continued)

Air Handler 3.

Diffuser No.	Consultant	NIOSH
1	420	390
2	440	390
3	470	440
4	530	450
5	560	500
6	440	410
7	200	185
8	385	355
9	395	365
Total Air Supplied	3840	3485
Design	4000	
Return Air		
E 1	785	1430
E 2	1080	1280
Total	1865	2710

Outside Air - 775 (22%)

Air Handler 4.

Diffuser No.	Consultant	NIOSH
1	370	365
2	435	430
3	345	330
4	370	360
5	640	620
6	520	470
7	205	200
8	170	155
9	120	115
Total Air Supplied	3175	3045
Design	4000	
Return Air		
E 1	1460	1340
E 2	1100	1040
E 3	----	425
Total	2560	2805

Outside Air - 240 (8%)

Table III (Continued)

Air Handler 6.

Diffuser No.	Consultant		NIOSH
1	220		220
2	300		300
3	130		120
4	210		190
5	195		195
6	250		250
7	220		225
8	230		210
9	135		120
Total Air Supplied	1890		1830
Design		2000	
Return Air			
E 1	520		500
E 2	720		690
Total	1240		1190

Outside Air - 640 (35%)

Air Handler 7.

Diffuser No.	Consultant		NIOSH
1	185		180
2	140		130
3	195		180
4	250		245
5	200		200
6	195		180
7	240		225
Total Air Supplied	1405		1340
Design		1200	
Return Air			
E 1	950		790

Outside Air - 550 (41%)

Table III (Continued)

Air Handler 10.

Diffuser No.	Consultant	NIOSH
1	170	130
2	190	140
3	295	190
4	240	160
5	290	240
6	180	140
7	145	115
8	215	180
9	---	300
10	---	270
Total Air Supplied	1725	1865
Design	2000	
Return Air		
E 1	615	485
E 2	185	200
Total	800	685

Outside Air - 1180 (63%)

Air Handler 11.

Diffuser No.	Consultant	NIOSH
1	280	195
2	360	270
3	200	140
4	300	230
5	160	110
6	---	360
7	---	300
Total Air Supplied	1300	1605
Design	2000	
Return Air		
E 1	800	1050
E 2	135	170
Total	935	1220

Outside Air - 385 (24%)

Table IV

Syntex Dental Products Incorporated
Audubon, Pennsylvania

HHE 84 392

August 14, 1984

Viable Organisms in Bulk Carpet and Filters

Sample Description	Location	Bacteria Per Gram	Fungi Per Gram
Dirty Filter	Large Office	$5.6X10^2$	N.D.*
Dirty Filter	Accounting	$1.1X10^4$	$6.3X10^2$
Unused Filter	----------	N.D	N.D
New Carpet	----------	N.D.	N.D.
Used Carpet	Large Office	N.D.	N.D.
Used Carpet	Accounting	$1.9X10^3$	$8.6X10^2$

*N.D. - Denotes None detected.

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