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W. N. DOAK, Secretary
BUREAU OF LABOR STATISTICS
ETHELBERT STEWART, Commissioner

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SAFETY CODE SERIES

SAFETY CODES FOR THE PREVENTION OF DUST EXPLOSIONS

NATIONAL FIRE PROTECTION ASSOCIATION AND
UNITED STATES DEPARTMENT OF AGRICULTURE
SPONSORS

AMERICAN STANDARD
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ILLUSTRATIONS

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BULLETIN OF THE
U.S. BUREAU OF LABOR STATISTICS

NO. 562 WASHINGTON DECEMBER, 1931

SAFETY CODES FOR THE PREVENTION OF DUST EXPLOSIONS

Introduction

Dust explosions have been responsible for a series of disasters involving large losses of life and property extending over a long period of years. It is only recently, however, that the seriousness of this hazard has been generally recognized and measures for its control undertaken. Following extensive research into the phenomena of dust explosions by the Bureau of Chemistry of the United States Department of Agriculture, the National Fire Protection Association organized, in January, 1922, a committee on dust explosion hazards charged with the preparation of recommended regulations for the prevention of fires and dust explosions in occupancies subject to this hazard. This committee was formed with the cooperation of the United States Department of Agriculture, the present joint sponsors thus having been closely associated in this work since the inception of the project. The committee of the National Fire Protection Association on dust explosion hazards proceeded with the preparation of the regulations which form the basis of this pamphlet, the reports of the committee being adopted by the association and published as the recommended regulations of the National Fire Protection Association. These standards as prepared were also adopted by the National Board of Fire Underwriters.

In 1926 the dust explosion hazards committee of the National Fire Protection Association was reorganized to qualify as a sectional committee of the American Engineering Standards Committee. This reorganization consisted merely in adding the representatives of a few organizations which had not previously participated in the work. Following this the codes adopted by the committee and by the National Fire Protection Association and the United States Department of Agriculture were officially approved as "Tentative American Standards" by the American Engineering Standards Committee and published in the Bulletin of the United States Bureau of Labor Statistics No. 433. Subsequently the codes were advanced to the status of "American Standard" by the American Standards Association, additional codes were prepared, and original codes revised to keep pace with developments in industry. The present publication includes all the codes developed by this committee to date.

Committee on Dust Explosion Hazards

(*Personnel as of May, 1931, when last committee action was taken*)

DAVID J. PRICE, *Chairman*, U. S. Bureau of Chemistry and Soils, Department of Agriculture.

HYLTON R. BROWN, *Secretary*, U. S. Bureau of Chemistry and Soils, Department of Agriculture.

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EUGENE ARMS, Mutual Fire Prevention Bureau.

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LOGAN J. BORLAND, Conference of Special Risk Underwriters.

NATHAN G. BURGSTER, Western Actuarial Bureau.

W. J. BURK, Association of Governmental Officials in Industry of United States and Canada.

G. F. BUTT, Grain Elevator Construction.

P. J. CONLON, U. S. Department of Labor.

G. R. HURD, Railway Fire Protection Association.

J. A. MULL, Terminal Elevator Grain Merchants Association.

H. E. NEWELL, National Board of Fire Underwriters.

A. H. NUCKOLLS, Underwriters' Laboratories.

ROBERT PALM, Consulting Engineer, Sugar Industry.

S. E. PHILLIPS, Dust Collection Equipment Manufacturing Group.

GEORGE S. RICE, U. S. Bureau of Mines.

EDWIN B. RICKETTS, National Electric Light Association.

JOHN ROACH, International Association of Industrial Accident Boards and Commissions.

F. W. SEHL, National Bureau of Casualty and Surety Underwriters.

PETER STEINKELLNER, International Association of Fire Chiefs and International Association of Fire Fighters.

N. J. THOMPSON, Associated Factory Mutual Fire Insurance Companies.

SCHUYLER VAN LOAN, American Spice Trade Association.

C. E. WOOD, Society of Grain Elevator Superintendents of North America.

National Fire Protection Association

The National Fire Protection Association, with offices at 60 Batterymarch Street, Boston, Mass., was organized in 1896 "to promote the science and improve the methods of fire protection and prevention; to obtain and circulate information on these subjects; and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire." The association has two classes of membership. There are some 140 organization members, including "National institutes, societies, and associations interested in the protection of life and property against loss by fire." The associate membership, which is open to anyone interested, includes over 4,000 architects, builders, merchants, manufacturers, warehousemen, engineers, fire marshals, fire wardens, fire chiefs, electricians, credit men, bankers, insurance agents, and inspectors, chambers of commerce, public libraries, and many other organizations, individuals, firms, and corporations.

The National Fire Protection Association is the internationally recognized standard-making body for regulations for the prevention of fire and for its control and extinguishment. The association operates through some 35 technical committees each having jurisdiction over one section of its standard-making activities. The regulations of the association are purely advisory in character, but after

adoption by the association are largely promulgated by State and municipal authorities as the basis of regulatory measures and are used by the fire insurance organizations as the basis of their requirements.

United States Bureau of Chemistry and Soils

The United States Bureau of Chemistry and Soils, Department of Agriculture, conducts special engineering and chemical research investigations relating to the determination of causes of dust explosions in manufacturing establishments and in the development of methods of control and prevention. The work is conducted in cooperation with other Government departments, State industrial commissions, fire prevention and insurance associations, and other national and State bodies interested in dust explosion and fire prevention.

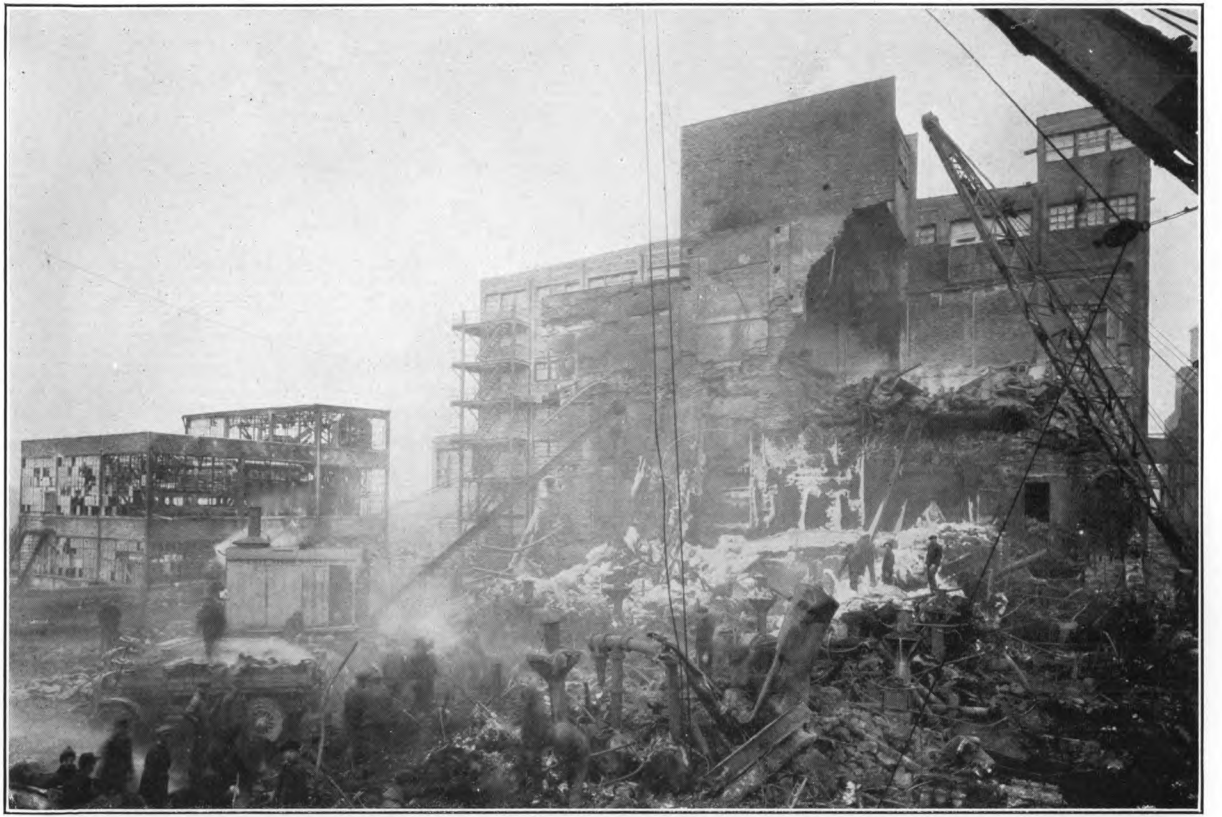
The Bureau of Chemistry and Soils cooperates with the National Fire Protection Association in the work of the dust explosion hazards committee, of which Dr. David J. Price, engineer in charge of the chemical engineering division in the Bureau of Chemistry and Soils, is chairman. The regulations prepared by this committee, and published in the bulletin, embody the control measures developed in the Bureau of Chemistry and Soils as a result of research relating to dust explosion prevention in industrial plants.

Importance of Dust Explosions

The research work of the United States Bureau of Chemistry and Soils, Department of Agriculture, indicates that practically all types of combustible dusts when mixed with air in proper proportions can be readily ignited by external sources of heat or flame. We can more nearly appreciate the importance of this industrial problem when it is realized that a recent Census of Manufactures shows that at least 28,000 industrial plants, employing over 1,324,000 persons and manufacturing products of an annual value in excess of $10,000,000,000, are subject to the hazard of dust explosions. It has been only in recent years that direct attention has been given to the determination of the causes of industrial plant dust explosions and the development of control measures. Large losses of life, property, and foodstuffs are occurring annually from explosions of this character. Many of the explosions are occurring in lines of industry in which dust explosions have not previously taken place. The extension to larger operating scale and the utilization of by-products and waste materials, resulting in the accumulation of large quantities of explosive dusts, have greatly increased the hazard. The introduction of new manufacturing processes, as well as new types of mechanical equipment, have added to the importance of dust explosion prevention.

The regulations of the dust explosion hazards committee have been prepared to assist in the adoption of proper control measures for the prevention of these explosions and the reduction of losses resulting therefrom.

RESULT OF EXPLOSION OF STARCH DUST IN A PLANT IN THE MIDDLE WEST. FORTY-THREE PERSONS WERE KILLED AND 30 INJURED; PROPERTY DAMAGE OVER $3,000,000



EXPLOSION OF STARCH DUST. FORTY-TWO LIVES WERE LOST AND 22 EMPLOYEES INJURED; PROPERTY LOSS, $750,000

EXPLOSION OF STARCH DUST. FOUR WORKMEN INJURED; PROPERTY DAMAGE, APPROXIMATELY $200,000

THE EXTENT OF THIS EXPLOSION OF STARCH DUST WAS LOCALIZED AS THE RESULT OF LARGE WINDOW-GLASS AREA, WHICH PROVED EFFECTIVE IN VENTING THE EXPLOSION

Safety Code for the Prevention of Dust Explosions in Starch Factories

(American Standard, approved September 24, 1931, by American Standards Association)

This safety code applies only to buildings erected subsequent to the adoption of this code.

Introduction.

1. Many factories make wet starch only for subsequent conversion to sugar or sirup, others produce starch only, others produce sugar, starch, and dextrine.

2. The explosion hazard appears in three places: First in the corn receiving and storage departments in the form of grain-elevator dust; second, in the dust arising from the milling and storage of the so-called gluten feed; third, from the presence of starch dust.

3. As to grain storage departments, arrangements shall conform to the Code for the Prevention of Dust Explosions in Grain Elevators. (See p. 15.)

4. As to gluten and feed departments, arrangements shall conform to the Code for the Prevention of Dust Explosions in Flour and Feed Mills. (See p. 11.)

5. These regulations relate specifically to the hazard involved in the handling of dried starch.

6. This hazard is characteristically present first at the kilns, and follows all processes involving the handling of the starch from the kilns up to and including the packing operation.

7. It is now generally accepted that any kind of starch dry enough to float in air is dry enough to contribute to an explosion, even though the department may be one in which the air is quite humid.

Definitions.

In this safety code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

1. Construction and arrangement of buildings.

11. The four operations of (*a*) starch drying, (*b*) dry starch grinding and grading, (*c*) pearl and powdered starch bulk packing, and (*d*) lump starch cooking, pressing, grading, and packing shall be in four separate buildings, which shall be removed at least 50 feet from any other, and not be a part of or standing within 50 feet of buildings containing operations of manufacturing. If there is a dextrine department, it shall be separate and conform to the regulations hereinafter applying to lump starch pressing, grading, and packing. Edible corn starch and package goods, other than bulk packages, may be packed in the lump starch department (*d*).

12. The buildings housing the last three operations, (*b*), (*c*), and (*d*), shall be of daylight type construction, with large windows of thin glass with at least 50 per cent of the wall area of windows, or other light construction that shall not offer greater resistance to explosions than glass area. Door openings along loading platforms shall be accepted as equivalent to glass or other light construction. Buildings should not be more than three stories above the basement in height.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of requirements for glass or equivalent area.

13. Construction shall be fire resistive.

14. Transfer of starch between buildings shall be only by cart over a tramway; or by inclosed spiral conveyors, equipped with a positive seal or choke, under wide shed roofs, or by inclosing galleries having sides at least 50 per cent open; or by other approved means.

15. All walls shall be finished smooth and irregularities of contour brought flush with the surface, or filled to reduce lodgment of dust to a minimum. It is recommended that these surfaces then be finished with white enamel paint. The surfaces of all posts shall be brought to conform to this regulation. All ceilings and beams shall be smooth finished, without crevices or ledges or roughness, such as would provide attachment for dust. All floors shall be surfaced smooth with cement or composition, or shall be of wood finish without crevices or pockets offering lodgment for starch dust.

16. There shall be no floor openings other than those necessary for the spouts and bin openings. Crevices between floors and spouting shall be tightly closed with either hard or plastic cement to prevent drafts through the floor. Stairs and elevators shall be outside of the walls of the buildings, with fire doors on communications at floor levels, or may be within the building if inclosed by fire walls with fire doors on any stair or elevator opening into the building. Door openings to uninclosed outside stairs shall be protected by standard fire escape doors.

17. There shall be no locker or change rooms within these departments.

2. Kilns.

21. Except where kilns extend solid from floor to roof the top of kilns shall be finished smooth with cement, and the roof of the building shall be not less than 6 feet above the surface of the top of the kilns, so that this surface may be easily accessible for cleaning. It is recommended that this space above the kilns and below the roof be entirely walled off from the rest of the kiln house by a fire-resistive partition extending from the kiln structure to the roof about the perimeter of the kiln structure, this space to be lighted and ventilated by skylight, and if possible by doorways and windows in one or more exterior walls of the kiln house.

22. Operations in the kiln building shall be limited to charging, discharging, dumping, and preliminary reeling of starch.

23. The starch dumps shall be under hoods of fire-resistive construction, ventilated by fans of sufficient power to prevent escape of dust when dumping, exhausting to water spray type collector, or cyclone or cloth dust collector, housed in fire-resistive shelters above

the roof of the kiln house or in other locations safely isolated from the building. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1])

24. In hot air drying systems, the inlet and outlet to and from the drying tunnels shall be entirely above the level of the tunnel floors.

3. Dry starch grinding and grading.

31. *Dry* dust-collecting systems for apparatus ahead of the mills shall be separate from the collecting systems for apparatus after the mills. The apparatus immediately after the mills should preferably have its own collecting system, which should be independent for each mill.

32. All hoppers for bulk starch shall be provided with an explosion relief panel in one wall, or in the top, with area equal to at least one-third the horizontal cross section of the hopper. This panel shall be built so as to give way to outside of the building. The separation between hoppers shall be by partitions of at least twice the strength of the explosion relief panels. All hoppers shall be so constructed as to minimize arching of the stock. The slope of the walls of the bottom of the hopper shall not be less than 60° from the horizontal. The interior of hoppers shall be finished smooth, preferably with shellacked hardwood; if of steel, the seams shall be lap joints and shall have the projecting edge faced downward.

33. All starch before milling shall pass a ½-inch or smaller mesh screen, and electromagnetized pulley-and-belt separator, or shall be raised by air lift.

34. The grinding chambers and all parts within the grinding chambers of the mills should be of brass, bronze, or other non-sparking metals.

35. Each mill shall be effectively isolated from the trunk line of transfer of stock, such as by individual rotary valves, or by effective choke conveyors, before and after the grinding device with the space between the valves or chokes fitted with adequate pressure relief vent to outside air.

4. Pearl and powdered starch bulk packing.

41. Hoppers in this department shall conform to section 32.

42. If there are five or more barreling or bagging stands in one assembly, the floor surrounding the stand shall be of grating so arranged over a spiral conveyor as to receive and remove the fall of starch to prevent its being trodden under foot.

5. Lump starch cooking, pressing, grading, and packing (including permissible packing of edible starch and other so-called package goods).

51. The cooking room, the pressing and opening room, the cylinder seasoning room, the grading room, and the packing room shall each be separated from the additional space on the floor on which it is located by draft-stopping partition of fire-resistive construction. The cooking room and the pressing and opening room shall be ventilated by draft fans exhausting outdoors, or if desirable, to water spray type collector or cyclone or cloth dust collectors in fire-resistive

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street Boston, Mass.

inclosures on the roof, or in other locations safely isolated from the building. There shall be a separate system of fans, ducts, and collectors for each department, and the collector housings shall be placed as remote from each other as the arrangements of the premises will permit. The doorways in these partitions shall be provided with self-closing doors, so as to prevent the dust in the department from escaping into other departments, except when people or objects are passing the doorway.

52. The floors about the presses shall be provided for as about barreling and bagging stands, section 42.

53. All hoppers for ground or powdered starch shall conform to regulations under section 32.

6. Control and removal of suspended dust.

61. All elevator legs, spouting, screw conveyors, stock hoppers, bins, and grading machines shall be dust tight, and shall be equipped with mechanical exhaust to dust collectors so that dust will not escape from the apparatus under conditions of use and inspection. Each department shall have its own complete dust-collecting system.

62. When a water spray type collector is used it may be within building. Collectors of cyclone type shall be vented directly outdoors or to a secondary system of similar collectors which are vented to the outside air. If cloth collectors are used they shall be located in fire-resistive housings on the roof of the building or at other locations safely isolated from the building. All wind trunking of such systems shall be of metal.

63. Dust escaping from filling machines or in hand-filling operations shall be controlled by properly arranged collecting hoods connected with mechanical exhaust.

7. Removal of static dust.

71. All surfaces on which dust settles shall be cleaned off sufficiently often to prevent the accumulation of a coating of dust.

72. The cleaning of surfaces shall be by vacuum sweeping apparatus, if it can feasibly be applied, and if not, shall be by soft brushes or wipers or mops of loose fabrics.

73. For removal of dust from motors, building should be equipped with a stationary compressed-air system, operating at from 80 pounds to 100 pounds pressure. Fixed compressor piping systems shall be of extra heavy type, and the compressors and receivers shall be stationary and shall not be located in dusty departments. This apparatus shall not be used while department is operating.

74. Kiln-tray repairing department shall be separated from adjacent occupancy by dust-tight fire-resistive partitions, and shall be daily cleared of starch dust accumulations.

75. Starch bags shall not be cleaned in the open, but may be cleaned by drawing over the nose of a draft spout, or by shaking them within an open top inclosure under mechanical draft sufficient to prevent the escape of the dust into the room, or by other completely inclosed bag cleaning device.

8. Prevention of ignition.

81. Open flames or igniting surfaces shall not be permitted.

82. Smoking and the carrying of matches shall not be permitted.

83. Electrical equipment shall be installed according to the regu-

lations of the National Electrical Code,[1] article 32, which covers electric wiring and apparatus in dusty locations.

84. Static electricity shall be removed from such machines as accumulate a charge by permanent ground wires, and from belts by grounded metal combs or other equally efficient systems.

85. Fans and blowers shall be so constructed that fan blades cannot come in contact with fan housing. Bearings shall set well away from fan housing to prevent the forcing of grease to the inside of the fan housing or air chamber. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1])

86. Ball or roller bearings should be used whenever practical, otherwise ring, chain, or roller oiler bearings should be used.

9. Mechanical precautions.

91. The speed of revolution of spiral conveyors shall not exceed 100 revolutions per minute, and graphite buttons or other suitable material shall be inserted in the bearing surfaces of all inner bearings. When feasible the upper half of the bearing may be removed to permit the stock to move freely over the bearing surfaces.

92. All elevator legs should be equipped with an automatic overload release, or a signal system which will register when the leg begins to slow down, thus indicating to the operator the possibility of choke at the boot.

93. Attention is directed to the fact that warning of the overheating of bearings, in dusty and inaccessible locations and where the heating of the bearing may cause explosions, may be obtained by the use of approved journal alarms.

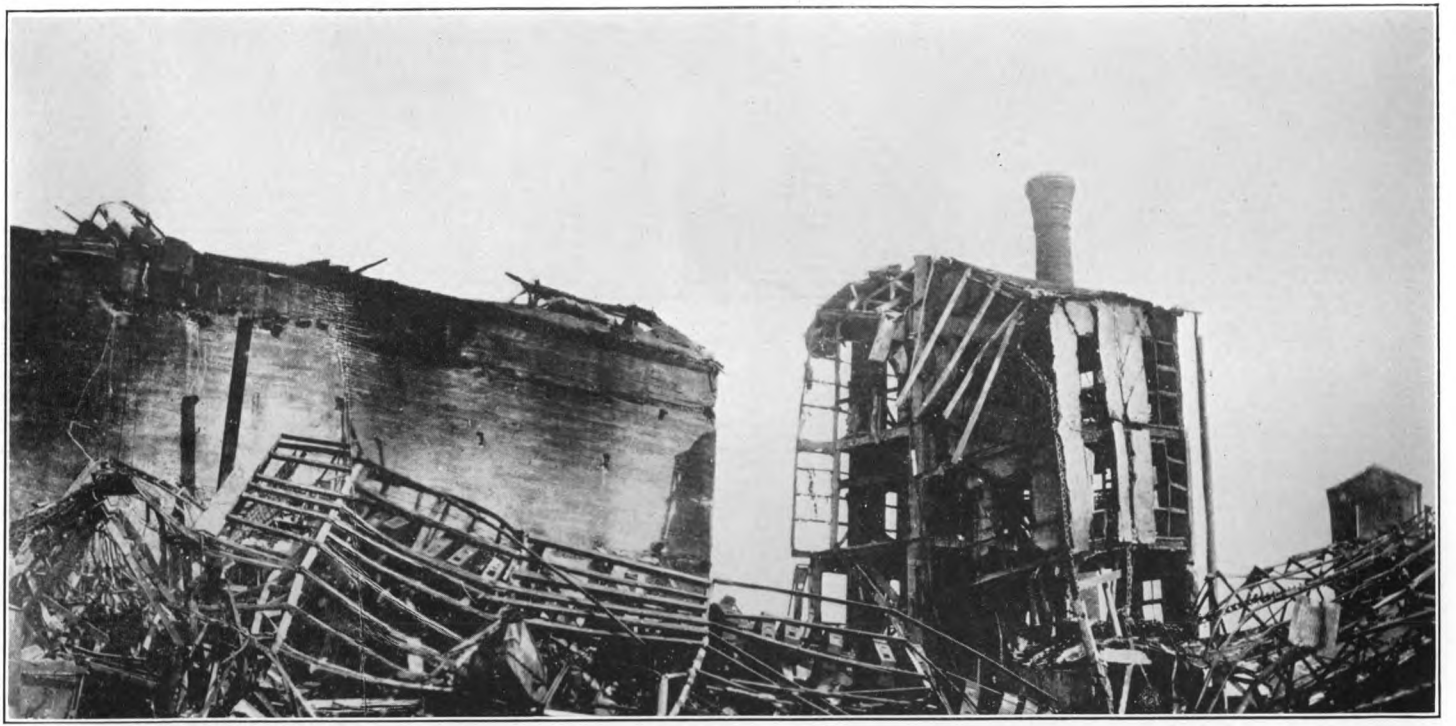
10. Housekeeping.

101. All of the departments devoted to the handling and packing of dry starch shall be kept free of stored material of every sort, other than starch which has just been packed and is about to be removed to the warehouse. This requirement embraces new and discarded machinery and parts not in use and pieces of apparatus.

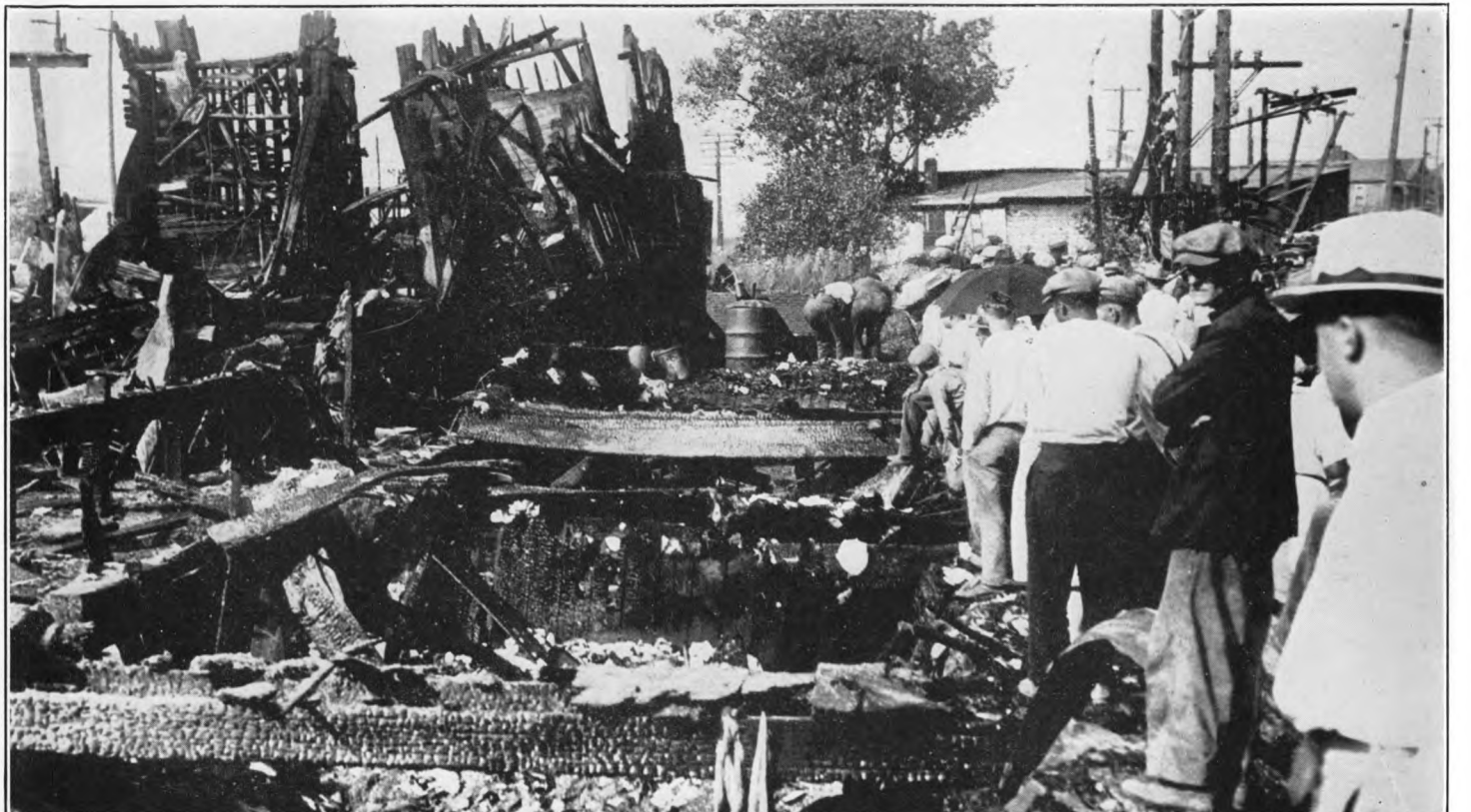
102. Efficient help and methods shall be employed to prevent miscellaneous dust clouds and to keep the departments clean at all times, and no accumulations of starch dust shall be permitted on any surfaces, other than those immediately about places where starch is being handled in the open. The word "accumulation" as used here is to be interpreted as that amount of dust which is sufficient to obscure the view of the surface. All spills of starch from apparatus and accumulations gathered in cleaning of surfaces shall be shoveled up and sacked as made, and removed from building or to a recovery department, or else returned to the stream of starch in process where trade practice permits.

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

RESULTS OF EXPLOSION OF FEED DUST. ONE MAN WAS KILLED AND THREE INJURED; PROPERTY DAMAGE FROM EXPLOSION AND RESULTING FIRE, APPROXIMATELY $1,000,000



EFFECTS OF EXPLOSION OF FEED DUST. THIRTY-THREE WORKMEN WERE KILLED AND 80 INJURED; PROPERTY DAMAGE, OVER $450,000



DUST EXPLOSION AND FIRE IN A FEED MILL. TWO MEN WERE KILLED AND TWO INJURED; PROPERTY DAMAGE, $75,000

EXPLOSION OF FLOUR DUST. DAMAGE CONFINED LARGELY TO UPPER FLOORS ON ACCOUNT OF WINDOW-GLASS AREA WHICH SERVED AS AN EFFECTIVE VENTING METHOD

Safety Code for the Prevention of Dust Explosions in Flour and Feed Mills

(American Standard, approved January 12, 1928, by American Standards Association)

Definitions.

In this safety code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

Construction of buildings.

1. *Mill.*—The "daylight" type of mill building (with large window area) is recommended. Wired glass should not be used unless necessary as protection against exposure.

2. Fire-resistive construction or mill construction is recommended.

3. Cleaning department shall be cut off from other departments by standard fire walls or cut off in other standard manner.

4. *Elevator and storage bins.*—All storage bins shall be covered, the side walls extending solidly to the roof of the bins, there being no connection between bins.

5. Tunnels and basements shall extend as much above natural ground level, and shall be as large and roomy as is practicable. All tunnels and basements shall be dry and shall have all the natural light possible to obtain, either by means of windows, areaways, or sidewalk glass.

6. Basements of all buildings shall be of such construction as to permit the free circulation of air to all parts and shall be vented by air shafts exhausting above the roof or by other approved method.

7. *Mill, elevator and storage bins.*—Construction shall generally be such that all interior walls, including bin walls, shall be smooth and free from pockets or ledges that will permit the accumulation of dust. In special cases where it is not practicable to entirely eliminate ledges, then such ledges shall be finished with smooth surface and be made as steep as possible. All pipes, conduits, etc., that of necessity are exposed, shall be fastened to walls or ceilings in such manner as to present a minimum surface for the collection of dust.

8. Roofs and side walls of belt conveyor galleries and the side walls of all cupolas above bins shall be constructed of light material offering little or no resistance to explosive energy.

NOTE.—The term "light material" contemplates corrugated galvanized iron, corrugated zinc, corrugated asbestos, brick tile, or gunite, and for cupola construction is intended to apply only to curtain or panel walls between columns. Concrete may also be used similarly, provided the window area is greater than 40 per cent of the free wall area.

Control and removal of suspended dust.

9. All elevator legs, spouting, roll housings, screw conveyors, and stock hoppers and bins shall be dust tight.

10. All roll housings, elevator heads, and elevator boots on large stands of elevators shall be vented by mechanical exhaust to dust collectors.

11. Dust collectors shall be of the metal cyclone type and each shall be vented directly out of doors or to a secondary system of similar collectors which are vented to outside air.

12. Wind trunking shall be of tight metal.

13. Belt conveyors shall be provided with hooded air suctions at either or both ends when practical.

14. All grain bins (except tempering bins) shall be vented to the outside air with a 12-inch or larger metal pipe properly hooded to prevent the entrance of excessive moisture.

Removal of static dust.

15. Good housekeeping is a requirement of the utmost importance. Dust, either in large or small quantities, must not be permitted to accumulate on floors, walls, ledges, or other interior surfaces, as the presence of such dust represents a very positive dust explosion hazard. All surfaces on which dust tends to settle shall be cleaned sufficiently often to prevent the accumulation of a coating of dust.

16. For removal of dust from motors, drier coils, and other such surfaces, mills shall generally be equipped with a compressed-air system operating at from 80 pounds to 100 pounds pressure. Either a fixed compressor with suitable piping and hose, or a portable compressed-air tank may be used. When the latter is used it shall be provided with a tank of sufficient capacity to maintain pressure for a considerable length of time, making it unnecessary to bring the tank to pressure while in the mill.

17. The use of vacuum sweeping systems is recommended for the removal of static dust in grain storage and elsewhere when practical.

Prevention of ignition.

18. Open-flame heating or lighting arrangements and other devices where dusty atmospheres may come in contact with direct fire or flame are prohibited.

19. Open-flame heaters or electric heaters shall not be used except in such locations as in a laboratory where not exposed to dust.

20. Smoking and the carrying of matches shall not be permitted.

21. Electrical equipment shall be installed according to the regulations of the National Electrical Code[1] for electrical devices in dusty locations.

22. Static electricity shall be removed from such machines as would otherwise accumulate a charge by permanent ground wires and from belts by grounded metal comb or by other equally efficient methods.

23. Fans and blowers shall be so constructed that fan blades can not come in contact with fan housing. Bearings shall set well away from fan housing to prevent the forcing of grease to the inside of the fan housing or air chamber. (See Regulations of the National

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Fire Protection Association for the Installation of Blower and Exhaust Systems.[1])

24. Ball or roller bearings should be used wherever practical, otherwise ring, chain or collar oiler bearings shall be used.

NOTE.—Attention is directed to the fact that warning of the overheating of bearings, in dusty and inaccessible locations and where the heating of the bearing may cause explosions, may be obtained by the use of approved journal alarms.

25. Pneumatic or magnetic separators (preferably pneumatic) shall be placed ahead of all grinding or pulverizing machines of the roller, attrition, or beater type (except those grinders which further reduce the ground stock in the same system and those machines grinding bulky stock on which separators can not be operated). In addition to the above such separators shall be placed ahead of scourers where used.

26. Stock from each attrition mill or beater type of grinder should be lifted by air through a metal wind trunk to a cyclone dust collector properly vented or be discharged into a metal screw conveyor. The flights on the conveyor shall terminate 18 inches or farther from the discharge and in such a way as to form a solid mass of stock at that point. The cover of conveyor at the discharge end shall be held in place by springs to give relief if the spout receiving stock from the conveyor should choke.

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Safety Code for the Prevention of Dust Explosions in Terminal Grain Elevators

(American Standard, approved September 24, 1931, by American Standards Association)

Definitions

In this safety code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

Section 1.—Introduction

101. *Object.* These regulations have but two principal objects: First, to prevent dust explosions and minimize the resulting damage, should an explosion occur; and second, to provide regulations for minimizing fire hazards.

102. These regulations are applicable to terminal grain elevators erected subsequent to the date of these regulations. These rules are offered as an advisory guide for owners and operators who may wish to avail themselves of the information herein contained to improve existing elevators.

103. *Good housekeeping and clean premises are the first essentials in the elimination of explosion hazard, consequently these regulations are not intended to lessen in any way the responsibility of the owner or operator in this respect.* It should also be emphasized that every potential fire cause may produce a dust explosion. All devices and processes should be safeguarded in accordance with the regulations applying.

Section 2.—Structural Features

Construction.

201. As all new elevators of large capacity will be of noncombustible construction, with probably no exceptions, these regulations will assume and require such construction. Full fire-resistive construction (all steelwork protected by approved fireproofing) is not required if combustibles in or exposing building consist only of grain and belts. Where combustible material (other than grain and belts), in whatever form, is present in quantity sufficient to produce a serious fire, all steelwork exposed thereby should be protected by approved fireproofing. In situations where extension of automatic sprinkler protection to such parts of buildings containing combustible materials is feasible, such protection is recommended, and if so equipped the requirement for fireproofing is waived.

Surfaces and ledges.

202. All interior surfaces, including the inside of bins and garners, shall be as smooth as practicable. Horizontal surfaces inaccessible to cleaning and all pockets and ledges shall be minimized. Such as must necessarily exist shall be inclined as steeply as possible.

Walls and roofs.

203. All exterior walls above or below the bins or tanks in the working house and storage annex sections of the elevator, also the walls of belt conveyor galleries and track sheds and the roofs of all buildings or sections shall be so designed and constructed as to offer the least possible resistance to explosion. In so far as possible, the roofs and walls of tunnels between buildings or sections shall conform to the foregoing, although it is recognized that tunnels generally must be of heavier construction. Reinforced concrete is more generally used than all other materials for walls, floors, and roofs, except that steel is commonly used for track sheds and conveyor galleries. The lighter the construction the less damage will result from an explosion, but the type employed will be influenced by considerations of cost, permanence, ease of obtaining smooth interior finish, condensation of atmospheric moisture, etc., though it is desirable that a thoroughly satisfactory type of light construction be developed. With concrete or other heavy wall construction dependence for explosion venting must continue to be placed on large window area, which is also desirable even with light construction, as glass offers much less resistance than the lightest practicable wall construction. Glass should be no thicker than necessary. Wired glass should be used only where necessary as protection against exposure.

Track shed.

204. Track shed for unloading and (or) loading of cars shall be separated from the elevator by a tight noncombustible partition to exclude dust from elevator, or by as much clear space as practicable. Windows in partition should be stationary, and doors, if any, self-closing.

Locations.

205. As great a space as is practicable shall be provided between the various buildings or sections of the elevator, but in no case less than required by the inspection department having jurisdiction.

Communications.

206. At the points where belt conveyor galleries or tunnels are connected to main buildings, tight incombustible partitions shall be provided. When communicating with structures wholly or partly of combustible construction, partitions shall be of fire resistance equal to adjoining noncombustible walls. Belt openings in the partitions shall be as small as possible and equipped with a vertical automatic fire door with roller at bottom, closing down on belt, leaving smallest possible opening when closed. Door opening shall be protected by self-closing fire door. All fire doors shall be of approved class A type if partition is of masonry; if partition is of metal approved class B or class C doors may be used. All other

openings toward or into the combustible structure shall be protected by approved fire doors, shutters, or fire windows as required by inspection department having jurisdiction. The requirement for self-closing doors on communications is to prevent circulation of dust-laden air.

NOTE.—For the installation of fire doors and shutters see Regulations of the National Fire Protection Association on the Protection of Openings in Walls and Partitions.[1]

Bins and tanks.

207. All bins and tanks should be provided with dust-tight cover or deck.

NOTE.—If bins are covered, bin floor should be water-tight to prevent water damage to grain in event of explosion or fire, and manholes should be curbed at least 2 inches, with overlapping covers. Curbs may be sloped if desired. Bin floor should be scuppered. For standards applying to scuppers see Regulations for Mill Construction.[1] Manholes should be large enough to admit workmen wearing respiratory apparatus; 24 inch diameter is suggested.

Basements, tunnels, and galleries.

208. Exterior walls of basements and tunnels should have as much natural light and ventilation as possible. Tunnels and galleries should be of such width and height as to afford easy access for sweeping on both sides and under each belt.

Shafts.

209. All stairways and passenger elevators shall be inclosed in tight noncombustible shafts, with all doors noncombustible and self-closing, or closed from within by elevator operator. Stairs from basement to working or first floor shall not be continuous with stairs from working floor to floors above. Where elevator leg belts are in an inclosed beltway between bins, such inclosures should be tightly closed at top and bottom, and hoppered to prevent accumulation of dust.

Section 3.—Ventilation

Windows.

301. All buildings and operating rooms shall be provided with the largest practicable area of windows, or a combination of windows and louvers. Windows shall be easily accessible for operation, shall be arranged to provide maximum ventilation when open, and shall preferably be of the hinged or tilting type.

Basements, etc.

302. All rooms and areas, including basements, tunnels, and galleries, and space around track hoppers, shall be well ventilated, by windows or otherwise. Basements more than 100 feet wide should be ventilated by one or more noncombustible shafts extending above roof, or by other suitable means to provide frequent change of air, forced draft to be used if necessary. Permanent openings in basement for admission of air should be provided. During periods of operation all windows and exterior doors should be open unless weather conditions prevent.

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[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Roofs.

303. Roofs of track shed, cupolas, galleries, and tunnels should be provided with monitors or other ventilators which will, in conjunction with windows, provide frequent change of air.

Venting of bins and tanks.

304. Each bin or tank, including interspaces, shall be provided with adequate positive air aspiration, or shall be separately vented to outside. If the latter, each vent shall be equivalent in area to a round opening 12 inches in diameter or larger. All vents, wherever possible, should be vertical stacks, and should be equipped with a weather hood of a type that will not permit wind to blow into vent. Where there is a story above the bins, such vent may necessarily be located in the side of bin immediately below its top, in which case the terminal of vent shall be of special design which will not permit wind to blow into vent. No portion of vent shall be other than vertical if such arrangement is possible, on account of liability of choking with accumulation of dust.

305. If a vertical stack or air aspiration can not be installed on a bin or tank on account of interference with operation of house, or structural conditions, stack may be inclined not more than 45° from vertical, and where necessary, two or more such stacks may be connected to a common header stack and thence to the outside. Such stacks (including header) may be inclined not more than 45° from vertical. There shall be no intercommunication of bins except through stacks which may necessarily join in a common header stack as above.

Section 4.—Equipment

Elevator legs.

401. Elevator leg belts shall be inclosed in separate casings for both up and down legs, except where running through belt way between bins. (See item 209.) Heads shall be hoppered to either the down or up leg, but not to both. Leg casings and connecting spouts shall be dust tight. All doors or other openings in same shall be equipped with dust-tight covers. Wood or wood rim pulleys shall not be used. Boots should be above floor, rather than in pits, but if latter, should be afforded ample room for cleaning and oiling, be accessible by permanent iron ladder, and well lighted without the use of extension cords.

402. Elevator boots should be so constructed as to minimize the possibility of chokes.

403. Where grain is delivered to boot by conveyor belt, the latter should be equipped with an automatic mechanical or electrical device that will stop the belt or notify operator when the leg chokes or slows down.

Power.

404. Legs should be driven by individual motors. Motors shall be large enough to elevate maximum amount of grain that can be delivered by largest single tributary spout or conveyor. Motors shall be equipped with approved overload protection and no-voltage protection. All legs should be equipped with a tamper-proof safety device to either call attention of operators to leg slowing down or to stop leg automatically in event of choke.

Back stops.

405. Elevator legs should be equipped with special automatic back stops.

Legs, etc., run idle.

406. All legs, conveyors, machines, car pullers, etc., shall have individual connections to power source, and shall not be run idle.

Cleaners.

407. All cleaning, or other grain processing machinery should be of noncombustible construction. When wooden machines are used, such machines should be metal clad; i. e., metal sheathing is tightly secured to all wooden surfaces that may feasibly be so covered. All clippers, smutters, and scourers shall be equipped with a screen to exclude all matter of larger size than the grain treated by the machine.

Space under machines.

408. All cleaners and similar machines should be set at least 8 inches above floor to provide access for sweeping.

Electromagnetic or pneumatic self-cleaning separators.

409. Electromagnetic or pneumatic self-cleaning separators shall be provided ahead of all shellers, crackers, crushers, and grinding machinery.

Friction clutches.

410. If friction clutches are used, they shall be constructed entirely of noncombustible material.

Screw conveyors.

411. Screw conveyors shall be fully inclosed in tight substantial metal housings, with free-lifting covers at discharge and over each shaft coupling.

Bearings.

412. Roller or ball bearings are recommended for all boot pulleys, fans, cleaning, processing, or grinding machinery, trippers and belt conveyors. Ordinary sleeve or flat bearings in old equipment should be equipped with approved journal alarms. All bearings should be provided with dust caps or other tight closure of all lubrication inlets.

Space under conveyors.

413. There should be at least 6 inches clear space under all rollers supporting conveyor belts, to provide access for sweeping.

Nonchoking devices.

414. All garners should be equipped with a reliable "telltale" or other device which will guard against overfilling, with consequent possibility of a choke in leg.

Spouts and throw of grain in the open.

415. Spouts shall be stationary wherever feasible. Portable and movable spouts will be permitted in working floor, bin, or distributing floor. There should be no throw of grain in the open for considerable distances not confined in spouts (not applying to discharge of grain inside of bins). Grain chutes also permit large amounts of

dust to escape and should not be used if their use may be dispensed with.

NOTE.—Dropping grain from bin bottoms or conveying in open chutes releases dust clouds dense enough to explode and scatters large amounts of dust which must be swept up, producing a highly undesirable condition in an elevator in which all other danger spots may be well safeguarded. Specially designed aerators located on the exterior of elevator or separated from same by a space, are now used to some extent and are recommended as removing a dust-creating process from the working story to the open air.

Spouting of grain into bins or tanks.

416. Spouts introducing grain into bins or tanks should be arranged, where possible, to prevent grain stream striking side of bin, on account of the possibility of tramp iron striking a spark on contact with side.

Section 5.—Grain Driers

Location.

501. Driers should be placed in a separate fire division, separated from elevator or tanks by as much space as practicable.

Separation.

502. Drier units should be separated from each other by dust-tight partitions.

Louvers.

503. Louvers, or other permanent openings where air enters or is exhausted from buildings, shall be protected by substantial corrosion resistive wire screens, not exceeding one-third inch mesh, to exclude sparks, birds, paper, etc.

Belt conveyors.

504. Belt discharge above drier and belt loader below cooler (where belts are used) shall be equipped as required under items 602 and 603.

Garners and hoppers.

505. Garner, hopper, or bin over drier and same under cooling section shall be dust-tight and provided with adequate positive air aspiration or effective vents to outside. If grain is brought to drier by belt, the belt shall not enter garner but shall discharge into spout or aperture in closed top of garner.

NOTE.—No special ventilation is required for hopper open to cooler which is under suction.

Removal of refuse from grain.

506. Where operating conditions permit, all grain should pass over a coarse screen immediately ahead of drier to remove cobs, paper, sticks, etc.

Top of drier.

507. Top of drier should be open, so that there will be no surface on which dust will lodge, also to provide access for cleaning out refuse which may lodge on ducts. If closed, the top should be inclined at a steep angle, or hopper from garner should be same size and shape as top of drier.

Floors.

508. Where floors or runways around drier and cooler are necessary, same shall be of gratings. Where air separation is necessary (as between drier and cooler) it shall consist of dust hoppers under the grating floor, such hoppers to be connected at bottom to dust-collecting system.

NOTE.—Solid floors may be used if all air is drawn from drier and cooler through continuous ducts to fan and blown to dust-settling chamber with hopper bottom connected with dust-collecting system.

Floor sweeps.

509. A floor sweep ("sweep-up" pipe) shall be located on each solid floor in building containing drier. The development and installation of satisfactory permanent vacuum sweeping apparatus is recommended.

Fans.

510. Fans and power for same shall conform to Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1] The requirement for nonferrous parts (item 411 of blower regulations) shall apply unless blowing only air taken from outside building through continuous tight duct. Power and control shall conform to section 140, and items 151, 152, and 153 of the blower regulations.

Steam coils.

511. (*a*) Steam coils shall be so designed, installed, and arranged that dust will not lodge on coils, headers, or elsewhere in casing containing same. Coil room shall be separated by dust-tight partitions and floors from drying section and all other parts of drier house.

(*b*) If coils heat air which has passed through cooler there should be baffles or other arrangement to remove husks, paper, etc., so that same will not go through either fans or coils.

(*c*) Room containing coils shall have grating floor, and if system requires separation from room below, same shall consist of dust hoppers under the grating floor, such hoppers to be connected at bottom to dust collecting system. This rule shall not apply if room containing coils is segregated as recommended in items 512 (*a*), or if all air is drawn from drier and cooler through continuous ducts to fan and blown to dust settling chamber with hopper bottom connected with dust collector system, but floor of coil room shall be so arranged that hand sweeping is not rendered difficult by obstructions.

Fire-heated driers.

512. (*a*) Furnace shall be located in a fire-resistive room or division separated from drier and elevator by masonry walls with no communication to drier except duct for products of combustion.

(*b*) Driers shall be equipped with a reliable automatic means for regulating temperature in drier, and a separate and independent automatic device which will effectively and reliably prevent temperature rising to a dangerous point.

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[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

(σ) It would be highly desirable to devise some effective means of preventing the introduction of sparks (flakes of carbon, etc.) into the drier along with the products of combustion.

Section 6.—Removal of Dust from Grain-Handling Equipment

Heads, boots, garners, and scales.

601. All heads, boots and garners, shall be dust-tight and provided with adequate positive air aspiration or effective vents to outside. Scale hoppers shall be inclosed around top, between scale and garner, to effectively prevent the escape of dust, and shall be provided with aspiration or vent as above, or may be vented into garner by means of any effective special arrangement.

Belt loaders.

602. All places where grain is discharged onto belts shall be provided with adequate positive air aspiration, except where equipped with specially designed choke feed or other arrangement which is effective in preventing the liberation of dust.

Belt discharges and trippers.

603. All places where belts discharge grain should be provided with adequate positive air aspiration both above and below grain stream. Trippers may be equipped with a self-contained fan unit mounted on tripper carriage and driven by the belt, or by other effective means. It is recommended that air aspiration or other effective means be applied to ends of belts where no grain is discharged, to prevent tailings of chaff and dust accumulating on floor at end of belt.

Machines.

604. All cleaning and similar machines which produce an appreciable amount of dust shall be provided with adequate positive air aspiration.

Dust-collecting system.

605. The entire dust-collecting system shall conform to Regulations for Blower and Exhaust Systems. All collected dust shall be stored in dust house or vault located outside and as far detached as practicable. (Much valuable information is contained in Underwriters' Laboratories Report of an Investigation of the Suction Method of Control of Floating Dust in Terminal Grain Elevators, dated February 26, 1924.[2])

Shipping galleries.

606. Discharge from belt or transfer from one belt to another at a distance of 100 feet or more from elevator may be exempted from requirement for air aspiration (items 602 and 603) at discretion of inspection department having jurisdiction, if gallery is adequately ventilated by windows at such points.

Car unloading.

607. The dust liberated by car unloading, and especially where car dumpers are used, should be controlled by inclosing as much of the

[2] Obtainable from the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.

top of the track hoppers as possible and by applying adequate positive air aspiration to such inclosures, or by other effective means.

Section 7.—Removal of Static Dust

Sweeping.

701. Dust on floors and other surfaces, including all galleries and tunnels, shall be removed daily by sweeper. As many sweepers shall be employed as are necessary to keep the building clean. Push brooms of hair or soft fiber are recommended, as they will throw less dust into suspension than ordinary brooms and are better adapted to sweeping under belts and other machinery. Spills and chokes shall be cleaned up daily. (See item 907, Shovels.) General cleaning should not be done with compressed air (for use in cleaning motors, see note under item 802 (*b*). The development and installation of satisfactory permanent vacuum sweeping apparatus is recommended.

Floor sweeps.

702. Floor sweeps ("sweep-up" pipes) shall be located at convenient points throughout building to facilitate disposal of sweepings by introducing them into dust collecting system. The development and installation of satisfactory permanent vacuum sweeping apparatus is recommended.

Section 8.—Electrical Equipment

Wiring and equipment.

801. All electric wiring and equipment shall conform to National Electrical Code.[1] All parts of grain elevators, tanks, and driers shall be considered Class II locations under article 32, except offices and similar locations so occupied and segregated as to be reasonably free from dust and so classed by inspection department having jurisdiction.

Motors.

802. (*a*) Individual motor direct connected (or through suitable speed-reducing devices) to each head pulley, conveyor, cleaner, car puller, fan, etc., shall be the standard hereunder.

(*b*) Of the permitted types of motors for Class II locations (National Electrical Code [1]), preference should be given motors listed by Underwriters' Laboratories as suitable for use in atmospheres containing grain dust.

NOTE.—Uninclosed motors, such as are used in many elevators, gather dust in the windings, which is blown out by compressed air. While objectionable because it throws dust into suspension, periodic cleaning is necessary, and no better method being known, it is recommended that such motors be blown frequently under supervision of plant electrician. Motors shall not be blown while running.

Switch room.

803. In all large elevators it is recommended that service entrance equipment, panel boards, and switchboards be located in a room as described in National Electrical Code, item 3204 (*b*). It is also

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

recommended that such room be adequately vented to outside building if large oil immersed switches are used.

Light for bins.

804. It is recommended that portable spotlights of suitable design and approved construction, to be directed into bin through manhole, be used as temporary or occasional lights for bin examination, instead of extension cords let down into bin. (See 3204 (j) of the National Electrical Code.[1])

Lighting.

805. Lighting shall be incandescent electric, conforming to provisions of National Electrical Code. Watchman shall use electric lantern or flash light, or a separate light circuit on each floor for use of watchman shall be provided. Electric lanterns or flash lights shall be used in elevators where electric current is not available.

Section 9.—Miscellaneous

Heating.

901. Heating should be steam from outside source. Radiators and pipes shall be kept free of all combustible material. Approved electric heaters will be permitted in offices and similar locations so occupied and segregated as to be reasonably free from dust, and so classed by inspection department having jurisdiction.

Sulphur bleacher.

902. Sulphur bleacher shall be of noncombustible construction and located outside. Furnace shall be outside, not exposing any combustible material. Fumes shall pass through cooling chamber with at least 25 feet travel through cooler and piping, or if no cooler, through at least 40 feet of pipe before entering bleaching tower.

Protection against sparks.

903. All openings less than 50 feet above ground, in exterior walls on track or dock side, should be protected against sparks by substantial galvanized wire screens of one-third to one-quarter inch mesh.

NOTE.—This is especially necessary for wooden elevators.

Locomotives excluded.

904. Steam locomotives should not be permitted to enter elevator or track shed, on account of the spark hazard, and possibility of live coals dropping into track hoppers.

Railway cars.

905. Railway cars shall not be allowed to remain inside car shed or elevator, nights, Sundays, holidays or when elevator is shut down and not in operation.

Insect control.

906. (*a*) Processes and materials for extermination of weevil, Mediterranean moth, etc., shall be without fire hazard, or with hazard reduced to an acceptable degree. Materials used for this purpose, if combustible, shall not be stored in building, and quantity in building shall be limited to that needed for use on the day brought in.

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

(*b*) Materials used for this purpose shall not be sufficiently irritating or toxic to human beings to prevent entry while process is being used. Materials and methods of application shall be acceptable to the inspection department having jurisdiction.

NOTE.—Revision of paragraph 906 is under consideration by the committee with a view to harmonizing with the Recommended Good Practice for Fumigation, prepared by the National Fire Protection Association Committee on Fumigation Hazards.

Shovels.

907. In shoveling of grain, dust, and other refuse on concrete or steel bin bottoms, floors, etc., the danger of igniting suspended dust by sparks should be reduced by equipping the cutting edge of shovels with a strip of nonferrous metal or by use of wooden shovels.

Smoking.

908. Smoking shall be prohibited, and conspicuous signs to that effect posted throughout the elevator buildings.

Waste cans.

909. Approved containers shall be provided, all oily waste and other rubbish deposited therein, and emptied daily.

Lockers.

910. Workmen's clothing shall be kept in approved metal lockers, preferably in a separate building.

Oils.

911. Main storage of lubricating oil and grease shall be outside. Storage of lubricating oil and grease in the building shall be limited to a maximum of 5 barrels and shall be in an oil room of noncombustible construction.

Miscellaneous storage.

912. There should be no storage within the elevator of sacks, sacked grain, or screenings, or other combustible merchandise, materials, machinery, parts, and supplies.

Lightning protection.

913. All combustible elevators should be equipped with approved lightning protection, or if roof and walls are metal clad, same may be accepted as constituting lightning protection if provided with approved metallic contacts at eaves, and walls grounded in approved manner.

Static electricity.

914. Static electricity shall be removed from such machines or equipment as accumulate a charge, by permanent ground wires, and from belts by grounded metal combs or other effective means. Grounds shall conform to provisions of article 9 of the National Electrical Code.[1]

Section 10.—Fire Protection

First-aid appliances.

1001. Casks and pails and other suitable first-aid protection shall be provided in noncombustible buildings to protect all combustible

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

parts, machines, materials, etc. (except grain and belts), and throughout all combustible buildings. Suitable fire extinguishers shall be maintained near all motors and other electrical apparatus (other than lighting equipment). (See Regulations of the National Fire Protection Association for First Aid Fire Appliances.[1])

Watchman.

1002. All combustible elevators should be patrolled by watchman reporting to approved time recording apparatus. Rounds, apparatus, etc., shall conform to requirements of inspection department having jurisdiction. The employment of watchman in noncombustible elevators, tanks, or driers, is desirable for reasons outside the scope of these rules, but it is not considered especially necessary in relation to fire and explosion hazard, except that if containing combustibles in quantity sufficient to produce a serious fire, watchman service is desirable. See item 805 for recommendation as to lights for use of watchman. For further information on this subject see the National Fire Protection Association pamphlet entitled "The Watchman."[1]

Standpipe and hose.

1003. Standpipe systems should be installed to protect all parts of combustible elevators and to protect noncombustible buildings containing combustible parts, machinery, etc., to any considerable extent where required by the inspection department having jurisdiction. (See Regulations of the National Fire Protection Association for Standpipe and Hose Systems.[1])

Use of hose streams.

1004. Fire department or standpipe hose stream should be used with great care around an elevator. Their careless and unnecessary use may cause dust explosions by throwing dust into suspension.

NOTE.—Large fire-resistive elevators usually contain little combustible material other than grain. When the combustible material, such as a wooden cleaner, is located above bins, the application of water by hose streams may result in heavy water damage to grain in bins, unless bins are curbed and floor scuppered. (See note under item 207.)

Fire in bin or tanks.

1005. If fire occurs in a bin, no attempt to clear the bin should be made until it is definitely known that the fire has been extinguished, as there is possibility of a dust explosion in dropping grain onto a belt if a trace of fire remains in the grain.

Automatic sprinklers.

1006. An approved system of automatic sprinklers is recommended for any combustible elevator, and, where feasible, for the protection of such parts of noncombustible elevators as contain combustibles, other than grain and belts, in quantity sufficient to produce a serious fire.

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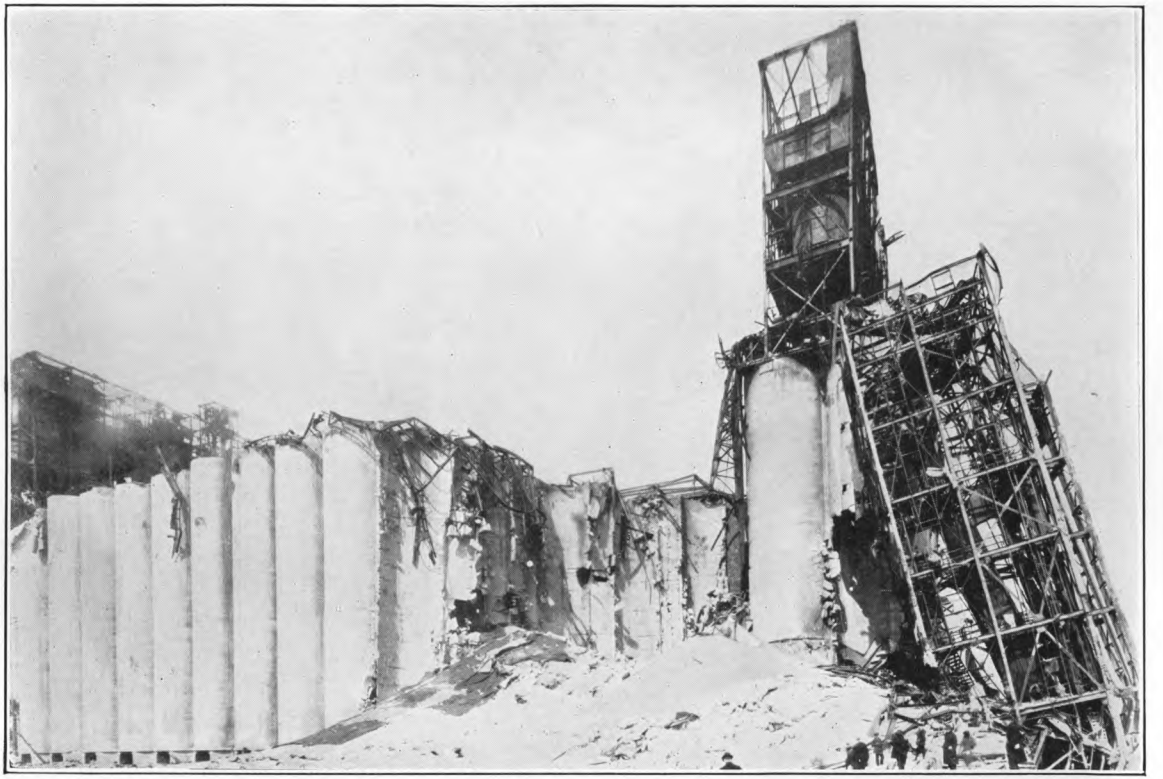
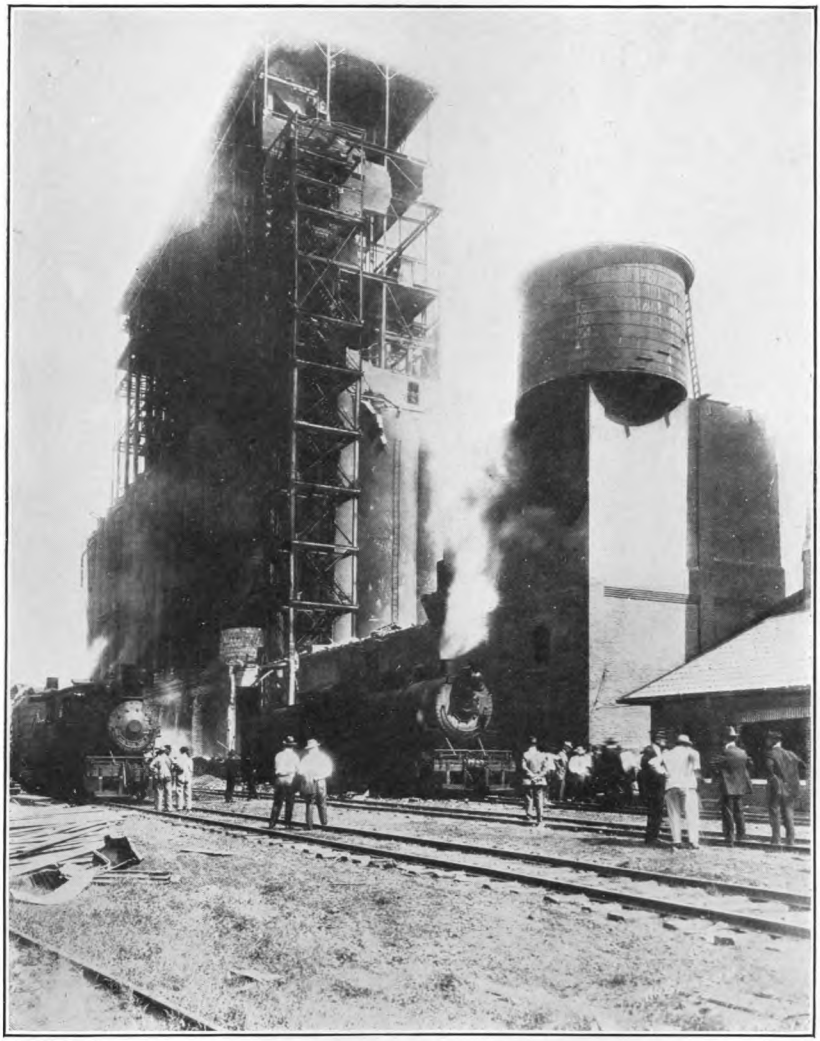
[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

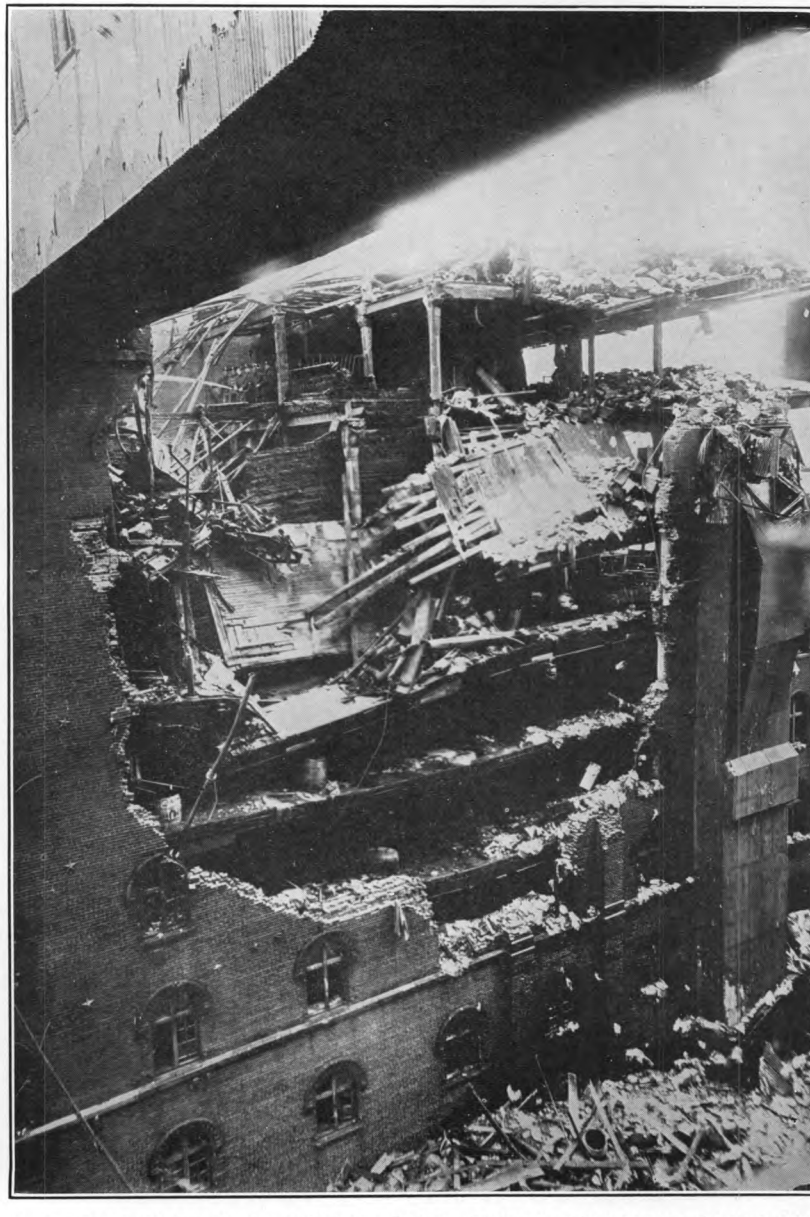


DUST EXPLOSION IN A LARGE TERMINAL GRAIN ELEVATOR IN THE MIDDLE WEST. ALL THE SIX WORKMEN IN ELEVATOR AT TIME OF EXPLOSION WERE KILLED; PROPERTY DAMAGE OVER $3,000,000

DUST EXPLOSION IN A LARGE EASTERN TERMINAL GRAIN ELEVATOR. SIX MEN KILLED AND 14 INJURED; PROPERTY DAMAGE, APPROXIMATELY $250,000



RESULTS OF EXPLOSION OF GRAIN DUST IN A TERMINAL GRAIN ELEVATOR IN THE SOUTHWEST. FOURTEEN MEN WERE KILLED AND 10 INJURED; PROPERTY DAMAGE, APPROXIMATELY $500,000



RESULT OF EXPLOSION OF SUGAR DUST. TWELVE MEN WERE KILLED AND 24 INJURED; DAMAGE, $1,000,000

Safety Code for Pulverizing Systems for Sugar and Cocoa

(American Standard, approved September 24, 1931, by American Standards Association)

Introduction.

This safety code is issued to eliminate or reduce the hazards inherent in the manufacture of pulverized sugar and cocoa, particularly the hazard of their ignition and the propagation of a resulting fire. It is essential that there shall be no escape of dust into the atmosphere of the room, a condition favorable to a dust explosion and to the rapid propagation of fire.

For this reason it is important that the apparatus be provided with effective appliances to prevent ignition and confine fire; proper venting of the apparatus and ventilation of the pulverizing department are important.

The term "pulverizing department," as used in this code, comprises the portion of the plant in which the pulverizing processes are carried on. The equipment consists of the mills or pulverizers, in conjunction with which may be used scalpers, bolters or screens, separators or dust collectors, spouts and conveying apparatus.

Definitions.

In this code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

Location.

1. (*a*) The processes of pulverizing should preferably be carried on in a detached building used for no other purpose and located at a safe distance from other property, or if close by, have exposing walls blank and parapeted; such structure, except the exposing walls, to be of light noncombustible materials.

(*b*) If the processes, owing to the layout of the plant, can not be carried on in a location as recommended in section 1 (*a*), the portion of the plant devoted to them shall be segregated and be located, if possible, in the upper stories, under the roof.

Construction.

2. (*a*) When the processes are carried on in locations as designated in section 1 (*b*), the walls, partitions, floors and ceilings of such section of the plant shall be not less than 4 inches reinforced concrete or the equivalent in strength and fire resistance if the building is of fire-resistive construction; in buildings of nonfire-resistive construction, partitions, floors, and ceilings shall be of equivalent strength as

required for buildings of fire-resistive construction, and shall be able to withstand a standard 1-hour fire test.

In buildings of nonfire-resistive construction the partitions, floors, and ceilings of the pulverizing departments may be constructed of not less than 2½-inch tongued and grooved or splined planking, firmly secured, and protected throughout by at least 1 inch of cement plaster on expanded metal. All openings in such partitions shall be provided with approved structural iron frames or have the edges otherwise protected in an approved manner. Communications shall be protected as provided for under rule 3.

(*b*) A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the inclosing walls shall be of light noncombustible material, preferably thin glass, so located and arranged that it shall not be a greater distance from the opposite wall or walls than the least horizontal dimension of the room; or where confined to end walls the length of the room shall not exceed twice the least horizontal dimension of the room. The width of the corner jamb or wing wall formed by a wall thus pierced and the adjacent wall shall not exceed 10 per cent of the length of the pierced wall, and in no case shall the distance from the glass or equivalent area to the corner formed by the adjacent wall beyond, or in L-shaped rooms to the projected line of the adjacent wall, exceed the least horizontal dimension of the room.

Thin glass skylights may be accepted in part or entirely in lieu of the required glass or equivalent area, provided the area of such skylights whether used entirely or in part shall be based upon a requirement for 10 per cent of the combined areas of the inclosing walls. Such skylights shall be located not farther from the outer walls of the room than a distance equal to 10 per cent of the length of the adjacent walls, and shall have a free venting area to the room not less than the glass area required.

When structural conditions prevent the close observance of this rule a deviation of not over 10 per cent in the dimension and distances given in the foregoing paragraphs may be permitted, provided the minimum glass or equivalent area required is based upon the modified room dimensions.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of the above requirement for glass or equivalent area.

(*c*) Wired glass should only be used when necessary as a protection against exposure. If used, it shall be in sash so hung that they will readily swing out in case of an explosion; such sash shall not be secured. When thin glass is used, this form of hanging is not necessary. Glass areas in walls shall be so located as to vent the force of an explosion in the direction or directions of least exposure.

(*d*) Window ledges, girders, beams and other projections shall have the tops beveled or other provisions made to minimize the deposit of dust thereon.

Communications.

3. (*a*) Access to the pulverizing department should be from the outside; this can be accomplished by means of balconies. Where this is not feasible and direct communications are required, these

shall be protected by standard self-closing, hinged class B fire doors,[1] swinging outward from the rooms in which the processes are conducted, unless safe egress is provided to the outer air, in which case standard automatic sliding fire doors may be used to protect these openings.

NOTE.—Where extensive operations are carried on it is recommended that the direct communications referred to in rule 3 be protected by double class B fire doors, automatic sliding on the inner side and self-closing hinged, swinging

Figure 1

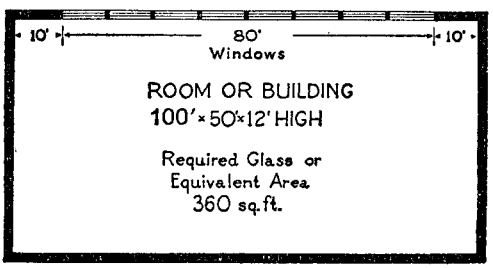


Figure 2

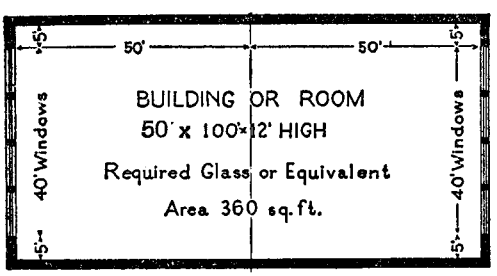


Figure 3

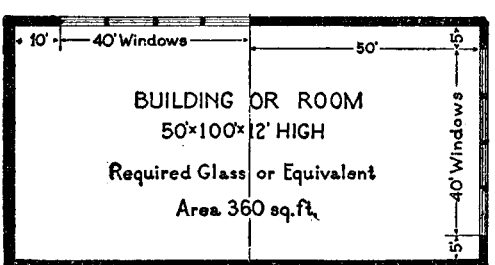


Figure 4

outward, on the outer side; where such communications constitute serious exposures, vestibules, of noncombustible materials to divert the direction of the force or flames, are also recommended.

(*b*) Where power is transmitted to apparatus within the rooms from any driving mechanism or unit outside of same by means of shafts, these shall pass through close-fitting shaft holes in walls or

[1] See Regulation for the Protection of Openings in Walls and Partitions, obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

partitions; if the transmission is by means of belts or chains these shall be incased both inside and outside of the pulverizing department in dust-tight inclosures, substantially constructed of noncombustible materials.

(*c*) All pipe openings through walls or partitions shall be tight.

(*d*) Conveyors, spouts, chutes, and elevator inclosures shall be of substantial metal construction and dust tight.

(*e*) With the exception of spouts and conveyors for raw material or finished product in bulk, no conveyors, spouts, chutes, etc., shall pass through any of the walls or floors separating the pulverizing department from other portions of the building. Conveyors of the screw type only shall be permitted to pass through the walls, provided a portion of the blade, equivalent to at least one diameter of the screw, shall be omitted at a point immediately inside of the wall

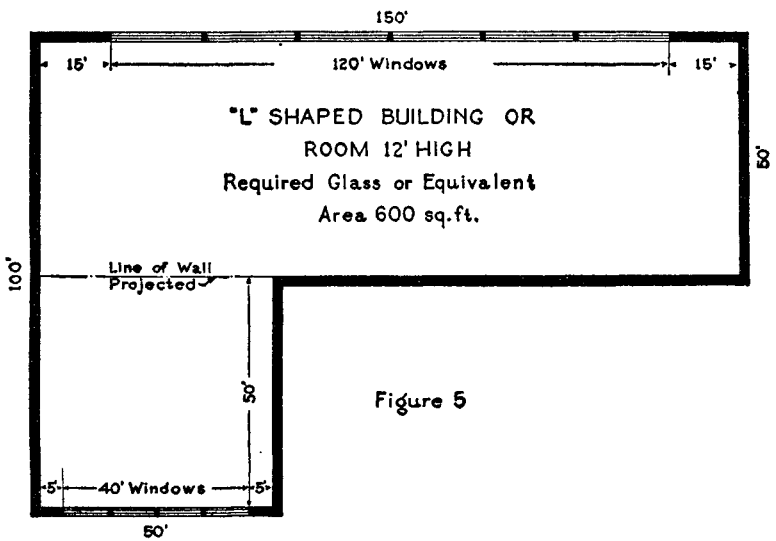


Figure 5

of the pulverizing department and pins substituted therefor; when the finished product is delivered from the pulverizing department through spouts it shall be conveyed from the apparatus within the pulverizing department to the spouts by means of screw conveyors from which a portion of the blade, equivalent to at least one diameter of the screw, has been omitted and pins substituted therefor, or an equally effective means of producing a "choke" between the delivery section of the apparatus and the spout shall be provided.

NOTE.—See also secs. 7 (*a*) and 7 (*f*).

(*f*) The use of air for the conveying of the material, either in its raw or finished state, to or from the pulverizing department, shall not be permitted, neither shall it be permitted within this department, except that air currents generated by the fans within the mills or fans operated in conjunction with the mills may be used in connection with the processes of pulverizing. (See Regulations of the

National Fire Protection Association for Blower and Exhaust Systems,[1] sec. 420.)

NOTE.—In this connection, see also secs. 7 (*e*) and 7 (*g*) of this code.

Power.

4. (*a*) If electric motors are used, these should preferably be located outside of the pulverizing department and the power transmitted as noted under paragraph 3 (*b*). If inside of this department, they shall be of a type approved for dusty locations.

(b) All controlling and circuit-breaking devices, if within the pulverizing department, shall be of the approved inclosed safety type; cabinets or inclosures shall be dust tight and kept fully closed when apparatus is in operation.

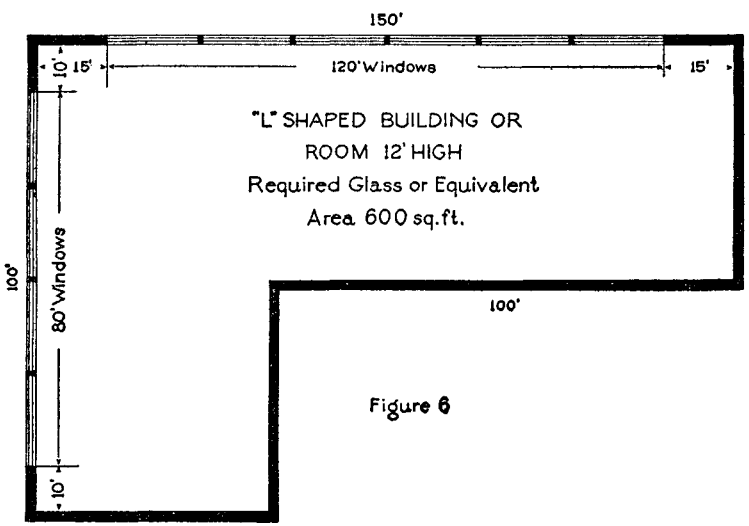


Figure 6

Lighting.

5. (*a*) Electric incandescent lights only shall be permitted in the pulverizing department. Lamps shall be inclosed in dust-proof globes provided with approved guards.

(*b*) When portable lights or drop lights are required they shall be inclosed in dust-proof globes and shall be guarded, utilizing approved flexible cord designed for hard usage. Special dust-proof outlets shall be provided.

(*c*) Switches and cut-outs shall be approved and dust tight. These should preferably be located outside of the rooms containing the pulverizing department.

Wiring.

6. All wiring shall be in conduit, in accordance with the National Electrical Code.[1]

NOTE.—Electrical materials, appliances, and apparatus noted under rules 4 (power), 5 (lighting), and 6 (wiring), their location, installation and use, shall

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

be in accordance with the National Electrical Code. See art. 32, particularly Class II locations.

Preventive measures.

7. (*a*) All apparatus shall be properly and securely installed to insure constant true alignment and to avoid hot bearings or friction, and no moving parts shall be fitted close to or come in contact with any part of the inclosures or the structure. On all pulverizing apparatus, 1-piece cast-iron driven pulleys shall be used. Bearings shall be self-lubricating, if possible, and all bearings shall be so designed as to be dust tight. The apparatus shall be equipped with such devices as will prevent ignition, or confine the results of ignition, and with devices which will minimize the amount of dust in the atmosphere. The apparatus should be installed and arranged in unit systems so that pulverizers will deliver to but one set of scalpers and bolters; interconnections between sets of apparatus should not be permitted.

Screw conveyors shall be fully inclosed in tight, substantial, metal housings; if the tops of these housings are removable they shall be well secured. (This should not be understood to prohibit the use of pressure relief vents at the discharge end of the conveyor.)

NOTE.—Attention is directed to the fact that warning of the overheating of bearings in dusty or inaccessible locations and when the heating of bearings may cause explosions, may be obtained by the use of approved journal alarms.

(*b*) All mills and other apparatus, including dust collectors, in connection with the pulverizing system, together with their pulleys, shafting and belts shall be electrically grounded in an effective manner.

(*c*) All of the material delivered to the mills or pulverizers shall pass over self-cleaning magnetic separators and shall be protected against the entry of foreign materials in its passage to the mills. The separators shall be of sufficient size to expose and insure the removal of all ferrous materials passing over them; one separator, if of sufficient size and strength, may serve a group of mills. Sugar shall be passed through ¼-inch wire mesh screens before entering the mills or pulverizers, and if dumped into a delivery hopper from a floor above the mill or pulverizer, such hopper shall have a curbing at least 7 inches above the floor and be provided with a screen of ¼-inch wire mesh.

(*d*) All inspection openings in the pulverizing apparatus shall be provided with wire mesh screens of not less than four meshes to the inch.

(*e*) The mills shall either discharge the pulverized product directly through spouts or scroll conveyors into the screens, bins, or bulk containers, or the product may be discharged from the mills by air currents set up by the centrifugal force of the blades or beaters and an inclosed fan, or the pulverized product may be removed by means of an exhaust fan.

(*f*) Mills delivering directly through spouts should be provided with devices in or underneath the discharges which retard the flow of product in such a manner as to keep a small space immediately underneath or near the discharge filled up with pulverized material, thus smothering any spark that may originate in the mill. This can be effected either by means of a revolving choke valve, or if

the material is delivered directly into the scroll or screw conveyor, by the omission of a small portion of the blade and substituting therefor pins.

(*g*) Blowers or exhaust fans shall be installed on proper foundations and secured in a substantial manner and shall not be used for any other purpose.

Where practicable the exhaust fan shall be located beyond the collector. When located between the collector and the pulverizing apparatus or any portion thereof from which the dust is to be removed, the blades and spider should be of bronze or similar composition, or the casing consist of or be lined with similar material. Ample clearance shall be provided between the blades and the casing. The fan bearings shall not extend into the casings. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1])

(*h*) Screens (scalpers, bolters, etc.) shall have their reels or sieves in dust-proof inclosures. When connected to dust collectors, the flues shall be of metal, and the collectors shall be properly vented to the outside of the building.

(*i*) All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials; cloth type collectors shall be provided with dust-tight metal inclosures or their equivalent. The fabric of cloth type collectors should be electrically grounded in an effective manner.

All dust collectors used in connection with the pulverizing system, if not located outside of the building, shall be located within the pulverizing department and shall be properly vented to a safe point outside of the building. (See also Regulations of the National Fire Protection Association for Blower and Exhaust Systems,[1] class C.)

(*j*) Pressure relief vents shall be of ample size and properly proportioned. These are especially required at certain types of mills, screens, dust collectors, and elevator heads. The vent flues must be substantially constructed of metal and be carried out of doors as directly and as nearly vertically as possible and shall not deviate more than 22½° from the direction of the pipe from which they lead. They shall not pass through an adjoining building or room. Horizontal runs shall be avoided.

Vent outlets should be provided with cowls or hoods, and where the nonescape of dust is essential, with counterbalanced relief valves or covers provided with a soft felt gasket, at least three-fourths inch thick. (For illustration of safety relief vent see p. 34.)

(*k*) Open flames of any kind, or any operations or repairs resulting in sparks or utilizing direct heat, shall not be permitted in the pulverizing department while in operation or when the air is charged with floating particles of dust.

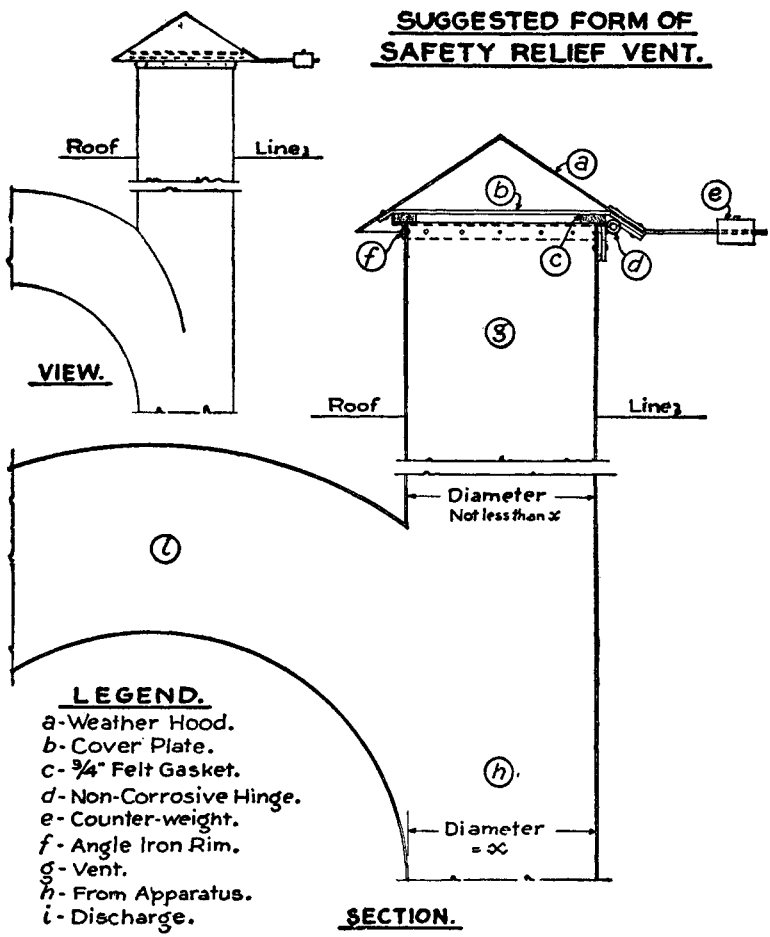
Housekeeping.

8. Good housekeeping is one of the most important factors; apparatus which will not leak and permit the escape of dust or sifting out of the material is essential. Accumulations of escaping dust

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

must not be tolerated in the building. It is recommended that the interior of the pulverizing department be painted a color which is in contrast with that of the dust.

Cleaning that is liable to produce dust clouds shall not be done while machinery is in operation because of the possibility of the dust being ignited by sparks originating from electrical discharges or from other causes.



Fire protection.

9. The building or rooms in which the processes of pulverizing are carried on shall be protected by approved first-aid fire appliances together with approved small hose and should be protected by a system of approved automatic sprinklers. (See Regulations of the National Fire Protection Association for First Aid Fire Appliances, Standpipe and Hose Systems, and Sprinkler Equipment.[1])

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Safety Code for the Prevention of Dust Ignitions in Spice-Grinding Plants

(American Standard, approved September 24, 1931, by American Standards Association)

Introduction.

1. This safety code is issued to eliminate or reduce the hazards inherent in the manufacture of ground or pulverized spices, particularly the ignition and the propagation of a resulting fire or explosion.

NOTE.—No serious dust explosions have occurred during the normal operation of spice-grinding plants. However, some spice dusts will explode, and these regulations have accordingly been prepared as a guide to safe practice in the construction and operation of such plants.

Definitions.

2. In this code the following words are used as defined below:

The term "grinding department" as used in this code comprises the portion of the plant in which the grinding processes are carried on. The equipment generally consists of cutters, mills, rolls, or pulverizers; scalpers, bolters, or screens; dust collectors; conveying and elevating apparatus; and may include packing equipment where barrels, sacks, or similar large packages are filled from a bin or hopper containing bulk material received directly from the grinding or bolting machinery.

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of the regulations.

The terms "adequately," "effective," and "securely" shall be interpreted as conditions subject to the approval of the inspection department having jurisdiction.

Location.

11. The grinding department should be located in a detached or segregated section of the plant or along an outside wall or in the upper stories under the roof where vents to the outside can conveniently be provided for dust collectors and other equipment in which dust clouds may exist.

Construction.

21. The "daylight" type of mill building (with large window area) is recommended.

22. Fire-resistive construction or mill construction is recommended.

23. Where other processes are carried on on the same floor the grinding department shall be separated by partitions of a type corresponding to the building construction and designed to prevent the forming of dust deposits outside the grinding department.

24. As much of the exterior walls of the grinding department as practicable should be of light noncombustible material, preferably thin glass designed and placed to give way at a pressure less than that required to rupture the partition, floor, or ceiling separating the grinding department from other sections of the plant.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of requirements for glass or equivalent area.

25. The grinding department should be arranged so that a minimum of 1 square foot of light exterior wall can be provided for each 80 cubic feet of volume and so that no part of the room is farther from the venting area than 1.1 times the least horizontal dimension of the room.

26. Construction should be such that all interior walls including bin walls shall be smooth and free from pockets or ledges where dust could accumulate.

27. Window ledges, girders, beams, and other projections within the grinding department which are impractical to eliminate should have the tops beveled or other provision made to prevent dust accumulations thereon.

Communications.

31. Self-closing doors shall be used on all direct communications between the grinding department and other sections of the plant provided such doors will not prevent ready egress from the department in case of fire.

Electric power, lighting, wiring.

41. Motors and other electrical power equipment if used within the grinding department shall be in accordance with the standards of article 32 of the National Electrical Code [1] for dusty locations.

42. Electric incandescent lights only shall be permitted in the grinding department and all lights and switches shall be of the type required by, and installed in accordance with the standards of article 32 of the National Electrical Code [1] for dusty locations.

43. All wiring shall be in accordance with the standards of article 32 of the National Electrical Code.[1]

Prevention of ignition.

51. All apparatus shall be properly and securely installed to insure constant true alignment and prevent hot bearing or friction likely to cause a fire.

52. Static electricity shall be removed from such machines or equipment as accumulate a charge by permanent ground wires and from belts by grounded metal combs or other equally efficient systems. Grounds shall be attached to equipment and to the earth in accordance with the National Electrical Code,[1] article 9.

53. (*a*) All raw material delivered to the mills or pulverizer shall pass over magnetic separators of sufficient size to expose and insure the removal of all ferrous materials passing over them.

(*b*) Coarsely ground or small size material should be passed through a wire screen of a mesh suitable to the product before en-

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

tering a mill even though it was passed over a magnetic separator previously.

54. (*a*) Mills delivering directly through spouts should be provided with devices in or underneath the discharges which will retard the flow of the product in such a manner as to keep a small space directly underneath or near the discharge filled up with the product, thus smothering any fire which may start. This can be accomplished by means of a revolving choke valve.

(*b*) When mills discharge to screw conveyors a small portion of the conveyor blade should be removed and pins substituted therefor, thus providing protection similar to that obtained in the previous rule.

55. All dust collectors used in connection with the grinding system if not located outside of the building shall be located within the grinding department and properly vented to the outside.

56. Pressure relief vents should be provided at the mills where ignitions are likely to occur. The vents should be of ample size, substantially constructed of metal, and be carried out of doors as directly as possible.

57. No open flames of any kind nor any operations or repairs resulting in sparks or utilizing direct fire heat shall be permitted in the grinding department until all equipment has ceased operating and the room has been carefully cleaned, including the wiping down of equipment near the point where it is necessary to use the open flame or direct fire heat. Care shall be taken to see that the air in the room is free of dust and that first-aid fire protection in the form of small hose or extinguishers is close at hand during such periods.

58. Smoking and the carrying of matches shall not be permitted.

Housekeeping.

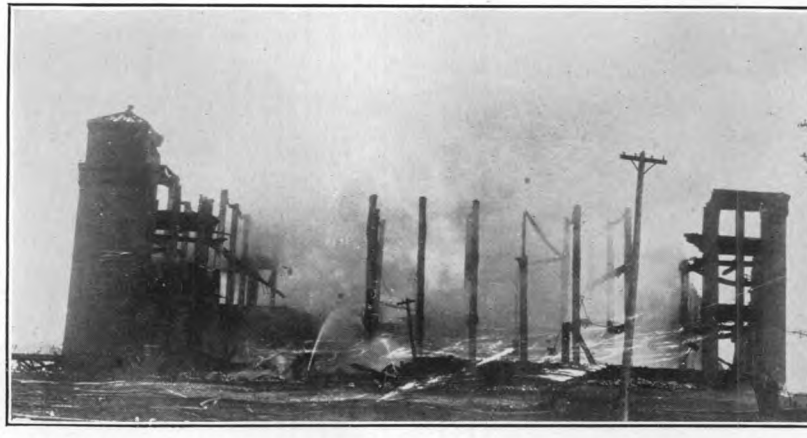
61. Good housekeeping is one of the most important factors and it is essential that apparatus be kept in such condition that it will not leak or permit the escape of dust into the room. Accumulations of dust shall not be tolerated in the building. It is desirable to have the interior of the grinding department painted a color which will show by contrast the presence of any dust accumulations.

Fire protection.

71. The building or rooms comprising the grinding department shall be protected by approved first-aid fire appliances together with approved small hose and should be protected by a system of approved automatic sprinklers. (See National Fire Protection Association Regulations for the Installation, Maintenance, and Use of First-Aid Fire Appliances, Regulations for Standpipe and Hose Systems, and Regulations for Installation of Sprinkler Equipment.[1])

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

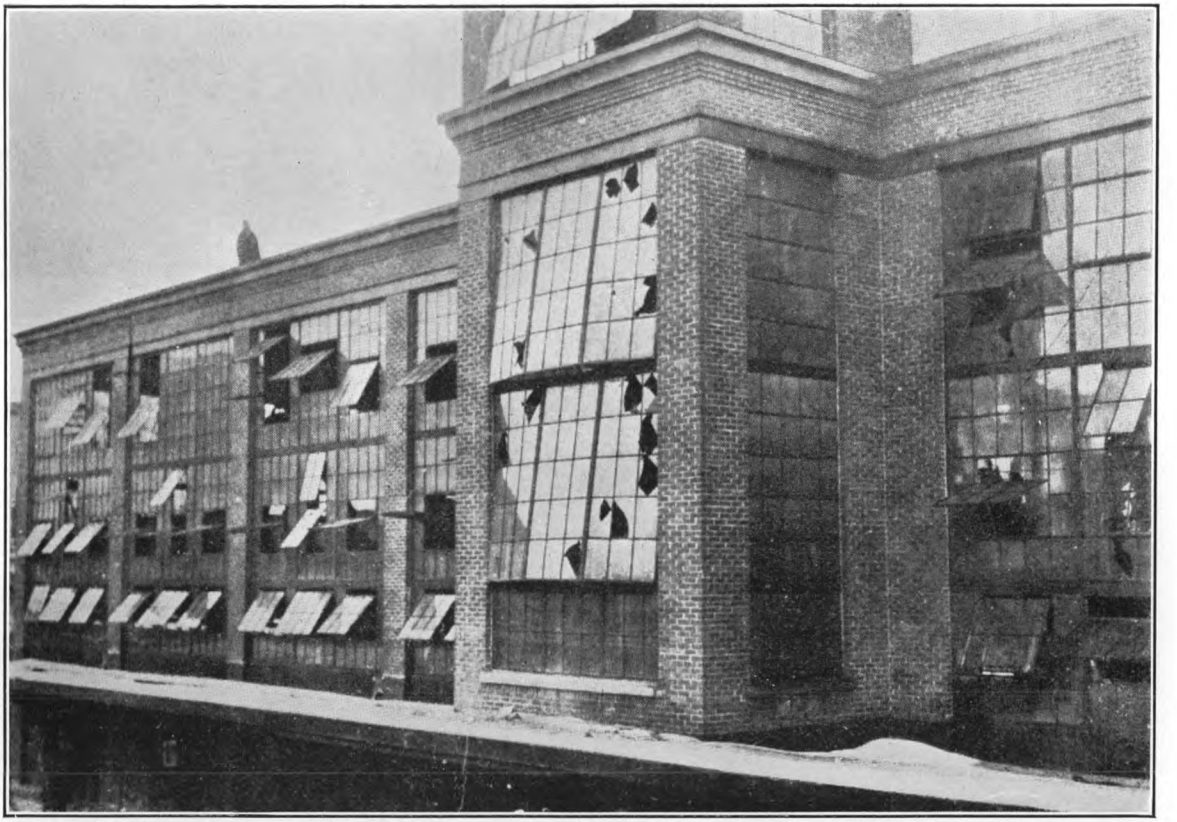
DUST EXPLOSION FOLLOWING A FIRE IN SPICE PLANT. FOUR FIREMEN LOST THEIR LIVES AND 13 WERE INJURED; DAMAGE, $150,000



EXPLOSION OF COCOA DUST AND RESULTING FIRE. THREE MEN WERE KILLED AND ONE WAS INJURED; PROPERTY DAMAGE, $750,000

EFFECTS OF EXPLOSION OF WOOD-FLOUR DUST. FOUR MEN WERE INJURED; PROPERTY DAMAGE, $10,000

RESULTS OF EXPLOSION OF WOOD DUST AND RESULTING FIRE. ONE PERSON WAS INJURED; ESTIMATED PROPERTY DAMAGE, $75,000



EXPLOSION OF WOOD-FLOUR DUST, WHICH WAS EFFECTIVELY VENTED WITHOUT STRUCTURAL DAMAGE WHEREVER HINGED WINDOWS WERE PROPERLY INSTALLED

Safety Code for the Prevention of Dust Explosions in Wood-Flour Manufacturing Establishments

(American Standard, approved September 24, 1931, by American Standards Association)

Introduction.

1. This safety code is issued as a guide to eliminate or reduce the hazards inherent in the manufacture of wood flour, particularly the hazard of its ignition and the propagation of a resultant fire. This code is intended to apply to new construction and rebuilt or remodeled plants. It is advisable to remodel wherever possible any present installations to conform with these regulations.

2. It is essential that there shall be no escape of dust into the atmosphere of the plant, this condition being favorable to a dust explosion and to the rapid propagation of fire. It is important that the apparatus be provided with effective appliances to prevent ignition and confine fire; proper venting of the apparatus and ventilation of the pulverizing department are important.

Definitions.

3. In this code the following words are used as defined below:

"Pulverizing department" refers to that portion of the plant in which the pulverizing processes are carried on. The equipment usually consists of mills or pulverizers, in conjunction with which may be used bolters or screens, separators or dust collectors, spouts and conveying apparatus.

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of the regulations.

The terms "adequately," "effective," and "securely" shall be interpreted as conditions subject to the approval of the inspection department having jurisdiction.

Location.

11. (*a*) The processes of pulverizing should preferably be carried on in detached building used for no other purpose and located at a safe distance from other property.

(*b*) If conditions are such that it is necessary for the pulverizing building to be located in such a way as to expose other buildings, walls between pulverizing building and other buildings should be blank, fire resisting, and parapeted. Walls of pulverizing building, except as noted, shall be of light noncombustible materials.

12. If the processes, owing to the layout of the plant, can not be carried on in a location as recommended in section 11, the portion of the plant devoted to them shall be segregated in such a manner as to minimize the possibility of an explosion or fire reaching other portions of the plant.

Construction.

21. In buildings of fire-resistive construction, when the processes are carried on in locations as designated in section 12, the walls, partitions, floors, and ceilings of such section of the plant shall be not less than 4-inch reinforced concrete, or the equivalent in strength and fire resistance.

22. In buildings of nonfire-resistive construction the partitions, floors, and ceilings of the pulverizing departments shall be constructed of not less than 2½-inch tongue and grooved or splined planking, firmly secured, and protected throughout by at least 1 inch of cement plaster on expanded metal, or shall be of equivalent strength if constructed of noncombustible or fire-resistive material. All openings in such partitions shall be provided with approved structural iron frames or have the edges otherwise protected in an approved manner. Communications shall be protected as provided for under section 31.

23. (*a*) A portion of the exterior walls in the ratio of not less than 1 square foot of wall surface for each 80 cubic feet of volume in a given room shall be composed either of light, noncombustible material, preferably ⅛-inch thin glass, or of automatic venting devices in the form of hinged windows or panels so balanced as to open under a predetermined pressure. Hinged windows or panels shall not be fastened in such a way as to prevent opening under pressure originating inside of the room. Venting areas shall be located in such a manner that no part of the room shall be further away from the venting area than a distance equal to 1.1 times the least horizontal dimension of the room.

(*b*) If other than ⅛-inch thin glass is used as a protection against exposure, it shall be in hinged sash as described above.

(*c*) One-eighth inch thin glass skylights may be accepted in part or entirely in lieu of the required glass or equivalent venting area, provided the area of such skylights, whether used entirely or in part shall be based upon a requirement of 1 square foot of venting area for each 80 cubic feet of volume of room to be vented. Such skylights shall be located not farther from the outer walls of the room than a distance equal to 10 per cent of the length of the adjacent walls, and shall have a free venting area to the room not less than the glass area required.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of requirements for glass or equivalent area.

(*d*) Glass or equivalent venting areas in walls shall be so located as to vent the force of an explosion in the direction or directions where least damage may be done to adjacent buildings.

24. Window ledges, girders, beams, and other horizontal projections or surfaces shall have the tops beveled or other provision made to minimize the deposit of dust thereon.

Communications.

31. In buildings of fire-resistive construction, access to the pulverizing department should be from the outside. On floors above the ground floor this can be accomplished by means of balconies. Where this is not feasible and direct communications are required, these shall be protected by standard self-closing hinged class A fire doors,

swinging outward from the room in which the processes are conducted, unless safe egress is provided to the outer air; in which case standard automatic sliding class A fire doors, normally kept closed, shall be used to protect these openings. (See National Fire Protection Association Regulations on Protection of Openings in Walls and Partitions.[1])

32. In buildings of nonfire-resistive construction, access to the pulverizing department should be from the outside. On floors above the ground floor this can be accomplished by means of balconies. Where direct communications are required these shall be protected by standard class B hinged self-closing doors, swinging outward from the room in which the processes are conducted, unless safe egress is provided to the outer air, in which case standard automatic sliding class B fire doors, normally kept closed, shall be used to protect these openings. (See National Fire Protection Association Regulations on Protection of Openings in Walls and Partitions.[1])

33. Where power is transmitted to apparatus within the room from any driving mechanism or unit, outside of the pulverizing department, the transmission medium (belt or chain) shall be encased both inside and outside of the pulverizing department in practically dust-tight inclosures, constructed of substantial noncombustible material. Where power is transmitted by means of shafts, these shall pass through close-fitting shaft holes in walls or partitions. Shaft transmission of power is preferable.

34. All pipe openings through walls or partitions shall be tight.

35. Conveyors, spouts, chutes, and elevator inclosures shall be of substantial metal construction and practically dust tight.

36. (*a*) With the exception of spouts and conveyors for raw material or for finished product in bulk, no conveyors, spouts, chutes, etc., shall pass through any of the walls or floors separating the pulverizing department from other portions of the building. Conveyors of the screw type only shall be permitted to pass through the walls, provided a portion of the blade, equivalent to at least one diameter of the screw, shall be omitted at a point immediately inside of the wall of the pulverizing department and pins substituted therefor; when the finished product is delivered from the pulverizing department through spouts it shall be conveyed from the apparatus, hoppers, or bins within the pulverizing department to the spouts by means of screw conveyors from which a portion of the blade, equivalent to at least one diameter of the screw, has been omitted and pins substituted therefor, or an equally effective means of producing a "choke" between the delivery section of the apparatus and the spout shall be provided. (See secs. 51 and 54.)

(*b*) Air may be used for conveying raw material to supply bins in pulverizing department, but it shall not be used for conveying material directly to the pulverizers nor for conveying the finished product from the pulverizing department to other departments of the plant, nor for conveying material within the pulverizing department except between the pulverizers and separators, where air cur-

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

rents generated within the mills or by fans operated in conjunction with the mills are generally used.

NOTE.—In this connection see section 55. See Regulations of the National Fire Protection Association for Blower and Exhaust Systems, section 11.[1]

Electric power, lighting, wiring.

41. Motors and other electrical equipment should preferably be located outside of the pulverizing department. If located within the department they shall be in accordance with the standards of article 32 of the National Electrical Code [1] for dusty locations.

42. Electric incandescent lights only shall be permitted in the pulverizing department, and all lights and switches shall be of the type required by and installed in accordance with article 32 of the National Electrical Code,[1] for dusty locations.

43. All wiring shall be in accordance with article 32 of the National Electrical Code.[1]

Preventive measures.

51. (*a*) All apparatus shall be properly and securely installed to insure constant true alignment and to avoid hot bearings or friction, and no moving parts such as belts, pulleys, drive chains, etc., shall be fitted close to or come in contact with any part of the inclosure or the structure. On all pulverizing apparatus, one-piece cast-iron driven pulleys should be used. Bearings should be of the ball or roller type, if possible, and all bearings shall be so designed as to be dust tight. The apparatus shall be equipped with such devices as will prevent ignition, or confine the results of ignition, and with devices which will minimize the amount of dust in the atmosphere. The apparatus should preferably be installed and arranged in unit systems so that each pulverizer will deliver to but one set of scalpers and bolters. Interconnections between sets of apparatus should not be permitted, unless the material passing from one unit to another is conveyed through screw conveyors containing positive chokes. (See sec. 36.)

(*b*) Screw conveyors shall be fully inclosed in tight, substantial metal housings; if the tops of these housings are removable, they shall be well secured. (This should not be understood to prohibit the use of pressure relief vents at the discharge end of the conveyor.)

NOTE.—Attention is directed to the fact that warning of the overheating of bearings in dusty and inaccessible locations, and when the heating of bearings may cause explosions, may be obtained by the use of approved journal alarms.

52. Static electricity shall be removed from such machines or equipment as accumulate a charge by permanent ground wires, and from belts by grounded metal combs or other equally efficient systems. Grounds shall be attached to equipment and to the earth in accordance with the National Electrical Code,[1] article 9.

53. (*a*) All of the material delivered to the mills or pulverizers shall pass over magnetic separators, preferably of the self-cleaning type, and shall be protected against the entry of foreign materials in its passage to the mills. The separators shall be of sufficient size to expose and insure the removal of all ferrous materials passing over

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

them; one separator, if of sufficient size and strength, may serve a group of mills.

(*b*) If the material is dumped into a delivery hopper from a floor above the mill or pulverizer, such hopper shall have a curbing at least 6 inches above the floor.

(*c*) All inspection openings in the pulverizing apparatus shall be provided with wire mesh screens of not less than four meshes to the inch.

54. Mills delivering directly through spouts should be provided with devices in or underneath the discharges which retard the flow of product in such a manner as to keep a small space immediately underneath or near the discharge filled up with the pulverized product, thus smothering any spark that may originate in the mill. This can be effected either by means of a revolving choke valve, or, if material is delivered directly into the scroll or screw conveyor, by omitting a small portion of the blade and substituting pins therefor.

55. Blowers or exhaust fans shall be installed on proper foundations and secured in a substantial manner. Where practicable the exhaust fan shall be located beyond the collector. When located between the collector and the pulverizing apparatus, or any portion thereof from which the dust is to be removed, the blades and spider should be of bronze or other nonsparking metal or the casing consist of or be lined with similar material. Ample clearance shall be provided between the blades and the casing. The fan bearings shall not extend into the casings. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1])

56. Screens (scalpers, bolters, etc.) shall have their reels or sieves in dust-tight inclosures. When connected to dust collectors, the flues shall be of metal, and the collectors shall be properly vented to the outside of the building.

57. (*a*) All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials. Cloth type collectors should be provided with dust-tight metal inclosures or their equivalent. The fabric of cloth type collectors should be electrically grounded in an effective manner. (See sec. 52.)

(*b*) All dust collectors used in connection with the pulverizing system should be located on the roof, in segregated sections of plant, or in separate buildings. If this is not possible they shall be located within the pulverizing department and shall be properly vented to a safe point outside of the building. (See also Regulations for Blower and Exhaust Systems, class C.)

58. (*a*) Pressure relief vents shall be of ample size. These are especially required at certain types of mills, screens, dust collectors, and elevator heads. The vent flues shall be substantially constructed of metal and be carried out of doors as directly and as nearly vertically as possible, avoiding especially short turns—never through an adjoining building or room—and be properly proportioned.

(*b*) Vent outlets should be provided with cowls or hoods, and where the nonescape of dust is essential, with counterbalanced relief valves or covers provided with a soft felt gasket, at least three-fourths inch thick. (For illustration of safety relief vent see p. 34.)

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

59. No open flames of any kind, nor any operations or repairs resulting in sparks or utilizing direct fire heat shall be permitted in the pulverizing department until all equipment has ceased operating and the room has been carefully cleaned, including the wiping down of equipment near the point where it is necessary to use the open flame or direct fire heat. Care shall be taken to see that the air in the room is free from dust and that the first-aid fire protection in the form of small hose or extinguishers is close at hand during such periods.

Housekeeping.

61. (*a*) Good housekeeping is one of the most important factors; apparatus which will not leak and permit the escape of dust or sifting out of the material is essential. Accumulations of dust shall not be tolerated in the building. It is recommended that the interior of the pulverizing department be painted a color which is in contrast to that of the dust.

(*b*) Interior surfaces shall be cleaned in such a manner as to minimize the scattering of dust to other places. To this end it is recommended that dust removal be accomplished by an adequate pneumatic or vacuum-sweeping system.

(*c*) Cleaning that is liable to result in production of dust clouds shall not be done while machinery is in operation because of the possibility of the dust being ignited.

62. (*a*) Portable vacuum cleaners and air compressors shall not be used for cleaning. Suction-cleaning appliances should be connected by hose to taps of permanent piping extending to a suction fan or equivalent.

(*b*) The fan or equivalent and the collector shall be located in a separate room. The discharge from this dust collector may be to the dust collector used for the discharge of air from the vacuum system connected with the pulverizing and screening equipment.

Fire protection.

71. The buildings or rooms in which the processes of pulverizing are carried on shall be protected by a system of approved automatic sprinklers and shall be equipped with approved first aid fire appliances, together with approved small hose. (See Regulations of the National Fire Protection Association for Automatic Sprinkler Systems, Standpipe and Hose Systems, and First Aid Fire Appliances.[1])

72. Wherever possible, pulverizing machinery, screens, bolters, conveyors, bins, etc., should be protected against fires and explosions by the use of inert gas. (See Regulations for the Use of Inert Gas for Fire and Explosion Prevention, p. 69; also Technical Bulletin No. 74, U. S. Department of Agriculture.)

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Safety Code for the Installation of Pulverized-Fuel Systems

(American Standard, approved September 5, 1930, by American Standards Association)

Introduction

1. This safety code is designed for application to new installations and when making alterations or extensions to existing equipment. It is not retroactive.

2. Installation of pulverized-fuel systems should be under the supervision of engineers qualified by experience in the design, construction and operation of such equipment.

Definitions

3. In this code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

The terms "adequately," "effective," and "securely" shall be interpreted as conditions subject to the approval of the inspection department having jurisdiction.

Types of Systems

4. Pulverized-fuel systems are of various types; all involve the hazard incident to the creation and possible liberation of combustible dusts unless properly designed, constructed, and operated. In general they may be arranged in three classes as follows:

Class A systems.—Indirect or those in which the fuel is intimately mixed with air at the point or points where used and involving storage bins at points of consumption.

Class B systems.—Direct or those in which the pulverized fuel is fed to a fan by which it is blown as a combustible mixture through large pipes to furnaces or other points of consumption. In the case of circulating systems of this class, the unused fuel is returned to the initial point to again be blown through the line. In these systems, the pulverizers are located remote from points of consumption.

Unit systems.—Those in which the fuel is pulverized at or near the point or points of use, and delivered directly from the pulverizer into the furnace by means of fan or blower, which may be an integral part of the apparatus; the air being admitted in the apparatus or in conjunction with the fuel. Systems of this type do not employ bins.

Regulations for All Classes of Systems

Location.

11. (*a*) The building housing fuel-pulverizing equipment shall be constructed of noncombustible material.

(*b*) The process of pulverizing fuel may be accomplished either:
1. In the room or section of the building where it is burned, or
2. In a room, building, or floor separated from the rest of the building by masonry walls and floors and used for no other purpose.

12. (*a*) Where the process of pulverizing fuel is carried on in the room or section of building where it is burned and the volumetric capacity of the mill housing, mixing, or separating chamber (if any) and all of the piping conveying coal suspended in air does not exceed 100 cubic feet, all such piping shall be at least equal to the requirements of paragraph 25, specification No. 1.

(*b*) Where the volumetric capacity of the mill housing, mixing, or separating chamber (if any) and all piping conveying fuel in suspension in air exceeds 100 cubic feet all such piping shall be at least equal to the requirements of paragraph 26, specification No. 2, and all mixing and separating chambers shall either be constructed for a working pressure of 50 pounds per square inch with a factor of safety of four based on the ultimate strength of the material, or located in a separate room or floor cut off from the rest of the building and constructed in accordance with section 13.

(*c*) Where an inert atmosphere containing not more than 13 per cent of oxygen is maintained in an approved manner within the mill, separator, and piping, the entire milling and separating system, regardless of cubic capacity, may be located within the room or section of building where the fuel is burned. All piping conveying fuel in suspension in gas shall be at least equal to the requirements of section 25, specification No. 1, and the separator (if any) shall be constructed in accordance with section 19.

Construction.

13. Where the process of pulverizing fuel is accomplished in a room, building, or floor separated from the rest of the building by masonry walls, such building or section of building shall be constructed as follows:

(*a*) It shall be constructed of noncombustible material and specially designed (1) to secure minimum lodgment of dust; (2) so that all interior parts of the building on which dust may lodge may be cleaned readily; and (3) to relieve the force of an explosion through skylight, window, or explosion doors.

(*b*) Depending on local conditions, either light or heavy type of building construction may be used.

(*c*) A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the inclosing walls shall be of light noncombustible material, preferably thin glass, so located and arranged that it shall not be a greater distance from the opposite wall or walls than the least horizontal dimension of the room; or where confined to end walls the length of the room shall not exceed twice the least horizontal dimension of the room. The width of the corner jamb or wing wall formed by a wall thus pierced and the adjacent wall shall not exceed 10 per cent of the length of the pierced wall, and in no case shall the distance from the glass or equivalent area to the corner formed by the adjacent wall beyond, or in L-shaped rooms to the projected line of the adjacent wall, exceed the least horizontal dimension of the room.

Thin glass skylights may be accepted in part or entirely in lieu of the required glass or equivalent area, provided the area of such skylights whether used entirely or in part shall be based upon a requirement for 10 per cent of the combined areas of the inclosing walls. Such skylights shall be located not farther from the outer walls of the room than a distance equal to 10 per cent of the length of the adjacent walls, and shall have a free venting area to the room not less than the glass area required.

When structural conditions prevent the close observance of this rule a deviation of not over ten per cent in the dimension and distances given in the foregoing paragraphs may be permitted, provided the minimum glass or equivalent area required is based upon the modified room dimensions.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of the above requirement for glass or equivalent area.

(*d*) Wired glass should only be used when necessary as a protection against exposure. If used, it shall be in sash so hung that they will readily swing out in case of an explosion; such sash shall not be secured. When thin glass is used, this form of hanging is not necessary. Glass areas in walls shall be so located as to vent the force of an explosion in the direction or directions of least exposure.

(*e*) In buildings of light construction, the frame should be preferably of steel with light nonbearing walls (except fire walls), constructed of such materials as stucco on metal lath, tile, metal or equivalent noncombustible materials and with roof of monitor or gable type, and all secured in such manner as to give way readily under pressure of explosion.

(*f*) In order to prevent accumulations of dust the design of the buildings shall be such and the structural members so shaped and assembled or protected as to present the least possible extent of surface on which dust can lodge. Access must be provided for cleaning all parts of building on which dust may accumulate.

(*g*) Except for the passage of shafts, pipes, and closed conveyors, these walls and/or floors separating the pulverizing plant from other portions of the building shall, where practicable, be unpierced. Where feasible all communication between the pulverizing plant and the rest of the building shall be from the outside or by means of fire-resistive stairways inclosed by masonry walls. In cases where this method of access to pulverizing plant is not feasible indirect communication through separating walls by means of vestibules may be permitted, provided the wall opening is protected by an automatic sliding fire door approved for class A situations and the vestibule opening by a heavy closed hinged fire door approved for class B situations at right angles to the sliding door, or other suitable protected indirect communication approved by the inspection department having jurisdiction. (See Regulations of the National Fire Protection Association for the Protection of Openings in Walls and Partitions.[1])

(*h*) All piping conveying fuel in suspension in air shall be at least equal to the requirements of section 25, specification No. 1, and

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

the separators (if any) shall be constructed in accordance with section 19.

Ventilation and dust collection.

14. (*a*) All buildings or parts of buildings in which the processes of pulverizing are carried on shall be well ventilated to the outer air.

(*b*) The atmosphere of the room shall be kept as free as possible from suspended or floating dust by maintaining all apparatus in a dust-tight condition.

(*c*) Good housekeeping is a factor of the utmost importance. To this end every coal drying and pulverizing plant shall be kept free from even small accumulations of coal dust. All interior surfaces shall be smooth and of a color, preferably white, which contrasts with the dust. They shall be cleaned at sufficiently frequent intervals to prevent accumulations of dust.

Interior surfaces shall be cleaned in such manner that no dust will be scattered or distributed. To this end it is recommended that dust removal be accomplished by an adequate pneumatic or vacuum cleaning system. The use of compressed air for blowing dust from motors or other equally inaccessible places is permissible, but the general use of compressed air (except in connection with water spray) for blowing dust from walls and other interior surfaces is prohibited.

(*d*) Because of the hazard attending the use of flexible electric cable in coal pulverizing plants, the use of portable vacuum cleaners or air compressors should be avoided. Portable tanks containing compressed air may be used providing no electrical equipment is operated inside of the pulverizing room in connection therewith.

(*e*) Vacuum cleaning systems, if installed, shall comply with the following general requirements:

1. Systems shall be of sufficient power and capacity to accomplish effective results.
2. Nozzles and handles shall be constructed of nonferrous metal, fiber or other nonsparking material.
3. Hose, nozzles, handles and other metal parts shall be electrically grounded to the piping system and the piping system effectively grounded to the earth.
4. Dust separation shall take place before the dust reaches the exhauster. The discharge of separators shall be carried outside buildings. The dust shall enter the receiving end of the separator in a direction tangential to the metallic surface.
5. The motor and separator should preferably be located outside of the pulverizer room.

Pulverizer.

15. All pulverizer mills shall be safeguarded against the hazard of fire and explosion and be operated under competent supervision. Means for interrupting power supply to pulverizing equipment shall be provided near the equipment and at a readily accessible location separated from the equipment by noncombustible partitions.

Magnetic separator.

16. (*a*) A magnetic separator of the self-cleaning type shall be provided for each system employing pulverizing mills of other

than ball and tube type. In each case the magnetic separator shall be installed ahead of the pulverizers.

Coal that has passed the magnetic separator shall be located or protected in such a manner as to prevent the entry of foreign materials.

Every magnetic separator shall be safeguarded against the passage of coal when it is not magnetized, either by an interlock which will stop the flow of coal or by a suitable alarm system which will notify the operator that the separator is not functioning.

(*b*) The magnetic separator shall be of such size as to expose and insure the removal of tramp iron or other magnetic substances.

(*c*) One separator, if of sufficient size and strength, may serve a group of mills.

Electricity for light and power.

17. (*a*) All electrical equipment for light and power in pulverizer house shall conform with the National Electrical Code.[1] Provision shall be made for remote control in order that current for light and power may be cut off in an emergency without entering pulverizer house.

(*b*) In no plant shall coal storage bins, conveying machinery or fuel pipe lines be used as supports for electric lighting or power lines other than those installed in conduit.

Grounding of machinery.

18. Static electricity shall be removed from such machines or equipment as accumulate a charge by permanent ground wires and from belts by grounded metal combs or other equally effective methods. Grounds shall be attached to equipment and to the earth in accordance with the National Electrical Code,[1] article 9.

Dust collectors.

19. (*a*) All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials; cloth type collectors should be provided with dust-tight metal inclosures or their equivalent. The fabric of cloth type collectors shall be electrically grounded as required by paragraph 18. All dust collectors used in connection with the pulverizing systems, unless located in the department devoted to the pulverizing, drying or storing of coal, or in connection with transport systems on class A bins, shall be located in a separate room unless the proportion of oxygen within the separator is maintained at less than 13 per cent. Dust collectors, and rooms in which they are located shall be properly vented to a safe point outside of the building.

(*b*) Cyclone separators shall meet the following minimum requirements:

1. The shell and thimble shall be made of $\frac{3}{16}$-inch steel plate.
2. All seams shall be welded or riveted and welded.
3. All flanges shall conform to the flanges used on connecting piping.

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[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

Vents.

20. (*a*) Safety relief vents shall be liberally provided on all pulverizing equipments, particularly in the discharge of the mill in class A and B systems, or in the case of air separating systems, at the top of the return duct to the mill; at elevator heads, at every storage bin for pulverized fuel and at dust collectors. Storage bin vents shall have a cross-sectional area sufficiently large to permit the separation of air from fuel without building up an abnormal pressure within the bin. Safety relief vents taken off pipes and flues shall be of at least the same area as the pipes or flues vented; they shall lead by the most direct practicable route to the outside air in as nearly a vertical direction as practicable; and shall not deviate more than 22½ degrees from the direction of the pipe or flue from which they lead. Horizontal runs shall be avoided. (For illustration of safety relief vent see p. 34.)

NOTE.—This rule does not apply to operating vents, meaning thereby such vents as may be required for efficient means of operation. Such vents may be connected into natural draft boiler stacks or breechings into same, or into an induced draft suction near the fan, or into the furnace, provided they are equipped with automatic balanced, noncorrodible dampers opening in the direction of the normal draft.

In no case shall operating vents be permitted to deliver into the open room.

(*b*) Where operating bin and mill vents are discharged into the furnace, each pipe to the furnace shall be provided with a fan; fan and discharge pipe shall be so proportioned that the velocity in the discharge pipe from the fan is not less than 70 feet per second. Each fan shall be provided with tight inlet and outlet dampers, arranged to open only when the flow is toward the furnace, to close automatically on interruption of flow and be positively held closed when the fan is not in operation. The pipe from the fan to furnace shall be laid out at such an angle as to provide no place for dust to accumulate and from the outlet damper to the furnace shall be at least equal to the requirements of section 26, specification No. 2.

Blowers handling fuel in suspension.

21. (*a*) Blowers shall be installed on proper foundations and secured in a substantial manner. They shall not be used for any other purpose, but this shall not be construed as prohibiting the use of a blower as a means of supplying secondary air also.

(*b*) Bearings of blowers handling fuel in suspension shall not extend inside of blower casings or ducts.

(*c*) All connections between discharge end of blower and main duct shall be made so as to prevent leakage of fine dust. (See Regulations of the National Fire Protection Association for Blower and Exhaust Systems.[1])

NOTE.—Nonferrous metals need not be used in the construction of fan blades or lining of fan casings.

Driers.

22. Fuel may be dried either in the raw state or during the process of pulverizing, in the mill and separating system.

(*a*) Raw-fuel driers may consist of three types, the direct and semi-indirect types which are fired by special furnaces, and the

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

indirect type in which coal is dried by means of inert gas from boiler breechings or by means of steam or hot air before entering the mill.

(*b*) Driers of the direct and semi-indirect types shall be so designed and constructed that the products of combustion of the heating unit shall not come in contact with the fuel being dried, except at a distance of at least one-half of the length of the drier, and in no case within 12 feet of the fuel bed.

Such driers shall be designed to prevent gases of combustion from entering its shell when not in operation.

On account of the danger of spontaneous ignition due to overheating coal, the use of this type of drier should be confined to fuels having a high ignition temperature.

(*c*) Driers may be installed in boiler rooms of fire-resistive construction, cut off in a standard manner from the rest of the plant. When drier is located in a boiler house, construction of latter shall be of noncombustible material.

(*d*) Direct and semi-indirect driers if not located in boiler room as noted in 22 (c) or in a separate building shall be separated from the pulverizing department or any other section of the plant (except as noted under 22 (c) or in similar occupancies) by means of noncombustible partitions or walls constructed of materials having a fire resistance of not less than one hour in accordance with standard specifications for fire tests of materials for construction.

Indirect driers, unless in a separate building, or in boiler room, shall be similarly segregated or be provided with a protective covering or insulation which will afford protection equivalent to materials capable of withstanding a 1-hour fire test as noted in the foregoing.

(*e*) *Mill driers.*—In the process of drying coal in the mill, heated air is injected into the air duct where it enters the mill and an equal quantity of moisture laden air removed at some point beyond the mill. The danger of fire and explosion from such a system is primarily due to overheating the coal in the mill or piping system. Such overheating may occur either when the mill is shut down or when it is in operation. This overheating can be prevented as follows:

Mill shut down.—So interlock the mechanism supplying heated air to the mill with the power supply to the mill that heated air can not enter the mill when it is not in operation. Dampers are seldom tight, and if used must be supplemented by other more positive means.

Mill in operation.—If the quantity and temperature of air supplied remains constant with a varying coal feed or a varying moisture content in coal, overheating may occur. Such overheating can be prevented by so controlling the heat supplied to the mill that a safe temperature will be maintained in the mill discharge pipe. (The safe temperature varies with different coal, under most conditions satisfactory drying and safe operation can be obtained with a discharge temperature of 90° to 125° F.) Heat control may be accomplished either manually or automatically. If manual, install a thermometer with a high-temperature alarm in the mill discharge pipe for the guidance of the operator; if automatic, use a thermostat in the same location. Whether manual or automatic control is used the necessary reduction in mill discharge temperature should be

accomplished by reducing the heat input to the drying air and not by reducing the quantity of air.

NOTE.—A table of safe temperatures for drying coal is given in the Appendix.

(*f*) *Air heaters for mill driers.*—Two types of air heaters are commonly used with mill drying, i. e., steam air heaters and flue-gas air heaters.

Steam air heaters.—Fires occur in this type of heater due to the accumulation of dust on steam coils and other parts of heater; these fires shall be prevented by the following precautions:

1. Keep the heater free from dust accumulations.
2. In starting up, start air flow through heater before turning on steam.
3. In shutting down, maintain the air flow after steam is shut off long enough to cool down the heater.

Flue-gas air heaters.—With this type of heater the temperature of air entering the heater is not usually controllable within narrow limits and adjustment of air temperature entering the mill is obtained by tempering with cold air.

For the safe operation of this type of system the following provisions shall be made:

1. Heated air must be positively prevented from entering the mill when it is not in operation.
2. Dampers, fans, and other auxiliary equipment must be so arranged and interlocked that under no conditions will an open path be provided for the flow of gas from the furnace to the mill.

NOTE—Design practice varies so widely that detailed rules can not be given for accomplishing the above requirements. Some typical examples of good practice are given in Appendix B.

(*g*) *Coals (other than anthracite and coke).*—On leaving the drier the coal is hot and dry and in this state is particularly subject to spontaneous ignition. The quantity of dried coal, either unground or pulverized, stored in any plant should be kept as small as possible without interfering with the continuity of plant operations. In all cases operating schedules should be so arranged as to leave no dried unground coal in the plant when the mills are shut down for a period of 24 hours or more.

Pulverized coal exceeding a temperature of 150° F. shall not be stored in any bin in connection with a class B system.

In order to draw attention to excessive rise in temperature of the coal in the raw-coal driers, a temperature-indicating alarm device shall be installed in the discharge end of the drier with its sensitive member as close to the coal within the drier as practicable.

23. Dried coal elevator shall be of noncombustible construction, dust tight, and provided with a safety relief vent to the outer air.

24. All pulverizing mills and driers shall be constructed as dust tight as practicable, and so operated as to avoid leakage of dust.

Pipe lines—Specification No. 1.

25. (*a*) All pipe lines conveying fuel in suspension shall be constructed of lap-welded steel pipe, seamless steel tubing, butt-welded sheet steel or their equivalent. Where butt-welded sheet steel is used it should be No. 10 gage or thicker.

(*b*) Fittings shall be constructed either of cast iron or butt-welded sheet steel not less than No. 10 gage.

(*c*) Where cast-iron flanged fittings are used, flanges shall conform to the 125-pound American standard in diameter and number of bolts.

(*d*) Where welded sheet steel fittings involving a change in direction are used they shall be provided with removable wearing plates at all bends subject to abrasion. When such plates are used the size of the fittings should be increased accordingly so as not to decrease their effective diameter.

(*e*) All joints shall be made either by means of standard pipe fittings or by steel angle flanges welded to pipes. Where welded steel flanges are used, they shall be not less than one-fourth inch thick, held together by bolts not less than five-eighths inch diameter, number of bolts to conform to the 125-pound American standard, center line of bolt holes to be not less than 1¼ inches from outside edge of flange. All pipe joints, control, switching, and shut-off valves shall be of dust-tight construction.

Pipe lines—Specification No. 2.

26. The wall thicknesses given are the minimum requirement with 12½ per cent added to cover the usual mill tolerances.

Flat ring steel flanges 50-pound W. P.

Nominal pipe size (inches)	Bolt circle (inches)	Number of bolts	Size of bolts (inches)	Size of holes (inches)	O. D. of flange (inches)	Flange thickness (inches)
4	7½	4	⅝	¾	9	0. 391
5	8½	4	⅝	¾	10	. 437
6	9½	4	⅝	¾	11	. 478
8	11¾	8	⅝	¾	13½	. 568
10	14¼	8	⅞	¾	16	. 710
12	17	8	¾	⅞	19	. 914
14 O. D	18¾	8	¾	⅞	21	. 917
16 O. D	21¼	8	¾	⅞	23½	1. 063
18 O. D	22¾	12	¾	⅞	25	1. 090
20 O. D	25	12	¾	⅞	27½	1. 170
24 O. D	29½	16	¾	⅞	32	1. 214
30 O. D	36	24	¾	⅞	38¾	1. 685
36 O. D	42¾	24	⅞	1	46	1. 987
42 O. D	49¼	32	⅞	1	53	2. 298
48 O. D	56	44	⅞	1	59½	2. 612

Pipe dimensions 50-pound W. P.

Nominal pipe size (inches):	Wall thickness (inches)
4	0. 133
5	. 135
6	. 138
8	. 147
10	. 154
12	. 162
14 O. D	. 169
16 O. D	. 177
18 O. D	. 186
20 O. D	. 194
24 O. D	. 210
30 O. D	. 234
36 O. D	. 258
42 O. D	. 282
48 O. D	. 306

Pipe lines—Specification No. 3.

27. Pipe shall be standard full-weight steel. Flanges and fittings shall be A. S. A. standard B (16a) (125-pound standard).

Storage and furnace bins.

28. (*a*) Storage and furnace bins for pulverized fuel shall be located as far as consistent with operating requirements from furnaces, and away from open flames or open lights of any kind. Bins shall be so located and constructed that no radiation from furnaces, boilers, steam pipes or flues, or other heating appliances, can materially raise the temperature of the contents of the bin.

(*b*) All bins shall be of noncombustible material so constructed as to present a smooth surface on the interior, and so shaped that a minimum of material will be left in the corners under normal emptying operation of the bin. Material used in construction of metal bins shall be steel of sufficient thickness to secure ample mechanical strength. Joints shall be riveted and caulked or welded; size and spacing of rivets shall be such as to secure a dust-tight joint. Dust tightness shall also be secured in cases where metal bins are lined with concrete or where bins are constructed of concrete.

(*c*) Except for vent openings, all storage and furnace bins shall be normally tightly closed. When bins are filled by transferring pulverized coal by means of air, either under pressure or by a fan, the arrangement should be such as to assure a minimum dust cloud within the bin. Such vent openings shall be equipped with tight-fitting dampers or checks to prevent entrance of air from the outside.

(*d*) All bins should be equipped with a reliable indicating device to warn the operator before the bin is in danger of overflowing without exposing the contents. At no time shall there be any pressure other than that caused by the weight of the fuel in any pulverized fuel storage bin.

Ignition.

29. For purposes of fuel ignition or supplementary use, fuel oil, natural gas or artificial gas may be used if installed in an approved manner.

30. Every coal conveying line shall be located away from all open flames or open lights of any kind and at a safe distance from sources of radiated heat such as furnaces, ovens, boilers, boiler settings, etc.

Class A Systems—Specific Regulations

Fire protection.

31. Every building or room containing the foregoing processes shall be provided with approved fire extinguishers in such quantity and of such type as outlined in the Regulations of the National Fire Protection Association for First Aid Fire Appliances.[1] Wherever the introduction of combustible material into the pulverizing room makes automatic sprinklers necessary for fire protection, their arrangement and control shall be approved by the inspection department having jurisdiction.

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

All raw-coal driers shall be provided with means of introducing live steam or inert gases controlled by readily accessible, quick acting valves.

Means should be provided to divert the contents of these driers to the outside of the building in case of emergency. (See sec. 51 (*b*).)

NOTE.—Attention is directed to the fact that warning of the overheating of bearings in dusty and inaccessible locations, and when the heating of bearings may cause explosions, may be obtained by the use of approved journal alarms.

Transportation pipe lines.

32. All pipe lines for transporting pulverized coal between mill bins and points of consumption or storage shall be at least equal to the requirements of section 27, specification No. 3.

Screw conveyors.

33. Systems using screw conveyors for handling pulverized fuel shall be normally arranged with the driving power applied at the end toward which the fuel is being conveyed. Where the length of transfer is too great for a single screw so driven, any additional units shall be similarly driven and so interconnected that the stopping of the last screw in the series will automatically stop the others, or as an alternative for such interlocking the junction point between the two screw conveyors shall be placed outside of the building, and be provided with a normally closed spillway or relief valve.

When it is necessary to transport fuel in different directions, and this is to be accomplished by the reversal of motors, the motors operating the screw conveyors shall be provided with overload releases and screw conveyor drives should be provided with shearing pins. All motors driving screw conveyors shall be provided with overload releases.

A solid flooring shall be placed immediately under all screw conveyors to retain any spilled material.

Unit Systems—Arrangement of Systems

41. No pulverizer shall be connected to supply more than one furnace at a time. This shall not be construed as preventing the installation of spare pulverizers which may be connected to any of several furnaces if the regular pulverizer is disconnected; i. e., a section of the discharge pipe between the pulverizer and the furnace removed.

42. Piping from mill to burners shall be so arranged that when a mill is in use all burners which that mill can supply shall be in operation.

43. Two discharge pipes from separate mills shall not be connected to the same burner nozzle.

Instruction Cards

51. An instruction card, including the following precautions relating to safe operation, shall be conspicuously posted in the pulverizing plant, boiler plant, and in buildings where pulverized fuel is used.

(*a*) The use of shavings or other similar light combustible materials for starting fire in drier furnace is prohibited.

(*b*) The rotation of a revolving drier shall not be stopped while it contains a charge of fuel.

Indirect driers delivering directly to the mills shall be run empty before cutting out the mills, and coal gates, gas gates, or steam heating valves shall be shut tightly. If it becomes necessary to shut down the mills for any reason for more than 24 hours, the driers should be emptied.

In cases of indirect drier fires, shut off coal inlet and outlet gates, gas inlet and outlet gates, and steam heating valves, if steam heated, and turn on steam or inert gas extinguishing lines.

NOTE.—When opening up a drier, transport line, or other apparatus which has been sealed to extinguish a fire in the coal, or any place where live steam has been injected for the same purpose, precautions must be taken to prevent ignition of any gas which may have been generated during the period of the fire.

After the fire has been extinguished and the coal has been cooled below ignition temperature, the drier should be ventilated with a vigorous current of fresh air for 10 minutes or more to remove poisonous gases before persons are allowed to enter.

(*c*) Whenever a plant has been idle for a period of two days or more, all storage bins shall be thoroughly inspected before resuming operation.

(*d*) Manhole or inspection openings of furnace bins shall not be open while fuel is being discharged into the bins.

(*e*) Operators are cautioned against causing leaks in pipe lines or bins by hammering.

(*f*) Damper in drier chimney uptake shall be wide open when fire is started.

(*g*) In class B systems, if fuel supply line becomes clogged, the furnace shall be immediately cut off and the secondary air stopped. When obstruction has been cleared and before starting fan, a thorough examination shall be made to ensure the removal of smoldering particles of fuel.

(*h*) All fuel supply lines (of class B and unit system types) shall be blown clear of fuel when shutting down at end of day.

(*i*) All conveyors and elevators shall be tightly and securely inclosed and never opened while running. All conveying and distributing piping shall be inspected daily and any leaks promptly repaired. Previous to opening, machinery shall be stopped and dust allowed to settle for a period of 20 minutes.

(*j*) Only daylight or hand flashlights shall be used when inspecting the interior of coal storage bins and pulverizing and coal conveying apparatus when in operation. When apparatus is not in operation guarded droplights with dust-proof globes utilizing cord approved for hard usage such as type S or PA may be used. Portable cord shall be used only from approved convenience outlets provided for this purpose.

(*k*) Smoking and the use of open lights or torches shall be prohibited in the crushing, drying, and pulverizing plant.

(*l*) *Lighting pulverized fuel furnaces.*—Before injecting pulverized fuel into a furnace:

1. See that there is sufficient draft on the furnace to adequately remove the products of combustion.
2. Provide lighted torches, adequate in number and volume of flame, so disposed as to ignite all burners to be started.

Keep the torches in operation until all danger of losing ignition has passed.

NOTE.—Many explosions resulting in loss of life and property have occurred due to improper lighting-off practice. The requirements of a safe lighting-off system vary so widely with coals and equipment having different characteristics that universally applicable detailed rules can not be written. The following suggestions are offered as representing good ignition practice.

1. Permanent oil torches should be installed according to the National Fire Protection Association Regulations for the Installation of Oil Burning Equipments.

2. Low-viscosity, high-flash-point oils such as kerosene or gas oil are recommended.

3. Torches should have a supply of air under pressure independent of furnace draft.

4. Portable torches, with which the tank and piping are not in accordance with codes for oil fired plants, should be withdrawn from the furnace completely when not in use.

5. No gas having less than 400 B. t. u. per cubic foot is to be used for an ignition torch, except that in furnaces fired primarily by blast furnace gas, having coal burners only for use in emergencies, the gas may be used as a lighting medium for the coal if the two types of burners are located according to the best practice.

6. All gas torches should have a supply of air under pressure independent of furnace draft or should be arranged like a Bunsen burner with the gas under sufficient pressure to induce its own air supply.

7. The size of each torch should be proportioned according to the size of the coal burner.

8. Each torch should preferably be located so that its flame will approximately parallel the coal stream to obtain contact for an appreciable length of time with a given mass of coal.

9. The torch should be so located that the tip and ignition zone are outside of the coal stream to avoid danger of having the torch snuffed out.

Appendix A.—Storage of Coal

The observance of proper precautions in the storing of pulverized or dried crushed coal is of pronounced importance in that failure in this respect will probably result in fire due to spontaneous ignition. In order to safeguard against this hazard it is urged that the following advisory requirements be complied with:

	Maximum time for storing pulverized or dried crushed coal
1. Semianthracite coal:	
Temperature of coal entering mills—	
200° F	12 hours.
175° F	16 hours.
150° F	24 hours.
140° F	36 hours.
130° F	1 week.
2. Bituminous coal having less than 2 per cent sulphur:	
Temperature of coal entering mills—	
180° F	12 hours.
150° F	18 hours.
130° F	24 hours.
120° F	1 week.
3. Lignite, subbituminous, and high sulphur coal:	
Temperature of coal entering mills—	
150° F	12 hours.
130° F	16 hours.
120° F	24 hours.
110° F	36 hours.
100° F	1 week.

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The last group of coals because of their higher inherent moisture will drop in temperature in milling and will go to the pulverized coal storage at considerably lower temperatures, provided the milling system is properly vented to release the moisture given off in grinding. If no water is evaporated, there will be only a small drop in temperature. Whenever pulverized coal or crushed coal are stored in the plant, a regular daily inspection should be made to see that there are no fires or overheating.

Apendix B.—Recommended Procedure for the Extinguishment of Fires in Pulverized-Fuel Conveyors, Pipes, Ducts, Collectors, and Bins

The difficulty in extinguishing fires of the type noted above is recognized by all persons who have had any material experience in connection with the operation or maintenance of a pulverized-fuel plant. Fires which otherwise would have been of slight extent have spread beyond the incipient stage owing to the application of improper extinguishing methods due to the lack of experience. For purposes of general information and guidance to those who may be called upon to aid or direct such fire-extinguishing operations, the following procedure governing such fire-fighting operations is given:

Fires in conveyors, pipes, ducts, or collectors.

In case fire is discovered in pulverized-fuel conveyors, pipes, ducts, or collectors:

1. Stop coal supply as quickly as possible.
2. Stop air supply as quickly as possible.
3. Close all vents and gates and inspect all vents and gates which should close automatically.
4. Introduce steam, carbon dioxide, or other inert gas. It is suggested that pipe connections be provided on all such equipment for the ready introduction of the extinguishing medium. Such connections should not be less than 1 inch.
5. If fire extinguisher can not be applied or is ineffective, water may be introduced. Care should be taken not to use a high-pressure stream which would create dust clouds which would be an explosion hazard. Water should be used only under supervision of responsible authorities.
6. Procedure after fire is out will depend entirely on local conditions. In general, the equipment should not be put into operation until it has been thoroughly cleaned.

Fires in pulverized-fuel bins.

In case fire occurs in a pulverized-fuel bin:

1. Stop coal supply to bin.
2. Stop carrier air to bin.
3. Close bin vent damper or, if it is automatic, make sure it is tight.
4. Make sure that all other openings into bin, other than feeders, are tight.
5. Notify foreman and fireman.
6. Foreman should size up situation to see if fire has been caught quickly enough to be snuffed out by its own fumes.

7. If necessary introduce steam or inert gas. It is suggested that 1-inch or 2-inch pipe connection or small hand hole be provided in the top of bin for this purpose.

8. If fire has made considerable headway before being discovered so that vent damper has been damaged or seams have opened, it is imperative that every effort be made to close these openings with water-soaked bags or similar material. If the material used is combustible it should be kept wet.

9. The use of large quantities of water inside the bin should be avoided because it is of practically no value in putting out fire in large quantities of pulverized fuel, and because it makes it almost impossible to use the feeders.

10. The bin should be emptied as quickly as possible, even while fire is in progress, by feeding coal to the furnace. This should be done in spite of difficulties with feeders due to lumps of coke.

11. If coal can not all be fed to furnace through feeders, the fire should be completely extinguished before the bin is opened.

12. After the fire is out and the bin is opened as much coal as possible should be scraped from the side walls with rods manipulated through the manhole on top of the bunker. If coke jams the feeders, an attempt should be made to break it up with rods. If this fails men must enter the bin.

13. Before men enter the bin it shall be thoroughly aired for several hours to eliminate fumes and to test whether fire is really out. The bin should then be entered only on authority of responsible persons, and the men shall wear oxygen breathing apparatus and have ropes around their waists held by men outside the bin. The men in the bin shall be watched continuously unless the fire has been out and the bin opened for at least 24 hours.

Practically all fires can be extinguished and coal can be fed through the feeders without the emergency measures discussed above in sections 6 to 13, unless there has been negligence in routine inspection of bin. Routine inspection should consist in opening such bin once a day. A man putting his head within the manhole can determine whether there is any unusual increase in bin temperature or in fumes from smoldering fire, and if he temporarily turns out his light he may be able to notice a dull red glow. Such inspections, of course, should not be made while bin is being filled nor until dust is settled after a filling period.

The following might be added to recommendation on bin fires:

14. The bin need not be emptied after a fire unless so much coke has been formed that it jeopardizes safe feeder and burner operation.

It is not safe operation if intermittent feeding and burning results in deposits of unburned fuel in the furnace.

In this case the bunker should be emptied without burning the coal, either by disconnecting feed pipe and discharging to buckets, or by filling buckets in bunker and taking them out through the manhole in the top. Under no circumstances should the coal be freely discharged to floor or sluiceway through openings in bottom of bunker.

Safety Code for the Prevention of Dust Explosions in Coal Pneumatic Cleaning Plants

(American Standard, approved December 31, 1930, by American Standards Association)

Article I.—Introduction

11. This safety code is designed for application to new installations and when making alterations or extensions to existing equipment. It is not retroactive.

12. Installation of pneumatic cleaning systems should be under the supervision of engineers qualified by experience in the design, construction, and operation of such equipment.

Definitions.

13. In this code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of the regulations.

The terms "adequately," "effective," and "securely" shall be interpreted as conditions subject to the approval of the inspection department having jurisdiction.

Article II.—Buildings, Machines, and Apparatus to be Covered by these Regulations

Types of systems.

21. Coal pneumatic cleaning systems as covered in these regulations employ air pressure and evacuation and are subject to the hazard incident to the creation and distribution of dust, explosive in air when ignited, also means of its ignition unless the system is properly designed, constructed and operated. There are two principal dust-making mechanisms, and which may also be the means, unless properly designed and operated, of distributing the dust:

(*a*) Screens, shaking and/or vibrating screens, and revolving screens.

(*b*) Pneumatic jigs or tables for separating the pure coal from the refuse.

(*c*) Other machines which may produce and distribute dust are as follows: Conveyors, which may be of rubber or canvas, and inclosed elevators used for several purposes, such as for carrying or conveying the raw coal into the top of the building, conveying the clean coal of the several sizes to bins or to the outside of the building, reelevating middling products, and conveyors or elevators for discharging the refuse outside.

Dust-making adjuncts.

22. Potential dust hazards, either in dust making or in ignition of dust already made, are found in:

(*a*) Dust collectors for collecting dust from air discharged by evacuating hoods, separable into three general types:

(1) Cyclone collectors.
(2) Stocking or bag collectors for the finest dust.
(3) Screen-cloth collectors.

(*b*) Coal bins, such as bins for raw coal and for the cleaned products. In some plants, however, some or all of these bins are not within the plant itself excepting there would be almost always within the building raw coal bins which may be small in size for equalizing the feed to the pneumatic jigs or tables.

(*c*) Dryers, which may be required if the coal to be cleaned is wet or damp.

Article III.—Installation Requirements of Pneumatic Cleaning Machinery and Apparatus

Location.

31. The process of pneumatic cleaning shall preferably be accomplished in a separate detached building used for no other purpose. If driers are requisite in the operation it is desirable these be located in a separate fire-resistive building or isolated room.

Construction of building.

32. The building containing pneumatic screening and cleaning equipment and driers shall be constructed of noncombustible materials and be of such design:

(*a*) To have internal surfaces, other than floors, for a minimum lodgment of dust.

(*b*) That all interior parts of the building on which dust may lodge may be cleaned readily.

(*c*) That will relieve the force of an explosion through skylight, window or explosion doors.

Screen-room arrangement.

33. Where the coal screening is not in a separate building but is in a room or rooms above the pneumatic or air jigs or tables, the floor material should be of concrete or steel plate with openings only for the passage of inclosed chutes, conveyors and pipes, and inclosed stairways. Also, where the screen room is very large, with outside walls having windows in at least one wall, it is desirable to subdivide, so far as is practicable, by erection of partitions of substantial fire-resistive construction, with self-closing fire doors, extending across the room from side wall to side wall, to limit the extent and violence of an inflammation in any one subdivision. It is preferable that the communication between rooms be indirect, such as by doors opening outward on an outside balcony or else use double doors.

Jig or table room.

34. The room or rooms in which the pneumatic jigs or tables are located should be arranged as provided in the preceding paragraph for screen rooms.

Window arrangement and construction.

35. (*a*) A portion of the exterior walls of each of the several floors or separate rooms shall have windows of an area in square feet not less than one-fiftieth of the number of cubic feet in volume of the respective room and there shall be a window or windows not over 10 feet from each end of the room. The windows shall be so constructed that they will rupture under an internal pressure of 1 ounce per square inch (9 pounds per square foot), or else they shall be so hinged and not bolted or otherwise fastened, as to open outward under this pressure. Skylights of similar strength or hinged may be accepted in lieu of equal area.

NOTE.—See Figures 1 to 6, inclusive (pp. 29–31), for illustrations of typical applications of requirements for glass or equivalent area.

(*b*) Wired glass should only be used when necessary as a protection against exposure. If used, it shall be in sash so hung that they will readily swing out in case of an explosion; such sash shall not be fastened by bolt or lock. Windows and skylights shall be so located as to vent the force of an explosion in the direction or directions of least hazard to adjacent buildings or constructions.

Building construction.

36. (*a*) In buildings of light construction, the frame should be of steel with light nonbearing walls (except fire walls), constructed of such materials as stucco on metal lath, tile, metal or equivalent noncombustible materials and with roof of monitor or gable type, and all secured in such a manner as to give way readily under pressure of explosion.

(*b*) In order to prevent accumulation of dust, the design of the buildings shall be such and the structural members so shaped and assembled or protected as to present the least possible extent of surface other than the floor on which dust can lodge. No exposed surface, except the floor, stairs, steps and machinery, shall have an inclination of less than 45 degrees, which condition may be met by fastening securely a covering of iron sheeting or by using concrete or hard plaster for filling up to the required angle to prevent dust from accumulating thereon. Access must be provided for cleaning all parts of building on which dust may accumulate.

Ventilation and dust collection.

37. (*a*) All parts of the building in which the process of coal pneumatic cleaning is carried on shall be ventilated to the outer air and where clouds of dust are given off, evacuating hoods at appropriate places and connected to an ample sized evacuating pipe, must be installed to draw off dust as rapidly as made.

(*b*) The atmosphere of the room shall be kept as free as possible from suspended or floating dust by maintaining all apparatus in a dust-tight condition.

(*c*) Good housekeeping is a factor of the utmost importance. To this end every coal pneumatic cleaning plant shall be kept free from even small accumulations of coal dust. All exposed surfaces other than that of machinery shall be smooth and of a color, preferably white, which contrasts with the dust. Floors and all other surfaces shall be cleaned at sufficient frequent intervals to prevent dust from accumulating.

(*d*) Interior surfaces shall be cleaned in such a manner as to minimize the scattering of dust to other places. To this end it is recommended that dust removal be accomplished by an adequate pneumatic or vacuum-sweeping system. Compressed air should not be used (except in connection with water spray) for blowing dust from walls and other interior surfaces.

(*e*) Because of the hazard attending the operation of motors and the use of flexible electric cable in coal pneumatic cleaning plants, portable vacuum cleaners and air compressors shall not be used, but instead the usual suction-cleaning appliances should be connected by hose to taps of permanent piping extending to a suction fan or equivalent.

(*f*) The fan or equivalent and the collector for the sweeping system shall be located in a separate room. The discharge from the dust collector may or may not be the dust collector used for the discharge of air from the vacuum system connected with the screens and air jigs or tables.

Dust collectors.

38. All dust collectors (except those of cloth type) shall be constructed throughout of noncombustible materials and be provided with dust-tight metal inclosures. The fabric of cloth type collectors should be electrically grounded as far as practicable in an effective manner. All dust collectors shall be located in separate rooms; dust collectors and rooms in which they are located shall be properly vented to a safe point outside of the building and the discharge shall be at sufficiently low velocity as to avoid fine dust being forced through the bag or screen.

Air vents.

39. Safety relief vents shall be liberally provided in air separating systems, at the top of the return duct to the respective machine; also at elevator heads, at every coal-dust storage bin and at dust collectors. Storage-bin vents shall have a cross-sectional area sufficiently large to permit the separation of air from dust without building up an abnormal pressure within the bin.

Safety vents.

40. To provide for relief of pressure of an internal dust explosion or gas explosion there shall be vents taken off pipes and flues of at least the same area as the pipes or flues vented; they shall lead by the most direct practicable route to the outside air in as nearly a vertical direction as practicable, and shall not deviate more than 22½ degrees from the direction of the pipe or flue from which they lead. Horizontal runs to the point of venting shall be avoided. (For illustration of safety relief vent see p. 34.)

Coal driers.

41. Driers if used may consist of three types, the direct and semi-indirect types which are fired by special furnaces, and the indirect type in which the coal is dried by means of inert gases from the boiler breechings, or by means of steam or hot air.

(*a*) Driers of the direct and semi-indirect types shall be so designed and constructed that the products of combustion of the

heating unit shall not come in contact with the fuel being dried, except at a distance of at least one-half of the length of the drier, and in no case within 12 feet of the fuel bed. Such driers shall be designed to prevent gases of combustion from entering its shell when not in operation.

(*b*) Driers shall be installed in rooms of fire-resistive construction, cut off in a standard manner from the rest of the plant.

(*c*) Direct or semi-indirect driers if not located in a separate building shall be separated from the dust-making parts of the plant by means of substantial noncombustible partitions or walls constructed of materials having a fire resistance of not less than one hour in accordance with standard specifications for fire tests of materials for construction.

(*d*) Storage of dried coal: On leaving the drier the coal is hot and dry and in this state, except for anthracite, is particularly subject to spontaneous ignition. The quantity of dried coal, either coarse or fine, stored within in any plant should be kept as small as possible without interfering with the continuity of plant operation. Coal exceeding a temperature of 150° F. shall not be stored in any bin.

In order to draw attention to excessive rise in temperature of the coal in the driers a temperature-indicating alarm device shall be installed in the discharge end of the drier with its sensitive member as close to the coal within the drier as practicable.

Dried-coal elevator shall be of noncombustible construction, dust tight and provided with a safety relief vent to the outer air.

All driers, conveyors and other dust making and transporting machinery shall be constructed as dust tight as practicable, and so operated to avoid leakage of dust.

Storage bins.

42. (*a*) Storage bins for coal located in coal pneumatic cleaning plants shall be so located and constructed that no radiation from furnaces, boilers, steam pipes or flues, or other heating appliances, can materially raise the temperature of the contents of the bin.

(*b*) All coal bins in the coal pneumatic cleaning building shall be of noncombustible material so constructed as to present a smooth surface on the interior and so shaped that no material shall be left in the corners under normal operation of emptying the bin. Material used in construction of bins shall be steel or reinforced concrete of sufficient thickness to secure ample mechanical strength. Dust tightness shall be secured in all cases.

(*c*) Except for vent openings all coal-dust bins shall be normally tightly closed. The vent openings shall be equipped with tight fitting dampers or check valves to prevent circulation of air from the outside.

Article IV.—Electricity for Light, Heat, and Power

51. Provision shall be made for remote control so that the current for both light and power may be cut off when an emergency occurs, without entering the coal pneumatic cleaning house.

52. All electrical equipment throughout the coal pneumatic cleaning plant (except in sections so cut off as to be free from dust) shall

conform to article 32 of the National Electrical Code [1] relating to "Hazardous Locations, Class II."

NOTE.—Article 32 of the National Electrical Code calls for totally inclosed or other special types of motors specifically approved for use in hazardous atmospheres. Fuses, circuit breakers, and similar devices are required to be in dust-tight metal cabinets or cases, or to be of types which can not cause exposed sparks. Lights are required to be in approved dust-tight globes—which should be protected by substantial guards. Service entrance equipment switchboards, etc., are required to be in separate dust-tight rooms or inclosure. All wiring is required to be in rigid metal conduit.

53. Where, in the case of machinery, there are moving parts electrically driven which require flexible cord, or in the case of temporary machinery, or machinery under test, only approved cord shall be used, such as special flexible trailing cables used in mining machinery. Where this is used, care should be exercised in the placing of cords or cables so that the insulation is not cut by movements of the machinery, and in no case shall conveying machinery or pipe lines be used as supports except when the wires are placed in rigid metal conduits.

54. When the fixed lights described above are not sufficient for making inspections and repairs, especially within the inclosures of machinery and bins, it may be necessary to employ portable lights. If these are used, the cord, the lights, and the attachment plugs must be of approved design for use in a dusty atmosphere. However, it is preferable, in place of portable cords and light attachments, to employ "permissible" flash lights and/or miners' portable electric storage battery lamps such as employed in gassy and dusty mines which are termed "permissible" miners' lamps.

NOTE.—The term "permissible," used as a prefix to a motor, apparatus, or device, means tested and approved by the United States Bureau of Mines for use in gassy and dusty coal mines.

Article V.—Fire and Explosion Protection

61. Every building or room containing the foregoing processes shall be provided with approved portable fire extinguishers in sufficient quantity and of such types as outlined in the Regulations of the National Fire Protection Association for First Aid Fire Appliances.[1] Other fire protection for fighting fires from within and without the plant shall be in accordance with approved fire-fighting regulations.

62. Driers and bins should be provided with a means of introducing live steam, or inert gases controlled by readily accessible, quick-acting valves. Means should be provided to divert the contents of driers to the outside of the building in case of emergency.

Open flames and torches.

63. No stoves for heating the building, torches, or flames of any sort shall be used under normal conditions. In case of repairs, when it may be necessary to use electric, oxyhydrogen cutting or welding torches, operation of the plant should cease and every precaution

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

shall be taken to clean up all dust in the vicinity prior to use of the torches.

Smoking.

64. Smoking shall be prohibited in every part of the plant.

Fire drills.

65. Fire-fighting drills, embracing all employees of the plant, including foremen, shall be held at least once a month.

Safety Code for the Use of Inert Gas for Fire and Explosion Prevention

(American Standard, approved September 24, 1931, by American Standards Association)

Introduction.

This safety code, prepared in cooperation with the National Fire Protection Association Committee on Manufacturing Risks and Special Hazards, is applicable to the prevention of fires and explosions in industries and processes using flammable liquids and gases, as well as to the prevention of dust explosions.

1. Carbon dioxide or other inert gases which when mixed with air reduce the oxygen percentage of the atmosphere below the combustion limit can be used successfully in providing protection against fires and explosions in certain hazards.

NOTE.—These regulations cover only the use of inert gas for fire and explosion prevention. For extinguishing fires by carbon dioxide see Regulations of the National Fire Protection Association for Carbon Dioxide Fire Extinguishing Systems.[1]

2. These rules indicate a standard method of using carbon dioxide or other inert gases for the prevention of explosions and fires where the hazards are of such a nature as to make this form of protection necessary or desirable.

NOTE.—Examples of where such protection may be called for are ovens, driers, grinders, or pulverizers, special machinery and apparatus involving the use or handling of flammable liquids, vapors, or dusts within an inclosure, tanks used for storage of flammable liquids, and bins, vaults, or other such inclosures containing material through which gas may permeate and where it is unnecessary for anyone to enter the inclosure at frequent intervals.

3. *Inert gas protection is not recommended* for nitrocellulose or other pyroxylin plastics in large quantities nor to prevent ignitions or explosions of aluminum or magnesium powders, nor in cases where decomposition or the release of combustion supporting agents may occur and render ineffective inert gas protection.

4. Neither carbon dioxide nor nitrogen are poisonous, but in sufficient quantity they are suffocating, and it is not intended that inert gas should be used in inclosures where employees are at work.

NOTE.—Ordinarily no one would be overcome in an atmosphere of air and carbon dioxide or nitrogen in the concentrations recommended within a time amply sufficient for retirement from the room or inclosure.

5. Neither carbon dioxide nor nitrogen will injure metals, fabrics, food products, or other perishable material. They do not freeze, deteriorate, nor will they conduct electricity.

6. Where other inert gases such as flue gas, internal-combustion engine exhaust, carbon tetrachloride, sulphur dioxide, di-chloro methane, etc., are used special precautions are necessary to prevent

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

possible injurious effects on employees or on the product being protected.

NOTE.—Flue gas is generally the most readily available and most frequently used inert gas because it is economical and contains a relatively high percentage of carbon dioxide. Injurious gases, particularly carbon monoxide, may be present in flue gas or internal combustion engine exhaust and no one should be permitted to enter any inclosure where poisonous gas is present or has been used until the inclosure has been thoroughly ventilated and a test or an analysis shows that no injurious gas remains.

In certain processes the use of steam is necessary or desirable, and in such cases it may be used in combination with other inert gases provided it does not introduce any additional fire hazards due to high temperatures.

7. Since the use of inert gas for fire and explosion prevention is a comparatively new development it is recommended that these rules be used with discretion. Only general essentials and the average necessary specifications to make a workable code are given. Details for each installation will necessarily vary according to the local conditions and the hazard involved. Inspection departments having jurisdiction should be consulted as to the application of these standards and all details of installation, including the question of what additional special hazard protection, if any, should be provided and what other standards are applicable.

Definitions.

In this code the following words are used as defined below:

"Shall" is intended to indicate requirements.

"Should" is intended to indicate recommendations, or that which is advised but not required.

"Approved" refers to approval by the authority having jurisdiction in the enforcement of regulations.

General.

8. The reduction of the oxygen content of air (normally 21 per cent) necessary to prevent explosions and fires varies with the different materials being handled. Detailed information concerning the oxygen reduction necessary is given under the section entitled "Determining the Amount of Inert Gas Required."

9. Apparatus protected should be inclosed as tightly as possible and arranged so that the supply of inert gas may mix with and dilute the air entering the inclosure before any possible sources of ignition are reached.

10. Inert gas should be injected into inclosures at the top or in such a way that it will be distributed as uniformly as possible.

11. In tubes, spouts, conveyors, etc., or where drafts are present the gas should be injected into the inclosure so as to be carried along with the draft or stock.

12. At spreaders, belt feeders, or other machines where hoods are provided to carry away dust or fumes the gas should be introduced at the point of hazard and distributed in such a way as to sufficiently dilute the air entering the hood.

13. Before any inert-gas equipment is installed or remodeled complete working plans showing necessary details of the local conditions, hazards, and of the proposed equipment shall be submitted for approval to the inspection department having jurisdiction.

14. All apparatus and devices used shall be approved and standard so far as such approvals and standards apply.

Determining the amount of inert gas required.

15. Before the amount of inert gas required can be determined it is necessary to know the volume of air entering the inclosure or hood where the hazard exists and the reduction of the oxygen percentage necessary to prevent ignition. In closed rooms or bins the normal air leakage or rate of air change represents the volume to be considered. This determination should be made by actual measurement if possible but may be computed if necessary.

16. Table I indicates the percentage to which the oxygen must be reduced to prevent ignitions or explosions of the dusts and gases listed when the required oxygen percentage is obtained by adding to air pure carbon dioxide. Where gases other than pure carbon dioxide are used lower oxygen percentages are required. The information at present available indicates that when nitrogen is used instead of carbon dioxide the oxygen percentage should be reduced about 10 per cent below the figure given in the table. Both carbon dioxide and nitrogen are present in different percentages in flue gas, the medium most generally used in installations requiring extremely large quantities of inert gas. When it is desired to provide inert gas protection for a dust or vapor not listed or to use an inert gas other than pure carbon dioxide, or where any unusual condition exists the inspection department having jurisdiction should be consulted and if the information is not available arrangements should be made for laboratory tests to determine the oxygen reduction necessary under the existing conditions.

TABLE I.—*Permissible Percentage of Oxygen Based on the Addition of Carbon Dioxide*

Material	Maximum permissible oxygen percentage
Pittsburgh coal dust	16
Pyrethrum flower dust	15.5
Acetone	15
Cotton lint or dust in suspension in air	15
Ethyl alcohol	15
Gasoline vapor	15
Kerosene vapor	15
Methane	14.5
Cork dust	14.1
Wheat, corn, or oat elevator dust	14
Ground oat hulls	13.7
Ether	13
Hard rubber dust	13
Wheat starch	12
White dextrine	12
Ethylene	10
Sulphur	8.5
Carbon disulphide	8
Cotton in bulk—to prevent smoldering and reignition	8
Jute	8
Carbon monoxide	5.9
Hydrogen	5.9

17. If a pure inert gas is to be used, i. e., a gas which contains no oxygen or other combustible component, the amount required is calculated on the basis of the percentage of oxygen permitted by using the formula:

$$x = \frac{21 - O}{O} V$$

in which x is the amount of inert gas required, O is the maximum percentage of oxygen permitted and V is the volume of fresh air containing 21 per cent oxygen within an inclosure and to be introduced into a machine or inclosure.

For example, if 12 per cent is the maximum amount of oxygen permitted and the inclosure to be protected contains 1,000 cubic feet of fresh air

$$x=\left(\frac{21-12}{12}\right)1000$$
$$x=750$$

Under such conditions it would be necessary to introduce 750 cubic feet of pure inert gas into an inclosure to replace 750 cubic feet of the 1,000 cubic feet of air or gas and air contained therein before it would be safe to start the process creating the hazard. To maintain this safe condition it would be necessary to add 750 cubic feet of inert gas to each 1,000 cubic feet of fresh air admitted to the inclosure to replace leakage or as a part of the process.

18. When the inert gas to be used already contains a certain percentage of oxygen as is the case when flue gas is the source of supply the amount is calculated on the basis of the percentage of oxygen permitted and the percentage of oxygen already present in the gas by using the following formula:

$$x=\left(\frac{21-O}{O-O_F}\right)V$$

in which x is the amount of inert gas required, O is the maximum percentage of oxygen permitted. O_F is the percentage of oxygen in the flue gas and V is the volume of fresh air containing 21 per cent oxygen within an inclosure or to be introduced into a machine or inclosure.

For example, if 12 per cent is the maximum amount of oxygen permitted and the flue gas contains 11 per cent of oxygen and the inclosure contains 1,000 cubic feet of fresh air

$$x=\left(\frac{21-12}{12-11}\right)1000$$
$$x=9000$$

Under such conditions it would be necessary to pass 9,000 cubic feet of flue gas containing 11 per cent oxygen into and through an inclosure of 1,000 cubic feet capacity before it would be safe to start the process creating the hazard. To maintain this safe condition it would be necessary to mix 9,000 cubic feet of flue gas with each 1,000 cubic feet of fresh air admitted to the inclosure to replace leakage or as a part of the process.

NOTE.—In cases such as cited in the foregoing example where the proportion of flue gas to fresh air is so large it is recommended that flue gas be used in the full amount necessary to replace leakage or carry on the process without making any attempt to combine or mix it with fresh air.

Sources of inert gas supply.

19. Inert gas for fire and explosion prevention shall be obtained from a dependable source capable of supplying continuously the amount required to dilute the oxygen within the inclosure protected

to the predetermined point where ignitions will be impossible. Gas may be obtained from storage tanks, gas producers, boiler settings, special furnaces, internal combustion engines, or similar sources.

20. If gas is obtained from storage tanks or gasometers provisions shall be made to maintain the gas supply while recharging the tank or tanks. A duplicate set of tanks may be necessary unless the system is arranged so that a sufficient reserve supply can be maintained to provide protection during the recharging period.

21. If gas producers are used to furnish the inert gas they shall have twice the gas producing capacity necessary to protect the hazard unless they are used in connection with storage tanks or gasometers, and can be operated to replenish the stored supply during periods when no gas is needed for protection.

22. When inert gas is obtained from boiler settings or special furnaces provision shall be made to maintain the supply at all times while the hazard exists. Where the gas supply may fail and the process protected is continuous a reserve supply in storage tanks may be necessary. If gas is obtained from the breeching of a battery of boilers provision shall be made through the use of dampers or valves to prevent dilution of the flue gas with fresh air drawn through the grates or openings of any boilers which are idle or shut down.

23. If power is necessary to operate the equipment in which the hazard exists, an internal combustion engine can often be used as a source of power and the exhaust gases used to provide protection against fire and explosion. The engine can also be used to operate a compressor to compress the exhaust gases or force them through pipes to the point where they are to be used.

24. When exhaust gases from an internal combustion engine are used precaution shall be taken to keep the air-fuel ratio 12 to 1 or higher, otherwise the exhaust gases themselves may contain sufficient combustibles to form explosive mixtures with air.

Gas conditioning equipment.

25. When flue gas or any gas which may be injurious to the product or plant equipment is used suitable cooling and conditioning apparatus shall be installed. No conditioning equipment will be necessary if clean, pure carbon dioxide or other commercially available inert gas is obtained from an approved source.

26. Gas shall be cooled below the temperature at which it would be a fire hazard to the product or equipment. Cooling of flue gas may be accomplished by using it as the source of heat in preheaters, economizers, or similar boiler-room equipment in which air or water is heated, or by passing it through cooling towers consisting of long runs of straight or spiral air or water cooled pipe.

27. Conditioning equipment may consist of a dust or soot separator, a coke or wooden grid scrubber, a spray washer, one of the many types of filters or air cleaners now on the market, a moisture trap or a combination of these or similar equipment designed to remove the objectionable impurities or render the gas suitable for use.

NOTE.—Special fans or filters can be used to remove a large percentage of the dust, soot, and cinders generally present in flue gas.

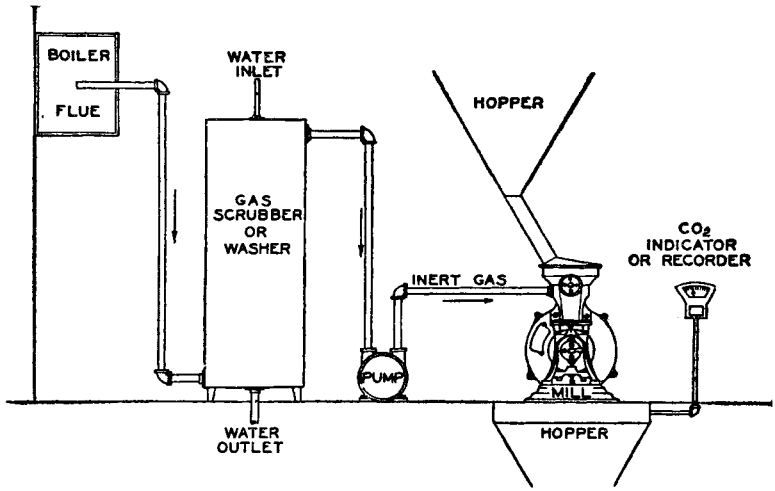
Spray washers can be used to remove very fine dust, soot, and certain other impurities.

A good and low cost scrubber of the grid type may be constructed by grouping inside a steel shell through which the gas passes a number of grids consisting of thin boards on edge and spaced a short distance apart. The boards of one grid should cross the boards in the grid immediately below or above at a slight angle to induce a spiral flow of gas and the entire interior of the scrubber kept moist by a flow of water counter to the flow of gas.

Moisture traps may be provided to catch any excess moisture in the gas leaving the cleaning equipment, where moisture would be injurious to the product or material being protected or the gas distributing system.

Gas distributing system.

28. Equipment for distributing inert gas to the various machines, inclosures, or points where an explosion and fire hazard exists will consist of a fan, blower pump or compressor near the source of gas supply with the necessary pipings and valves. Fans or blowers may be unnecessary if sufficient suction is provided by the process creating the hazard, but care should be taken in such installations to guard against the dilution of the inert gas due to the entrance of fresh air through leaky joints or fittings.



APPLICATION OF INERT GAS TO A GRINDING SYSTEM.

29. Fans, blowers or compressors shall be of ample capacity to handle the required amount of gas and shall be installed in accordance with the National Fire Protection Association Regulations for the Installation of Blower and Exhaust Systems.[1]

30. The distributing pipes where gas is to be used at more than one point should be installed so that the cross sectional areas of the various branch lines are proportional to the amount of gas they are to carry.

31. Piping should be of ample size to deliver the required amount of gas without unnecessary friction loss. High or low pressure systems may be used.

[1] Obtainable from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

32. Valves which can be sealed after the proper setting is determined shall be installed to control and regulate the flow of gas in all branch lines.

33. Drains shall be provided in the pipe line where necessary for the removal of condensed moisture.

34. Pipe connections to the inclosures to be supplied with inert gas shall be arranged to distribute the gas uniformly, and when high-pressure systems are used provision shall be made to reduce the pressure before it enters any inclosure so that the contents would not be disturbed by the entering stream of high-pressure gas.

35. Where spray nozzles, discharge cones or horns are found necessary to distribute the gas uniformly, they should be designated to particularly apply to the local conditions and shall be made of heat resisting material.

36. Noncorrosive pipe and fittings should be used where no conditioning equipment is used to remove from the gas sulphur or other impurities which would attack ordinary iron piping.

Analyzing, indicating, and recording equipment.

37. Suitable analyzing, indicating or recording equipment shall be provided to indicate the percentage of oxygen present within the inclosure or at the point where the hazard exists, except that where suitable equipment is not available the undiluted inert gas or flue gas with the required CO_2 content shall be used for protection.

38. The instruments may be arranged to draw their samples from as many points within the inclosure as desired, but the point at which the highest oxygen reading is obtained should be the one used in controlling the hazard.

39. Where a process or equipment in which inert gas is used for fire and explosion prevention is not under the direct control of an operator who can observe regularly the instruments indicating the amount of oxygen present, automatic apparatus shall be installed and arranged to signal a dangerous increase in the oxygen percentage.

40. When a dangerous increase in the oxygen percentage occurs the equipment creating the hazard shall be shut down unless the operator is able to promptly reduce the oxygen to the required percentage.

Test for approval.

41. An operating test of the complete installation, including an analytical check, shall be made before final approval. Inspection departments having jurisdiction shall be consulted before such tests are made. No changes shall be made in the rate of production in machines using inert gas protecting systems which would affect the quantities of air passing through without altering the inert gas system to provide for the change and having another approval test made.

Subject Index