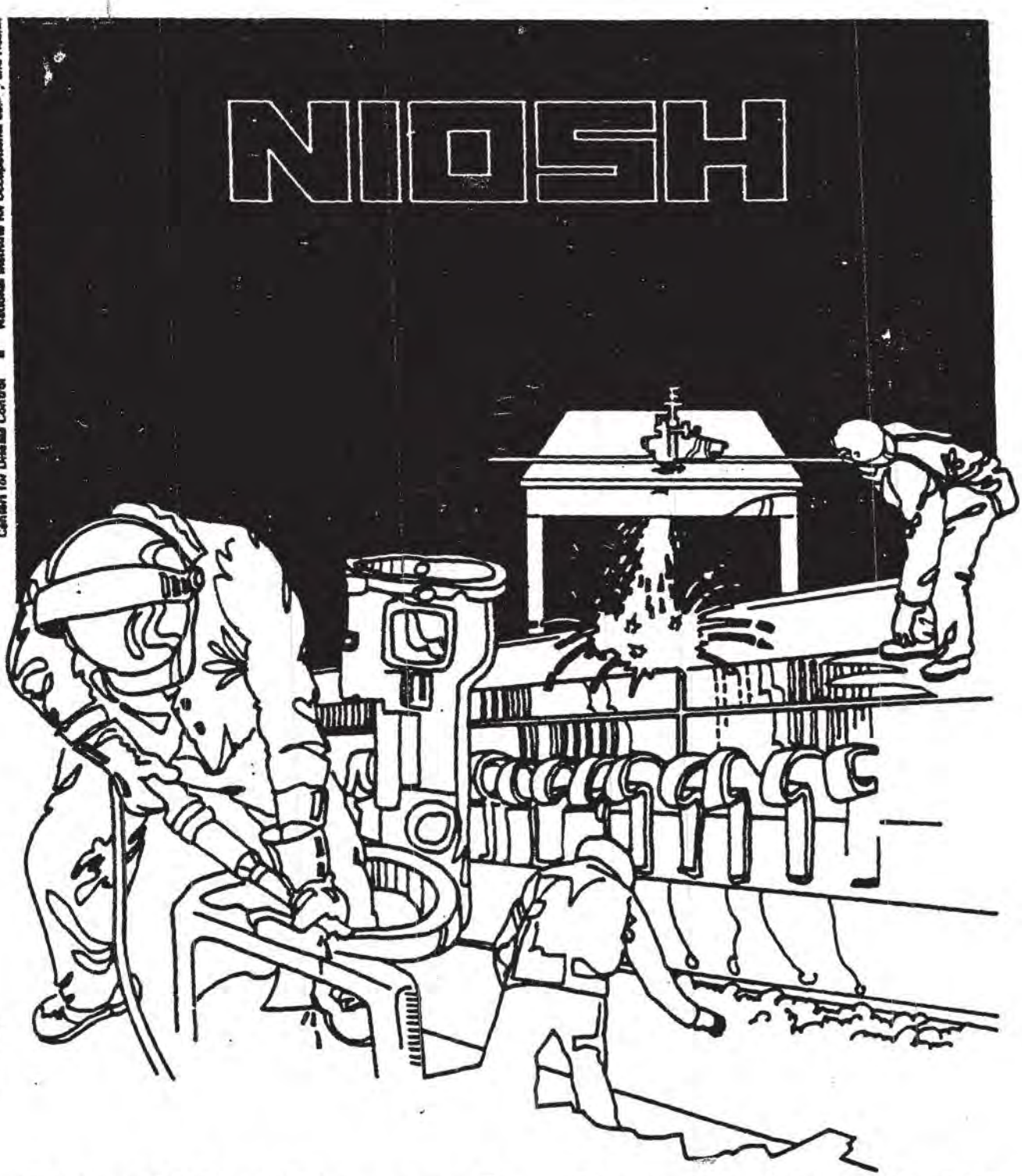
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 84-446 & HETA 85-017-1640
FEDERAL AVIATION ADMINISTRATION
FACILITIES:
PHILADELPHIA, PENNSYLVANIA
WESTBURY, NEW YORK

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 84-446 and HETA 85-017-1640
DECEMBER 1985
FEDERAL AVIATION ADMINISTRATION FACILITIES:
PHILADELPHIA INTERNATIONAL AIRPORT
AIR TRAFFIC CONTROL TOWER, PHILADELPHIA, PENNSYLVANIA
NEW YORK TRACON, WESTBURY, NEW YORK

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I. SUMMARY

In July and October 1984 NIOSH received requests from the Federal Aviation Administration (FAA) for an assessment of the air quality at the Philadelphia International Airport Control Tower, and the New York Terminal Radar Approach Control (TRACON), respectively. Both requests were prompted by employee complaints of eye irritation and respiratory problems.

NIOSH investigators visited the Philadelphia International airport on October 10-11, 1984 and March 15, 1985; and the New York TRACON on November 13, 1984 and March 14, 1985.

The environmental assessment included collecting airborne samples for carbon monoxide (CO), carbon dioxide (CO_2), ozone (O_3), formaldehyde, and organic solvents in one or both facilities. Additionally, temperature and relative humidity readings were collected and the ventilation systems at each facility were evaluated.

The medical investigation included anecdotal interviews among air traffic control and airway facilities personnel at both sites to determine the type, extent and work relatedness of ill health effects experienced by these individuals. Results of these interviews at both sites revealed a variety of irritative symptoms typically associated with indoor air quality and non-specific to any disease etiology. Eye irritation, characterized by itching and burning sensations along with skin, throat and respiratory irritations were the most commonly reported symptoms.

At the Philadelphia facility one CO_2 short-term sample value of 1100 parts per million (ppm) exceeded the level (1000 ppm) that has recently been used as an indicator of insufficient outdoor air supply into buildings. Most of the other CO_2 samples were much lower at each facility although some were in the range (600 to 1000 ppm) associated with increased employee discomfort. Short-term sample values for CO, O_3, and formaldehyde, were below the limit of quantitation (5 ppm for CO, 0.05 ppm for O_3, 0.5 ppm for formaldehyde) on the one to four samples collected for each material. Toluene was the only material identified on the organics sample. The value was less than 0.01 ppm. The corresponding ASHRAE recommended level is 1/10 of an appropriate industrial criterion or 10 ppm. Problems in the design characteristics were noted for each ventilation system. Problems included no outside air utilization during temperature extremes at the Philadelphia facility, and ventilation system intake and exhausts located in the same area at the New York facility.

Based on the results of these investigations NIOSH investigators believe that during the NIOSH visits a health hazard did not exist for employees at either FAA facility. However, problems noted in the design of both ventilation systems and lack of outdoor air use during ambient temperature extremes at the Philadelphia International Airport indicate that the HVAC systems are at least partially responsible for employee complaints. Recommendations are included in Section VIII to improve the ventilation systems at both facilities.

KEYWORDS: SIC 4580 (Fixed Facilities and Services related to Air Transportation) office environment, carbon dioxide, carbon monoxide, ozone, formaldehyde, air traffic control.

II. INTRODUCTION

On July 24, 1984 and October 15, 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Federal Aviation Administration's (FAA) Regional Occupational Safety and Health Manager for an assessment of the air quality at the Philadelphia International Airport Control Tower, Philadelphia, Pennsylvania, and the New York TRACON, Westbury, New York, respectively. Each request resulted from employee complaints including watery eyes, eye irritation, frequent colds, and respiratory problems.

NIOSH investigators made an initial site visit to the Philadelphia International Airport Control Tower on October 10-11, 1984 and a follow-up visit on March 15, 1985. An initial site visit was made to the New York TRACON on November 13, 1984 and a follow-up visit on March 14, 1985.

Results of each investigation were forwarded to interested parties via letters in October 1984, December 1984, and April 1985 for the Philadelphia International Airport Control Tower and in November 1984, and April 1985 for the New York TRACON.

III. BACKGROUND

Each FAA facility has a workforce divided into Air Traffic Control and Airway Facilities personnel. Airway Facilities personnel are responsible for maintaining buildings and equipment in support of the Air Traffic Control personnel. The Air Traffic Control Personnel are responsible for guiding and monitoring commercial and private air traffic.

The Philadelphia International Airport Control Tower is approximately 5 years old and includes about 140 personnel. The facility consists of the Tower Cab located approximately 120 ft above ground and a lower building that includes the TRACON room. In the Tower Cab there are five to six air traffic control specialists. This includes a local controller who is responsible for planes in the immediate vicinity (within 7 miles); a ground controller who is responsible for ground movement of aircraft; two flight data personnel who receive and approve flight plan requests from individual aircraft; and a supervisor who monitors activities in the cab.

The TRACON room provides service to aircraft to and from seven regional airports. It serves as the parent approach facility for the surrounding area, controlling air traffic up to 8,000 ft, within a 50 mile radius. The room is dark except for dim lights at the stations and on information boards. Normally 10-12 personnel are in the room including a supervisor, and about 10 air traffic control specialists.

The New York TRACON is a 60,000 ft^2 two-story facility located in Westbury, New York (Long Island). Construction began in 1976 and was completed in 1980. This facility is one of FAA's Air Route Traffic Control Centers (ARTCC's) which monitor aircraft traveling cross country. Each of the 20 ARTCC's in the continental United States monitors air traffic covering a certain geographical area.

The New York TRACON handles all air traffic for the three major New York City airports and about 35 other airports in the vicinity.

Air traffic control specialists are given responsibility for aircraft that enter their sector. This action is called "handing off". The pilot identifies his aircraft to the TRACON controller who monitors it via a flash of light (blip) on his radar screen. Each blip is accompanied across the radar screen by an alpha-numeric tag supplied by a central computer which contains the plane identification, altitude and speed.

The controller monitors the aircraft's relationship to other aircraft and issues instructions to the pilot concerning direction of flight and clearance for altitude changes.

The entire facility includes about 400 employees divided among air traffic control and airway facilities. Air traffic control specialists work eight hour shifts and generally get a break every hour.

The air traffic control room measures 75 ft by 90 ft by 15 ft and normally has 35-40 employees during the day shift. The air traffic control equipment is located in a smaller rectangle occupying about 70% of the larger room.

IV. METHODS

A. Environmental

In assessing the air quality, NIOSH investigators evaluated the ventilation system, measured the temperature and relative humidity levels, and collected air samples for CO, CO_2, O_3, and formaldehyde in both facilities and organic solvents at the Philadelphia International Airport Control Tower. The evaluation of the ventilation system consisted of quizzing building personnel about each systems' operation, visually inspecting various components of each system and using smoke tubes and/or an air velocity meter to check air flow parameters.

Short-term samples for CO, CO_2, O_3, and formaldehyde were collected with direct reading indicator tubes.[1] Long-term samples for organic solvents were collected on charcoal tubes attached to battery-operated pumps calibrated at 0.2 liters per minute. These samples were analyzed by gas chromatography utilizing flame ionization detection. Temperature and relative humidity measurements were collected with a battery-operated psychrometer and/or a Reuter Stokes Wibget.

B. Medical

The medical investigation included anecdotal interviews of Air Traffic Control and Airway Facilities personnel to documment complaints and health effects believed to be associated with each facility's ventilation system.

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. Products of combustion

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. Formaldehyde

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. Sprayed-on insulation materials

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[2].

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, ASHRAE has recommended that 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:

	Concentration/Exposure Period		
Contaminant	8-Hour TWA	Continuous	Source
Carbon monoxide	50	---	OSHA/ACGIH
(ppm)	35 (200C)	---	NIOSH
	---	9	ASHRAE
Formaldehyde	3	---	OSHA
(ppm)	CA	---	NIOSH
	---	0.1	ASHRAE
Total particulates	15	---	OSHA
(mg/m^3)	10	---	ACGIH
	---	0.26 (24-hrC)or 0.075 (1-yr mean)	ASHRAE
Asbestos	2	---	OSHA
(fibers/cc)	0.5--2	---	ACGIH
	0.1, CA	0.01, 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[3].

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.

Recently investigators have suggested that indoor CO_2 levels in excess of 1000 ppm are indicative of inadequate outdoor air supply to the HVAC system.[4,5] Levels between 600 and 1000 ppm are associated with increased employee complaints as follows:

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

VI. RESULTS

A. Environmental

Tables 1 and 2 present the results of short-term samples collected for CO, CO_2, O_3, and formaldehyde during the first visit to each facility. One to four samples were collected for CO, O_3, and formaldehyde at each facility. These materials were all below the limit of quantitation on all samples. Thus at a minimum these materials were less than 5 ppm for CO, 0.05 ppm for O_3, and 0.5 ppm for formaldehyde. Additionally, only one CO sample resulted in any discoloration on the indicator tube used. This suggests that if these materials were present their concentrations were much less than the limit of quantitation. The corresponding ASHRAE guidelines are 9 ppm for CO, 0.1 ppm for O_3, and 0.05 ppm for formaldehyde.[3] Indoor CO_2 levels ranged from 600 to 1100 ppm at the Philadelphia facility and from 400 to 800 ppm at the New York TRACON. One sample at the Philadelphia Control Tower exceeded 1000 ppm, the level that has been used as an indicator of insufficient outdoor air. Many of the remaining CO_2 sample values were between 600 and 800 ppm. Levels of 600 to 1000 have been associated with increased employee complaints.

Tables 3 and 4 list results for CO_2 short-term samples collected during the follow-up surveys. Indoor CO_2 levels ranged from 425 to 600 ppm at the Philadelphia facility and from 425 to 700 at the New York TRACON. One sample, at the Philadelphia facility was in the range (600 to 1000 ppm) associated with increased employee complaints.[4,5]

Toluene was the only material identified on the long-term samples for organics collected at the Philadelphia facility. Airborne concentrations were less than 0.01 ppm. ASHRAE recommends that if no indoor criteria exists for a specific material then an appropriate industrial criterion should be selected and reduced to 1/10 of its industrial value. The NIOSH recommended standard for toluene is 100 ppm. This would result in a criterion of 10 ppm.

Temperature and humidity measurements revealed a 9°F variation in temperature and a 14% variation in relative humidity during one shift in the Tower Cab at the Philadelphia Control Tower. At one point during the same shift (10/11/84), the Tower Cab was 9°F cooler than the TRACON room. The humidification component of the Tower Cab HVAC system was not functioning. Additionally, Tower Cab employees had access to the thermostat. These factors were probably at least partially responsible for the variations measured.

General observations

The ventilation system at each facility was in need of improvements. Both facilities had air intake and exhausts located in the same general area (Figures 1-2). The New York facility had intakes and exhausts for seven air handling units (AHU) plus short exhaust stacks for bathrooms, kitchen, etc., all located on the roof. The exhaust for AHU number 4 is located 9 ft away from and blowing toward, the intake for AHU number 1 (Figure 1). Air blown from a duct retains 10% of its original velocity at 30 duct diameters away.[7] Since the exhaust for unit 4 measured approximately 5 ft x 5 ft, system 1 probably takes in some of the exhaust rather than just outdoor air.

The Philadelphia facility had a similar situation (figure 2) as two AHUs were located only 12 ft apart. Each unit had both an exhaust and an intake. However, the possibility of exhausted air being drawn back in was much less because each unit's exhaust is directed away from both intakes.

All AHUs checked during the follow-up surveys, using smoke tubes and an air velocity meter, were utilizing outdoor air. Table 5 lists the results of the air velocity readings. At the New York facility air velocity readings were taken on only three of seven intakes due to time limitations. The AHU intake and exhausts had no identifying marks which made it impossible to know exactly which systems were being evaluated. For this report the units were designated A, B, and C.

Discussions with environmental technicians and other building occupants elicited several theories as to the causative agent for employee complaints at each facility. For the Philadelphia facility the theories included:

1. fumes/odors from a ship unloading dock located about 500 ft away on the Delaware River.

2. atmospheric pollution originating from any of several refineries located in the area.

3. plane exhaust from airport traffic.

For the New York facility the theories included:

1. odors or other materials from an adjacent race track.
2. something (i.e., pollen) from cutting of weeds that occurred around the time of employees' complaints.
3. combination of smoking and stress from the dark environment.
4. combination of the chiller operating after setting idle and a chemical used to clean the chiller coils.
5. fallout from insulation located inside some of the duct work.

While any of the above may contribute to the reported problems, our investigation did not single out any as a primary causitive agent. At the time of the March visits both facilities were considering eliminating smoking in the employee work areas. This action will probably result in reduced symptoms.

B. Medical

Anecdotal interviews conducted among personnel at both the Philadelphia and New York sites revealed a variety of non-specific, irritative symptoms, typically associated with indoor air quality. Some of these symptoms included eye irritation, skin irritation, throat and respiratory irritations, headaches, detection of odors and fatigue.

Personnel in the Tower Cab at the Philadelphia International Airport complained most often about the frequent and extreme fluctuations in the cab's room temperature. Some respondents described the shifts as going from "tropical" to "arctic" modes and vice versa. NIOSH investigators experienced these conditions at the time of the investigation. These fluctuations could be explained by variations in the temperature and humidity, such as was measured during the first survey. Airway facilities personnel located in the ground level building at Philadelphia reported occasional presence of noxious odors, especially late at night (possibly attributed to refineries located across the Delaware River in New Jersey).

Personnel in the New York TRACON facility complained most frequently of a "dirty mop-like" odor present in the TRACON room, as well as a variety of other non-specific complaints. Among the four work sectors, individuals working the evening shift at the "Newark Sector" reported more complaints than any of the other sectors and shifts. Many of these individuals attributed their complaints to poor ventilation, temperature stratification, cigarette smoke and dust.

There were no other pertinant findings for either the Philadelphia or New York facility.

VII. DISCUSSION AND CONCLUSIONS

Based on the results of these surveys NIOSH investigators believe that no health hazard existed at either FAA facility during the time of the NIOSH surveys. While a specific cause of the employee complaints was not identified, problems with the ventilation systems at each facility were noted. The most significant problem was the lack of outdoor air supply to the HVAC system during ambient temperature extremes at the Philadelphia facility.

As noted in the Evaluation Criteria Section, pinpointing the agent responsible for employee complaints is very difficult in office type environments. When specific agents are not found and there are documented problems in the building ventilation system then poor air quality is generally considered at least partially responsible.

NIOSH has conducted evaluations in over 200 office type environments.[6] Several of these are listed in the appendix as examples.[8-44] Specific agents that have been implicated and/or detected include asbestos, formaldehyde, fiber glass, toluene, benzene, ozone, methyl alcohol, sulfur dioxide, sewer gases, gasoline vapors, and cigarette smoke.[13-16, 31-37] Some studies have implicated microbiological organisms as the causative agent.[45] Microbiological organisms are not believed to be the causative agents in either of these facilities based upon the diverse and non-specific symptoms reported, the absence of an epidemiologic pattern of common illnesses and the close inspection of the facilities and the air handling systems.

VIII. RECOMMENDATIONS

1. The Philadelphia International Airport Control Tower's HVAC system should be modified so that outdoor air is supplied to the system year round. The minimum amount will vary from 5-20 CFM per occupant depending on whether smoking is allowed in the area. Additionally, the exhaust for AHU number 4 should be modified to avoid re-intrainment by the intake for AHU number 1.

2. Fluctuations in the Philadelphia Tower Cab's environment should be reduced. Repairing the humidification component of the HVAC system and eliminating the possibility of frequent adjustments to the thermostat should be beneficial.

3. The AHU intakes and exhausts for both facilities should be marked to indicate which system they belong to.

4. Each facility should compile a short strategy sheet for the HVAC system, outlining how the systems are designed to operate.

5. After implementing recommendation number 1, the Philadelphia facility should evaluate the adequacy of the outdoor air supply at a time when the minimum amount of outdoor air is being used. Evaluating CO_2 levels with indicator tubes is one possibility. Indicator tubes are relatively simple to use and CO_2 levels give an indication of the adequacy of the outdoor air component.

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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, Publications Dissemination Section, 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. Regional Occupational Safety and Health Manager, FAA
2. New York TRACON, Westbury, New York
3. Philadelphia International Airport Control Tower, Philadelphia, Pennsylvania
4. NIOSH, Region II and Region III
5. OSHA, Region II and 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.

Table 1

Short-Term Sample Results - First Survey
Collected with Direct Reading Indicator Tubes

Philadelphia International Airport - Control Tower
Philadelphia, Pennsylvania
HETA 84-446

October 10-11, 1984

Location	Time	Date	Analyte	Concentration (ppm)
Tower cab	1256	10/10	CO_2	1100
	1539	10/10	CO_2	700
	720	10/11	CO_2	600
	1126	10/11	CO_2	800
	1512	10/11	CO_2	800
TRACON room	1234	10/10	CO_2	700
	1601	10/10	CO_2	700
	745	10/11	CO_2	700
	1030	10/11	CO_2	600
	1530	10/11	CO_2	800
Outside 20' from front door	1320	10/10	CO_2	400
Outside, at fresh air intake, main unit	1550	10/10	CO_2	500
	730	10/11	CO_2	400
	1230	10/11	CO_2	400
	1522	10/11	CO_2	400
Tower cab	1303	10/10	CO	<5
	1010	10/11	CO	<5
	1308	10/10	O_3	<0.05
	1020	10/11	O_3	<0.05
	1015	10/11	FOR	<0.5
TRACON room	1239	10/10	CO	<5*
	1244	10/10	O_3	<0.05
	918	10/11	O_3	<0.05
	925	10/11	FOR	<0.5

CO_2 = carbon dioxide, CO = carbon monoxide, O_3 = ozone, FOR = formaldehyde
Indicator tube limit of quantitation: CO_2 = 100 ppm, CO = 5 ppm, O_3 = 0.05, FOR = 0.5.
* = Trace but not enough for quantification.

Office Building Criteria (ppm):		ASHRAE	Canadian (Ref. 4,5)
	CO_2	2500	1000=indicates inadequate outdoor air 600-1000=associated with increased employee complaints
	CO	9	-
	O_3	0.1	-
	FOR	0.05	-

Table 2

Short-Term Sample Results - First Survey
Collected with Direct Reading Indicator Tubes

New York TRACON
Westbury, New York
HETA 85-017

November 13, 1984

Location	Time	Analyte	Concentration (ppm)
Station 103	1328	CO_2	800
Newark Station	1809	CO_2	500
LaGuardia Station	1332	CO_2	700
	1815	CO_2	500
At ceiling level,	1800	CO_2	500
18" below supply	1804	CO_2	400
LaGuardia Station	1340	FOR	>0.5
LaGuardia Station	1348	O_3	>0.05
LaGuardia Station	1353	CO	>5

CO_2 = carbon dioxide, CO = carbon monoxide, O_3 = ozone, FOR = formaldehyde

Indicator tube limit of quantitation: CO_2 = 100 ppm, CO = 5ppm,
FOR = 0.5 ppm, O_3 =0.05 ppm.

Office Building Criteria (ppm):		ASHRAE	Canadian (Ref. 4,5)
	CO_2	2500	1000=indicates inadequate outdoor air 600-1000=associated with increased employee complaints
	CO	9	-
	O_3	0.1	-
	FOR	0.05	-

Table 3

Short-Term Sample Results for CO_2 - Second Survey
Collected with Direct Reading Indicator Tubes

Philadelphia International Airport - Control Tower
Philadelphia, Pennsylvania
HETA 84-446
March 15, 1985

Location	Time	Number of People In Room	Number of Lit Cigarettes	Concentration (ppm)
Tower cab, end of	755	6	1	450-500
center console,	925	5	1	600
above air return	1020	12/15*	0	600
	1115	9/3*	0	600
	1205	12*	1	575-600
	1310	5	0	500
	1445	6/5	1	450
	1455		0	400
	1556	5	1	575
	1644	5	0	425
TRACON room, satellite	804	12	0	500
handoff station	915	10	1	500
	1012	16*	0	600
	1124	9	-	550-600
	1244	10	0	500
	1432	10	0	550
TRACON room, north	809	11	0	600
arrival handoff	910	9	1	600
station	1006	14*	0	500
	1130	8	-	600
	1237	11	0	500
	1437	10	0	550
Outside, on road	815	0	0	250
leading to gate,	943	0	0	250
end of parking lot	1138	0	0	225
	1510	0	0	275-300

CO_2 indicator tube limit of quantitation = 100 ppm
* Higher number due to the visitors in room.
/ Indicates different number of people at beginning and end of test.

Office Building Criteria (ppm): CO_2 (Ref. 4,5) 1000=indicates inadequate outdoor air
600-1000=associated with increased employee complaints

Table 4

Short-Term Sample Results for CO_2 - Second Survey
Collected with Direct Reading Indicator Tubes

New York TRACON
Federal Aviation Administration Facilities
HETA 85-017

March 14, 1985

Location	Time	Number of People In Room	Number of Lit Cigarettes	Concentration (ppm)
Air Traffic Control room, 5' from station #1, 12' from supervisor station	750	43	4	500
	920	44	3	500
	1100	35	4	500
	1235	34	6	600
	1337	42	3	575-600
	1505	46	6	575-600
Air Traffic Control room, 3' from station #14, next to supervisors desk	756	43	4	550-600
	926	44	3	550
	1055	35	4	500
	1220	34	6	575-600
	1344	42	3	600
	1510	46	6	700
Front lobby, midpoint between front door and wall	812	0	0	425
	950	0	0	600
	1048	0	0	600
	1325	0	0	550
Outside, at guard building	725	0	0	200
Outside, 25' from front door, next to shrubbery	955	0	0	225
	1255	0	0	225

CO_2 indicator tube limit of quantitation = 100 ppm.

Office Building Criteria (ppm): CO_2 (Ref. 4,5) 1000=indicates inadequate outdoor air
600-1000=associated with increased employee complaints

Table 5

Characteristics of Each Facility

HETA 84-446
HETA 85-017

	Philadelphia International Airport Control Tower		New York TRACON
	Tower Cab	TRACON Room	Air Traffic Control Room
Floor space (ft^2)	575	1,080	6,750
Room volume (ft^3)	6,050	8,850	94,500
Usual number of occupants during surveys	5-6	10-12	40-42
Outside air use - 1st survey	yes	yes	yes
Outside air use - 2nd survey	no*	yes	yes
Number of air handling units	2	2	7 for building 1 for air traffic control room
Quantity of outside air being drawn in, for unit tested (in CFM)			
P-TC	**	-	-
P-TR Main unit	-	5,790	-
P-TR Supplemental unit	-	3,290	-
NY Unit A	-	-	17,350
NY Unit B	-	-	600
NY Unit C	-	-	20,800

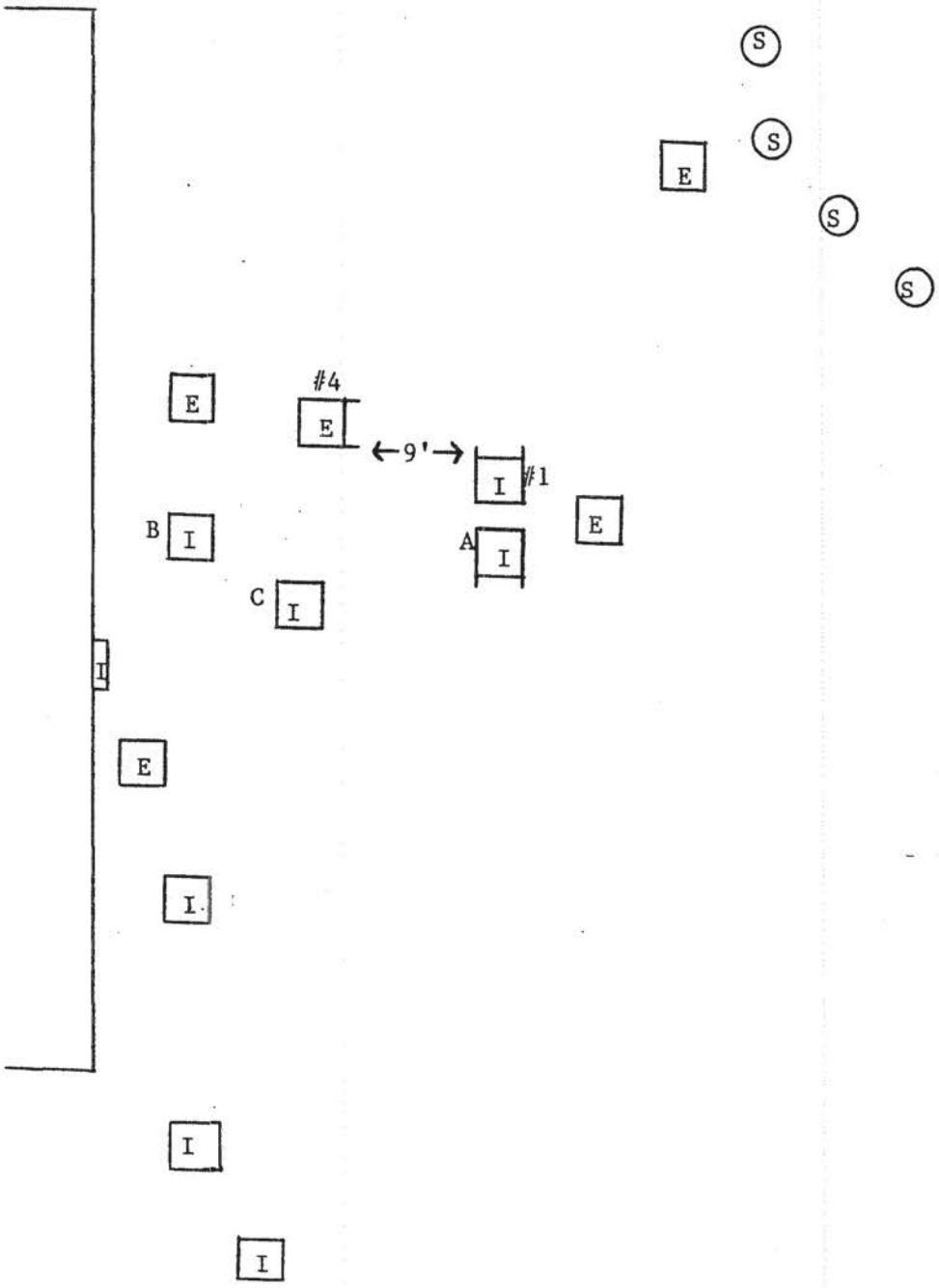
* Reported that no fresh air was being used, but it could not be verified.
** Unable to evaluate these 2 units
\- Not applicable

P-TC = Philadelphia-Tower Cab
P-TR = Philadelphia-TRACON Room
NY = New York

Figure 1

Intake and Exhaust Locations

New York TRACON
Westbury, New York
HETA 85-017



Note: Locations are approximate.
There were other intake/exhausts, not shown.
I = intake, E = exhaust, S = stack exhaust.
A,B,C, indicate units tested with velometer.

Figure 2

HVACs for Main Building

Philadelphia International Airport
Control Tower
Philadelphia, Pennslyvania
HETA 84-446