

STATE OF NEW JERSEY
DEPARTMENT OF LABOR & INDUSTRY
Percy A. Miller, Jr., *Commissioner*

RULES AND REGULATIONS

Governing

LOCAL EXHAUST SYSTEMS

in

Industry

Bureau of Engineering and Safety
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Division of Labor

TRENTON, NEW JERSEY

Effective Date: June 28, 1951

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F O R E W O R D

There is no question or doubt concerning the importance of ventilation and local exhaust systems in industrial health engineering. The object in promulgating rules and regulations of this nature may be stated as twofold. *(1) It is proposed to establish minimum standards by which installations shall be designed and evaluated and, (2) it will provide a basis for maintaining and improving the environment of the worker.*

General acceptance and strict application of any code will ultimately be reflected in multiple advantages to the employee, the employer and the public.

The Bureau of Engineering and Safety of the New Jersey Department of Labor and Industry has initiated these rules in cooperation with the New Jersey Industrial Safety Committee for the benefit of both industry and the industrial worker. The contents are a result of close study, experience and adaptation of nationally recognized codes and publications, other state codes and the review by the Industrial Hygiene Engineering Advisory Committee of the Division of Labor Standards, U. S. Department of Labor of the International Labor Office's proposed Local Exhaust System Code.

Comments and suggestions are urged for presentation to and study by the Rules and Regulations sub-committee of the New Jersey Industrial Committee which group has examined and recommended these rules and regulations for adoption.

These rules supercede and replace the former Engineering Industrial Standards for ventilation, reprint of 1939, which are out of print.

R.S. 34:6-48 Duty of Employer in General:

Every employer, shall, without cost to his employees, provide reasonably effective devices, means and methods to prevent the contraction by them of any illness or disease incident to the work or process in which they are engaged.

R.S. 34:15-31 Willful Self-exposure to Occupational Diseases shall include:

1. Failure or omission to observe such rules and regulations as may be promulgated by the Department of Labor and posted in the plant by the employer, tending to the prevention of occupational diseases.
2. Failure or omission to truthfully state to the best of the employees knowledge, in answer to inquiry, made by the employer, the location, duration and nature of previous employment to the employee in which he was exposed to any occupational disease as herein listed.

R.S. 34:6-58 Maintenance of Blowers:

All employers conducting a manufacturing business and using emery wheels or emery belts of any description, either solid emery, leather, leather covered, felt, canvas, linen, paper, cotton or wheels or belts rolled or coated with emery or corundum or cotton wheels used as buffs, shall provide the same with blowers or similar apparatus so placed as to protect the operators from particles of dust thrown off and to carry such dust directly to the outside of the building or to some receptacle placed to receive and confine such dust.

R.S. 34:1-37 Safety and Sanitation in Industry

The deputy commissioner in charge of the Bureau of Hygiene, Sanitation and Mine Inspection shall perform, under the supervision and control of the Commissioner, the duties devolving upon the department or the Commissioner with relation to the elimination of dust, fumes and excessive heat in industrial operations, the investigation of occupational diseases, the ventilation and sanitation of factories, mills, bakeries, workshops and places where goods are manufactured, the inspection of mines, quarries, tunnels and caissons, the direction of industrial safety education, and, such additional correlated duties as the commissioner shall direct.

R.S. 34:1-20

The Commissioner may make and publish rules and regulations not inconsistent with law as he shall deem necessary to enforce the provisions of this title.

Whenever any condition is found to exist in contravention of any provision of this title, the Commissioner may by written order signed by him specifying the things to be done and the time for compliance, require such conditions to be corrected.

R.S. 34:6-61

The owner, agent or lessee of any factory, workshop, mill or place where the manufacture of goods is carried on shall provide in each workroom proper and sufficient ventilation and means of ventilation which shall so far as practicable render harmless any excessive heat, and any steam, gases, vapors, dust or other impurities injurious to health that may be generated in any manufacturing process.

In the event of insufficient ventilation, the Commissioner shall order adequate means of ventilation to be provided. Whenever dust, gas, vapors or other impurities are generated by any process in such manner as to be inhaled by employees to an injurious extent and it appears to the Commissioner that such conditions could be substantially improved by a fan or other mechanical means he may order the installation of such fan or mechanical means of proper construction.

Any owner, agent or lessee failing to comply with an order of the Commissioner, shall be subject to a penalty of ten dollars (\$10.00) for each day such failure continues after the expiration of twenty (20) days from the day of service of the written order on him.

R.S. 34:6-1 Fire escapes; fire protection:

Every factory, workshop, mill or place where the manufacture of goods of any kind is carried on shall under the supervision and direction of the Commissioner be provided with ample and proper ways and means of egress or escape in emergency arising from fire or otherwise, sufficient for the use of all persons therein, and as well shall be protected, so far as practicable, against the origin and spread of fire.

R.S. 34:6-141 Owner to register before commencing business:

Every person engaging in any productive industry within the supervision of the department, as a factory, workshop, mill, newspaper plant, printery, or commercial laundry shall register the same with the Commissioner before the commencement of business, giving the legal name, home address, the nature of the business, the maximum number of persons to be employed, and such other data as the Commissioner may require.

S E C T I O N 1 - Purpose and Scope

1.1 Purpose:

It is the purpose of these rules to provide minimum standards of performance, workmanship and material; and to provide for standard safeguards and safe practice in the operation and maintenance of dust, gas, vapor, mist and fume removal systems.

1.2 Scope:

These rules shall apply to every industrial or registered business establishment engaged in operations creating dust, gas or fume, the control of which is herein specified.

S E C T I O N 2 - Definitions

2.1 General Definitions

- 2.1.1 *Approved*: shall mean approved by the Commissioner of Labor and Industry or his authorized representative.
- 2.1.2 *Commissioner*: shall mean the Commissioner of Labor and Industry of the New Jersey Department of Labor and Industry or his authorized representative.
- 2.1.3 *Department*: shall mean the New Jersey Department of Labor and Industry.
- 2.1.4 *Division*: shall mean the Division of Labor of the Department.
- 2.1.5 *Bureau*: shall mean the Bureau of Engineering and Safety of the Division.
- 2.1.6 *Deputy Director*: shall mean the deputy director in charge of the Bureau.
- 2.1.7 *Place of Employment*: every factory, workshop, mill or other place where goods are manufactured; laundry, bakery, confectionery, newspaper plant, printery, mine, quarry; and mercantile establishments.
- 2.1.8 *Registered*: shall mean every person or firm listed with the Department in accordance with R. S. 34:6-141.
- 2.1.9 *Effective date*: the date indicated on the cover on which these rules and regulations become effective.
- 2.1.10 *Rules*: shall mean rules and regulations.
- 2.1.11 *Existing*: installed or operated before the effective date and including work for which plans have been approved prior to the effective date.
- 2.1.12 *Shall*: where used, shall mean a mandatory requirement.
- 2.1.13 *Should*: shall mean an advisory or recommended practice recognized as satisfactory to the Department.
- 2.1.14 *Singular - Plural*: the singular shall mean the plural and the plural the singular.
- 2.1.15 *Adequately, effective, securely*: shall mean satisfactory conditions subject to determination by the Commissioner.
- 2.1.16 *Substantial*: shall mean construction of such strength and workmanship that the assembly shall under normal or reasonably foreseen conditions or circumstances resist usage, wear, shock and deterioration.

2.2 Special Definitions

- 2.2.1 *Exhaust System*: shall mean a system of mechanical ventilation or other air-flow producing equipment for the removal of dusts, fibres, fumes, gases, mists, vapors or refuse, including all hoods, ducts, exhausters, air cleaning equipment and receptacles when required, and any other part necessary for the proper installation and operation of the system, but does not include any part of the building structure.
- 2.2.2 *Hood*: shall mean the total or partial enclosure forming that part of an exhaust system which is nearest to the point of origin or liberation of the atmospheric contaminant or the refuse and through which air enters the system during operation.
 - 2.2.2.1 *Enclosing Hood*: shall mean one which (a) projects over the entire operation, (b) is fixed in position in such a location that the head of the workman in all his normal operating positions while working is in front of all hood openings and (c) is completely enclosed on at least two sides.
 - 2.2.2.2 *Canopy Hood*: shall mean a hood which projects over the entire operation and which does not conform to Section 2.2.2.1.

- 2.2.2.3 *Lateral Exhaust Hood*: shall mean a hood which does not project over an operation, and in which the direction of air movement into the hood or hoods is substantially horizontal.
- 2.2.3 *Duct*: shall mean piping, conduit tunnel or passage forming part of an exhaust system.
- 2.2.4 *Branch Duct*: shall mean a duct or pipe connected directly to the hood or to a main duct.
- 2.2.5 *Main Duct*: shall mean a duct or pipe to which one or more branch ducts are connected, and which connects such branch ducts to the remainder of an exhaust system.
- 2.2.6 *Exhauster*: shall mean the exhaust fan or other air flow producing equipment which serves to move the air through an exhaust system, including its source of motive power.
- 2.2.7 *Air Cleaning Equipment*: shall mean that part of an exhaust system in which part of the atmospheric contaminants collected by the system are removed from the air stream before it is expelled through the discharge duct, and includes settling chambers, cyclone separators, screens, cloth filters, oil and water air washers, electrostatic precipitators, centrifugal separators and fan type collectors, and any other approved type of air cleaning equipment.
- 2.2.8 *Refuse Receptacle*: shall mean a box, chamber, vault or tank into which the dust or other refuse from the air cleaning equipment is deposited.
- 2.2.9 *Fire Wall*: shall mean a fire resistant wall which sub-divides a building or separates buildings to restrict the spread of fire and which starts at the foundation and extends continuously through all stories to and above the roof.
- 2.2.10 *Pitot Tube*: shall mean a velocity pressure indicating instrument consisting of an impact tube with an outer or static pressure tube connected to a manometer gauge.
- 2.2.11 *Abbreviations*:
- FPM - feet per minute
 - CFM - cubic feet per minute
 - Ft. - feet
 - In. - inches
 - Dia. - diameter
 - PPM - parts per million
 - Ug. - micrograms
- 2.2.12 *Hazard Potential*: shall be on index, on a scale of from A to C inclusive of the severity of the hazard associated with a substance because of the toxic or explosive nature of the vapor, gas, or mist produced therefrom.
- 2.2.13 *Rate of Gas, Vapor, or Mist Evolution*: shall be a numerical index, on a scale of from 1 to 4, inclusive, both of the relative capacity of the substance or operation to produce gas, vapor, or mist and the relative energy with which it is projected or carried from the point of generation.

S E C T I O N 3 - Compliance

- 3.1 Compliance with the requirements of these regulations shall be necessary in all places of employment as set forth in the scope article 1.2.
- 3.2 In cases of practical difficulty or unnecessary hardship, the commissioner may grant exceptions from these rules provided that a request for such exception has been made in writing to the Deputy Director. Exceptions can only be granted when it is clearly evident that a satisfactory, safe and sanitary condition is attained but cannot be granted in any case where conflict would be created with mandatory requirements of the law.

S E C T I O N 4 - Requirements for Exhaust Systems

4.1 General Requirements and Minimum Standard Design Data

- 4.1.1 In order to permit the use of the shortest lengths of ducts and the least number of bends and to ensure proper proportioning of air flow from the various hoods, processes to be connected to the same exhaust system should be located close together wherever possible.
- 4.1.2 Processes generating or liberating different kinds of dusts, gases, mists, fumes, or vapors which might combine into explosive or flammable products or compounds shall not be connected to the same exhaust systems.
- 4.1.3 The capacity of exhaust systems shall be calculated on the assumption that all hoods connected to the system are open, except where the system is so interlocked that only a portion or the parts of it can be operated at a given time, in which case the capacity shall be calculated on the basis that all the hoods in the group requiring the greatest volume of exhaust are open.
- 4.1.4 All parts of exhaust systems shall be as free as possible from air leakage either into or out of the system except at points where air is taken into or discharged from the system by design, and the interior of all parts shall be smooth and free of obstructions.

- 4.1.5 All metal parts of exhaust systems shall be effectively grounded.
- 4.1.6 Exhaust systems shall be kept in operation whenever any machine connected to them is in use.
- 4.1.7 Hoods, ducts and other parts of exhaust systems subject to contact with corrosive gases shall be:
- constructed of corrosion-resisting materials; or*
 - coated, inside with asphalt, rubber, bitumastic paint or other corrosion resisting substances.*
- 4.1.8 Workrooms equipped with exhaust systems shall be provided with clean or fresh air sufficient to replace the air removed by the systems so that the workers are not subjected to draughts of air:
- having a temperature more than 10° F. below the general temperature of the room; or*
 - exceeding the following velocities.*

Distance of Air Inlet Above Floor Level	Maximum Permissible Inlet Velocity
(Feet)	(Feet per minute)
<i>Less than 8</i>	<i>120</i>
<i>8 - 12</i>	<i>250</i>
<i>12 - 18</i>	<i>500</i>
<i>More than 18</i>	<i>1000</i>

- 4.1.9 Suction hoods for exhaust systems shall be so designed and located as to provide the necessary air velocity with the smallest possible volume of air flowing into the hood, either by enclosing the process as much as possible or, where it cannot be enclosed, by -
- placing the hood with the opening as close as practicable to the source of contamination;*
 - shaping the hood to conform to the area of contamination;*
 - providing flanges, vanes or baffles if necessary, and*
 - locating the hood opening or part of it, so that the dusts, fibres, fumes, gases, mists, vapors or refuse will fall, be projected or be drawn into the hood in the direction of air flow.*
- 4.1.10 The following air velocities shall be attained for capture of dusts, fumes and vapors released in certain processes.

Conditions of Generation of Contaminant	Minimum Air Velocity	Typical Processes*
<i>1. Released without noticeable air movement</i>	<i>50 F.P.M.</i>	<i>Evaporation of liquids</i>
<i>2. Released with low air velocity</i>	<i>100-200 F.P.M.</i>	<i>Paint Spraying in booths, dumping dust into hopper</i>
<i>3. Active Generation</i>	<i>200-500 F.P.M.</i>	<i>Stone cutting, mixes barrel filling, conveyors</i>
<i>4. Released with great force</i>	<i>500-2000 F.P.M. and higher</i>	<i>Grinding, heavy crushing</i>

- 4.1.11 Provision shall be made to eliminate or control cross currents or other air movement which would interfere with the control air currents created by the hood and render the exhaust system ineffective.
- 4.1.12 Where hoppers troughs or other receptacles beneath work tables, work benches or floors, serve as suction hoods for downward exhaust of metal or mineral particles or of fumes, gases, vapors, etc., the connection with the branch duct shall be made at the side of the hood and the bottom utilized for trapping the larger particles.
- 4.1.13 Suction hoods for exhaust systems shall be free from sharp edges and rough burrs, and suitably reinforced when necessary.
- 4.1.14 Adjustable hoods on exhaust systems shall be provided with convenient and rapid action adjusting devices.
- 4.1.15 Where a duct system is used for removal of flammable dusts, fibres, fumes, gases, mists, vapors or refuse this system shall be self contained, and no room or other portion of a factory building shall be used as an integral part of the system unless it is of non-combustible construction and used for no other purposes.
- 4.1.16 The area of the main duct in an exhaust system shall be in reasonable proportion with the combined areas of the branch ducts joining it, taking into account acceptable differences in air-flow velocities and duct resistance allowances. Ducts may be sized for constant resistance and based on such publications as the Duct Resistance Chart published by the American Society Heating and Ventilating Engineering Standard.
- 4.1.17 Exhaust ducts for removal of flammable fumes, gases, mists, vapors and residues shall lead to the outside of the building as directly as possible, and not through intermediate rooms unless this is unavoidable and approved.

* IN ANY CASE THE MINIMUM AIR VELOCITY SHALL BE SUFFICIENT TO REDUCE THE CONCENTRATION OF VAPORS, MISTS, ETC. BELOW THE APPROVED MAXIMUM ALLOWABLE CONCENTRATION LIMIT AS SET FORTH IN THE MAXIMUM ALLOWABLE CONCENTRATION CODE.

- 4.1.18 The following transport velocities are recommended for conveying dusts, fumes and vapors released in manufacturing processes, but in all cases the velocity shall be adequate to prevent settlement of material.

Material Conveyed	Design Velocity*
1. Vapors & gases, fumes, very light dusts	2000 f.p.m.
2. Medium density, dry, dusts	3000 f.p.m.
3. Average industrial dusts	4000 f.p.m.
4. Heavy materials	5000 f.p.m.
5. Large particles, high density loads, moist materials	5000 f.p.m. and over

*(Refer to Department rules governing specific requirements)

- 4.1.19 Ducts shall be so located as to require minimum length of duct and a minimum number of bends or elbows.
- 4.1.20 Ducts shall be constructed entirely of materials of adequate strength and thickness to meet the conditions of services and minimize damage due to accidental contact. (See 4.2)
- 4.1.21 Ducts shall be installed as to
- be readily accessible for inspection, cleaning and repairs;
 - provide proper drainage of condensation;
 - avoid interference with the operation of cranes, elevators, trucks, etc.
- 4.1.22 Where possible ducts shall be placed so that no part is less than six (6) inches above the floor or six (6) inches below the ceiling.
- 4.1.23 All reinforcing of ducts shall be done on the outside of the duct.
- 4.1.24 Dampers, gates or orifice plates used for the purpose of balancing air flow in an exhaust system shall be rivetted or otherwise permanently fastened.
- 4.1.25 Ducts shall be kept open and unobstructed throughout their length.
- 4.1.26 Ducts shall have no openings other than those required for the proper operation and maintenance of the system.
- 4.1.27 The inside diameter of any duct or elbow connected to the collars on suction hoods shall be full branch-duct size and the collars on the hoods shall fit tightly into such connecting ducts or elbows without clearance.
- 4.1.28 Where it is necessary to pass exhaust ducts or their inlets or outlets through a fire wall, an automatic fire door or shutter shall be provided on each side of the wall.
- 4.1.29 Where exhaust ducts pass through floors, partitions, walls, ceilings or roofs, the space around the duct shall be sealed with asbestos, mineral wool or other non-combustible material, to prevent the passage of flame or smoke.
- 4.1.30 Exhaust systems for removal of combustible refuse or stock of an explosive nature shall be provided with safety relief vents. (See Section 2)
- 4.1.31 Motors employed in exhaust systems shall be of a type designed and constructed for the particular conditions or hazards, or shall be located outside rooms in which flammable dusts, vapors, etc. are being generated or removed.
- 4.1.32 Where highly flammable materials or vapors are passed through fans, the entire wheel of the fan or casing shall be of non-ferrous material.
- 4.1.33 Where conditions permit, fans shall be located on the clean air side of the separator equipment, particularly where abrasive dust, explosive material or harmful gases are exhausted.

4.2 Minimum Standard Specifications for Construction and Installation of Exhaust Systems.

- 4.2.1 Materials shall be galvanized sheet metal or other material of equivalent strength or suitability. Flexible rubber, metal or composition hose of a substantial character may be used for connections between hoods and piping where movement of the hood is required.
- 4.2.2 Ducts shall be so constructed as to provide structural strength and stability at least equivalent to sheet steel of not less than the following thickness:

Diameter	U. S. Gauge for		U. S. Gauge for Fumes, Vapors, Gases
	Non Abrasive Materials	Abrasive Dusts	
8 inches or less	24	20	24
9 in. to 18 in.	22	18	22
19 in. to 30 in.	20	16	20
Over 30	18	14	18

- 4.2.3 All elbows, bends and fittings shall be two gauges heavier than runs of corresponding diameter.

- 4.2.4 All elbows should be made by rolling on a radius of not less than 2 times the diameter of the elbow. No internal crimped edges shall be used. Rectangular elbows or bends, venturi shaped elbows or other bends of low resistance design may be used in place of the long radius elbow.
- 4.2.5 All joints shall have at least a one inch (1 in.) lap placed in the direction of air flow. All joints and seams shall be soldered, welded, rivetted or otherwise be rigidly connected and made air tight. All straight seams shall be rivetted with tinned rivets placed on not more than 3 inch centers unless welded or made by means of a groove or lock seam.
- 4.2.6 All pipe collars and branch pipes shall enter the main pipes at an angle not exceeding 45 degrees. Not more than one (1) branch pipe shall enter the main pipe at the same point.
- 4.2.7 All telescopic slip joints shall be two (2) gauges heavier than the outside pipes, and provided with a fastener to hold same in position. The inside pipe shall extend into the outside pipe at least one duct diameter and not less than six (6) inches when the joint is fully extended.
- 4.2.8 At the point where the piping connects with the suction side of the exhaust fan, there shall be a detachable sleeve at least 18 inches or one pipe diameter in length.
- 4.2.9 All piping shall be braced and supported in a substantial manner, at least every ten (10) feet. Horizontal runs must not sag and vertical runs shall not be subject to lateral movement.
- 4.2.10 Dust separators shall be set in structural steel frames on substantial foundations and all connecting piping suspended or supported with substantial braces.
- 4.2.11 Clean out openings should be in the lower side of the pipe and of sufficient size to permit ready access to the interior. They shall be equipped with tight fitting sliding or swinging doors or lids with latches. They should be located at the bottom of all vertical runs of pipe and shall not exceed twenty foot (20 ft.) intervals in horizontal runs or wherever settlement is likely to occur.
- 4.2.12 Chip traps may be installed in the exhaust pipe to collect large particles of material provided the trap discharges into an enclosed container from which the material shall be readily removable for disposal.
- 4.2.13 The length of transition pieces should be six (6) times the diameter of the transition inlet pipe and should maintain a straight run on the bottom of all horizontal ducts.
- 4.2.14 Main ducts should be blanked off at the tail end with removable caps and the last branch connections should be not more than one (1) diameter from the capped end.

SECTION 5 - Requirements for Grinding, Polishing and Buffing Equipment

- 5.0 General - Minimum branch duct velocities for metal grinding, polishing and buffing equipment shall be 4500 F.P.M. unless otherwise noted.
- 5.1 Exhaust outlets of suction hoods for abrasive grinding cut off buffing and polishing wheels and for scratch brush wheels over six (6) inches in diameter on floor stands, pedestals, benches or special purpose grinding machines and for cutting off wheels, and the branch ducts connected to the hoods, shall have not less than the following inside diameters and air quantities.

Diameter of Wheel

Type 1 - Abrasive Grinding, Surface Grinding & Cut Off	Maximum Thickness (Inches)		Min. Dia. Branch Duct (in.)		Min. Air Quant. CFM	
Type 11 - Buffing, Polishing, Scratch	1	11	1	11	1	11
Under 9 inches	1½	2	3	3½	221	300
9 to 16	2	3	4	4½	392	497
17 to 19	3	4	4½	5	497	614
20 to 24	4	5	5	5½	614	742
25 to 30	5	6	6	6½	885	1035
31 to 36	6	-	7	-	1200	-

- 5.2 Where wheels used for grinding, polishing, buffing or scratch grinding exceed the thickness for the corresponding diameters specified in Sec. 5.1 above, the minimum inside diameter of the hood outlet and the branch duct connected to the hood shall be increased 0.3 inches for each 1 inch increase in wheel thickness, provided that the increase shall be such as to bring the diameter at least up to the next higher diameter in such section.
- 5.3 Suction hoods for horizontal disc grinders shall be connected to one or more branch ducts of the following minimum inside diameters:

Maximum Diameter (Disc) and type of machine Minimum Number of Branch Duct Minimum Diameter of each Duct (Inches) Minimum Air Quantities CFM per Duct

Single-Spindle Horizontal Disc Grinder

Up to 12 in. incl.	1	3	221
13 in. to 19 in. incl.	1	4	392
20 in. to 30 in.	1	5	614
31 in. to 36 in.	1	6	885

Maximum Diameter (Disc) and type of machine Minimum number of Branch Duct Minimum Diameter of each Duct (Inches) Minimum Air Quantities CFM per Duct

Double Spindle Horizontal Disc Grinders

Up to 19 in. incl.	1	5	614
20 in. to 25 in. incl.	1	6	885
26 in. to 30 in. incl.	1	7	1200
31 in. to 53 in. incl.	2	6	885
54 in. to 72 in. incl.	4	8	1570

- 5.4 Suction hoods for vertical disc grinders shall be connected to one or more branch ducts of the following inside diameters.

Maximum Diameter of Disc

Type 1 Where one-half or more of the top of the disc is covered	Minimum Number of Branch Ducts		Minimum Dia. of Each Branch Duct		Minimum Air CFM-duct Quantities	
Type 11 Where less than one-half of the top of the disc is covered	Type 1	Type 11	Type 1	Type 11	Type 1	Type 11
Up to 20 in. incl.	1	2	4½	4	497	392
21 in. to 30 in. incl.	2	2	4	5½	392	742
31 in. to 53 in. incl.	2	4	6	6	885	885
54 in. to 72 in. incl.	2	5	8	7	1570	1200

- 5.5 Suction hoods for belt grinders shall be connected to branch ducts of a minimum inside diameter of 3 inches for belts up to 3 inches in width and increased ¼ inch for each 2 inches or fraction thereof increase in belt width.

SECTION 6 - Requirements for Woodworking Machines

- 6.0 General - Minimum branch duct velocities for woodworking machines shall be 4000 F.P.M. unless otherwise specified.

6.1 Sanders

- 6.1.1 Suction hoods for disc sanders shall be connected to one or more branch ducts of the following minimum inside diameters:

Maximum Diameter Standing Disc	Minimum Number of Branch Ducts	Minimum Diameter of Each Duct (In.)	Minimum Air Quantity Duct (CFM)
Up to 19 in. incl.	1	4	349
13 to 18	1	4½	440
19 to 26	1	5	544
27 to 32	2	4	349
33 to 38	2	(1)-4	349
		(1)-5	544
39 to 48	3	(1)-5	544
		(2)-4	349

- 6.1.2 Suction hoods for drum sanders shall be connected to branch ducts of the following minimum inside diameters:

Maximum Diameter or Length Drum Sander (Inches)	Maximum Surface Area (Square Inches)	Minimum Diameter Branch Duct (Inches)	Minimum Air Volume
Diameter - Single Drum Sanders			
Up to 10	200	4	349
Over 10	400	4½	440
Over 10	700	5	544
Over 10	1400	6	786
Over 10	2400	7	1068
Length - Triple Drum Sanders			
Up to 30	-	7	1068
31 to 36	-	8	1396
37 to 42	-	9	1768
43 to 48	-	10	2180
Over 48	-	11	3640

- 6.1.3 Suction hoods for each horizontal belt sander using the bottom run of the belt shall be connected to two branch ducts one at the bottom and the other at the top having the following minimum inside diameters:

Minimum Width of Belt (Inches)	Minimum Diameter of Branch Duct		Minimum Air Volume	
	Bottom	Top	Bottom	Top
Up to 5	4½	4	440	349
6 to 9	5	4	544	349
10 to 14	6	4½	786	440
Over 14	7	5	1068	544

- 6.1.4 Where horizontal belt sanders using the top run of the belt are operated exclusively on flat work, top ducts are not necessary, but where other work is done a suction hood above the work shall be connected to telescopic branch ducts conforming to Sec. 6.1.3 above.

- 6.1.5 Suction hoods for vertical belt sanders shall be connected at the bottom to a single branch duct conforming to the dimensions for bottom ducts specified in Sec. 6.1.3 above, where the rear belt and both pulleys are enclosed.

- 6.1.6 Suction hoods for post or column swing arm sanders shall be connected to one branch duct of 4 inches minimum inside diameter divided into two 3 inch diameter ducts.

6.2 Lathes

- 6.2.1 The inside diameter of branch ducts connected to suction hoods on automatic wood turning lathes shall be not less than 4 inches, and shall be increased according to the size and character of the work.

- 6.2.2 The inside diameter of branch ducts on non-automatic wood turning lathes shall be not less than 4 inches.

6.3 Jointers

- 6.3.1 The inside diameter of branch ducts connected to suction hoods for jointers shall conform to the following:

Size of Cutting Knives	Branch Duct Diameter	Air Volume
Up to 6 in.	4 in.	349
7 in. to 12 in.	4½ in.	440
13 in. to 20 in.	5 in.	544
Over 20 in.	6 in.	786

6.4 Matchers, Moulders and Sizers

- 6.4.1 Suction hoods for each matcher, moulding planer or timber sizer shall be connected to four (4) branch ducts one at the top head, one at the bottom head and one at each side, having the following minimum inside diameters.

Size of Machine	Top Head	Minimum Diameter of Branch Duct		Each Side	Minimum Air Volume for Each Machine
		Bottom Head	Each Side		
Up to 7 in.	5 in.	4½	4		1233
8 to 12 in.	6 in.	5	4½		1670
13 to 18 in.	7 in.	6	5		2398
19 to 24 in.	8 in.	7	6		3250
Over 24 in.	9 in.	8	7		4232

6.5 Sash Stickers

- 6.5.1 Suction hoods for sash stickers shall be connected at each head to a branch duct of a minimum inside of 4 inches.

6.6 Planers

- 6.6.1 Suction hoods for each single or double wood planer shall be connected to branch ducts having the following minimum inside diameters.

Minimum Size of Cutter Knives Type 1 Single Planer Type 11 Double Planer	Minimum Diameter of Branch Duct			Minimum Air Volume per Branch
	Bottom Duct	Top Duct		
	Type 11	Type 1	Type 11	
Up to 20 in.	5	5	5	544
21 to 26	5	6	6	786
27 to 36	6	7	7	1068
Over 36	7	8	8	1396

6.7 Shapers and Variety Machines

- 6.7.1 Suction hoods for wood shapers and variety machines shall be connected at each spindle to a branch duct of a minimum inside diameter of 4 in. to 6 in. according to the size and character of the work.

6.8 Panel Raisers

- 6.8.1 Suction hoods for panel raisers shall be connected at each head to a branch duct of a minimum inside diameter of 4 inches.

6.9 Tenoners

- 6.9.1 Suction hoods for tenoners shall be connected to one branch duct at the bottom head and one at the top head, each having a minimum inside diameter of 5 inches and at each additional head to one branch pipe having an inside diameter of 5 inches.

6.10 Dovetailers, Dowelers, Gainers, Ploughs and Relishers

- 6.10.1 The inside diameter of branch ducts connected to suction hoods for dovetailers, dowel machines, gainers, ploughs and relishers shall be not less than 4 inches.

6.11 Saws

- 6.11.1 Suction hoods for each band saw shall be connected to two branch ducts, one at the front of the saw and the other at a point near the floor on the uprun side of the lower wheel having the following minimum inside diameters:

Maximum Width of Band Saw Blade	Minimum Diameter of Branch Duct		Minimum Air Volumes per saw
	Down Run	Up Run	
Less than 2 in.	4	4	698
2 in. to 3 in.	5	5	1088
3 in. to 4 in.	6	5	1330
4 in. to 6 in.	7	5	1612
6 in. to 8 in.	8	5	1940

- 6.11.2 Suction hoods for self feed circular rip saws shall be connected at the top to one branch duct of 4 inches minimum diameter and at the bottom to a second branch duct of a minimum inside diameter of either 5 inches for saws up to 16 inches or 6 inches for saws over 16 inches in diameter.

- 6.11.3 Suction hoods for large self feed rip saws for green lumber shall be connected at the bottom to one branch duct of 7 inches in minimum diameter and at the top to a second duct of 6 inch minimum inside diameter.

- 6.11.4 Suction hoods for circular resaw mills with hipsaws shall be connected at the bottom to one branch duct and at the top to a second branch duct of the following minimum inside diameter:

Diameter of Resaw	Minimum Diameter of Branch Duct		Air Volume for each saw
	Bottom Duct	Top Duct	
Up to 24 in.	5 in.	4 in.	893
25 to 36 in.	6 in.	4½ in.	1126
37 to 48 in.	7 in.	5 in.	1612
Over 48 in.	8 in.	5½ in.	2138

6.11.5 Suction hoods for swing saws shall be connected to a single branch duct of a minimum inside diameter of either 4 inches for saws up to 20 inches in diameter or 5 inches for saws over 20 inches in diameter.

6.11.6 The inside diameter of branch ducts connected to suction hoods for woodworking circular saws other than those specified in Sections 6.11.2 to 6.11.5 shall be as follows:

Diameter of Saw (Inches)	Minimum Diameter of Branch Duct	Air Volume
Up to 16 in.	4	349
17 to 24	4½	440
Over 24	5 in.	544

6.12 Chain Mortise Machines

6.12.1 Suction hoods for chain mortise machines shall be connected to a single branch duct of not less than 3 inch inside diameter.

6.13 Hog Chippers

6.13.1 The inside diameter of branch ducts connected to suction hoods for hog mills shall be not less than 3 inches for machines up to 12 inches wide or 12 inches for machines over 12 inches wide.

6.14 Floor Sweeps

6.14.1 The inside diameter of exhaust ducts for floor sweeps in woodworking plants shall be not less than 6 inches for fine dust and up to 8 inches for coarse material, and the dimensions at the mouth at the floor shall be at least 12 inches by 3 inches up to 12 inches by 5 inches.

SECTION 7 - Requirements for Open Tanks

7.1 Control of atmospheric contamination due to open surface tank operations shall be by one of the following means:

- Enclosing hood exhaust
- Lateral exhaust
- Overhead canopy exhaust
- General room (dilution) ventilation
- Any other method providing equivalent ventilation or control

7.2 Open surface tank operations shall be classified into 12 classes, numbered A-1 to C-4 inclusive.

7.2.1 Class is determined by two factors, (a) hazard potential designated by a letter A to C inclusive, and (b) rate of gas, vapor or mist evolution designated by a number from 1 to 4 inclusive.

7.3 Hazard potential shall be determined from the following table with the value indicating greater hazard being used, except for steam or water vapor from non-hazardous operations which shall be included under C.

Hazard Potential	Gas or Vapor*	Mist*	Flash Point
A	0-100 ppm	0-100 ug/cm	under 100° F.
B	101-500 ppm	101-500 ug/cm	100-200° F.
C	over 500 ppm	over 500 ug/cm	over 200° F.

* Refer to Department rules governing Maximum Allowable Concentrations

7.4 Rate of gas, vapor or mist evolution shall be determined from the following table using the lowest numerical value, except for steam or water vapor from non-hazardous operations which shall be included under 4.

Rate	Liquid Temp ° F.	Degrees Below Boiling Point	Relative Evaporation	Gassing
1	over 200	0-20	Fast	High
2	150-200	21-50	Medium	Medium
3	94-149	51-100	Slow	Low
4	under 94	over 100	Nil	Nil

- 7.4.1 Relative evaporation rate shall be determined according to the time for 100% evaporation as follows: Fast: 0-3 hours; Medium: 3-12 hours; Slow: 12-50 hours; Nil: more than 50 hours.
- 7.4.2 Rate of gassing shall be determined by evaluation, observation, or test depending on (a) the kind and amount of material being treated, (b) the kind and strength of the solution in the tank, (c) the temperature of the solution and (d) the current density applied to the work in electro chemical tanks.
- 7.4.2.1 High gassing operations shall include: Bright dip (nitric acid) of brass and bronze, chrome plating, anodizing of aluminum, stripping galvanizing in acid baths, satin finishing of aluminum, and others.
- 7.4.2.2 Medium gassing operations shall include such operations as pickling of steel, alkaline cleaning of aluminum (cold), electrolytic strike, battery plate forming and others.
- 7.4.2.3 Low gassing operations shall include: Alkaline cyanide plating of zinc, phosphoric acid dipping of steel, tin plating from stannate solution, phosphate treatment of metal and others.
- 7.5 Where internal condensers or vapor level thermostats are used such as in vapor degreasers, the effective rate of evolution shall be taken as 4 where the operating condition is excellent, as 3 where the condition is average and 2 or 1 for poor installations depending on severity of conditions.
- 7.5.1 The level of vapors in any vapor degreasing tank equipped with a condenser or vapor level thermostat shall be kept by said condenser or thermostat below the top edge of the tank by a distance at least equal to one-half the tank width, but not more than 36 inches.
- 7.5.2 Where gas is used as a fuel for heating vapor degreasing tanks, the combustion chamber shall be of tight construction, except for such openings as are necessary for supplying air for combustion and the exhaust flue. Flues shall be of corrosion resistant construction and shall extend to the outer air. If mechanical exhaust is used on this flue, a draft diverter shall be used.
- 7.5.3 A thermostatic safety control should be provided above the vapor zone which will control the heat source when the temperature reaches 20° F. below the boiling point of the pure solvent or mixture.
- 7.5.4 A thermostatic safety control should be provided within the liquid zone to control the heat source when the liquid temperature reaches 10° F. above the boiling point of the pure solvent or mixture.
- 7.5.5 The heating elements shall be so designed and maintained that their surface temperature will not cause the solvent or mixture to decompose or break down.
- 7.6 Where degreaser tanks require local exhaust, lateral exhaust should be used and the minimum control volume shall be 50 cfm/ sq. ft. of evaporative area.
- 7.7 Control air velocities shall conform to the following table in all cases where the flow of air past the breathing or working zone of the operator and into the hood is undisturbed by local environmental conditions such as open windows, wall fans, unit heaters, or moving heaters or machinery in motion.

MINIMUM CONTROL VELOCITY (FPM)
for undisturbed location

Class	Enclosing Hood		Lateral Exhaust	Canopy Hoods	
	One Side Open	Two Sides Open		Three Sides Open	Four Sides Open
A-1, A-2 and B-1	75	100	100	125	175
A-3, B-2 and C-1	65	90	75	100	150
B-3 and C-2	50	75	50	75	125
A-4, B-4, C-3 and C-4	Adequate general room ventilation				

- 7.7.1 Minimum control velocity for enclosing type hoods shall be required at any point in the plane of any opening in the enclosure and the air quantity shall be not less than the product of the control velocity times the net area of all openings in the enclosure through which air can flow into the hood.
- 7.7.2 Minimum control velocity for lateral exhaust shall be required at the point at the top of the tank most remote from the hood opening or openings and the quantity of air exhausted shall be not less than the product of the area of tank surface times the cfm/ sq. ft. of tank area.

Minimum Ventilation Rate in cfm/ sq. ft. of Tank Area for Lateral Exhaust

Required Minimum Control Velocity (fpm) (from 7.7)	Where Hood is along one side or two parallel sides of tank or when one side is against a wall or is baffled. cfm/ sq. ft. to maintain Minimum FPM at following					
	Tank width (W) ratios Tank Length (L)					
	0-0.09	0.1-0.24	0.25-0.49	0.5-0.99	1.0-2.0	
50	50	60	75	90	100	
75	75	90	110	130	150	
100	100	125	150	175	200	
150	150	190	225	260	300	

Minimum Ventilation Rate in cfm/ sq. ft. of Tank Area for Lateral Exhaust	Where Hood is along one side or two parallel sides of free standing tank not against a wall or baffled.				
	cfm/ sq. ft. to maintain Minimum FPM at following Tank width (W) ratios				
	Tank Length (L)				
	0-0.09	0.1-0.24	0.25-0.49	0.5-0.99	1.0-2.0
Required Minimum Control Velocity (fpm) (from 7.7)					
50	75	90	100	110	125
75	110	130	150	170	190
100	150	175	200	225	250
150	225	260	300	340	375

When exhaust manifold is along centerline use W/2 as tank width in computing.

- 7.7.3 For canopy hoods the minimum control velocity shall be required at any point in the plane of any opening between any bottom edge of the hood and the top edge of the tank nearest thereto and the air quantity exhausted shall be not less than the product of the control velocity times the net area of all openings between the hood and edge of tank.
- 7.8 Tanks, draining and drying areas shall be enclosed or baffled as completely as possible in order to minimize the quantity of air required for exhaust ventilation.
- 7.8.1 Where enclosure or baffling of a fixed nature is not feasible, removable structures should be employed.
- 7.9 Methods of ventilation in which air is supplied through ducts or pipes to the tank may be used as long as they do not adversely affect the exhaust or general room ventilation provided. Such methods include:
- Provision of unheated outdoor air at low supply velocity for the purpose of conserving heated room air during cold weather;
 - Provision of compressed air at high pressure to nozzles directed at the exhaust hood opening to project and entrain air into the hood opening;
 - Provision of either room air or unheated outdoor air at medium pressure to nozzles to accomplish either or both of the foregoing objectives;
 - Provision of a portion of the air exhausted from the tank to nozzles directed at the exhaust hood opening to project and entrain air into the hood opening.
- 7.10 Spraying operations conducted over an open surface tank shall be enclosed as completely as practicable and shall be ventilated to conform to control requirements for enclosed hood exhaust (Section 7.7), and shall have sufficient inward velocity into the enclosure to prevent the discharge of spray into the workroom or mechanical baffles shall be provided to accomplish this result.
- 7.11 Tank covers, foams, beads, chips, or other materials floating on the tank surface so as to confine gases, mists, or vapors to the area under the cover or to the foam, bead, or chip layer; or surface tension depressive agents added to the liquid in the tank to minimize mist formation or any combination thereof may all be used as gas, mist or vapor control means for open surface tank operations, provided:
- They do not introduce an explosion hazard due to accumulation of explosive gases or vapors under said cover or within or under said floating layer; and
 - They give effective control throughout the entire operating cycle of the tank.
- 7.11.1 Where criteria (a) and (b) of Section 7.11 are not met, sufficient ventilation shall be provided to make the overall control of gas, mist, or vapor conform to these criteria.
- 7.12 Plating bath levels in tanks should be at least 4 in. below the bottom of the lateral exhaust and preferably 6 in. to 8 in. below for wide tanks to prevent excessive loss and to insure mist or vapor removal.
- 7.13 Anodes, cathodes, bus bars and hangers shall be placed so as to avoid interference with the exhaust.
- 7.14 In cases where rinse tanks and acid baths are used in conjunction with cyanide tanks they shall be ventilated as follows:
- Where a rinse tank containing traces of acid is used after a cyanide tank, the rinse tank shall be ventilated.
 - Where a rinse tank containing traces of acid is used before a cyanide tank, the cyanide tank shall be ventilated.
 - Where a rinse tank containing traces of cyanide is used before an acid tank, the acid tank should be ventilated.
 - Where a rinse tank containing traces of cyanide is used after an acid tank, the rinse tank should be ventilated.

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SECTION 8 - Recommendations for Industrial Garages

- 8.1 Industrial garages should be provided with means for ventilation as necessary due to operating conditions.
- 8.1.1 Storage garages having a capacity of 6 to 24 vehicles and having less than 2 walls with window openings should be mechanically ventilated, with windows opening to the outside.
- 8.1.2 Storage garages having a capacity of 25 to 34 motor vehicles and having less than 3 walls with window openings should be mechanically ventilated with windows opening to the outside.
- 8.1.3 All storage garages having a capacity of more than 34 vehicles should be mechanically ventilated.
- 8.2 Natural ventilation may be employed where practicable to maintain open windows or other openings at any time. Such openings should be distributed as uniformly as possible in at least two outside walls and should have a total area at least 5 per cent of the floor area.
- 8.2.1 Where it is impractical to operate such a system of natural ventilation, a mechanical ventilating system should be provided.
- 8.3 Mechanical ventilation systems may be combined with the heating system, and should comply with the following:
- Positive provision should be made for supplying at least one cfm of fresh air for each sq. ft. of floor area, or for removing the same amount and discharging it to the outside.
 - Positive means of handling air refers to power driven fans and also includes, for garages of not over 35 vehicle capacity, air exhaust stacks, provided they have not less than 15 sq. ft. of steam heating surface for each sq. ft. of duct area, and not less than one sq. ft. of floor area. Such an exhaust duct should discharge above the roof and extend in any case to a height of not less than 15 feet above the heating coils.
 - Where positive means of exhausting air are used, the exhaust openings should extend not more than 2 feet above the floor and should be not more than 50 feet apart, around the perimeter of the garage.
 - Where mechanical systems of introducing outside air are used, and where air is recirculated after adequate cleaning, the air should be delivered horizontally and in sufficient volume and with sufficient velocity to secure distribution to all parts of the building. The height of the air inlet opening should be such that the air will discharge above the top of the vehicles.
 - All fans used for recirculating air within the garage or exhausting air from the garage should be on non-sparking type.
- 8.4 All duct openings either supply or exhaust, should be covered with $\frac{1}{4}$ inch mesh screen.
- 8.5 The passing of air ducts through fire walls should be avoided.
- 8.6 Tail pipe exhaust systems may be used and should be designed so that engine exhaust gases do not blow out around the connection between the duct and the tailpipe.
- 8.7 Air tight connections between tailpipe and flexible exhaust duct are not necessary.
- 8.8 The following minimum air flow and exhaust duct sizes are recommended at the tailpipe.

Vehicle	Airflow (cfm)	Duct Diameter (in.)
Automobiles	100	2 $\frac{1}{4}$
Trucks	200	3
Diesel Trucks	300	3 $\frac{1}{2}$

SECTION 9 - Recommendations for Industrial Kitchens

- 9.1 Hoods over kitchen cooking equipment should be constructed of non-combustible materials, with tight joints and have a clearance of at least 18 in. from all unprotected combustibles.
- 9.2 Duct systems should be so designed to create a conveying air velocity in exhaust system of not less than 1500 fpm and not more than 2200 fpm.
- 9.2.1 The average velocity across the face of any hood in the exhaust system should be not less than 150 fpm.
- 9.3 Systems should be provided with grease filters or with fire extinguishing equipment or both.
- 9.3.1 Range or grease filters, if used, should be of non-combustible construction designed for the specific purpose and so proportioned as not to decrease the air velocity in the duct below the limit specified in 9.2.
- 9.3.2 Fire extinguishing equipment may be fixed or portable inert gas, or fine water spray, either manually controlled or provided with manual or automatic control.

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- 9.4 Ducts from hood over cooking equipment should be constructed of No. 16 US gauge or heavier steel, or No. 20 US gauge stainless steel or other acceptable non-combustible materials with tight joints and separated at least 18 in. from all unprotected combustible material.
- 9.4.1 Inside laps in duct joints shall project in the direction of the air flow.
- 9.5 Ducts should lead as directly as possible to the outside.
- 9.6 The ducts should constitute an independent system in no manner connected with any other ventilating system.
- 9.7 Hand holes, for inspection and cleaning purposes, equipped with tight fitting sliding or swinging doors and latches, should be provided in horizontal sections of exhaust ducts. Such openings should be at the sides of the horizontal run in order to prevent dripping of residue. Spacing of such openings should not exceed 20 ft.
- 9.8 Vertical risers should be located outside of and adequately supported by the exterior building wall.
- 9.8.1 If absolutely necessary to locate the riser inside the building, it should be enclosed in a shaft preferably constructed of masonry at least the equivalent of 4 in. hollow tile extending continuously from the first floor to and through the roof.
- 9.8.2 Access openings should be provided in the enclosure at each clean out point.
- 9.9 At the base of each vertical riser a residue trap should be provided with provisions for clean out.
- 9.10 Where it is necessary to pass exhaust ducts or their inlets or outlets through a fire wall, an automatic fire door or shutter should be provided on each side of the wall.
- 9.10.1 Where exhaust ducts pass through floors, partitions, walls, ceilings or roofs, the space around the duct should be sealed with asbestos, mineral wool or other non-combustible material, to prevent the passage of flame or smoke.
- 9.11 In addition to the fan motor control close by the ventilating unit, a remote control should be provided near the hood.
- 9.11.1 Motors should be provided with automatic shut down by means of one or more thermal control units located in the hood close to its exhaust outlet.
- 9.12 All electrical equipment including lighting fixtures should be installed in accordance with the National Electric Code, with due regard to the use of 'vapor-tight' fixtures and the location of equipment to avoid the effects of fumes and grease deposited along the air stream.

S E C T I O N 1 0 - F i r e P r o t e c t i o n

- 10.1 Duct systems operating at elevated temperatures shall have clearance from any portion of the combustible building structure not less than the following:

Duct Air Temp.	Largest Duct Dimension	Clearance
Over 200° F. to 600° F. incl.	8 in.	8 in.
	Over 8 in.	12 in.
Over 600° F. - 900° F. incl.	8 in.	18 in.
	Over 8 in.	24 in.
Over 900° F.	All ducts lined with refractories	24 in.

Sec. 4.1.22 for systems operating at room temperature.

Referred to Sec. 4.1.29 for passage through combustible structures.

- 10.2 All electrical equipment shall be installed in accordance with the National Electric Code.
- 10.2.1 All metal parts of apparatus, used in systems for the removal of flammable gases or vapors, or systems used for the removal or conveying of combustible or flammable dust, including fans, ducts etc., as well as shafting in connection therewith, shall be electrically grounded in an effective and approved manner.
- 10.2.2 When metallic contact is broken at duct joints or at other points on the installation assembly, metallic straps, preferably of copper, shall be installed where necessary to afford effective grounding connections.
- 10.2.3 When systems are used for the handling of flammable gases or vapors or combustible or flammable dust, static electricity shall be removed from belts by grounded metal combs or other effective means.

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- 10.2.4 Motors shall be located outside of rooms in which flammable vapors or flammable dust are being generated and removed, unless of the type approved for the particular conditions or hazard.
 - 10.2.5 Where necessary to install switches or other electrical apparatus in areas where explosive atmospheres might be created only such equipment as is approved for the specific conditions shall be used.

- 10.3 Remote control of all blower or exhaust fans shall be provided in addition to any control located close to the equipment.
- 10.4 Adequate fire protection equipment and first aid fire appliances shall be provided.
- 10.5 Automatic or special extinguishing equipment for systems handling flammable vapors or combustible material should be provided and be approved by the Bureau of Engineering and Safety. Inert gas may be effectively used to create safe atmospheres in conveying systems.
- 10.6 Equipment of large volume in which pulverized combustible or explosive stock is stored or may accumulate, such as bins, dust collectors, etc., should be protected by automatic sprinklers or fixed pipe inert gas extinguishing systems, or both. If fixed pipe inert gas extinguishing systems are used, it is important that means be provided to automatically close all openings to the enclosure involved, including rupture diaphragm vent openings, also to shut down all blowers in connection therewith in order to confine the extinguishing agent and prevent the spread of fire.
- 10.7 Small hand hose connections with adequate hose and nozzles or water spray applicators, should be provided and properly located for use in manually extinguishing smoldering stock fires. Proper precautions should be taken in combatting magnesium or other special type fires.

SECTION 11 - Explosion Relief Venting

- 11.1 Explosion relief vents should be provided on all duct systems used for conveying materials which form an explosive mixture with air and shall have a cross sectional area not less than the cross sectional area of the duct vented.
- 11.2 Vents shall be provided where the direction of flow is changed and also at the maximum elevation of the system.
- 11.3 Explosion relief vents for ducts shall lead by the most direct practical route to the outside of the building and should not deviate more than $22\frac{1}{2}^{\circ}$ from the direction of the duct from which they lead.
 - 11.3.1 Vents shall not pass through adjoining buildings unless designed to resist maximum explosion pressure.
- 11.4 Storage bins or other receptacles which contain an explosive mixture with air shall be provided with explosion relief vents.
 - 11.4.1 Automatic vent shutters should be provided to close the opening after the pressure has been relieved.
 - 11.4.2 The vent area for effective relief of explosion pressure will depend on various factors including the properties of the dust, the shape and strength of the structure or equipment, and the location and type of the vent used. The following areas should be adopted where specific design data is not available:
 - a. For mild explosion hazards vent area should be 1 sq. ft. for each 100 cu. ft. volume.
 - b. For moderate explosion hazards vent area should be 1 sq. ft. for each 50 cu. ft. volume.
 - c. For severe explosion hazards vent area should be 1 sq. ft. for each 15 cu. ft.
- 11.5 Explosion relief vent openings shall be provided with rupture diaphragms fitted with cutters to accelerate rupture or equivalent means of relieving pressure. Where necessary, the discharge opening of the relief vent may be suitably protected against the weather.
- 11.6 Explosion relief vents shall not be connected to chimneys or duct systems used for other purposes.

SECTION 12 - Air Flow Producing Equipment

- 12.1 The equipment for exhausting air shall have sufficient capacity to produce the flow of air required in each of the hoods and openings of the system. (Sec. 4.1.4)
- 12.2 The capacity required shall be obtained when the air flow producing equipment is operating against the following pressure losses, the sum of which is the static pressure:

- a. Entrance losses into the hood.*
b. Resistance to air flow in branch pipe including bends and transformations.
c. Entrance loss into main pipe.
d. Resistance to air flow in main pipe including bends and transformations.
e. Resistance of mechanics equipment, such as filters, washers, condensers, absorbers, collectors, separators etc. plus their entrance and exit losses.
f. Resistance in discharge duct and weather cap.

- 12.3 Fans shall be of non-combustible construction and have motors and bearings outside the air stream or otherwise be adequately protected from the substances being exhausted.
- 12.4 Where the substance is corrosive, the impeller and housing should be of corrosion resistant material or be provided with a protective coating of rubber, a resin, or in the case of mildly corrosive fumes, acid resisting paint.
- 12.5 Where the substance forms an explosive mixture with air, or otherwise presents a fire hazard, either the impeller shall be of non-ferrous or non-sparking material, or the casing should be fabricated of, or lined with, such material.
- 12.6 Fans shall be located and arranged as to afford ready access for repairing, cleaning, lubrication and inspection.
- 12.7 Fans shall be placed on solid foundations or firmly secured to substantial supports.
- 12.8 Fan housings or casings shall be of substantial construction to prevent a distortion and loss of alignment under operating conditions.
- 12.9 For certain types of installations where the gas being handled is extremely corrosive, flammable, or explosive, it may be desirable not to have the gas passed through the fan. Ejectors may be used for this purpose.

S E C T I O N 1 3 - Separating and Collecting Equipment

- 13.1 Separating and collecting equipment should be designed and constructed to withstand anticipated explosion pressures, due consideration being given the reduction in pressure afforded by adequate explosion relief vents.
- 13.2 Separating or collecting equipment should be outside the building and so located as to constitute a minimum hazard to adjacent structures, and at a safe distance from combustible construction or unprotected openings into buildings. When it is not practical to exhaust to an outside collector, the use of an approved type of indoor collecting system close to the source of the dust may be permitted.
- 13.3 Separating or collecting equipment shall be of steel or steel enclosed provided with clean out doors and supports shall be of steel, masonry or concrete.
- 13.4 All collectors which must be located indoors and cannot be constructed of sufficient strength to resist maximum calculated explosion pressure should be located close to exterior walls to facilitate explosion venting.
- 13.5 Discharge ducts shall not come in contact with nor expose combustible material and should terminate above the roofs if within 10 ft. of buildings of combustible construction or unprotected openings.
- 13.6 Delivery ducts from cyclones or collectors should not convey refuse directly into the fire boxes of boilers, furnaces, dutch ovens, refuse burners, incinerators etc.
- 13.7 Delivery of stock from separator, cyclone or other collection equipment to storage receptacles should be accomplished by means of gravity or other methods of transfer through tightly fitted ducts.
- 13.8 Where refuse is to be used as fuel, the discharge system from the storage receptacle or intermediate feed bin should be so designed that either by means of a choke feeder or choke conveyor, a positive cut-off is provided to prevent a flash back from the furnace.
- 13.8.1 The installation of a steam spray in the duct to the furnace, blowing steam in the direction of the fuel flow is recommended, as it provides an added safety factor in preventing flash back.
- 13.9 Cyclone collectors may be used for dust easily separated from the air stream.
- 13.10 Cloth filter dust collectors for fine and light dusts shall be of an approved manufacture or design; shall have an efficient cleaning system and sufficient volume not exceeding 4 cubic feet per minute per square feet of cloth area unless otherwise approved. In a small unit collector for every light duty or small concentrations of dusts, volume should not exceed 7 cubic feet per minute per square feet of cloth. Where lead dusts are handled or in especially dangerous processes, the volume shall not exceed 2 cubic feet per minute per square feet of cloth.
- 13.11 The resistance of filter collectors should be held to not less than 1 inch S.P. of water and should not exceed $2\frac{1}{2}$ inches differential of static pressure after 4 hours of continuous operation.

- 14.1 The required air flow shall be maintained at all times during which dust, gas, mist or vapor is emitted and at all times the area is in operation or use.
- 14.2 At the end of after a maximum period of every three months of operation, or after a prolonged shut down period, the duct system shall be inspected for evidence of corrosion and the air flow shall be checked.
 - 14.2.1 Deficient air flow shall be corrected and any significant change in air flow shall require tests to determine the effectiveness of the ventilating system under operating conditions, as indicated by atmospheric contamination.
- 14.3 The exhaust system shall discharge to the outer air and shall terminate 6 feet above the roof level and at a point where the effluent will not reenter the building.
 - 14.3.1 Recirculation will not be permitted except in instances where special devices for contaminant removal will prevent both the creation of a health or fire hazard in the room or area to which the air is circulated.
- 14.4 Thorough cleaning of ducts, hoods, and fans shall include scraping, brushing, or other positive means and shall be carried out as frequently as necessary, using all necessary precautions where flammable, combustible explosives are handled. (see 14.2)
- 14.5 Unit filters shall be cleaned or elements replaced as necessary to maintain efficient control of hazard and effluent.

S E C T I O N 15 - Plan Examination and Approval

- 15.1 No applications for approval will be considered unless there is compliance with the minimum requirements of these rules and regulations.
- 15.2 Application forms BSI-10 shall be submitted in triplicate and shall be accompanied by a filing fee of two dollars (\$2.00) per thousand dollars (\$1,000) or fraction thereof of the valuation based on the installation and applicable equipment costs up to twenty thousand dollars (\$20,000). Fifty cents (\$.50) is payable on each thousand dollars (\$1,000) valuation thereafter. Checks or money orders are to be made payable to the Commissioner of Labor and Industry.
- 15.3 Plans and specifications when the latter are required shall be submitted in triplicate prior to installation. Copies of original drawings shall have minimum dimensions of 12 inches x 18 inches.
- 15.4 Drawings title shall appear on each copy and shall show the following:
 - a. Designation of system, equipment or apparatus.
 - b. Name of party for whom installation is intended, and full address and location of premises.
 - c. Name of professional engineer, contractor or party by whom design was prepared.
 - d. Date, scale and number of sheet to be shown on each drawing.
- 15.5 Hood, booth or room details shown on the drawings shall include pipe sizes, kind of duct, materials and thickness, piping details, minimum hood or face velocities, total system air volume, make model size and rating of fan; complete collector data or details, electrical installation notes, equipment notes; construction materials of floor, walls and ceilings, electrical installation, and all pertinent details of ventilation and air control system.
- 15.6 Complete plan view and appropriate elevations of the installation or system shall be submitted. A location plan shall be shown to fix the area relative to the building and adjacent operations. Location of fresh air or 'make-up' air inlets and their proximity to exhaust outlets or discharge stacks. Provisions shall be shown for tempering fresh air during winter as necessary.
- 15.7 Complete details for supporting all parts and equipment of the installation shall be submitted on the drawings and shall include height and size of discharge stacks or ducts exhausting outside.
- 15.8 The proper identification, and quantities used, of flammable or harmful materials shall be given with, or on the applications or plans. When the chemical compositions cannot be identified definitely, the source from which these materials emanate or are procured must be similarly submitted.
- 15.9 Full details of the construction of all fire walls, floors and roofs pierced by any part of the system are to be indicated on the plans.
- 15.10 The owner, tenant or authorized agent upon completion of any installation shall notify the Bureau of Engineering and Safety, and if upon inspection and test it appears the system has been installed in accordance with approved plans and the controls effected comply with the standards, it shall be accepted as satisfactory.
- 15.11 A certificate of approval of each installation will be issued when an inspection indicates that work is completed in a manner satisfactory to the Bureau of Engineering and Safety.