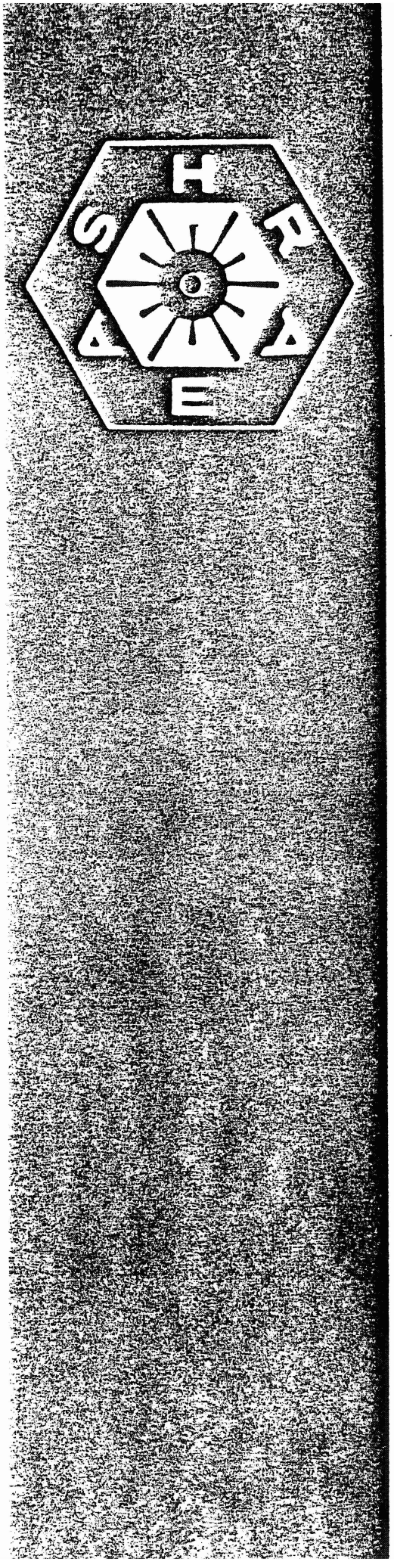

ASHRAE STANDARD

Standards for NATURAL AND MECHANICAL VENTILATION

Approved by the American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Standards Committee January 28, 1973, and Board of Directors by Letter Ballot February 16, 1973.

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FOREWORD

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A representative product sample of the ..... model, has been tested in accordance with ASHRAE Standard 62-73.

CONTENTS

INTRODUCTION

The importance and confusion regarding the need for ventilation standards is evidenced by the existence of such standards in numerous building codes since the early 1900's and, at the same time, the diverse and often conflicting specifications. In 1965, ASHRAE was invited to participate in the revision and updating of ASA Standard A53.1, Light and Ventilation, dated May 23, 1946. Responsibility for the Mechanical Ventilation Section of this Standard was assigned to an ASHRAE Project Committee appointed in 1966. With the reorganization of ASA (now ANSI) and a change in its procedures, the A53 Committee became inactive; at the instructions of the ASHRAE Standards Committee, the Project Committee was advised to continue its efforts and develop an ASHRAE Standard.

To meet its responsibility, the Project Committee undertook an extensive program to obtain input from all segments of industry, the public, and ASHRAE members. A comprehensive review and comparison of ventilation codes was undertaken to aid the Committee in its formulation and standardization of definitions and recommendations. An article in the ASHRAE JOURNAL and a press release to the trade press solicited opinions, comments and suggestions. An open forum was held at the ASHRAE Semi-annual Meeting in Chicago, January 1969. Interest was high and considerable information was obtained for guidance of the Project Committee. Following Project Committee acceptance of the eighth draft, the proposed Standard was submitted to an additional review by ASHRAE members and representatives from industry and government prior to approval by the Standards Committee and ASHRAE's Board of Directors.

The Standard recommends ventilation rates based upon the best available scientific and technical knowledge. It also incorporates, for the first time, a quantitative definition of "acceptable outdoor air" and specifies conditions under which the amount of outdoor air may be reduced, thereby taking advantage of advancements in air cleaning technology.

The Committee wishes to thank all those who submitted comments and suggestions and wishes it to be known that each reviewer's comment received serious consideration and in many cases was incorporated into this final document. Further comments are welcome and should be sent to the ASHRAE Director of Standards.

STANDARDS FOR NATURAL AND MECHANICAL VENTILATION

SECTION 1.0 PURPOSE AND SCOPE

This standard* defines ventilation requirements for spaces intended for human occupancy and specifies minimum and recommended ventilation air quantities for the preservation of the occupants' health, safety, and well-being.

Good ventilation practice exists when clean ventilation air is provided in sufficient quantities to maintain the required oxygen, carbon dioxide, and other air quality levels in the space under consideration.

The standard does not specify the air quantities required for the control of temperature and humidity or the exhaust quantities required for source control of domestic or industrial wastes. The specifications are based on the current state of knowledge and acceptable practice related to air filtration, odor control and environmental physiology.

*Replaces the ventilation section of ASA Standard A53.1 dated May 23, 1946.

SECTION 2.0 DEFINITIONS (SEE FIG. 1)

2.1 **AIR CLEANER:** a device capable of removing airborne impurities such as dusts, gases, vapors, fumes and smokes.

2.2 **AIR CONDITIONING:** the process of treating air to meet the requirements of the conditioned space by controlling simultaneously its temperature, humidity, cleanliness, and distribution.

2.3 **AIR, EXHAUST:** air removed from a space and not reused.

2.4 **AIR, OUTDOOR:** air taken from outdoors and therefore not previously circulated through the system.

2.5 **AIR, RECIRCULATED:** return air again supplied to a space.

2.6 **AIR, RETURN:** air removed from a space and recirculated or exhausted.

2.7 **AIR, SUPPLY:** that air delivered to each or any space in the system, or the total delivered to all spaces in the system, which is used for ventilation, heating, cooling, humidification, dehumidification, distribution, etc.

2.8 **AIR, VENTILATION:** that portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space. (See Section 3.0).

2.9 **EXFILTRATION:** air flow outward through cracks and interstices, around windows and doors, and through floors and walls of a space or building.

2.10 **INFILTRATION:** the inward air leakage through cracks and interstices, around windows and doors, and through floors and walls of a space or building.

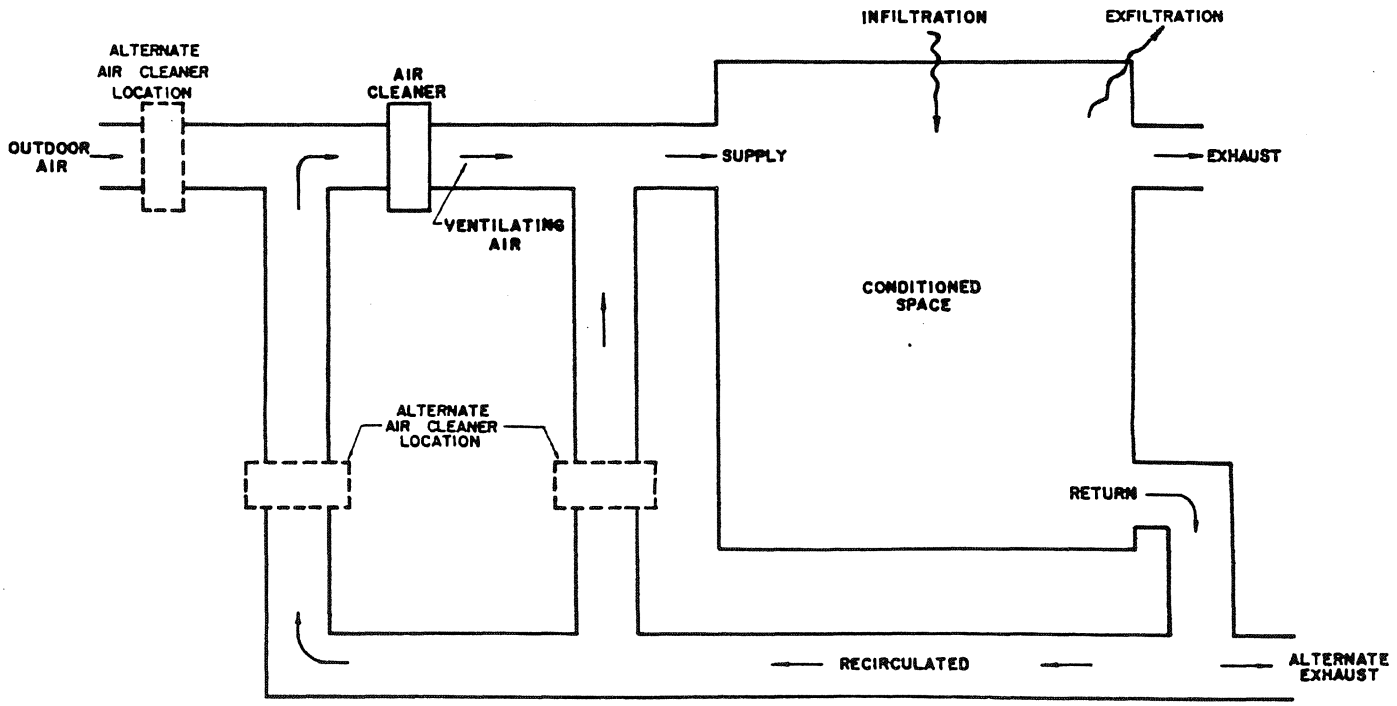

Fig. 1 Diagram of Definitions

2.11 MECHANICAL EXHAUST SYSTEM: a system for removing air from a room or space by mechanical means.

2.12 MECHANICAL SUPPLY SYSTEM: a system for forcing air into a room or space by mechanical means.

2.13 NATURAL VENTILATION: the movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through non-powered ventilators.

2.14 VENTILATION: the process of supplying ventilation air to any space by natural or mechanical means. (Provision must be made for simultaneous removal of air from the space.)

SECTION 3.0. ACCEPTABLE VENTILATION AIR QUALITY (SEE BIBLIOGRAPHY)

3.1 TABLE I lists the maximum allowable pollutant concentrations in ventilation air commensurate with the ventilation requirements set forth in Section 6.0 of this Standard. In addition ventilation air shall conform to the limiting conditions given in Section 3.3.

3.2 OUTDOOR AIR shall be considered of that quality which meets or exceeds the criteria of Table I if one of the following conditions is met:

3.2.1 Monitoring Data of governmental pollution-control agencies such as the National Air Pollution Control Administration show that the air quality of the community in which the ventilation system is located meets the requirements of Table I;

3.2.2 The Community in which the ventilation system is located is similar in population, geographic and meteorological setting and industrial pattern to a community having acceptable air quality as determined in paragraph 3.2.1;

3.2.3 The Community in which the ventilation system is located has a population of less than 20,000 people, and no nearby substantial contamination source;

3.2.4 Air Monitoring, for three consecutive months, as required for inclusion in the NAPCA-SORAD System, shows that the air quality meets the requirements of Table I.

3.3 AIR shall be considered unacceptable for ventilation use in accordance with this standard if it contains any contaminant in a concentration greater than one-tenth the Threshold Limit Value (TLV) currently accepted by the American Conference of Governmental Industrial Hygienists. Where there is reasonable expectation that the air is unacceptable, as indicated above, sampling and analysis shall be carried out by qualified personnel in accordance with procedures and equipment acceptable to the American Conference of

Table I
Maximum Allowable Contaminant Concentrations for Ventilation Air

Contaminant	Annual Average (Arithmetic Mean) $\mu g/m^3$	Short-Term Level (Not to be exceeded More than once a Year) $\mu g/m^3$	Averaging Period (hr)
Particulates	60*	150*	24
Sulfur Oxides	80	400	24
Carbon Monoxide	20,000	30,000	8
Photochemical Oxidant	100	500	1
Hydrocarbons (not including methane)	1,800	4,000	3
Nitrogen Oxides	200	500	24
Odor		Essentially Unobjectionable**	

*Federal criteria for U.S. by 1975.
**Judged unobjectionable by 60% of a panel of 10 untrained subjects.

The levels listed are met by ambient outdoor air in many major cities, or will be met by such outdoor air when passed through minimal air treatment systems (containing suitable combinations of heaters, coolers, humidifiers, etc., and including roughing particulate filters). Conformity of users' local air to these concentrations may be determined by reference to the Storage and Retrieval of Aerometric Data System (SORAD) of the National Air Pollution Control Administration, and by other means, as listed in Section 3.2.

Governmental Industrial Hygienists, the American Industrial Hygiene Association or the Occupational Health Section of the U.S. Public Health Service.

3.4 IF OUTDOOR AIR of the quality specified by Sections 3.1 and 3.3 is not available, filtration or other treatment devices shall be used to bring its quality to or above the minimum level defined by Sections 3.1 and 3.3.

3.5 ACCEPTABLE VENTILATION AIR may contain a mixture of suitably treated recirculated air and outdoor air such that the mixture meets or exceeds the quality limits stated in 3.1 and 3.3 (See Section 5.0).

SECTION 4.0. VENTILATING SYSTEMS— GENERAL REQUIREMENTS

4.1 VENTILATING SYSTEMS shall be provided with adequate openings for supply, return and exhaust air to obtain the required circulation.

4.2 OUTDOOR AIR INLETS shall be located to minimize or eliminate possible contamination.

4.3 EXHAUST DISCHARGES shall be located so that the air exhausted to the outside does not create a nuisance or contaminate outdoor air near outdoor air inlets.

4.4 VENTILATING SYSTEMS shall be designed and installed so that the air coming in contact with occupants is at a temperature, velocity and quality not to constitute a health hazard or discomfort.

4.5 VENTILATING DUCTS shall be constructed entirely of incombustible, nonporous materials. Their construction shall comply with the standards of air conditioning and ventilating systems of the National Fire Protective Association (Pamphlets NFPA No. 90A and NFPA No. 90B).

4.6 OCCUPIED SPACES shall be provided with means of supplying sufficient ventilation air for the maximum number of persons for which such spaces are designed.

4.7 THIS STANDARD assumes that contaminants from concentrated sources which can be a potential hazard or nuisance (heat, smoke, fumes, etc.) are collected as close as possible to the source by exhaust systems separate from the space ventilating system.

4.8 WHEN SPECIAL EXHAUSTS are used (as in the kitchen), consideration must be given to provide adequate supply air to the space to replace the exhaust air.

SECTION 5.0. RECIRCULATION

The requirements for ventilation quantities given in Section 6.0 are for 100% outdoor air when the outdoor air meets the specifications for air quality given in Section 3.0. Except for areas where recirculation is prohibited by other codes or standards having precedence, the outdoor air requirements may be reduced to 33% of the specified required ventilation air quantity if adequate temperature control is provided, in addition to filtering equipment, so that the maximum allowable concentration of particulates entering the space is less than that specified in Table I. If, in addition, high efficient adsorption or other odor and gas removal equipment is employed, so that the air entering the space has been purified to meet the requirements of Sections 3.1 and 3.3, the outdoor air requirement may be reduced to 15% of the specified required ventilation air quantity. *In no case shall the outdoor air quantity be less than 5 cfm per person.*

SECTION 6.0. VENTILATION REQUIREMENTS

The required air quantities are for outdoor air meeting the requirements of Section 3.0 or for a combination of acceptable outdoor air and recirculated air in accordance with Section 5.0. Minimum and recommended values are given to provide different quality levels in recognition of the need to provide choices of environmental performance for different classes of projects. In either case the designer is encouraged to use his experience and judgment in the application of this Standard as long as the minimum requirements are satisfied.

In many cases the required ventilation air quantities for spaces with positive exhaust systems, such as toilets, baths, lobbies, corridors, and kitchens, may be supplied from adjacent spaces. The sum of the ventilation requirements for the space and the adjacent space shall be provided.

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
6.1. RESIDENTIAL (Private dwelling places, single or multiple units)				
Single Unit Dwellings				
General Living Areas, Bedrooms	5	5	7-10	
Kitchens	–	20	30-50	*
Baths, Toilet Rooms	–	20	30-50	*
Basements, Utility Rooms	–	5	5	
Multiple Unit Dwellings				
General Living Areas, Bedrooms	7	5	7-10	
Kitchens	–	20	30-50	*
Baths, Toilet Rooms	–	20	30-50	*
Basements, Utility Rooms	–	5	7-10	
Garages	–	(1.5)	(2.0)-(3.0)	**
Mobile Homes	7	5	7-10	

*Installed capacity for intermittent use.
**cfm per sq ft of floor area.

6.2. COMMERCIAL				
General Requirements–Merchandising (Apply to all forms unless specially noted)				
Sales Floors and Showrooms (Basement and Street Floors)	30	7	10-15	
Sales Floor and Showrooms (Upper Floors)	20	7	10-15	
Storage Areas (Serving Sales Floors and Storerooms)	5	5	7-10	
Dressing Rooms	–	7	10-15	
Malls and Arcades	40	7	10-15	
Shipping and Receiving Areas	10	15	15-20	
Warehouses	5	7	10-15	
Elevators	–	7	10-15	
Food Markets, Supermarkets, etc.				
Meat Processing Rooms	10	5	5	*

*Spaces maintained at low temperatures (−10 to 50 F) are not covered by these requirements unless the occupancy is continuous. Ventilation from adjoining spaces is permissible. When the occupancy is intermittent, infiltration will normally exceed the ventilation requirement. (See Chapter 23, Refrigeration Load, ASHRAE Handbook of Fundamentals, 1972).

Drug Stores				
Pharmacists' Work Rooms	10	20	25-30	
Specialty Shops				
Pet Shops	–	(1.0)	(1.5)-(2.0)	*
Florists	10	5	7	**
Greenhouses	1	5	7-10	**, ***

*cfm per sq ft of floor area
**Maximum allowable concentration (MAC) for sulfur dioxide = 30 μg/cu m
***Ventilation to optimize plant growth, temperature, humidity, etc., will almost always be greater than shown.

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Banks (see sales floors and offices				
Vaults	–	5	5	
Food Services				
Dining Rooms	70	10	15-20	
Kitchens	20	30	35-35	*
Cafeterias, Short-Order, Drive-Ins, Seating Areas, and Queuing Areas	100	30	35-35	
Bars (Predominantly Stand-up)	150	30	40-50	
Cocktail Lounges	100	30	35-40	
*Exhaust to outside; source control as required.				
Hotels, Motels, Resorts				
Bedrooms (Single, Double)	5	7	10-15	
Living Rooms (Suites)	20	10	15-20	
Baths, Toilets (attached to bedrooms)	–	20	30-50	*
Corridors	5	5	7-10	
Lobbies	30	7	10-15	
Conference Rooms (Small)	70	20	25-30	
Assembly Rooms (Large)	140	15	20-25	
Public Rest Rooms	100	15	20-25	
Cottages (treat as single-unit dwellings)	–	–	– –	
(See also Food Services, Industrial, Merchandising, Barber and Beauty Shops, Garages for associated Hotel/Motel Services)				
*Installed capacity for intermittent use.				
Dry Cleaners and Laundries				
Commercial	10	20	25-30	*, **
Storage/Pickup Areas	30	7	10-15	
Coin-operated	20	15	15-20	**
*Exhaust to outside; source control as required. **Installed equipment must incorporate positive exhaust and control (as required) of undesirable contaminants (toxic or otherwise).				
Barber, Beauty and Health Services				
Beauty Shops (Hair dressers)	50	25	30-35	
Reducing Salons (Exercise Rooms)	20	25	30-35	
Sauna Baths and Steam Rooms	–	5	5	
Barber Shops	25	7	10-15	
Photo Studios				
Camera Rooms, Stages	10	5	7-10	*
Darkrooms	10	10	15-20	
*Thermal effects probably determine requirements.				
Shoe Repair Shops (Combined Workrooms/ Trade Areas)	10	10	15-20	

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Garages, Auto Repair Shops, Service Stations				
Parking Garages (enclosed)	–	(1.5)	(2.0)-(3.0)	*
Auto Repair Workrooms (general)	–	(1.5)	(2.0)-(3.0)	*, **
Service Station Offices	20	7	10-15	
*cfm per sq ft of floor area **Stands where engines are run must incorporate systems for positive engine exhaust withdrawal				
Theatres				
Ticket Booths	–	5	7-10	
Lobbies, (Foyers and Lounges)	150	20	25-30	
Auditoriums (in Motion Picture Theatres, Legitimate Theatres, Lecture, Concert and Opera Halls–no smoking)	150	5	5-10	
Auditoriums (smoking permitted)	150	10	10-20	
Stages (with proscenium and curtains)	70	10	12-15	*, **
Green Rooms and Workrooms	20	10	12-15	
Public Rest Rooms	100	15	20-25	
*Thermal effects probably determine requirements **Special ventilation will be needed to eliminate stage effect contaminants				
Ballrooms				
Public	100	15	20-25	
Bowling Alleys (Seating Area)	70	15	20-25	
Gymnasiums and Arenas				
Playing Floors–minimal or no seating	70	20	25-30	
Locker Rooms	20	(30)	(40)-(50)	*
Spectator Areas	150	20	25-30	
Ramps, Foyers, and Lobbies	150	10	15-20	
*cfm/locker				
Pool Rooms	25	20	25-30	
Amusement Parlors	25	20	25-30	
Tennis, Squash, Handball Courts (indoor)	–	20	25-30	
Swimming Pools (indoor)	25	15	20-25	*
*The same for air-supported structures				
Ice-skating and Curling Rinks	70	10	15-20	*
*The same for air-supported structures				
Roller Rinks	70	10	15-20	*
*The same for air-supported structures				

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Transportation				
Waiting Rooms	50	15	20-25	
Garages	–	(1.5)	(2.0)-(3.0)	*
Ticket and Baggage Areas, Corridors and Gate Areas	50	15	20-25	
Control Towers	50	25	30-35	
Hangers	2	10	15-20	**
Public Rest Rooms	100	15	20-25	
Platform	150	10	15-20	
Concourses	150	10	15-20	
Repair Shops	–	10	15-20	
Offices				
General Office Space	10	15	15-25	
Conference Rooms	60	25	30-40	
Drafting Rooms, Art Rooms	20	7	10-15	
Doctor's Consultation Rooms	–	10	15-20	
Waiting Rooms (Doctors, Employment Agencies, etc.)	30	10	15-20	*
Lithographing Rooms	20	7	10-15	*
Diazo Printing Rooms	20	7	10-15	
Computer Rooms	20	5	7-10	
Keypunching Rooms	30	7	10-15	
Public Rest Rooms	100	15	20-25	
Communication				
TV/Radio Broadcasting Booths, Radio Studios	20	30	35-40	*
Motion Picture and TV Stages	20	30	35-40	
Pressrooms	100	15	20-25	
Composing Rooms	30	7	10-15	
Engraving Shops	30	7	10-15	
Telephone Switchboard Rooms (Manual)	50	7	10-15	
Telephone Switchgear Rooms (Automatic)	–	7	10-15	
Teletypewriter/Facsimile Rooms	–	5	7-10	

*cfm per sq ft of floor area

**Special solvent and exhaust problems handled separately

*Installed equipment must incorporate positive exhaust and control (as required) of undesirable contaminants (toxic or otherwise).

*Thermal effects probably determine requirements

6.3. INDUSTRIAL

Occupational safety laws in the various states usually regulate the ventilation requirements. Almost always, these are far in excess of the ventilation requirements for the occupants. The following list gives the requirements for the occupants only, assuming that the ventilation air is of a quality equal to or exceeding the limits listed in Section 3.0.

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Mining and Rock Products*				
Underground Mine Shafts	–	20	25-30	
Underground Mine Faces (non-Toxic Materials)	–	35	40-45	
Underground Mine Faces (Toxic Materials: Beryl, Uranium and other radioactive rocks; radon emanators)		35	40-45	
Underwater Tunneling	–	35	40-45	
Control Cabs for Rock-Handling Machinery	–	20	25-30	
Control Rooms (for Lime and Cement Kilns, Crushers, Tipples, Weighing stations, etc.)		15	20-25	
Stonecutting Rooms	–	36	40-45	
Areas Serving Cement Kilns, Crushers, etc.	–	35	40-45	
*Special contaminant control systems may be required				
Metallurgy*				
Control Rooms	–	15	20-25	
Crane Cabs	–	20	25-30	
Halls Containing Cupolas, Melting Furnaces, Oxygen Furnaces, Pot Lines, etc.	–	35	40-45	
*Special contaminant control systems may be required				
Metalworking and Metal Finishing*				
Foundry Mold, Core Making and Shakeout Areas	–	35	40-45	
Halls Housing Heavy Metalworking, such as Foundry Pouring Rooms, Drop Forges, Scarfing and Rolling Stands, Cast Iron Machining	–	35	40-45	
Halls Housing Medium Metalworking, such as Finish and non-Ferrous Machining, Punch Press and Brake Operations, Spot-welding, Extruding	–	35	40-45	
Gas- and Arc-Welding Booths	–	35	40-45	
Halls Housing Light Metalworking: Appliance, Aircraft, Automotive and Machine Assembly (Excluding 3.3.7)	–	20	25-30	
Automotive Engine Test, Drive-Away Areas in Automotive Assembly Plants	–	–	– –	**
Paint Spray Booths	–	–	– –	**
Pickling, Etching, and Plating Lines	–	–	– –	**

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Degreasing Booths, Steam Cleaning Booths	–	–	– –	**
Sandblasting Booths, Frit Spraying Booths	–	–	–	**
Rooms Serving Porcelain Enamel and Heat-Treating Furnaces	–	–	– –	**
Grinding and Polishing Rooms	–	30	35-40	**
*Special contaminant control systems may be required **Special exhaust systems required				
Chemicals and Pharmaceuticals				
Rooms Containing Grinders, Mullers, Blenders, Pulverizers, Pelletizers Sieving and Other Dusty Operations	–	30	35-40	*
Rooms Containing Reaction Vessels, Stills, Contactors, Extractors, Evaporators and Other Potential Gas Emitters	–	20	25-30	*
Rooms Containing Drying Ovens	–	15	20-25	*
Fermentation Rooms	–	15	20-25	*
Pillmaking and Capsule Filling Booths	–	10	15-20	*
Packaging Areas	–	10	15-20	*
Utility Rooms (Refrigeration Plants, Heating Plants)	–	7	10-15	
Control and Computer Rooms	–	7	10-15	
*Special contaminant control systems may be required				
Textiles, Clothing Manufacture				
Carding Rooms; Nonwoven Fabric Production and Pile Fabric Shearing Areas	–	15	20-25	
Spinning Rooms (Natural and Staple Fibers)	–	15	20-25	
Spinning Rooms (Synthetic Continuous Fiber Production)		15	20-25	
Yarn Rewinding, Warping Rooms	–	15	20-25	
Yarn and Cloth Dyeing and Coating; Cloth Printing Rooms	–	15	20-25	
Weaving and Knitting Rooms	–	15	20-25	
Cutting and Sewing Lofts	–	15	20-25	
Plastics and Rubber Processing*				
Rooms Containing Mixing and Compounding Operations (dry or liquid)	–	15	20-25	
Rooms Housing Thermoplastic Thermosetting Froming Operations (Extrusion, Injection Molding, Bead Molding, Vacuum Forming, etc.)	–	15	20-25	

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Foam-moulding Rooms (especially Urethane)	–	15	20-25	
Glassfiber Reinforced Plastic Layup Rooms	–	15	20-25	
Trimming, Grinding and Polishing Rooms	–	25	30-35	
Vacuum-Coating Rooms	–	15	20-25	
Painting, Printing and Adhesive Assembly Operations	–	15	20-25	
Rubber Calendering Rooms	–	15	20-25	
Moulding, Vulcanizing, Lamination Rooms	–	15	20-25	
*Special contaminant control systems may be required				
Electrical Electronics and Aerospace				
Semiconductor Processing Rooms	–	10	15-20	
Circuit Board Etching, Soldering Rooms	–	20	25-30	
Magnetic Tape Production Areas	–	10	15-20	
Clean Rooms (Class 100)	–	10	15-20	
Clean Rooms (Class 10,000)	–	10	15-20	
Clean Rooms (Class 100,000)	–	10	15-20	
Encapsulation Operations (Plastic, Glass and Ceramics)	–	10	15-20	
Coil Winding Capacitor, Relay and Transformer Manufacturing Areas	–	10	15-20	
Lamp and Tube Manufacture	–	10	15-20	
TV Picture and Image Tube Manufacturing Areas	–	10	15-20	
Magnet, Magnetic Core Manufacturing Areas	–	10	15-20	
Wood Products, Papermaking				
Sawmills, Lumber Planing and Sanding, Wood Turning, Shaping, Drilling and Routing Operations, Veneer Making Areas	–	20	25-30	*
Glueing and Plywood Manufacturing Areas	–	20	25-30	*
Chipboard, Bagasseboard and Hardboard Manufacturing Areas	–	20	25-30	*
Rubbing, Staining, Varnishing and Painting Rooms	–	20	25-30	**
Crate and Pallet Making, Building Prefabrication (Nailing Operations) Areas	–	20	25-30	
Lumber and Panel Warehouses	–	20	25-30	
Chipping, Barking and Grinding Operations Areas	–	20	25-30	*
Pulping Operations, Digesters, Bleachers	–	10	15-20	*

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Papermaking Operations (Beaters, Fourdrinier machiners, dryers, creped wadding machines, calenders)	–	10	15-20	*
Winding, Slitting, Curring, Envelope Making Rooms	–	10	15-20	
Paper Warehouses	–	20	25-30	
Corrugated Board Honeycomb Manufacture, Boxmaking room	–	20	25-30	**
Coating Rooms	–	20	25-30	**
*Special contaminant control systems may be required **Special solvent and exhaust problems handled separately				
Brewing, Distilling, Wineries, Bottling**				
Grain Mixing and Handling Areas	–	20	25-30	*
Yeast Production Areas	–	20	25-30	*
Fermentation Areas	–	20	25-30	*
Distillation Rooms	–	20	25-30	*
Fruit Handling, Crushing Areas	–	20	25-30	*
Caves	–	20	25-30	
Warehouses	–	20	25-30	
Filtration Rooms, Blending Rooms	–	20	25-30	
Bottling Areas	–	20	25-30	
Soft-Drink compounding Areas	–	20	25-30	
Carbonation Areas	–	20	25-30	
*Special solvent and exhaust problems handled separately **Spaces maintained at low temperatures (–10 to 50 F) are not covered by these requirements unless the occupancy is continuous. Ventilation from adjoining spaces is permissible. When the occupancy is intermittent, infiltration will normally exceed the ventilation requirement. (See Chapter 23, Refrigeration Load, ASHRAE Handbook of Fundamentals, 1972).				
Food Processing**				
Fruit and Vegetable Sorting and Cleaning Areas	–	20	25-30	
Cutting, Chopping, Shredding, Crushing, Squeezing Areas	–	20	25-30	*
Canning Operations	–	20	25-30	*
Bakeries, Cereal Processing, Candymaking	–	20	25-30	*
Fish Processing	–	20	25-30	**
Meat Curring, Canning	–	20	25-30	*
Dairies (Fluid Milk Operations)	–	20	25-30	
Cheesemaking, Yogurt	–	20	25-30	
Flour Milling, Bagging, etc.	–	30	35-40	***
Sugar Purification and Salt Purification	–	20	25-30	
Control Rooms for Coffee Roasting, Grinding	–	10	15-20	
Vacuum Drying Operations	–	10	15-20	

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Tea and Spice Handling, Packaging	–	20	25-30	
Packaging	–	20	25-30	
Refrigeration Plants, Steam Plants	–	20	25-30	*

*Thermal effects probably determine requirements
**Special solvent and exhaust problems handled separately
***Special contaminant control systems may be required
****Spaces maintained at low temperatures (−10 to 50 F) are not covered by these requirements unless the occupancy is continuous. Ventilation from adjoining spaces is permissible. When the occupancy is intermittent, infiltration will normally exceed the ventilation requirement. (See Chapter 23, Refrigeration Load, ASHRAE Handbook of Fundamentals, 1972).

Tobacco Processing				
Blending and Shredding	–	20	25-30	
Redrying, Reconstituting	–	20	25-30	
Cigar Manufacturers	–	20	25-30	
Cigarette Manufacturers, Pipe Tobacco Packaging	–	20	25-30	
Power Plants				
Control Rooms	–	10	15-20	
Boiler Rooms	–	35	40-45	
Generator Rooms	–	20	25-30	
Sewage Treatment Plants				
Control Rooms	–	10	15-20	
Compressor/Blower Motor Rooms	–	20	25-30	
Glass and Ceramic Manufacture				
Sand Handling and Mixing Areas	–	20	25-30	
Melting Furnace Support Areas	–	20	25-30	*
Platemaking, Pouring Areas	–	20	25-30	*
Bottlemaking, Blowing Machinery Areas	–	20	25-30	*
Fiber Spinning Areas	–	20	25-30	*
Grinding Rooms	–	20	25-30	**
Ceranics (Powder) Pressing and Molding Areas	–	20	25-30	
Potters Workrooms (wet)	–	20	25-30	
Kiln and Sintering Furnace Service Areas	–	20	25-30	*
Frit and Glaze Sprayrooms	–	20	25-30	**

*Thermal effects probably determine requirements
**Special contaminant control systems may be required

6.4. AGRICULTURAL
(Includes installations on farms, farmers' markets, grain elevators, etc.; for processing operations)

Fodder, Seed and Grain Handling, Storage	–	20	25-30	*

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Animal Husbandry	–	20	25-30	*
Vegetable and Fruit Handling, Storage	–	20	25-30	**
Dairy Products	–	20	25-30	**
Natural Fiber Handling	–	20	25-30	
Tobacco Handling, Warehousing	–	20	25-30	
Mushroom Growing	–	10	15-20	

*Special contaminant control systems may be required
**Spaces maintained at low temperatures (–10 to 50 F) are not covered by these requirements unless the occupancy is continuous. Ventilation from adjoining infiltration will normally exceed the ventilation requirement. (See Chapter 23, Refrigeration Load, ASHRAE Handbook of Fundamentals, 1972).

6.5. INSTITUTIONAL

Schools				
Classrooms	50	10	10-15	
Multiple Use Rooms	70	10	10-15	
Laboratories	30	10	10-15	*
Craft Shops, Vocational Training Shops	30	10	10-15	*
Music, Rehearsal Rooms	70	10	15-20	
Auditoriums	150	5	5-7½	
Gymnasiums	70	20	25-30	
Libraries	20	7	10-12	
Common Rooms, Lounges	70	10	10-15	
Offices	10	7	10-15	
Lavatories	100	15	20-25	
Locker Rooms	20	(30)	(40)-(50)	**
Lunchrooms, Dining Halls	100	10	15-20	
Corridors	50	15	20-25	
Utility Rooms	3	5	7-10	
Dormitory Bedrooms	20	7	10-15	

*Special contaminant control systems may be required
**cfm/locker

Hospitals, Nursing and Convalescent Homes				
Foyers	50	20	25-30	
Hallways	50	20	25-30	
Single, Dual Bedrooms	15	10	15-20	
Wards	20	10	15-20	
Food Service Centers	20	35	35	
Operating Rooms, Delivery Rooms	–	20	– –	*
Ready Rooms, Recovery Rooms	–	15	– –	*
Amphitheatres	100	10	15-20	
Physical Therapy Areas	20	15	20-25	
Autopsy Rooms	10	30	40-50	
Incinerator Service Areas	–	5	7-10	**

For Shops, Restaurants, Utility Rooms, Kitchens, Bathrooms and other service items see Hotels.

*Special requirements or codes may determine requirements
**Special exhaust systems required

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Research Institutes				
Laboratories (Light-duty, nonchemical)	50	15	20-25	*
Laboratories (Chemical)	50	15	20-25	*
Laboratories (Heavy-duty)	50	15	20-25	*
Laboratories (Radioisotope, Chemically and Biologically Toxic)	50	15	20-25	*
Machine Shops	50	15	20-25	
Darkrooms, Spectroscopy Rooms	50	10	15-20	
Animal Rooms	20	40	45-50	**
*Special contaminant control systems may be required **Special requirements or codes may determine requirements				
Military and Naval Installations				
Barracks	20	7	10-15	
Toilets/Washrooms	100	15	20-25	
Shower Rooms	100	10	15-20	
Drill Halls	70	15	20-25	
Ready Rooms, MP Stations	40	7	10-15	
Indoor Target Ranges	70	20	25-30	*
*Floor area behind firing line only				
Museums				
Exhibit Halls	70	7	10-15	
Workrooms	10	10	15-20	
Warehouses	5	5	7-10	
Prisons (See also Gymnasiums, Libraries, Applicable Industrial Areas)				
Cell Blocks	20	7	10-15	
Eating Halls	70	15	20-25	
Guard Stations	40	7	10-15	
Veterinary Hospitals				
Kennels, Stalls	20	25	30-35	*
Operating Rooms	20	25	30-35	*
Reception Rooms	30	10	15-20	
*Special requirements or codes may determine requirements				

6.6. ORGANIZATIONAL

Churches, Temples (See theaters, schools and offices)	–	–	–	
Legislative Halls				
Legislative Chambers	70	20	25-30	
Committee Rooms and Conference Rooms	70	20	25-30	

	Estimated persons/ 1000 sq ft floor area. Use only when design occupancy is not known	Required ventilation air, cubic feet per minute per human occupant, (when the number is bracketed, refer to the notes).		Comments
		Minimum	Recommended	
Foyers, Corridors	50	20	25-30	
Offices	10	10	15-20	
Press Lounges	20	20	25-30	
Press/Radio/TV Booths	20	20	25-30	
Public Rest Rooms	20	15	20-25	
Private Rest Rooms	–	20	30-50	
(For Food Service, Utilities, etc. see Hotels)				
Police and Fire Stations				
(See Prisons and Military Installations)	–	–	–	
Survival Shelters	–	5	–	*

*Special requirements or codes may determine requirements

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