CHAPTER X

BLOWER AND EXHAUST SYSTEMS FOR DUST, STOCK, FLAMMABLE AND NON FLAMMABLE VAPOR REMOVAL AND CONVEYING

1000.0—SCOPE

(a) This code is submitted for the proper installation and safeguarding of these systems, taking into consideration the purpose for which they are intended and the functions that they are designed to perform. The object is to eliminate or reduce the known fire and explosion hazards inherent in the operation of these systems and to prevent them from becoming the means of spreading fire.

(b) The design and installation of systems coming within the scope of this code should be in the hands of competent engineers and their maintenance and operation should be in charge of reliable and experienced persons.

1001.0—GENERAL

(a) Blower and exhaust systems for dust, stock or vapors hereafter installed as part of or attached to parts of a building shall be constructed and installed to conform to the requirements of this section.

(b) Blower and exhaust systems heretofore installed as part of or attached to parts of a building shall not be altered, extended or enlarged, except in conformity with the requirements of this section.

1002.0—POWER AND CONTROL

(a) All electrical equipment shall be installed in accordance with the National Electrical Code.

(b) 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. 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 obtaining shall be used. See Art. 500 of the National Electrical Code.

(c) Remote control of all blower or exhaust fans shall be provided, in addition to any control located close to the equipment.

1003.0—GROUNDING

All metal parts of apparatus, used in systems for the removal of flammable gases or vapors, or systems used for conveying flammable dust, stock or refuse, and shafting in connection therewith, shall be electrically grounded in an effective and approved manner, as per N.E. code.

1004.0—FANS

(a) Fans shall be of noncombustible construction and of adequate capacity to properly perform the functions required. Excess capacity is undesirable as a producer of unnecessary drafts and should be avoided except where justified by the contemplated extension of operations.

(b) Fans shall be so located and arranged as to afford ready access for repairing, cleaning, inspection and lubricating. They should be placed on proper foundations or firmly secured to substantial supports.

(c) When flammable solid materials or vapors are passed through the fans, the rotating element shall be of non-ferrous or non-sparking material or the casing shall consist of or be lined with such material. Where there is a possibility of solid foreign material passing through the fan that would produce a spark, both the rotating element and the casings shall be constructed as required above.

(d) Housings or casings shall be of substantial construction to prevent distortion and loss of alignment under operating conditions.

(e) Blades or impellers and shafting shall be sufficiently strong and designed with adequate clearance to prevent contact with casings or prevent distortion under conditions of deposit loading or other factors.

(f) Fans shall not be located in fire walls, or required two-hour partitions.

(g) Exposed openings into housings shall be protected with substantial metal screens or gratings to prevent accidents or the entry of foreign material.

(h) Bearings shall be constructed in accordance with the best modern practice and shall be so proportioned, secured and aligned as to prevent overheating. Bearings shall be accessible for lubrication and shall be well designed to prevent leakage of oil and minimize dust infiltration. They shall be located outside of casings and ducts unless proper shielding and dustproofing is provided.

1005.0—DUCTS (General)

(a) Ducts shall be constructed entirely of sheet metal or other noncombustible material, and of adequate strength and rigidity to meet the conditions of service and installation requirements, and shall be properly protected where subject to mechanical injury.

(b) Metal ducts shall be constructed of steel or iron not thinner than specified in the following table:

Diameter of duct, inches	U.S. Standard Gauge	
	Non-Abrasive Materials	Abrasive Dusts
Up to 8, inclusive	24	20
Over 8 to 18, inclusive	22	18
Over 18 to 30, inclusive	20	16
Over 30	18	14

(c) The entire duct system should be self-contained. No rooms or portions of the building shall be used as an integral part of the system unless constructed of noncombustible material, and such design and arrangement shall be subject to the approval of the authority having jurisdiction.

(d) All ducts shall be made reasonably tight throughout and shall have no openings other than those required for the proper operation and maintenance of the system.

(e) All ducts, whether inside or outside of buildings, shall be thoroughly braced where required and substantially supported by metal hangers or brackets. Where ducts are used for conveying explosive gases or dust, the supports shall be designed to afford strength and rigidity against disruption. All laps in the piping should be made in the direction of the air flow.

(f) Changes in size of ducts shall be by means of a taper transformation piece, the included angle of the taper being not more than 30 degrees.

(g) Actuation of fire doors shall be by fusible links or other approved thermal units, such units to be loacted on both sides of fire wall.

(h) Hand holes for damper, sprinkler or fusible link inspection or resetting and for residue clean-out purposes, shall be equipped with tight fitting sliding or swinging doors provided with substantial latches, except in the case of vertical sliding doors held in place by gravity.

(i) Material for duct lining shall have a flame spread rating of 0.

(j) Ducts handling materials at temperatures in excess of 900° F. shall be lined with refractory material or the equivalent.

1006.0—DUCTS THROUGH WALLS, FLOORS, ETC. . .

(a) Ducts should not pass through fire walls. When ducts or the outlets from or inlets to same pass through fire walls they shall be provided with approved automatic fire doors or shutters, on both sides of the wall. (See Chapt. XI and Appendix "G".)

(b) Where ducts pass through walls, floors or partitions the space around the ducts shall be sealed with rope asbestos, mineral wool or other noncombustible material to prevent passage of flame and smoke.

(c) Duct Clearances—See Chapter II Section 305.36

1007.0—SYSTEMS FOR REMOVAL OF FLAMMABLE VAPORS (Including Paint Spraying Residue.)

(a) Where systems of this class are installed, the following rules and the preceding general rules except as modified herein shall apply.

(b) In exhaust systems for the removal of flammable vapors, ducts shall lead to the outside of the building in the most direct manner possible.

(c) Outlets to atmosphere shall be kept clear of and away from combustible materials.

(d) Due to the hazardous nature of the vapors to be removed, it is important that they be withdrawn from the rooms or equipment in which they are generated and taken to the outside of the building in the most direct manner possible. Processes generating such flammable vapor should be located along an outside wall of the building to facilitate efficient vapor removal. No ducts or other portions of any vapor removal system should extend into stories or rooms of a building other than those from which the vapor is being removed. Exhaust outlets to atmosphere should extend above or away from surrounding structures to prevent accumulation of combustible residues on such structures.

1008.0—SYSTEM DESIGN

(a) In the design of any vapor removal system, control at the point of generation should be provided wherever possible. Such systems will consist of hoods or enclosures connected to suction ducts. They are more positive and require lower exhaust volumes than general ventilation through remote suction openings.

(b) When flammable vapors are so generated that they cannot be readily picked up at the source, general ventilation through a system of suction ducts with inlets to the room or area may be employed. As suction inlets have but little directional effect beyond a few inches from the face of the inlet, such inlets should be located to best produce a sweeping or purging effect that will tend to avoid pockets in which vapors may accumulate. An air supply system properly located with

reference to point of vapor generation and exhaust openings will be beneficial in vapor dilution and removal.

(c) Where heavier than air vapors or mixtures are handled, exhaust openings located near the floor line will be more effective. This is particularly true when exhaust system is not in operation and its stack effect is utilized to remove any residual material. Conversely for vapors or mixtures lighter than air, exhaust system inlets should be located near the top of the room, hood, or enclosure.

1009.0—FIRE EXTINGUISHING APPARATUS, MANUAL AND AUTOMATIC

(a) The provision of automatic or special extinguishing equipment for systems handling flammable vapors or combustible materials should be subject to the approval of the authority having jurisdiction. Details of such systems are set forth in following sections covering specific materials being handled.

1010.0—FIRE EXTINGUISHING APPARATUS, AUTOMATIC OR MANUAL

(a) In systems used for the removal of flammable vapors or gases, the installation of an approved fixed pipe system for the application of water, dry chemical, or inert gas is recommended, as conditions warrant. Such systems may be automatically or manually controlled, as required by the authority having jurisdiction. (See Standard for the Installation of Sprinkler Systems, NFPA No. 13, Standard for Water Spray Systems, NFPA No. 15, Standard for Carbon Dioxide Fire Extinguishing Systems, NFPA No. 12, Standard for Dry Chemical Extinguishing Systems, NFPA No. 17, and Standard for Inerting for Fire and Explosion Prevention No. 69.)

1011.0—DUCTS (For flammable vapors)

(a) Ducts installed under this classification shall be independent structures, and not built in the walls. Exhaust ducts should lead to the outside of the building as directly as possible, and never through intermediate rooms.

(b) The installation of dampers, valves and shutters in this type of system is not ordinarily advisable, except where necessary at outlets to afford weather protection when the system is shut down or where such devices are used for the final balancing of the exhaust system. In such cases the dampers shall be securely locked to prevent further manipulation.

(c) Material for duct lining should have a fire hazard classification of 0 when tested in accordance with the Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255 or UL 723.

(d) No dissimilar matter shall be handled through one exhaust system when the intermingling or contact of one type of material with another would create a fire or explosion hazard in the duct system, collection unit or air flow producing equipment. Operations generating sparks, such as from hot materials or grinding wheels, shall not be consolidated in the same exhaust system that handles flammable or explosive matter.

1012.0—DUST COLLECTING SYSTEMS; STOCK AND REFUSE CONVEYING SYSTEMS

(a) Where systems of this class are installed, the following rules and the preceeding rules except as modified herein shall apply.

(b) These systems consist of suction ducts and inlets, airflow producing equipment, feeders, discharge ducts and outlets, collecting equipment, vaults and other receptacles, designed to collect by air or gas, powdered, ground or finely divided material.

(c) Systems collecting highly flammable or explosive dust preferably should be so arranged that the fan is on the clean air side of the collector.

(d) Conveying systems for cotton and similar textile materials which are readily ignitable shall be arranged so as not to create suction in machines producing the material.

(e) Rooms or bins into which readily ignitable material is discharged by a collecting or conveying systems should be of noncombustible material. Such rooms or bins shall be provided with vents, preferably leading to outside the building.

(f) Dust collecting systems from grinding and other machines which may produce sparks shall not be combined with collecting systems handling linty or other readily flammable dusts.

(g) Separating or collecting equipment shall be constructed of or be enclosed by steel or other approved noncombustible material. Supports shall be of steel, masonry or concrete and the structure shall be securely anchored to resist anticipated wind loads.

(h) Discharge ducts of separating and collecting equipment shall have clearances as specified for ducts in section on clearances, Chapter III.

(i) Explosion relief vents on duct systems shall have a cross-sectional area not less than that of the duct vented, and shall lead to the outside of the building. Explosion relief vent openings shall be provided with rupture diaphragms fitted with cutters to accelerate rupture, or equivalent means of relieving pressure.

(j) Explosion relief vents shall not be connected to chimneys or duct systems used for other purposes.

(k) The use of a trap at the junction of a hood or a branch duct may be permitted by the authority having jurisdiction provided it is not permitted to fill up with dust.

(l) Approved magnetic separators of the permanent magnet or electromagnetic types should be installed at those points where combustible materials which may contain ferrous particles enter the system. The separators shall be of sufficient size to insure the removal of all ferrous materials passing over them.

(m) Readily ignitable materials should not pass through the fan unless the fan is constructed and installed in accordance with Section 1004.0. Systems handling these materials should be operated entirely under suction with suitable equipment for removing the stock from the air stream before it reaches the fan.

(n) Where practical inert gas should be used to create safe atmospheres within the system or parts of the system, especially those handling exceedingly fine stock. (See Inerting for Fire and Explosion Prevention, NFPA No. 69 published in the National Fire Codes, Volume II in pamphlet form.)

1013.0—DUCTS (Dust Collecting Systems, Stock and Refuse)

(a) Metal ducts shall be constructed of sheet steel of not less than the following gauges.

Diameter of duct, inches	U.S. Standard Gauge Non-Abrasive Materials	U.S. Standard Gauge Abrasive Dusts
Up to 8 inches	24	20
Over 8 to 18 inches	22	18
Over 18 to 30 inclusive	20	16
Over 30	18	14

Buried ducts may be of concrete or ceramic materials, cast iron, or cement-asbestos and shall also comply with Section 1005.0.

(b) All sheet metal elbows and bends shall be made from material at least two (2) gauges heavier than is required for straight duct-work of the same diameter except that for No. 14 gauge and heavier, the elbows and straight duct-work may be of the same gauge.

(c) Round sheet metal elbows should be of at least five-piece construction for ducts six (6) inches in diameter or less and of seven-piece construction for larger ducts with a throat radius equal to one-half (½) to two (2) times the duct diameter unless space prohibits the use of such long bends. In place of long radius elbows specified above, rectangular elbows, venturi-shaped elbows or other bends of equivalent low-resistance design may be used.

(d) The main suction duct should receive only one branch in a section of uniform area, whenever space permits, and in no case shall it receive more than two branches in such a section.

(e) The inlet of the fan or exhaust should be at least 20 per cent greater in area than the sum of the areas of all of the branch ducts, and such increase shall be carried proportionately throughout the entire length of the main suction duct, i.e., the area of the air duct at any point shall be at least 20 per cent greater than the combined areas of the branch ducts entering it between such point and the tail end, or dead end of the system.

(f) Every branch duct should connect with the main duct at top or side at an angle not exceeding forty-five (45) degrees, inclined in the direction of the air flow.

(g) The main suction and discharge ducts should be made as short as practicable. To provide access for sweeping and cleaning, ducts should not be less than 6 inches above the floor at every point, and not closer than 6 inches at any ceiling.

(h) Every duct shall be kept open and unobstructed throughout its length, and no screen shall be placed in it. The use of a trap may be permitted by the authority having jurisdiction.

(i) Main ducts of systems handling materials which form an explosive mixture with air should be run on the outside of the building where practicable with ducts from each operation and each floor passing out directly through the wall and discharging into the main duct. All ducts shall be adequately supported.

(j) Additional branch ducts should not be added to an existing system without redesigning the system. Branch ducts should not be disconnected nor unused portions of a system be blanked off without providing orifice plates to maintain required airflow.

1014.0—SEPARATING AND COLLECTING EQUIPMENT

(a) This includes cyclones, condensers, cloth screen and stocking arrestors, centrifugal collectors and other devices used for the purpose of separating solid material from the air stream in which it is carried and hoppers, bins, silos and vaults for collecting the solid material so separated.

(b) 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.

(c) Separating or collecting equipment should be outside the building when conditions permit, and so located as to constitute a minimum hazard to adjacent structures. Their construction shall be of steel or steel enclosed. Supports shall be of steel, masonry or concrete and the structure securely anchored to resist anticipated wind pressures. It is recommended that clean-out doors be provided. Separating or collecting equipment should be located at a safe distance from combustible construction or unprotected openings into buildings.

(d) 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 relief venting.

(e) Discharge ducts shall not come in contact with nor expose combustible material and should terminate above the roofs if within 10 ft. of building of combustible construction or unprotected openings.

(f) Delivery ducts from cyclone collectors should not convey refuse directly into the fireboxes of boilers, furnaces (including Dutch ovens), refuse burners, incinerators, etc.

(g) Delivery of stock from separator, cyclone or other collection equipment to storage receptacles should be accomplished by means of gravity through tightly fitted ducts.

(h) 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. 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 a flash-back.

(i) Small scale dust collecting equipment may, by permission of the authority having jurisdiction, discharge into a substantial metal box preferably located outside the building.

1015.0—EXPLOSION RELIEF VENTING

(a) Explosion relief vents should be provided on all duct systems used for conveying materials which form an explosive mixture with air. Explosion vents shall have a cross sectional area not less than the cross sectional area of the duct vented. Vents should be provided where direction of flow is changed and at the maximum elevation in the system.

(b) Explosion relief vents for ducts should lead by the most direct practical route to the outside of the building and should not deviate more than 22½ degrees from the direction of the duct from which they lead. Such vents shall not pass through adjoining buildings unless designed to resist maximum explosion pressure.

(c) Storage bins or other receptacles which contain materials which form an explosive mixture with air shall be provided with adequate explosion relief vents (See Fig. 3.)

1016.0—FIRE EXTINGUISHING SYSTEMS

(a) The buildings or rooms in which the storage processing and handling of combustible material are conducted should be protected by a system of approved automatic sprinklers and shall be equipped with approved portable fire extinguishers, together with approved small hose. (See Standards for Sprinkler Systems, NFPA No. 13, Standpipe and Hose Systems, NFPA No. 14, and Portable Fire Extinguishers, NFPA No. 10.)

(b) Inert gas may be effectively used to create safe atmospheres in conveying systems.

(c) Equipment of large volume in which pulverized 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.

Note: 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. (See previous page for illustration.)

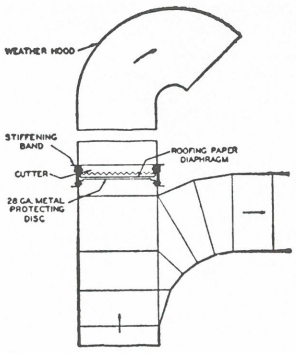
(d) Small hand hose connections, with adequate hose and nozzles or water-spray applicators, should be provided and properly located for use in manually extinguishing smoldering stock fires.

1017.0—PROTECTION AGAINST STATIC ELECTRICITY

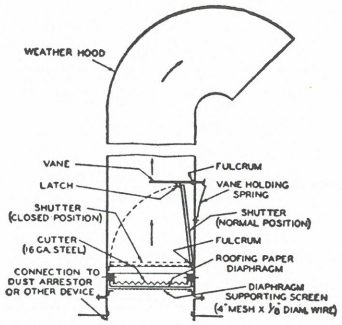
(a) All metal parts of apparatus, used in systems for the removal of flammable gases or vapors, or systems used for conveying combustible or flammable dust, stock or refuse, considered in these requirements, including fans, ducts, etc., as well as shafting in connection therewith, shall be electrically bonded and grounded in an effective and approved manner. (See NFPA No. 77M, Static Electricity.)

(b) 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 bonding connections.

(c) When systems are used for the handling of flammable gases or vapors or combustible or flammable dust, stock or refuse, static electricity shall be removed from belts by grounded metal combs or other effective means. (See recommendations of the NFPA Committee on Static Electricity.)



Suggested method of explosion relief vent suitable for use at duct turns, at storage bins or other receptacles. The thin metal protecting disk shown beneath the rupture diaphragm serves to prevent abrasion of the diaphragm, and upon operation of the device will blow free.



Suggested form of providing explosion pressure relief for large sheet steel enclosures such as dust collectors. The automatic shutter is provided to close the opening after the pressure has been safely relieved to atmosphere in order that efficient extinguishment of the resulting fire with CO_2 may be assured. The area of the explosion vent required is determined by the nature of the stock handled, the strength of the device to be protected, the rupturing strength of the diaphragm, the length and characteristics of the relief duct to atmosphere, etc. The diaphragm saw-tooth cutter shown is readily constructed and greatly reduces the bursting pressure required.

Note: 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 vent used. In the absence of more specific data, the following are recommended:

For mild explosion hazards
1 sq. ft. for each 100 cu. ft.
For moderate explosion hazards
1 sq. ft. for each 50 cu. ft.
For severe explosion hazards
1 sq. ft. for each 15 cu. ft.

(Excerpt from NFPA 91)