

Chapter Ind 20

DUSTS, FUMES, VAPORS AND GASES

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|------------|--|-----------|---|
| Ind 20.001 | Scope | Ind 20.10 | General exhaust ventilation; hazardous area |
| Ind 20.01 | Definitions | Ind 20.11 | Approval of plans |
| Ind 20.02 | Harmful exposure | Ind 20.12 | Extent of dust, fume, vapor and gas removal |
| Ind 20.03 | General ventilation required | Ind 20.16 | Capacity of local exhaust ventilation systems |
| Ind 20.04 | General ventilation equipment | Ind 20.17 | Hoods at exhaust outlet |
| Ind 20.05 | Exhaust ventilation at source of contamination and make-up air | Ind 20.18 | Ducts |
| Ind 20.06 | Protection from dusty operations | Ind 20.19 | Mechanical equipment |
| Ind 20.07 | Protection from harmful fumes, vapors or gases | Ind 20.20 | Disposal of exhaust material |
| Ind 20.08 | Separation of exhaust systems | Ind 20.21 | Respirators and similar protective devices |
| Ind 20.09 | Protection against interference of exhaust systems | Ind 20.22 | Shop cleaning |
| | | Ind 20.23 | Maintenance and operation of equipment |

Ind 20.001 Scope. (1) The provisions of this code shall apply to all places of employment and public buildings as defined in the statutes.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.01 Definitions. (1) Ventilation is the process of supplying or removing air by natural or mechanical means to or from any space.

(2) A ventilation system is any combination of building construction, machinery, devices or equipment, so proportioned, arranged, installed, operated and maintained as to secure, with normal operation, the standard of ventilation required by this code.

(3) A heating system is any combination of building construction, machinery, devices or equipment, so proportioned, arranged, installed, operated and maintained as to produce and deliver in place the required amount and character of heating service.

(4) A gravity system of ventilation is any ventilation, the practical effectiveness of which depends wholly upon atmospheric conditions, such as relative density, temperature or wind motion.

(5) A mechanical system of ventilation is any ventilation, exhaust or heating system, the effectiveness of which depends upon the operation of power-driven fan equipment.

(6) An exhaust system of ventilation is any combination of building construction, machinery, devices or equipment, so proportioned, arranged, maintained and operated, that dusts, fumes, vapors, gases, vitiated air, or other materials injurious to health, are effectively withdrawn from the breathing zone of employes and frequenters and disposed of in an approved manner.

(7) Air supply is the delivery and distribution of the air required for ventilation.

(8) Outside air is air that is taken from outside the building and is free from contamination of any kind in proportions detrimental to the health or comfort of the persons exposed to it.

(9) The outside air intake includes the ducts and outdoor openings through which outside air is admitted to a ventilation or heating system.

(10) An outlet or supply opening is any opening, the sole purpose of which is to deliver air into any space to provide heating, ventilation or air conditioning.

(11) An exhaust or "return" opening is any opening, the sole purpose of which is to remove air from any space being heated, ventilated or air conditioned.

(12) A duct is any pipe, flue or channel used, or intended to be used, for the conveyance of air, gases or entrained materials pertaining to a heating or a ventilation system. An underground duct is any duct wholly, or in part, below the surface of the ground adjacent to the duct.

(13) A hood is the enlargement of an outlet, shaped and arranged in a manner to direct air motion to, or confine exhaust air currents at, the source of air contamination.

(14) Dust is an air suspension of solid particles of any material.

(15) Fumes are the products of combustion or of chemical action on matter such that it is held in suspension in air.

(16) Vapor is the gaseous form of substances which are normally in solid or liquid state and which can be changed to these states by increasing the pressure or decreasing the temperature.

(17) Gases are normally formless fluids which tend to occupy a space or enclosure completely and uniformly at ordinary temperatures and pressures.

(18) The term "harmful" as applied to the effect of dusts, fumes, vapors or gases means any mechanical or toxic action which in any way injures any part of the body or reduces in efficiency the normal function of any part of the body.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.02 Harmful exposure. Harmful exposure, concentrations that equal or exceed those listed in the most recent list of maximum allowable concentrations (Threshold Limit Values) published by the American Conference of Governmental Industrial Hygienists shall constitute harmful exposures or harmful concentrations.

Note: The American Conference of Governmental Industrial Hygienists is located in the United States Public Health Service Offices, 1014 Broadway, Cincinnati 2, Ohio. Copies of the current "Threshold Limit Values" for 1961 are also on file with the revisor of statutes, the secretary of state, and the industrial commission.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57; r. and recr. Register, October, 1961, No. 70, eff. 11-1-61.

Ind 20.03 General ventilation required. Ventilation shall be provided and maintained for all occupied areas in places of employment as required under section Ind 58.53 of the Heating, Ventilating, and Air Conditioning code issued by the industrial commission.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.04 General ventilation equipment. The nature and control of air supply, and the details of general ventilation equipment installation and maintenance, shall be in conformance with the requirements of sections Ind 58.20 to Ind. 58.75, inclusive, of the Heating, Ventilating and Air Conditioning code issued by the industrial commission, except as otherwise provided in this code.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.05 Exhaust ventilation at source of contamination and make-up air. (1) Exhaust ventilation shall be provided in connection with all equipment and processes which create harmful exposure of

dusts, fumes, vapors or gases (section Ind 20.02) or any dusts, fumes, vapors or gases not listed in section Ind 20.02, which may be injurious to the health of any employes exposed thereto, except as provided in section Ind 20.12.

(2) The exhaust ventilation shall be installed in a manner which will effectively remove the harmful dusts, fumes, vapors and gases at the source to prevent their entrance into the breathing zone of an operator or other person in the vicinity and dispose of them in a manner so that they will not re-enter any occupied area.

(3) Where the volume of air exhausted from any area exceeds 3 air changes per hour, a tempered supply of outside air shall be provided to replace the total volume of air exhausted.

(4) Direct exposure to silica dusts, such as occur in most chipping, grinding, polishing, buffing, cleaning and similar operations, is always hazardous in some degree. The degree of hazard, so far as it can be controlled, depends upon the concentration of fine (less than 10 microns in the longest dimension) silica dust and the length of time a person is exposed to the dust. It is the intent of this code to require the protection of persons exposed to silica dust hazard by the provision of adequate exhaust ventilation at all those operations where it is practical or possible to capture the dust at the source. At those sources of harmful dust where it is definitely impossible or impractical to control the dust, all persons exposed thereto shall be effectively protected by means of approved respiratory protective devices of the positive pressure type. Masks or respirators may be used where approved in writing for specific operations by the industrial commission.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.06 Protection from dusty operations. (1) The required exhaust ventilation for the protection of persons exposed to equipment and processes which create harmful concentrations of dust shall be accomplished by the provision of hoods designed to catch all falling and deflected particles at the source, with duct connections to appropriate exhaust fans or other approved suction devices.

(2) Abrasive blasting rooms shall be totally enclosed, except for air intakes and shall be provided with exhaust ventilation over the entire projected floor area of the room. The operators of the abrasive blasting room shall be provided with personal respiratory protection of the positive pressure type.

Note: See section Ind 20.16 for the capacity of exhaust systems.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.07 Protection from harmful fumes, vapors or gases. (1) The exhaust ventilation for the protection of persons exposed to equipment and processes which create fumes, vapors or gases in harmful proportions shall be accomplished by the provision of appropriate hoods at the source, with duct connections to appropriate exhaust fans or other approved suction devices. The protection provided in any room, pit, vat or tank, or at any equipment or process, such as at machines, vats, tanks, furnaces, forges, salamanders or similar equipment, shall be designed to include all sources of contamination at that apparatus and prevent the flow or drift of generated fumes, vapors or gases away from the exhaust hood.

(2) Unvented gas and oil fired heating apparatus specifically designed to provide temporary heat for construction projects is not sub-

ject to the provisions of Wis. Adm. Code, subsection Ind 20.07 (1) provided such apparatus is so designed, operated and maintained that the concentration of products of combustion in any work area does not exceed the threshold limit values specified in Wis. Adm. Code, section Ind 20.02.

(a) When requested by the industrial commission, manufacturers of such unvented equipment shall supply the industrial commission with data showing the composition and concentration of the combustion gases under operating conditions.

Note: See section Ind 20.16 for the capacity of exhaust systems.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57; am. Register, February, 1964, No. 98, eff. 3-1-64.

Ind 20.08 Separation of exhaust systems. There shall be no connection between exhaust systems or ducts which convey different materials from separate operations, the combination of which may produce explosive, heat generating, corrosive, poisonous or otherwise dangerous mixtures.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.09 Protection against interference of exhaust systems. Where 2 or more local exhaust systems operating at different branch duct velocities are installed in the same room or ventilated area, and any system is adversely affected by this arrangement, tempered outside air, as defined in the Heating, Ventilating and Air Conditioning code, shall be supplied to the room in volume not less than that exhausted under simultaneous operation of all the exhaust systems in the room except where the separate exhaust systems are so arranged that they cannot be operated simultaneously.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.10 General exhaust ventilation; hazardous area. (1) Rooms or areas in which flammable fumes, vapors or gases may accumulate during periods of non-occupancy shall be equipped with a system of ventilation which will remove the fire and explosion hazard and prevent the flow of hazardous material to other rooms or areas.

(2) Where a gravity ventilation system is used, it shall consist of incombustible vent ducts extending from the floor level to well above the high point of the roof and surmounted with an approved siphon type roof ventilator.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.11 Approval of plans. (1) Plans and specifications for exhaust ventilation equipment installed, remodeled or moved under this code shall be submitted to the industrial commission in triplicate for approval before the affected work is commenced, and all work shall be executed according to the approved plans and specifications.

(2) A complete set of plans bearing the stamp of approval shall be kept at the building at all times.

Note: Extra copies of the plans may be filed for the approval stamp, but they should accompany the triplicate plans.

Note: Section 101.10 (12) (13), Wis. Stats. authorizes the commission to fix and collect fees for the approval of plans and provides that no plans shall be approved by the commission until the required fees have been paid.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.12 Extent of dust, fume, vapor and gas removal. (1) The protection required for persons exposed to harmful dusts, fumes, vapors or gases shall be adequate to prevent any dusts, fumes, vapors,

or gases in harmful concentration as specified in section Ind 20.02 from reaching the breathing zone of any such persons.

(2) Where it is impractical to eliminate harmful dusts, fumes, vapors or gases at the source in a manner to protect operators, or other persons in the vicinity, from harm, all persons exposed thereto shall be effectively protected by means of approved respiratory devices of the positive pressure type, except where approved in writing by the industrial commission approved respirators may be used.

(3) Where workmen are exposed to dusts, fumes, vapors or gases, which may irritate or be otherwise harmful, to the eyes, ears, nose, throat or other exposed parts of the body, effective protection against such exposure shall be provided for and used by such workmen.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.16 Capacity of local exhaust ventilation systems. (1) The design and capacity of local exhaust systems shall be such as to insure a volume and velocity of exhaust air at the exhaust opening sufficient to collect dusts, fumes, vapors or gases at their source and carry them to suitable points of disposal.

Note: See section Ind 20.17 for the requirements for hoods.

(2) The capacity of an exhaust ventilation system shall be such that the velocity of air motion will provide a direct moving air screen between the breathing zone of the operator and the source of contamination except as otherwise herein specified, but the volume and velocity shall not be less than the following:

(a) For gases, 60 feet per minute.

(b) For dusts, fumes and vapors as specified in the following sections.

(c) The velocity in the branch ducts shall be measured by a Pitot tube or other approved measuring device. A U-tube may be used where the entrance loss has been established.

Note: Spray coating operations governed by the requirements of the general orders on spray coating issued by the industrial commission are exempt from the provisions of this code.

(3) Exhaust systems for the control of dusts from woodworking operations shall be designed and operated to maintain a velocity of not less than 4000 feet per minute in the branch ducts and not less than 3500 feet per minute in the main ducts. The following table specifies the minimum size and air volume required for branch duct connections for woodworking machines.

(a) *Table—rip, miter and variety saws*

| Saw Diameter | Diameter of Branch Duct | | Exhaust Volume |
|----------------------------------|-------------------------|----------|----------------|
| | Down Run | Up Run | |
| Up to 16 inches ----- | 4 inches | 4 inches | 350 C.F.M. |
| Over 16 to 24 inches ----- | 4½ inches | 4 inches | 440 C.F.M. |
| Over 24 inches ----- | 5 inches | 5 inches | 550 C.F.M. |
| Variety saw with dado head ----- | 5 inches | 5 inches | 550 C.F.M. |

(b) *Band saws*

| Blade Width | Diameter of Branch Duct | | Exhaust Volume | |
|--------------------|-------------------------|----------|----------------|------------|
| | Down Run | Up Run | Down Run | Up Run |
| Up to 2 inches -- | 4 inches | 4 inches | 350 C.F.M. | 350 C.F.M. |
| Over 2 to 3 inches | 5 inches | 4 inches | 550 C.F.M. | 350 C.F.M. |
| Over 3 to 4 inches | 6 inches | 5 inches | 790 C.F.M. | 550 C.F.M. |
| Over 4 to 6 inches | 7 inches | 5 inches | 1070 C.F.M. | 550 C.F.M. |
| Over 6 to 8 inches | 8 inches | 5 inches | 1400 C.F.M. | 550 C.F.M. |

Register July, 1971, No. 187
Dusts, Fumes, Vapors and Gases

(c) *Jointers*

| <i>Knife Size</i> | <i>Diameter of Branch Ducts</i> | | <i>Exhaust Volume</i> |
|----------------------------|---------------------------------|--------|-----------------------|
| | | | |
| Up to 6 inches ----- | 4 | inches | 350 C.F.M. |
| Over 6 to 12 inches ----- | 4½ | inches | 440 C.F.M. |
| Over 12 to 20 inches ----- | 5 | inches | 550 C.F.M. |
| Over 20 inches ----- | 6 | inches | 790 C.F.M. |

(d) *Single Planers*

| <i>Knife Size</i> | <i>Diameter of Branch Ducts</i> | | <i>Exhaust Volume</i> |
|----------------------------|---------------------------------|--------|-----------------------|
| | | | |
| Up to 20 inches ----- | 5 | inches | 550 C.F.M. |
| Over 20 to 26 inches ----- | 6 | inches | 790 C.F.M. |
| Over 26 to 36 inches ----- | 7 | inches | 1070 C.F.M. |
| Over 36 inches ----- | 8 | inches | 1400 C.F.M. |

(e) *Double planers*

| <i>Knife Size</i> | <i>Diameter of Branch Ducts</i> | | | | <i>Exhaust Volume</i> | |
|----------------------------|---------------------------------|---------------|---------------|---------------|-----------------------|---------------|
| | <i>Top</i> | | <i>Bottom</i> | | <i>Top</i> | <i>Bottom</i> |
| | <i>Top</i> | <i>Bottom</i> | <i>Top</i> | <i>Bottom</i> | <i>Top</i> | <i>Bottom</i> |
| Up to 20 inches ----- | 5 inch | 5 inch | 5 inch | 5 inch | 550 C.F.M. | 550 C.F.M. |
| Over 20 to 26 inches ----- | 6 inch | 6 inch | 6 inch | 6 inch | 790 C.F.M. | 550 C.F.M. |
| Over 26 to 36 inches ----- | 7 inch | 6 inch | 6 inch | 6 inch | 1070 C.F.M. | 790 C.F.M. |
| Over 36 inches ----- | 8 inch | 7 inch | 7 inch | 7 inch | 1400 C.F.M. | 1070 C.F.M. |

(f) *Moulders, matchers, sizers and tenoners*

| <i>Size</i> | <i>Diameter of Branch Ducts</i> | | | | <i>Exhaust Volume (CFM)</i> | | | |
|----------------------------|---------------------------------|---------------|---------------|-------------|-----------------------------|---------------|---------------|-------------|
| | <i>Top</i> | | <i>Bottom</i> | | <i>Top</i> | | <i>Bottom</i> | |
| | <i>Top</i> | <i>Bottom</i> | <i>Right</i> | <i>Left</i> | <i>Top</i> | <i>Bottom</i> | <i>Right</i> | <i>Left</i> |
| Up to 7 in. | 5 in. | 4½ in. | 4 in. | 4 in. | 550 | 440 | 350 | 350 |
| Over 7 in. to 12 in. | 6 in. | 5 in. | 4½ in. | 4½ in. | 790 | 550 | 440 | 440 |
| Over 12 in. to 18 in. | 7 in. | 6 in. | 5 in. | 5 in. | 1070 | 790 | 550 | 550 |
| Over 18 in. to 24 in. | 8 in. | 7 in. | 6 in. | 6 in. | 1400 | 1070 | 790 | 790 |
| Over 24 in. | 9 in. | 8 in. | 7 in. | 7 in. | 1770 | 1400 | 1070 | 1070 |

(g) *Disc sanders*

| <i>Size</i> | <i>Diameter of Branch Ducts</i> | <i>Exhaust Volume</i> |
|-----------------------------|---------------------------------|-----------------------|
| Up to 12 inches -- | 4 inches | 350 C.F.M. |
| Over 12 in. to 18 in. ----- | 4½ inches | 440 C.F.M. |
| Over 18 in. to 26 in. ----- | 5 inches | 550 C.F.M. |
| Over 26 in. to 32 in. ----- | 2-4 inches | 350 C.F.M. each |
| Over 32 in. to 38 in. ----- | 1-4 in. and 1-5 in. | 350 C.F.M.-550 C.F.M. |
| Over 38 in. to 48 in. ----- | 1-5 in. and 2-4 in. | 550-350-350 C.F.M. |

(h) *Triple drum sanders*

| <i>Size</i> | <i>Diameter of Branch Ducts</i> | <i>Exhaust Volume</i> |
|-----------------------------|---------------------------------|-----------------------|
| Up to 30 inches long ----- | 7 inches | 1070 C.F.M. |
| Over 30 in. to 36 in. ----- | 8 inches | 1400 C.F.M. |
| Over 36 in. to 42 in. ----- | 9 inches | 1770 C.F.M. |
| Over 42 in. to 48 in. ----- | 10 inches | 2180 C.F.M. |
| Over 48 inches ----- | 11 inches | 2650 C.F.M. |

(i) *Horizontal belt sanders (When bottom run of belt is used)*

| Size | Diameter of Branch Ducts | | Exhaust Volume | |
|----------------------------|--------------------------|--------|----------------|-------------|
| | Top | Bottom | Top | Bottom |
| Up to 6 in. wide ----- | 4 in. | 4½ in. | 350 C.F.M. | 440 C.F.M. |
| Over 6 in. to 9 in. ----- | 4 in. | 5 in. | 350 C.F.M. | 550 C.F.M. |
| Over 9 in. to 14 in. ----- | 4½ in. | 6 in. | 440 C.F.M. | 790 C.F.M. |
| Over 14 inches wide ----- | 5 in. | 7 in. | 550 C.F.M. | 1070 C.F.M. |

(j) *Other woodworking machines*

| | | |
|--|------------------------------|----------------------|
| Sash Sticker --- | 4 inch duct on each head | 350 C.F.M. each head |
| Hogs up to 12 in. wide ----- | 8 inch duct | 1400 C.F.M. |
| Hogs over 12 in. wide ----- | 12 inch duct | 3145 C.F.M. |
| Woodshapers and variety machines ----- | 4½ inch duct on each spindle | 440 C.F.M. |

(4) Exhaust systems for the control of dusts from grinding, buffing and polishing operations shall be designed and operated to maintain a velocity of not less than 4500 feet per minute in the branch ducts and not less than 4000 feet per minute in the main ducts. The following table specifies the minimum size and air volume required for branch duct connections for grinding, buffing, and polishing machines.

(a) *Grinding wheels*

| Wheel Diameter | Wheel Width | Diameter of Branch Ducts | Exhaust Volume |
|-----------------------------|-----------------|--------------------------|----------------|
| Up to 6 in. ----- | Not over 1 in. | 3 inches | 225 C.F.M. |
| Over 6 in. to 9 in. ----- | Not over 1½ in. | 3½ inches | 300 C.F.M. |
| Over 9 in. to 16 in. ----- | Not over 2 in. | 4 inches | 400 C.F.M. |
| Over 16 in. to 19 in. ----- | Not over 3 in. | 4½ inches | 500 C.F.M. |
| Over 19 in. to 24 in. ----- | Not over 4 in. | 5 inches | 610 C.F.M. |
| Over 24 in. to 30 in. ----- | Not over 5 in. | 6 inches | 880 C.F.M. |
| Over 30 in. to 36 in. ----- | Not over 6 in. | 7 inches | 1200 C.F.M. |

(b) *Buffing and polishing wheels*

| Wheel Diameter | Wheel Width | Diameter of Branch Ducts | Exhaust Volume |
|-----------------------------|----------------|--------------------------|----------------|
| Up to 6 in. ----- | Not over 1 in. | 3½ inches | 300 C.F.M. |
| Over 6 in. to 12 in. ----- | Not over 2 in. | 4 inches | 400 C.F.M. |
| Over 12 in. to 16 in. ----- | Not over 3 in. | 4½ inches | 500 C.F.M. |
| Over 16 in. to 20 in. ----- | Not over 4 in. | 5 inches | 610 C.F.M. |
| Over 20 in. to 24 in. ----- | Not over 5 in. | 5½ inches | 740 C.F.M. |
| Over 24 in. to 30 in. ----- | Not over 6 in. | 6 inches | 880 C.F.M. |
| Over 30 in. to 36 in. ----- | Not over 6 in. | 7 inches | 1200 C.F.M. |

(c) *Horizontal single spindle disc grinders*

| Disc Diameter | Diameter of Branch Ducts | Exhaust Volume |
|-----------------------------|--------------------------|----------------|
| Up to 12 inches ----- | 3 inches | 225 C.F.M. |
| Over 12 in. to 19 in. ----- | 4 inches | 400 C.F.M. |
| Over 19 in. to 30 in. ----- | 5 inches | 610 C.F.M. |
| Over 30 in. to 36 in. ----- | 6 inches | 880 C.F.M. |

(d) *Horizontal double spindle disc grinders*
(One branch for 2 discs)

| <i>Disc Diameter</i> | <i>Diameter of Branch Ducts</i> | <i>Exhaust Volume</i> |
|-----------------------------|---------------------------------|-----------------------|
| Up to 20 inches ----- | 5 inches | 610 C.F.M. |
| Over 20 in. to 25 in. ----- | 6 inches | 880 C.F.M. |
| Over 25 in. to 30 in. ----- | 7 inches | 1200 C.F.M. |
| Over 30 in. to 53 in. ----- | 8½ inches | 1770 C.F.M. |
| Over 53 in. to 72 in. ----- | 17 inches | 7050 C.F.M. |

(e) *Vertical spindle disc grinders*

| <i>Disc Diameter</i> | <i>Diameter of Branch Ducts</i> | <i>Exhaust Volume</i> |
|-----------------------------|---------------------------------|-----------------------|
| Up to 20 inches ----- | 4½ inches | 500 C.F.M. |
| Over 20 in. to 30 in. ----- | 2-4 inch | 400 C.F.M. each |
| Over 30 in. to 53 in. ----- | 2-6 inch | 880 C.F.M. each |
| Over 53 in. to 72 in. ----- | 2-8 inch | 1565 C.F.M. each |

(f) *Polishing belts*

| <i>Belt Width</i> | <i>Diameter of Branch Ducts</i> | <i>Exhaust Volume</i> |
|-----------------------------|---------------------------------|-----------------------|
| Up to 3 inches ----- | 3 inches | 220 C.F.M. |
| Over 3 in. to 5 in. ----- | 3½ inches | 300 C.F.M. |
| Over 5 in. to 7 in. ----- | 4 inches | 400 C.F.M. |
| Over 7 in. to 9 in. ----- | 4½ inches | 500 C.F.M. |
| Over 9 in. to 11 in. ----- | 5 inches | 610 C.F.M. |
| Over 11 in. to 13 in. ----- | 5½ inches | 740 C.F.M. |

(5) All swing frame grinders shall be provided with an exhaust system consisting of a booth with the grinder operating in an opening in the face of the booth. When the opening is less than 2 feet in width, the exhaust shall be designed to maintain a face velocity of 200 feet per minute through the opening. When a larger opening is provided, a face velocity of not less than 150 feet per minute will be acceptable.

(a) The exhaust duct shall be connected to the back or top of the booth and the exhaust system shall be designed to maintain a velocity of not less than 3500 feet per minute in the duct.

(6) Exhaust systems for the control of dust from the following operations shall be designed to maintain the air movement or velocities specified in this section.

(a) *Abrasive blasting rooms.* 1. Not less than 80 cubic feet per minute per square foot of floor area of the room for down draft ventilation.

2. Not less than 80 C.F.M. per square foot of cross sectional area for cross draft ventilation.

3. Minimum duct velocity 4500 feet per minute.

4. All air inlets for abrasive blasting rooms shall be properly designed and baffled to provide an inlet velocity of not less than 500 feet per minute.

(b) *Foundry shakeout.* 1. Complete enclosure—200 C.F.M. per square foot of opening but not less than 200 C.F.M. per square foot of grate area.

2. Enclosed on two sides and 1/3 top area. 300 C.F.M. per square foot of grate area.
3. Side hood. 400 C.F.M. per square foot of grate area.
4. Shakeout hoppers shall be exhausted with a quantity of not less than 40 C.F.M. per square foot of grate area.
5. Where the flask size is greater than the shakeout dimension, the hood shall be of sufficient size to enclose the flask with a corresponding increase in air volume.
6. Branch duct velocity 4500 feet per minute.

(c) *Molding sand conveyor systems.* Molding sand conveyor systems shall be provided with an exhaust to remove the dust generated at various points in the system. All such area shall be enclosed with hoods and the hoods shall be exhausted. The exhaust system shall be designed to maintain the following velocities:

1. Branch duct velocity—4500 feet per minute.
2. Conveyor hoods—350 C.F.M. per foot of belt width but not less than 150 C.F.M. per foot of opening.
3. Elevator casing—100 C.F.M. per square foot of casing cross section.
4. Magnetic pulley to elevator boot—500 C.F.M. per foot of belt width.
5. Revolving screen—100 C.F.M. per square foot of screen cross section.
6. Vibrating screen—50 C.F.M. per square foot of screen area, or 150 feet per minute through all openings.

(d) *Mixer and muller.* 1. Complete enclosure—150 feet per minute through all openings.

(e) *Tumbling mills.* Exhaust systems for the removal of dusts from tumbling mill operations shall be designed and operated to maintain a velocity of not less than 4500 feet per minute in the branch ducts. The air volume exhausted from tumbling mills shall not be less than that specified in the following table. Stave type tumbling mills shall be housed in a complete enclosure and exhausted from the enclosure.

AIR VOLUME EXHAUSTED C.F.M.

| <i>Square Mill Side Dimension</i> | <i>Round Mill Inside Diameter</i> | <i>Trunnion Type</i> | <i>Duct Size (Trunnion Type)</i> | <i>Stave Type</i> |
|---------------------------------------|---------------------------------------|----------------------|--|-------------------|
| Up to 24 in. | Up to 24 inches | 430 C.F.M. | 4 inch | 800 C.F.M. |
| Over 24 in. to 30 in. | Over 24 in. to 30 in. | 680 C.F.M. | 5 inch | 900 C.F.M. |
| Over 30 in. to 36 in. | Over 30 in. to 36 in. | 980 C.F.M. | 6 inch | 980 C.F.M. |
| Over 36 in. to 42 in. | Over 36 in. to 42 in. | 1330 C.F.M. | 7 inch | 1330 C.F.M. |
| Over 42 in. to 48 in. | Over 42 in. to 48 in. | 1750 C.F.M. | 8 inch | 1750 C.F.M. |
| Over 48 in. to 54 in. | Over 48 in. to 54 in. | 2200 C.F.M. | 9 inch | 2200 C.F.M. |
| Over 54 in. to 60 in. | Over 54 in. to 60 in. | 2730 C.F.M. | 10 inch | 2730 C.F.M. |
| Over 60 in. to 66 in. | Over 60 in. to 66 in. | 3300 C.F.M. | 11 inch | 3300 C.F.M. |
| Over 66 in. to 72 in. | Over 66 in. to 72 in. | 3920 C.F.M. | 12 inch | 3920 C.F.M. |
| | | 4600 C.F.M. | 13 inch | 4600 C.F.M. |

(7) Exhaust systems for the removal of fumes and vapors from plating, cleaning, and stripping operations shall be designed and operated to maintain a velocity of not less than 2000 feet per minute at the hood slots and in the branch ducts, except for degreasers.

(a) The total volume of air exhausted from each operation shall not be less than the following:

Dusts, Fumes, Vapors and Gases
Register July, 1971, No. 187

VOLUME EXHAUSTED

| <i>Operation</i> | <i>C.F.M. Per Sq. Ft. Tank Area</i> |
|---|---|
| Plating (Chrome, Cyanide Solutions) ----- | 150 |
| Anodizing ----- | 150 |
| Pickling Sulfuric Acid—cold ----- | 150 |
| Pickling Sulfuric Acid—hot ----- | 250 |
| Nitric and Sulfuric Acids ----- | 250 |
| Nitric and Hydrofluoric Acids ----- | 250 |
| Hydrochloric Acid—cold ----- | 150 |
| Hydrochloric Acid—hot ----- | 250 |
| Phosphoric Acid—cold ----- | 150 |
| Phosphoric Acid—hot ----- | 250 |
| Cleaning Caustic or Electrolic (not boiling) ----- | 200 |
| Cleaning Caustic or Electrolic (boiling) ----- | 250 |
| Nitric Acid (strong) ----- | 250 |
| Stripping Concentrated Nitric Acid ----- | 250 |
| Stripping Concentrated Nitric and Sulfuric Acids ----- | 250 |
| Salt Baths Molten Salt ----- | 150 |
| Salt Solution—Phosphating or Similar Operations (not boiling) ----- | 150 |
| Salt Solution—Phosphating or Similar Operations (boiling) ----- | 250 |
| Solvent degreasing tanks ----- | 50 |

(b) Where slot type hoods are used on tanks or vats more than 36 inches in width, a hood shall be provided on each of the long sides of the tank.

(8) Exhaust systems for the removal of fumes from welding operations shall be designed and operated to maintain a duct velocity of not less than 2000 feet per minute in the branch ducts. Where hoods are used, the branch ducts shall not be less than 4 inches in diameter. Where hoods or booths are provided, the air velocity at the point of operation shall not be less than 100 feet per minute in the direction away from the operation and into the face of the hood or booth.

(9) Melting furnaces, ovens or similar equipment shall be provided with hoods or an enclosure connected to an exhaust system. The exhaust system shall be designed to maintain a moving air screen of not less than 100 feet per minute through all openings and at the source of contamination for ferrous materials and at least 200 feet per minute through all openings and at the source of contamination for non-ferrous or toxic materials.

(10) All fans installed in connection with exhaust systems under this code shall have sufficient capacity of simultaneous use of all connecting ducts under normal operating conditions. Where a fan discharge outlet is in a position where it is exposed to wind pressure, the capacity of the fan and motive equipment shall be increased to deliver the full capacity of the exhaust ventilation system against the normal outlet pressure plus a wind pressure equivalent to a ½ inch column of water.

(11) The requirements of this section, Ind 20.16, do not apply to stoves, furnaces and similar enclosed equipment in which the dusts, fumes, vapors and gases are prevented from entering the breathing zone by gravity or other means.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Register July, 1971, No. 137
Dusts, Fumes, Vapors and Gases

Ind 20.17 Hoods at exhaust outlet. (1) Hoods and other exhaust outlet enlargements at the source of dusts, fumes, vapors or gases shall be designed and arranged to draw dusts, fumes, vapors and gases into the exhaust duct, and to catch falling and deflected dust particles, in a manner to prevent the drift or flow of such contamination away from the exhaust outlet. Where manual operations are performed at a source of contamination, such as at grinding, cutting, dressing, cleaning, buffing or polishing wheels or devices, or at machines, vats, tanks, furnaces, forges, salamanders and similar equipment, the hood shall be so arranged as to expose the smallest portion of the working part of the protected machine or equipment consistent with efficient operation.

(2) The hood, connecting ducts and equipment shall be so arranged as to produce a downward draft, upward draft or lateral draft system of ventilation, or a combination of such systems, in a manner to use advantageously the natural falling, rising or floating tendency of the dusts, fumes, vapors and gases at the source of contamination.

(3) Hoods shall be constructed of appropriate sheet metal or other approved incombustible material the thickness of which shall be not less than the gauge thicknesses specified in section Ind 20.18. The free edges of every hood shall be turned back, faced or otherwise guarded in a manner to prevent injury to the workmen.

(4) Where the entrance into the duct of particles or objects causes damage, generates excessive heat or creates other hazards, a substantial screen, suitable trap or other effective device shall be provided in the exhaust outlet at, or near, the junction of the hood and duct.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.18 Ducts. (1) All ducts shall have a smooth, curved interior, as nearly circular as possible. Ducts constructed of sheet metal shall not be lighter than the following U. S. standard gauges:

| <i>Diameter of Duct</i> | <i>Gauge of Metal</i> | | |
|-----------------------------------|-----------------------|-----------------|------------------|
| | <i>Class I</i> | <i>Class II</i> | <i>Class III</i> |
| Not over 6 inches ----- | 26 | 24 | 22 |
| Over 6 inches to 8 inches ----- | 24 | 22 | 20 |
| Over 8 inches to 18 inches ----- | 22 | 20 | 18 |
| Over 18 inches to 30 inches ----- | 20 | 18 | 16 |
| Over 30 inches ----- | 18 | 16 | 14 |

(a) Elbows shall be two gauges heavier than the connecting ducts.

(b) Class I includes non-abrasive applications such as woodworking, pharmaceutical and food products and discharge ducts from dust collectors.

(c) Class II includes abrasive material in light concentrations such as exhaust from foundry shakeouts, sand handling systems, grit blast cabinets, buffing and polishing operations.

(d) Class III includes all abrasive material in heavy concentrations such as exhaust systems from sand and grit blasting, abrasive cleaning operations, rock and ore screening, dryers and kilns, and grinding operations.

(2) Ducts in connection with exhaust systems from corrosive applications shall be constructed of corrosive resistant materials or protected with a coating of non-corrosive material, suitable for the application.

(3) Ducts constructed of material other than sheet metal shall be the equivalent of metal ducts in resisting fire, wear, and interior and exterior pressures.

(4) The inner surfaces of ducts shall be smooth so that dust will not adhere to the sides and the friction loss will be at a minimum. All ducts shall be designed as short and straight as possible. Elbows and bends shall be designed with a mean radius of not less than one and one-half times the diameter of the connecting ducts. Blast gates or orifice plates may be provided for adjustment or balancing the system provided they are riveted or permanently fastened in place to prevent unauthorized persons from tampering with the system.

(5) In sheet metal ducts, straight seams and elbows shall be riveted on 3-inch centers, or welded, in an approved manner; round seams shall be welded, or riveted.

(6) All riveted connections shall be soldered to insure tight joints and seams.

(7) Straight seams in ducts exposed to the weather or moisture shall be on the upper side.

(8) In dust collecting systems, vertical runs of ducts shall be avoided so far as possible but where installed there shall be a clean-out with a tight fitting cover at or near the bottom of the vertical run, so arranged that it may be easily cleaned.

(9) Branch ducts shall enter at the top or side of main ducts and the axis of the branch ducts at the junction with the main duct shall not be below the horizontal. No branch ducts shall enter a main duct at an angle greater than 45 degrees with the axis of the main duct, and no two branch ducts shall be located directly opposite each other.

Note: The smaller the angle of incidence between branch pipe and main duct, the greater the efficiency.

(10) In sheet metal ducts, branch duct connections to main ducts shall be riveted and soldered, or welded, in an approved manner; in ducts of material other than sheet metal, such connection shall be made tight and to resist maximum possible stresses.

(11) Provision shall be made for cleaning all ducts by handholes with tight-fitting cover, takedown construction or other approved means.

(12) Exposed ducts shall be arranged with respect to the walls, floors, ceiling or other structural parts of a building to permit easy access to all parts of the exterior in the removal of all dust which may collect thereon.

Note: Covered hoods may be extended to the floor and arranged to remove sweepings.

(13) For dust collecting systems, the area of any main duct at any section shall be not less than 100% or greater than 115% of the combined area of all branch ducts on the outlet side of such section. Changes in cross sectional area of all ducts shall be by tapering, not abrupt, except in approved junction boxes.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.19 Mechanical equipment. (1) Fans for exhaust ventilation systems shall be of a type and design to comply with the requirements of this code.

(2) Fans used for conveying explosive dusts, fumes, vapors or gases shall have a non-sparking wheel.

Register July, 1971, No. 187
Dusts, Fumes, Vapors and Gases

(3) The fan housing shall be so arranged that it will be accessible for regular cleaning.

(4) The motive power for fans shall be kept out of airways unless of a type which will not obstruct the air motion, gather entrained material, or cause ignition of a dust, fume, vapor, or gas. Where electric motors are installed in airways handling inflammable or explosive mixtures they shall be of the explosion-proof or separately ventilated type.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.20 Disposal of exhaust material. (1) All dusts, fumes, vapors and gases from exhaust systems installed under this code shall be effectively disposed of in a manner to eliminate the health hazards from the occupied areas. Dust collecting systems shall be provided with dust separators, arresters, collectors, or precipitators to separate the dust from the air before the air is discharged from such exhaust system.

(2) All exhaust systems shall discharge to the outside atmosphere.

(3) Where an exhaust system washes, scrubs, or filters the exhaust air such air may be discharged into the building and recirculated provided the amount of contaminant in the exhaust air does not exceed 20% of the maximum concentration specified in section Ind 20.02. Where recirculation of the exhaust air is permitted, dust counts shall be made by the owner at regular intervals to show that the amount of contaminant in the air returned from the exhaust system does not exceed the concentration specified above and a record of such tests shall be kept. This exception applies only to systems handling non-hazardous dusts as distinguished from those that are a health hazard.

(4) Combustible solids or fluids, including gases, unless immediately destroyed, shall be delivered to containers which will effectively isolate the fire and explosion hazard from all occupied areas and structures. Collectors, or settling chambers, for combustible solids or fluids shall not be placed within an occupied building, or at any point where the ignition of the contents will be a direct life or fire hazard unless the collector or settling chamber is housed in a room or enclosure of 2-hour fire resistive construction or better.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.21 Respirators and similar protective devices. (1) Every respirator, mask, helmet or similar protective device used under this code shall be of a type and design approved for the specific use. The degree of efficiency and the period of effectiveness of every such protective device shall be known, and such device shall be used only during the period in which it is capable of removing harmful dusts, fumes, vapors and gases to a degree required to protect the user.

(2) Each type, size and grade of respirator and similar protective device shall be submitted to the industrial commission for approval before being used under this code.

Note: Tests of respirators, masks, helmets, and similar devices by the United States Bureau of Mines will be accepted by the industrial commission.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.

Ind 20.22 Shop cleaning. Where the working conditions are such that harmful dusts may be deposited on the machinery and other equipment, floor, walkways, or other parts of a working area such that the

dusts may be caused to enter the breathing zone of operators, or workmen in the vicinity, the dusts shall be treated to prevent this contamination unless protection is afforded as in section Ind 20.04. The treatment of deposited dusts shall be by daily flushing with water, vacuum cleaning, or sweeping or brushing in a manner to prevent the raising of dust; except that when such cleaning processes are impractical the dusts may be treated with a suitable dampening material.

Ind 20.23 Maintenance and operation of equipment. (1) Every exhaust ventilation system and other protective equipment installed under this code shall be maintained in effective and efficient working order and shall be operated consistently to provide the results required by this code.

(2) All power equipment, ducts, housing and other parts of an exhaust ventilation system shall be kept clean.

History: Cr. Register, April, 1957, No. 16, eff. 5-1-57.