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IND 20.001 - .12

STATE OF WISCONSIN)
) SS.
DEPT. OF INDUSTRIAL COMMISSION)

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Helen E. Gill, Secretary of the Industrial Commission of Wisconsin, and custodian of the official records of said commission, do hereby certify that on December 27, 1956 the Industrial Commission voted to repeal old safety orders 2000 to 2023, inclusive, known as the General Orders on Dusts, Fumes, Vapors and Gases, and adopt new safety orders Ind 20.001 to Ind 20.12, inclusive, and Ind 20.16 to Ind 20.23, inclusive, to be known as General Orders on Dusts, Fumes, Vapors and Gases.

The new orders became effective the first day of the month following their publication in the Wisconsin Administrative Code, namely May 1, 1957.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the department at the Capitol in the City of Madison, this 3rd day of May, A. D., 1 9 5 7.

Helen E. Gill

Wisconsin Administrative Code

Rules of

INDUSTRIAL COMMISSION

DUSTS, FUMES, VAPORS AND GASES

Cite the rules in this Code as

(for example)

Wis. Adm. Code section Ind 20.01

INDUSTRIAL COMMISSION

State Office Building, Madison 2, Wisconsin

Chapter Ind 20

DUSTS, FUMES, VAPORS AND GASES

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. For the purpose of this code, concentrations that equal or exceed the following shall constitute harmful exposures or harmful concentrations.

(1) GASES AND VAPORS

Substance	*Maximum Concentration (Parts of Vapor or Gas Per Million Parts of Air by Volume)*
Acetaldehyde	200
Acetic acid	10
Acetic anhydride	5
Acetone	1,000
Acrolein	0.5
Acrylonitrile	20
Allyl alcohol	5
Allyl propyl disulfide	2
Ammonia	100
Amyl acetate	200
Amyl alcohol (isoamyl alcohol)	100
Aniline	5
Arsine	0.05
Benzene (benzol)	35
Benzyl chloride	1
Bromine	1
Butadiene (1, 3-butadiene)	1,000
Butanone (methyl ethyl ketone)	250

Substance	*Maximum Concentration (Parts of Vapor or Gas Per Million Parts of Air by Volume)*
Butyl acetate (n-butyl acetate)	200
Butyl alcohol (n-butanol)	100
Butylamine	5
Butyl cellosolve (2-butoxyethanol)	200
Carbon dioxide	5,000
Carbon disulfide	20
Carbon monoxide	100
Carbon tetrachloride	25
Cellosolve (2-ethoxyethanol)	200
Cellosolve acetate (2-ethoxyethyl acetate)	100
Chlorine	1
Chlorine trifluoride	0.1
Chlorobenzene (monochlorobenzene)	75
Chloroform (trichloromethane)	100
1-Chloro- 1-nitropropane	20
Chloroprene (2-chloro-1, 3-butadiene)	25
Cresol (all isomers)	5
Cyclohexane	400
Cyclohexanol	100
Cyclohexanone	100
Cyclohexene	400
Cyclopropane	400
Diacetone alcohol (4-hydroxy–4-methyl–2-pentanone)	50
Diborane	0.1
o-Dichlorobenzene	50
Dichlorodifluoromethane	1,000
1, 1-Dichloroethane	100
1, 2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromonofluoromethane	1,000
1, 1-Dichloro-1-nitroethane	10
Dichlorotetrafluoroethane	1,000
Diethylamine	25
Difluorodibromomethane	100
Diisobutyl ketone	50
Dimethylaniline (N-dimethylaniline)	5
Dimethylsulfate	1
Dioxane (diethylene dioxide)	100
Ethyl acetate	400
Ethyl alcohol (ethanol)	1,000
Ethylamine	25
Ethylbenzene	200
Ethyl bromide	200
Ethyl chloride	1,000
Ethyl ether	400
Ethyl formate	100
Ethyl silicate	100
Ethylene Chlorohydrin	5
Ethylenediamine	10
Ethylene dibromide (1, 2-dibromoethane)	25
Ethylene dichloride (1, 2-dichloroethane)	100
Ethylene imine	5
Ethylene oxide	100
Fluorine	0.1
Fluorotrichloromethane	1,000
Formaldehyde	5
Gasoline	500
Heptane (n-heptane)	500
Hexane (n-hexane)	500
Hexanone (methyl butyl ketone)	100
Hexone (methyl isobutyl ketone)	100
Hydrazine	1
Hydrogen bromide	5
Hydrogen chloride	5
Hydrogen cyanide	10
Hydrogen fluoride	3
Hydrogen peroxide, 90%	1
Hydrogen selenide	0.05
Hydrogen sulfide	20
Iodine	0.1

Substance	Maximum Concentration (Parts of Vapor or Gas Per Million Parts of Air by Volume)
Isophorone	25
Isopropylamine	5
Mesityl oxide	50
Methyl acetate	200
Methyl acetylene	1,000
Methyl alcohol (methanol)	200
Methyl bromide	20
Methyl cellosolve (2-methoxy-ethanol)	25
Methyl cellosolve acetate (ethylene glycol monomethyl ether acetate)	25
Methyl chloride	100
Methylal (dimeth-oxymethane)	1,000
Methyl chloroform (1, 1, 1-trichloro-ethane)	500
Methylcyclohexane	500
Methylcyclohexanol	100
Methylcyclohexa-none	100
Methyl formate	100
Methyl isobutyl car-binol (methylamyl alcohol)	25
Methylene chloride (dichloro-methane)	500
Naphtha (coal tar)	200
Naphtha (petro-leum)	500
Nickel carbonyl	0.001
p-Nitroaniline	1
Nitrobenzene	1
Nitroethane	100
Nitrogen dioxide	5
Nitroglycerin	0.5
Nitromethane	100
2-Nitropropane	50
Nitrotoluene	5
Octane	500
Ozone	0.1
Pentane	1,000
Pentanone (Methyl propyl ketone)	200
Perchlorethylene (tetrachloro-ethylene)	200
Phenol	5
Phenylhydrazine	5
Phosgene (carbonyl chloride)	1
Phosphine	0.05
Phosphorus trichlo-ride	0.5
Propyl acetate	200
Propyl alcohol (iso-propyl alcohol)	400
Propyl ether (iso-propyl ether)	500
Propylene dichloride 1,2-dichloropro-pane)	75
Propylene imine	25
Pyridine	10
Quinone	0.1
Stibine	0.1
Stoddard solvent	500
Styrene monomer (phenylethylene)	200
Sulfur dioxide	10
Sulfur hexafluoride	1,000
Sulfur monochloride	1
Sulfur pentafluoride	0.025
p-Tertiarybutyl-toluene	10
1, 1, 2, 2-Tetrachlo-roethane	5
Tetranitromethane	1
Toluene (toluol)	200
o-Toluidine	5
Trichloroethylene	200
Trifluoromonobro-momethane	1,000
Turpentine	100
Vinyl chloride (chloroethylene)	500
Xylene (xylol)	200

(2) TOXIC DUSTS, FUMES, AND MISTS

Substance	*Milligrams of Dust, Fume or Mist Per Cubic Meter of Air*
Aldrin (1, 2, 3, 4, 10, 10—hexachloro-1, 4, 4a, 5, 8a-hexahydro-1, 4, 5,8–dimethanonaphthalene)	0.25
Ammate (ammonium sulfamate)	15
Antimony	0.5
Arsenic	0.5
Barium (soluble compounds)	0.5
Cadmium oxide fume	0.1
Chlordane (1,2,4,5,6, 7,8,8–octachloro-3a,4,7,7a–tetrahydro–4, 7–methanoindane)	2
Chlorinated diphenyl oxide	0.5
Chlorodiphenyl (42% chlorine)	1
Chromic acid and chromates (as CrO_3)	0.1
Crag herbicide (sodium 2–(2,4–dichlorophenoxy) ethanol hydrogen sulfate)	15
Cyanide (as CN)	5
2,4–D (2,4–dichlorophenoxyacetic acid)	10
Dieldrin (1,2,3,4,10, 10–hexachloro–6, 7–epoxy–1,4,4a,5,6, 7,8,8a–octahydro–1,4,5,8–dimethanonaphthalene)	0.25
Dinitrotoluene	1.5
Dinitro-o-cresol	0.2
EPN (O–ethyl O–p–nitrophenyl thionobenzenephosphonate)	0.5
Ferrovanadium dust	1
Fluoride	2.5
Hydroquinone	2
Iron oxide fume	15
Lead	0.15
Lindane (hexachlorocyclohexane, gamma isomer)	0.5
Magnesium oxide fume	15
Malathion (O,O–dimethyl dithiophosphate of diethyl mercaptosuccinate)	15
Manganese	6
Mercury	0.1
Mercury (organic compounds)	0.01
Methoxychlor (2,2–di–p–methoxyphenyl–1,1,1–trichloroethane)	15
Molybdenum (soluble compounds)	5
(insoluble compounds)	15
Parathion, (O,O–diethyl O–p–nitrophenyl thiophosphate)	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
Picric acid	0.1
Selenium compounds (as Se)	0.1
Sodium hydroxide	2
Sulfuric acid	1
TEDP (tetraethyl dithionopyrophosphate)	0.2
TEPP (tetraethyl pyrophosphate)	0.05
Tellurium	0.1
Tetyrl (2,4,6–trinitrophenyl-methylnitramine)	1.5
Titanium dioxide	15
Trichloronaphthalene	5

Substance	Milligrams of Dust, Fume or Mist Per Cubic Meter of Air
Trinitrotoluene	1.5
Uranium (soluble compounds)	0.5
Uranium (insoluble compounds)	0.25
Vanadium (V_2O_5 dust)	0.5
Vanadium (V_2O_5 fume)	0.1
Zinc oxide fumes	15
Zirconium compounds (as Zr)	5

(3) MINERAL DUSTS

Substance	Million Particles (Less Than 10 Microns in Longest Dimension) Per Cubic Foot of Air
Aluminum oxide	50
Asbestos	5
Dust (no free silica)	50
Mica (below 5% free silica)	20
Portland cement	50
Talc	20
Silica high (above 50% free SiO_2)	5
Silica medium (5 to 50% free SiO_2)	20
Silica low (below 5% free SiO_2)	50
Silicon carbide	50
Slate (below 5% free SiO_2)	50
Soapstone (below 5% free SiO_2)	20
Total dust (below 5% free SiO_2)	50

(4) IONIZING RADIATION

Type of Radiation	Permissible Total Weekly Dose For Whole Body Radiation
Gamma Ray	300 milliroentgens per week
X-Ray	300 milliroentgens per week
Beta	300 milliroentgens equivalent man per week

Note: The dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material. For beta radiation, this standard may be assumed to be met if the air dose does not exceed 300 milliroentgens per week.

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

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, Ventilation 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 58.75, inclusive, of the Heating, Ventilation 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 employees 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. 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.

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

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

Ind 20.08 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, Ventilation 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*
Up to 16 inches	4 inches	350 C.F.M.
Over 16 to 24 inches	4½ inches	440 C.F.M.
Over 24 inches	5 inches	550 C.F.M.
Variety saw with dado head	5 inches	550 C.F.M.

(b) *Band saws*

	Diameter of Branch Duct		*Exhaust Volume*	
Blade Width	*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.

(c) *Jointers*

Knife Size	*Diameter of Branch Ducts*	*Exhaust Volume*
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*

Knife Size	*Diameter of Branch Ducts*	*Exhaust Volume*
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*

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

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

Size	*Diameter of Branch Ducts*				*Exhaust Volume* (CFM)			
	Top	*Bottom*	*Right*	*Left*	*Top*	*Bottom*	*Right*	*Left*
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*

Size	*Diameter of Branch Ducts*	*Exhaust Volume*
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*

Size	*Diameter of Branch Ducts*	*Exhaust Volume*
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 Top	Bottom	Exhaust Volume 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)*

Disc Diameter	*Diameter of Branch Ducts*	*Exhaust Volume*
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*

Disc Diameter	*Diameter of Branch Ducts*	*Exhaust Volume*
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*

Belt Width	*Diameter of Branch Ducts*	*Exhaust Volume*
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.

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

VOLUME EXHAUSTED

Operation	*C.F.M. Per Sq. Ft. Tank Area*
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 nonferrous 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.

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:

	Gauge of Metal		
Diameter of Duct	*Class I*	*Class II*	*Class III*
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 resistent 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 maxium 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.

(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 nonhazardous 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.