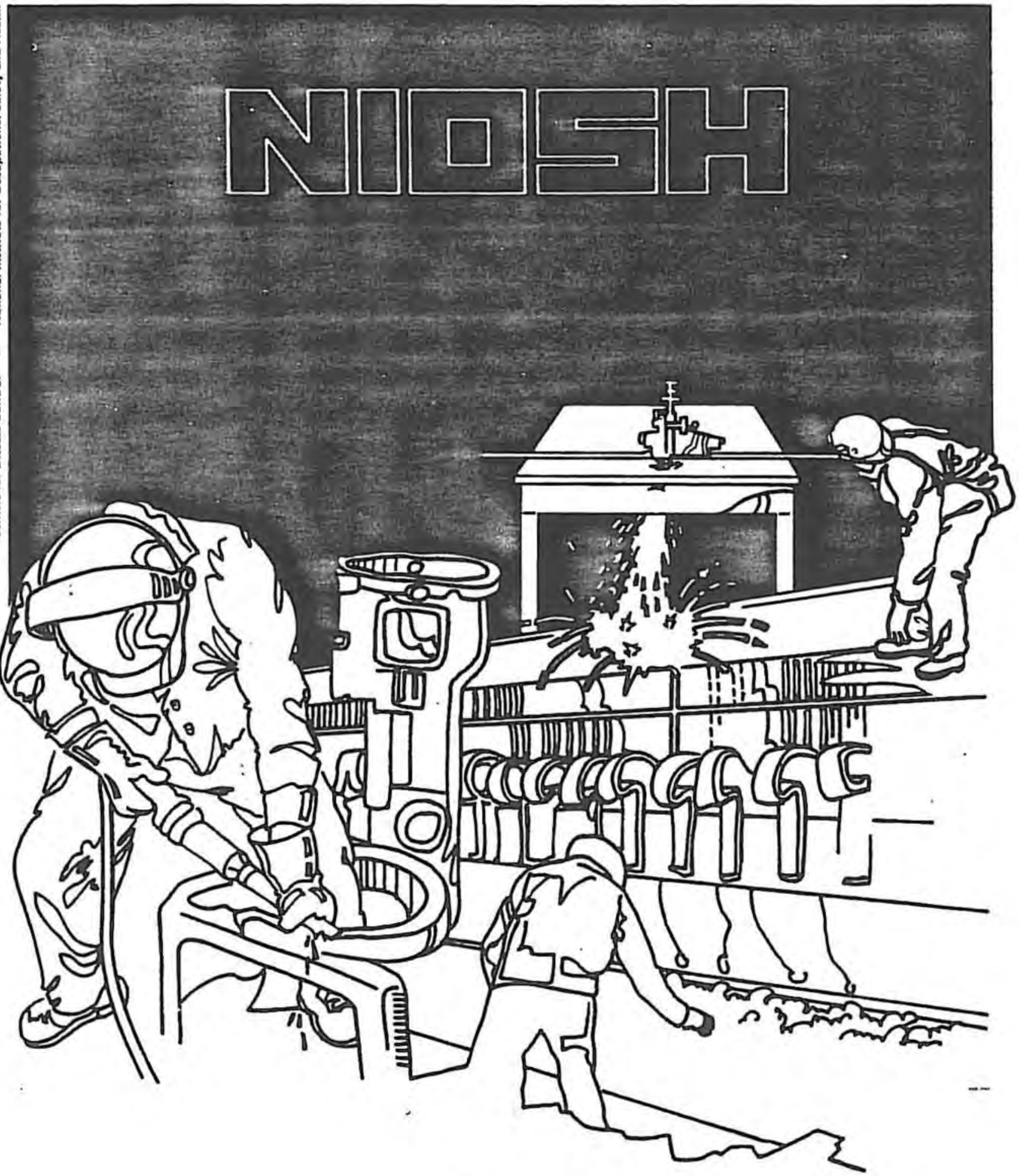
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 83-306-1548
SCHOLASTIC, INC.
NEW YORK, 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.

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SCHOLASTIC, INC.
NEW YORK, NEW YORK

NIOSH INVESTIGATORS:
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I. SUMMARY

In the Spring of 1983, the Region II office of the National Institute for Occupational Safety and Health (NIOSH) began a health hazard evaluation of environmental conditions at Scholastic, Inc., 730 Broadway, New York City in response to concerns of several employees about the air quality in the office and intermittent incidents of eye and respiratory irritation.

An industrial hygiene consulting firm engaged by the company had performed a survey for organic solvents which determined no exposure to excessive concentrations of solvents. An inspection of the office was performed and determined that there was no use of "chemicals" in the office other than those used in duplicating machines. NIOSH personnel interviewed 40 employees to determine their concerns with the office environment. The major concern of the employees interviewed was with the temperature and ventilation of the office.

A preliminary survey (June, 1983) of the ventilation system indicated that the system had become unbalanced. A complete ventilation survey (July and September, 1984) pinpointed areas of inadequate air supply. Analysis of environmental samples collected by NIOSH in July of 1984 confirmed the results of the previous study by the consulting firm, that no excessive exposure to organic chemicals existed at the office site.

Employee complaints were probably due to an inadequate supply of fresh air in several areas of the office. NIOSH recommends that the ventilation system be balanced and that the quantity of air provided to the front (west end) of the eighth and ninth floors be restored to that of the original design specifications for the ventilation system.

KEYWORDS: SIC 2731 (Book and Pamphlet Publishing), ventilation, closed building syndrome, organic vapors.

II. INTRODUCTION

In the Spring of 1983, the New York Regional Office of the National Institute for Occupational Safety and Health (NIOSH) was contacted by a representative of a group of employees of Scholastic, Inc., 730 Broadway, New York City, N.Y. 10003. The employees were concerned about the air quality in their newly occupied offices and complained about having experienced periods of intermittent eye and respiratory irritation. The offices were visited within the week of the original contact and a formal request for a health hazard evaluation was made in June, 1983. A preliminary ventilation survey done in the June of 1983 indicated that the ventilation system had become unbalanced. A complete survey of the ventilation system was performed on July 10 and September 11 of 1984, utilizing more precise survey equipment. That latter survey pinpointed areas of inadequate air supply. Analysis of environmental samples collected in July of 1984 confirmed the results of a survey performed in the Spring of 1983, that no exposure to excessive concentrations of organic solvents existed in the office. Results of the surveys were reported to Scholastic in August and October, 1984.

III. BACKGROUND

Scholastic, Inc. began to occupy their new offices at 730 Broadway, New York City in December, 1982. The three floors of offices were constructed above an existing 7 story building. This site houses the editorial and managerial offices of the firm, which publishes books, magazines and computer software. Manufacturing is done at other sites. Some construction (carpentry and painting, etc) was in progress during the initial few months of occupancy, and there were many complaints about odors and dust during that initial period as well as intermittent complaints about eye and respiratory irritation.

The employees had previously been housed in an old building in traditional, partitioned offices with windows that could be opened. The new office lay-out has very few private offices with walls extending to the ceiling. Most offices have walls about eight feet high, with two feet of open space between the top of the wall and the ceiling. Most of the employees are positioned in modular offices which have six foot high walls of sound deadening material. These modular offices are clustered together in several areas on each floor.

Mention should be made of the office decor, which many employees complained about when they first occupied the area. The walls are painted about 50 different shades of color and are covered with many different textures (fabric, tile, wood). A white and black tile walkway winds its way through the floors. Free standing archways provide visual perspectives. The general impression is that the work site is unconventional and initially was quite disconcerting to many of the employees, who have since adjusted to it.

The office operations are those typical of magazine publishing, reviewing, writing, proofreading, etc. Word processors are widely used. A small amount of solvents are used in the Art Department, but no specific complaints are associated with their use or in that area.

Ventilation is provided by 12 heating/ventilation/air-conditioning (HVAC) units, four on each floor. These units are designed to provide a total of about 100,000 cubic feet of air per minute (cfm) to the office. Air is supplied to the offices through 357 grills (2 feet by 2 feet or smaller) and is returned via 150 slot grills (2 inches by several feet long). These three floors do not share a ventilation system with other floors of the building. The area is zoned commercial and there are no manufacturing plants in the vicinity.

Because of employee complaints, in the Spring of 1983 management hired an industrial hygiene consultant to evaluate the environment. The consultant's investigation determined trace amounts of common organic solvents (toluene, etc.). The consultant also determined that formaldehyde concentrations in the office atmosphere were about 0.01 to 0.02 milligram per cubic meter of air. This concentration is within the range of airborne formaldehyde concentrations in urban atmospheres and should present no hazard to employees.

IV. Evaluation Design and Methods

About forty employees were chosen at random and were interviewed concerning their general health, health concerns since occupying the new quarters and their general impression of the new quarters. The interviews were conducted to determine the extent of the health concerns and if the health concerns were associated with specific areas of the office.

As the majority of complaints at Scholastic concerned the ventilation system, it was decided to perform a ventilation survey of the area. In mid-1983, the survey instrument available for ventilation studies was a thermal anemometer. The use of this instrument requires transversing the ventilation grill to determine an average air velocity across the grill. The input (quantity) of air which passes through the grill is then determined by multiplying the velocity of the air with the effective area of the grill. Because this procedure is time consuming, measurements of the quantity of air supplied were made at about 40 of the input grills, mostly in areas where the personnel complained of stuffiness. This limited survey indicated that the ventilation system had become unbalanced.

In the Spring of 1984, NIOSH obtained a "Flow Hood" survey instrument, which can measure the input of ventilation grills directly in cubic feet per minute (cfm). In July 1984, a resurvey of the ventilation system was made, using the new instrument. Because of the ease of use of the Flow Hood, all 357 input grills in the office were measured in the resurvey. The results of the resurvey indicated that large areas of the office were receiving inadequate amounts of air. Adjustments were made to sections of the ventilation system, and an additional survey was performed in September, 1984 to determine the results of these adjustments.

In addition, 5 samples were collected at the time of the July survey in vazrious offices to determine the concentrations of airborne organic vapors in the office.

V. EVALUATION CRITERIA

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 expenses. Modern high-rise office buildings often are totally dependent on mechanical systems for their air supply and ventilation. 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 have 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 may be 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: products of combustion such as carbon monoxide and nitrogen dioxide; formaldehyde and other aldehydes which may be released from foam plastics, particle board and textile fabrics; insulation materials such as asbestos and fibrous glass; tobacco smoke; microrganisms and allergens; and hydrocarbon vapors.

The primary sources of air contamination criteria generally consulted are: 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, Inc. (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 per 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.

Neither NIOSH nor OSHA has developed ventilation criteria for offices. The guidelines published by ASHRAE are criteria often used by ventilation design engineers. The old (1973) ASHRAE recommendations were based on studies performed before modern, air-tight office buildings became common. These older buildings permitted more air infiltration through leaks in cracks and interstices, windows and doors, and through floors and walls. Modern office buildings are usually much more air-tight and permit less air infiltration.

In 1981, ASHRAE published "Ventilation for Acceptable Indoor Air Quality". The new standard is based on an occupant density of 7 persons per 1000 square feet of floor area. For "general offices",where smoking is not permitted, the rate recommended under the new standard is 5 cubic feet per minute (cfm) of fresh, outdoor air per person. When smoking is allowed, the amount of outdoor air provided should be 20 cfm per person.

VI. RESULTS

Interviews

The information obtained from the interviews indicated that the employees had varied perceptions about the office. While some employees were pleased with the new surroundings, most employees had been upset about the unconventional decor of the office. Many employees, who were located near to the route of the tile walkway, had been disturbed by the noise of mail delivery carts on the tile (this problem was aleviated by the use of carts with large rubber wheels). Some individuals complained about glare on the screens of video display terminals. The installation of shades on the windows helped to reduce these complaints.

A number of persons complained about dust, odors and paint "fumes" while construction was in process at the time of first occupancy of the area. During that time, some employees complained about eye and respiratory irritation, but these complaints diminished with the reduction of construction work. Several employees were concerned about smoking in the open areas where partitioned work areas are clustered. Management had attempted to limit the complaints by positioning the smokers together, usually in the center of the work areas. It was pointed out to management that the return slots were positioned at the ends of the work areas and that grouping the smokers in the center caused the cigarette smoke to be dissipated throughout the areas. Cigarette smoke was be better controlled by positioning the smokers nearer to the return slots. The interviews did not disclose wide spread health concerns related to the office environment. The major complaint at the time of the investigation concerned "stuffiness" and "lack of air"

Environmental

Air Contaminants

Analysis of the samples collected at Scholastic indicated the presence of trace amounts (less than a part per million) of several organic chemicals: 1,1,1-trichloroethane, cyclohexane, hexane, toluene and other C6 and C7 alkanes. These chemicals are contained in many commercial cleaning products and have been found in samples collected in many offices. Exposure to these chemicals in trace amounts does not present a hazard to the office employees. Trace amounts of similar organic chemicals were determined to be present in samples collected by the consultant in the Spring of 1983.

The following table lists the NIOSH recommended exposure limit for these substances.

Substance	OSHA PEL	NIOSH Recommendation	Concentration Found
1,1,1-trichloroethane	350 ppm*	350 ppm**	< 1 ppm
cyclohexane	300 ppm	300ppm	< 1 ppm
hexane	500 ppm	100ppm	< 1 ppm
toluene	200 ppm	100ppm	< 1 ppm

*ppm = parts per million parts of air, time weighted average for an eight hour daily exposure, 40 hour work week.

**ppm = parts per million parts of air, time weighted average for an eight to 10 hour work day, 40 hour work week.

Ventilation

The ventilation survey performed at 40 input grills in mid-1983 indicated that the ventilation system had become unbalanced. With the introduction of the "Flow Hood" instrument, the entire system of 357 grills was measured in July,

1984. The results of the latter survey confirmed that the system had become unbalanced and was no longer performing according to design criteria. This was reported to Scholastic by letter on July 24th. A table which was included with the letter listed the input of each individual ventilation grill.

Upon receipt of that letter, Scholastic was able to determine that the input of the ventilation grills in several locations had been altered or blocked entirely since occupancy of the office. Scholastic attempted to repair parts of the ventilation system so that these grills would function at or near to the design criteria. A return visit was made to the office in September of 1984, and these areas were surveyed again. Spot checks were made at other input grills, which confirmed that the ventilation system was operating at the input rate of the July survey. The input from the 46 "repaired" grills increased the total air supplied to the office by 9,820 cfm, for a total of 64,500 cfm.

The ventilation system at Scholastic consists of 12 HVAC systems, 4 on each floor, two on each side of the building. Each HVAC system has from 1 to 5 diffuser boxes, and each diffuser box has from 20 to 39 input grills. There are 357 input grills on the three floors. The system is designed to supply a total of more than 100,000 cfm to the offices. Comparisons of the design criteria and the measured input for the 312 grills for which comparisons could be made are listed in the Appendix. The Appendix lists the output of each grill, according to the design criteria, along with the measurements of the survey made by a consulting firm in January 1983, and the measurements of the NIOSH surveys in July or September, 1984.

The 1983 survey by the consulting firm indicated that most of the grills were delivering air at or near the design criteria. However, the results of the NIOSH surveys of July and September, 1984 indicate that the ventilation system had become unbalanced and that there was a reduction in the quantity of air supplied to the Scholastic office.

Table I lists comparisons made of the quantity of air (input) measured during the 1984 surveys with the design criteria for 312 grills (87% of the total number of grills). Comparison could not be made at 45 grills: Measurements could not be made at 23 grills because of location, obstruction or configuration. Four grills had been closed at the request of office employees. Two new grills had been added since 1983. Data were missing for 16 grills (on the east end of the 9th floor). Table I also lists the design criteria for the entire ventilation system of the office. As noted in the Appendix, most of the input grills are supplying less than the amount of air called for in the design criteria.

The design criteria for the 312 comparable grills was 95,265 cfm. The quantity of air actually measured at the 312 grills was 64,500 cfm (or 67.7% of the design criteria. Assuming that the 45 grills where comparison could not be made also produced air at an average of 67.7% of their capacity, a total of about 68,000 cfm would be supplied to the office.

ASHRAE recommends that at least 20 cfm of fresh, outdoor air per person be supplied to office areas where smoking in allowed. Air supplied to offices is rarely 100% fresh air. Since the energy crisis of the mid-1970s, the percentage of fresh air which is mixed into ventilation systems typically ranges from 25% to 10%. These figures translate to a total air supply for 450 employees of from 36,000 to 90,000 cfm. Assuming that the total quantity of air supplied to the offices from all input grills is about 68,000 cfm, the ASHRAE minimum is supplied for a 25% mix of fresh air into the system, but does not meet the ASHRAE minimum of 90,000 for a 10% mix. The ventilation system appears to have been designed to provide ventilation for about 500 employees.

Apparently, the ventilation system has become unbalanced since 1983, with the result that several areas of the offices, primarily the western (Broadway) side of the 8th and 9th floors, receive an insufficient quantity of fresh air.

VII. CONCLUSIONS

The employees' complaints probably were related to an inadequate supply of fresh air in several areas of the office.

VIII. RECOMMENDATIONS

NIOSH recommends that a ventilation engineer be employed to return the ventilation system to its design criteria.

IX. REFERENCE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE handbook--fundimental. Atlanta, GA: ASHRAE, 1981.

X. ACKNOWLEDGEMENT AND AUTHORSHIP

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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 Road, Springfield, Virginia 22161. Information concerning its availability can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Scholastic, Inc.
2. OSHA, Region II
3. NIOSH, Region II
4. The New York State Department of Health

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SCHOLASTIC, INC
730 Broadway
New York, N.Y.

TABLE I

Summary

COMPARISON OF DESIGN CRITERIA WITH
AIR QUANTITIES MEASURED 9/84

FLOOR	# GRILLS COMPARED	MEASURED CFM	DESIGN CFM	%
8	115	19820	33730	58.8
9	94	12940	26345	49.1
10	103	26610	35190	75.6
Total	312	59370	95265	62.3

TOTAL AIR SUPPLIED
DESIGN REQUIREMENTS

FLOOR	HVAC UNIT	DIFFUSION BOXES	# GRILLS	REQUIRED CFM	
8	5	5	20	7000	
	5A	2	32	7530	
	6	4	30	9690	
	6A	7	39	10480	
9	3	5	25	7045	
6	3A	2	31	6970	
	4	4	31	9940	
	4A*	5	35	4740	(10000 estimate)
10	1	5	21	9120	
	1A**	4	31(33)	8450	
	2	3	28	10170	
	2A	7	32	10100	
TOTAL		53	355(357)	101235	(106490)

* Data on 16 grills are missing from the design criteria for the 1983 survey. It appears that the ventilation systems which supply the rear (east) of the 3 floors and the front of the 10th floor are designed to supply 10,000 CFM each, and that quantity has been estimated.

** Two new grills were installed in system 1A since the 1983 survey.

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SCHOLASTIC, INC
730 Broadway
New York, N.Y.

Appendix

INPUT OF INDIVIDUAL GRILLS

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ1	CFM (2/83)2	CFM (84)3
8	5	1	1-A	200	286	170
			1-1	500	503	360
			1-2	500	503	250
			1-3	500	498	250
			1-4	500	498	270
			1-5	500	492	320
			1-6	500	492	320
		2	2-1	250	242	160
			2-2	250	242	110
			2-3	250	242	110
			2-4	250	242	180
			2-5	150	154	100
			2-6	150	154	80
		3	3-1	350	330	0
			3-2	350	330	0
		4	4-1	300	330	170
		5	5-1	450	450	180
			5-2	450	455	120
			5-3	450	439	180
			5-4	150	154	200
8	5A	1	1-1	450	425	190
			1-2	450	425	180
			1-3	350	308	80
			1-4	350	308	100
			1-5	350	308	100

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
8	5A	2	2-1	250	231	160
			2-2	250	231	150
			2-3	450	424	120
			2-4	450	434	130
			2-5	250	242	50
			2-6	150	154	50
			2-7	250	242	120
			2-8	150	154	0
			2-9	120	132	100
			2-10	250	242	70
			2-11	120	121	70
			2-12	250	242	100
			2-13	250	242	120
			2-14	150	154	50
			2-15	120	110	0
			2-16	150	155	XXX
			2-17	100	110	0
			2-18	150	155	XXX
			2-19	100	110	0
			2-20	150	154	0
			2-21	100	101	XXX
			2-22	400	413	80
			2-23	400	413	100
			2-24	100	101	100
			2-25	120	121	110
			2-26	250	231	180
			2-27	100	110	110
8	6	1	1-1	300	297	50
		2	2-1	300	286	250
			2-2	300	308	300
			2-3	300	308	300
			2-4	300	308	300
		3	3-1	170	176	160
			3-2	170	176	190
			3-3	170	176	180
			3-4	170	176	110
			3-5	170	176	100
			3-6	170	176	320
			3-7	250	242	300
			3-8	250	242	300
			3-9	250	253	100
			3-10	250	253	110

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
8	6	3 (cont.)	3-11	250	253	110
			3-12	250	253	100
			3-13	170	176	100
			3-14	250	242	160
			3-15	250	252	160
8	6	4	4-1	500	503	180
			4-2	500	514	500
			4-3	500	519	320
			4-4	500	519	320
			4-5	500	519	350
			4-6	500	519	310
			4-7	500	519	300
			4-8	500	514	320
			4-9	500	519	440
			4-10	500	519	390
8	6A	1	1-1	400	424	80
		2	2-1	500	503	280
			2-2	400	425	240
			2-3	400	425	270
		3	3-1	250	242	50
			3-2	250	242	110
			3-3	250	231	160
			3-4	250	231	320
			3-5	170	165	190
			3-6	250	242	XXX
			3-7	170	165	320
			3-8	100	110	80
			3-9	250	242	0
			3-10	250	242	100
			3-11	250	231	140
			3-12	250	231	100
			3-13	250	231	110
			3-14	250	231	110
			3-15	250	242	100
		4	4-1	200	209	220
			4-2	200	209	230
			4-3	200	209	290
			4-4	200	211	200
			4-5	170	176	XXX
			4-6	250	264	290
			4-7	150	154	XXX

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]	
8	6A	5	5-1	425	450	300	
			5-2	425	450	350	
			5-3	425	439	100	
			5-4	425	434	120	
			5-5	500	487	200	
			5-6	500	498	170	
	6A	6	6-1	300	301	290	
			6-2	300	301	250	
	6A	0	1	100	265	130	
			2	100	143	0	
			3	100	352	200	
			4	200	209	210	
			5	170	176	230	
9	3	1	1-1	200	209	210	
			1-2	500	508	150	
			1-3	500	514	260	
			1-4	500	519	300	
			1-5	500	503	220	
			1-6	500	503	330	
			1-7	500	503	290	
		2	2-1	260	198	100	
			2-2	180	154	100	
			2-3	70	66	50	
			2-4	160	132	0	(closed)
			2-5	160	132	100	
			2-6	160	136	0	
			2-7	160	132	50	
			2-8	120	99	180	
			2-9	150	132	200	
			2-10	215	154	290	
		3	3-1	350	319	160	
			3-2	350	319	160	
		4	4-1	300	308	190	
		5	5-1	215	220	240	
			5-2	215	220	280	
			5-3	240	242	200	
			5-4	240	262	90	
			5-5	300	275	200	

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
9	3A	1	1-1	550	583	400
			1-2	550	352	220
			1-3	550	352	200
			1-4	550	583	300
			1-5	350	330	130
			1-6	350	330	200
9	3A	2	2-1	260	242	XXX
			2-2	110	116	130
			2-3	350	319	130
			2-4	350	308	80
			2-5	250	242	140
			2-6	250	242	110
			2-7	70	88	70
			2-8	120	132	0
			2-9	100	110	0
			2-10	350	286	80
			2-11	350	286	50
			2-12	150	154	70
			2-13	150	154	50
			2-14	120	121	80
			2-15	180	176	0
			2-16	60	66	0
			2-17	60	66	0
			2-18	60	66	0
			2-19	150	155	XXX
			2-20	60	66	0
			2-21	60	66	0
			2-22	100	110	XXX
			2-23	150	155	XXX
			2-24	110	110	0
			2-25	100	110	0
9	4	1	1-1	300	286	200
			1-2	380	318	0
			1-3	380	424	300
			1-4	380	425	340
		2	2-1	300	286	340
		3	3-1	200	209	150
			3-2	200	209	50
			3-3	200	211	80
			3-4	200	209	XXX
			3-5	200	209	100
			3-6	200	209	XXX
			3-7	200	204	100

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
9	4	3 (cont.)	3-8	200	204	70
			3-9	200	206	0
			3-10	200	202	60
			3-11	200	211	100
			3-12	200	211	100
			3-13	200	209	130
			3-14	200	209	120
			3-15	200	209	130
			3-16	200	209	XXX
9	4	4	4-1	500	503	160
			4-2	500	519	280
			4-3	500	519	100
			4-4	500	514	100
			4-5	500	519	220
			4-6	500	519	220
			4-7	500	519	200
			4-8	500	519	230
			4-9	500	519	230
			4-10	500	519	260
9	4A	1	1-1	300	318	0
		2	2-1	350	286	170
			2-2	350	297	160
			2-3	330	308	180
			2-4	350	286	130
			2-5	350	297	120
			2-6	200	198	XXX
			2-7	200	198	130
			2-8	150	154	50
			2-9	330	286	110
			2-10	330	286	XXX
			2-11	200	198	50
			2-12	100	110	60
			2-13	200	198	100
			2-14	200	198	50
			2-15	200	198	240
			2-16	200	198	230
			2-17	200	198	XXX
			2-18	200	482	XXX
		3	3-1			290
			3-2			270

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ1	CFM (2/83)2	CFM (84)3
9	4A	4	4-1			300
			4-2			120
			4-3			350
			4-4			150
			4-5			250
			4-6			400
			4-7			140
			4-8			300
			4-9			300
9	4A	0	1			320
			2			200
			3			290
			4			70
			5			0
10	1	1	1-1	250	352	130
			1-2	600	625	200
			1-3	600	625	540
			1-4	600	609	190
			1-5	600	609	600
			1-6	600	614	170
			1-7	600	625	230
		2	2-1	300	308	100
			2-2	300	308	100
			2-3	300	308	60
			2-4	300	301	220
			2-5	300	303	230
			2-6	300	303	170
			2-7	120	132	230
			2-8	500	522	XXX
		3	3-1	500	530	440
			3-2	500	530	400
		4	4-1	500	514	680
		5	5-1	400	524	460
			5-2	400	524	430
			5-3	550	430	430

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]	
10	1A	1	1-1	300	198	290	
			1-2	300	198	170	
			1-3	300	176	150	
			1-4	300	176	190	
			1-5	300	176	190	
			1-6	200	154	270	
			1-6A	200	154	170	
			1-7	200	132	250	
			1-8	200	132	230	
			1-9	150	110	220	
			1-10	300	154	220	
			1-11	150	110	0	(closed)
			1-12	150	99	190	
			1-13	150	99	150	
			1-14	100	66	140	
			1-15	100	66	60	
			1-16	500	290	XXX	
			1-17	100	66	XXX	
			1-18	100	66	XXX	
			1-19	150	110	100	
			1-20	100	66	140	
		2	2-1	600	609	310	
			2-2	600	609	700	
			2-3	600	609	450	
			2-4	350	371	500	
			2-5	350	371	320	
			2-6	350	371	440	
			2-7	350	371	420	
			2-8	250	253	240	
			2-9	250	253	100	
		3	3-1	400	408	440	
			3-2	new		400	
		4	4-1	new		680	
10	2	1	1-1	350	371	410	
			1-2	350	371	430	
			1-3	350	371	440	
			1-4	350	371	360	
			1-5	350	371	320	
		2	2-1	250	242	200	
			2-2	250	242	XXX	
			2-3	250	242	240	
			2-4	250	242	160	
			2-5	250	246	190	

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
10	2	2 (cont.)	2-6	250	253	200
			2-7	250	253	200
			2-8	250	253	160
			2-9	120	132	100
			2-10	200	204	180
			2-11	250	253	210
			2-12	250	253	210
			2-13	250	242	210
			2-14	250	242	200
			2-15	300	186	220
10	2	3	3-1	600	583	560
			3-2	600	583	410
			3-3	600	583	620
			3-4	600	609	190
			3-5	600	609	280
			3-6	600	609	580
			3-7	600	609	200 (closed)
			3-8	600	609	500
10	2A	1	1-1	600	620	180
		2	2-1	500	519	240
			2-2	500	519	400
			2-3	500	519	300
		3	3-1	250	242	90
			3-2	250	242	140
			3-3	250	253	170
			3-4	250	253	140
			3-5	250	253	170
			3-6	250	242	50
			3-7	250	242	90
			3-8	250	242	110
			3-9	250	253	XXX
			3-10	250	253	110
		4	4-1	250	242	120
			4-2	250	253	210
			4-3	100	110	100
			4-4	200	209	0 (closed)
			4-5	250	253	150
			4-6	250	253	120
			4-7	130	132	130
			4-8	250	253	140
			4-9	150	158	120
			4-10	170	176	140
			4-11	100	110	140
			4-12	100	110	110

FLOOR	HVAC UNIT	DIFFUSION BOX	INPUT GRILL	CFM REQ[1]	CFM (2/83)[2]	CFM (84)[3]
10	2A	5	5-1	550	583	150
			5-2	550	583	110
		6	6-1	650	662	580
			6-2	650	662	580
		7	7-1	450	477	500
			7-2	450	487	180

XXX = could not measure

1. Quantity of air from design criteria
2. Quantity of air determined by consultant survey (2/83)
3. Quantity of air determined by NIOSH survey (84)